

CHAPTER

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6	Sep 15/2021		16	Sep 15/2021	
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38	Sep 15/2021		62	May 15/2023	
39	Sep 15/2021		63	Sep 15/2021	
40	Sep 15/2021		64	Sep 15/2021	
41	Jan 15/2023		65	Sep 15/2021	
42	Sep 15/2021		66	Sep 15/2021	
43	Sep 15/2021		67	Sep 15/2021	
44	Sep 15/2021		68	Sep 15/2021	
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46	Sep 15/2021		70	Sep 15/2021	
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52	Sep 15/2022		76	Sep 15/2021	
53	Sep 15/2022		77	Sep 15/2021	
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57	Sep 15/2021		R 81	Sep 15/2023	
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87	Sep 15/2022		98.13	Sep 15/2022	
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96	Sep 15/2022		98.22	May 15/2023	
97	Sep 15/2022		98.23	May 15/2023	
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98.1	Sep 15/2022		98.25	May 15/2023	
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98.36	Sep 15/2022		10	Sep 15/2021	
98.37	Sep 15/2022		11	Sep 15/2021	
98.38	Sep 15/2022		12	Sep 15/2021	
98.39	May 15/2023		13	Sep 15/2021	
98.40	May 15/2023		14	Sep 15/2021	
98.41	Sep 15/2022		15	Sep 15/2021	
98.42	Sep 15/2022		16	Sep 15/2021	
98.43	May 15/2023		17	Sep 15/2021	
98.44	May 15/2023		18	Sep 15/2021	
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2	Sep 15/2021		34-31-00		
R 3	Sep 15/2023		1	Sep 15/2021	
4	BLANK		2	Sep 15/2021	
34-24-00			3	Sep 15/2021	
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2	Sep 15/2021		5	Sep 15/2021	
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5	Sep 15/2021		8	Sep 15/2021	
6	Sep 15/2021		9	Sep 15/2021	
7	Sep 15/2021		10	Sep 15/2021	
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14	Sep 15/2021		37	Sep 15/2021	
15	Sep 15/2021		38	Sep 15/2021	
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17	Sep 15/2021		40	Sep 15/2021	
18	Sep 15/2021		41	Sep 15/2021	
19	Sep 15/2021		42	Sep 15/2021	
20	Sep 15/2021		43	Sep 15/2021	
21	Sep 15/2021		44	Sep 15/2021	
22	Sep 15/2021		45	Sep 15/2021	
23	Sep 15/2021		46	Sep 15/2021	
24	Sep 15/2021		47	Sep 15/2021	
25	Sep 15/2021		48	Sep 15/2021	
26	Sep 15/2021		49	Sep 15/2021	
27	Sep 15/2021		50	Sep 15/2021	
28	Sep 15/2021		51	Sep 15/2021	
29	Sep 15/2021		52	Sep 15/2021	
30	Sep 15/2021		53	Sep 15/2021	
31	Sep 15/2021		54	Sep 15/2021	
32	Sep 15/2021		55	Sep 15/2021	
33	Sep 15/2021		56	Sep 15/2021	
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60	Sep 15/2021		17	Sep 15/2021	
61	Sep 15/2021		18	Sep 15/2021	
62	Sep 15/2021		19	Sep 15/2021	
63	Sep 15/2021		20	Sep 15/2021	
64	Sep 15/2021		21	Sep 15/2021	
65	Sep 15/2021		22	Sep 15/2021	
66	Sep 15/2021		23	Sep 15/2021	
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6	Sep 15/2021		30	Sep 15/2021	
7	Sep 15/2021		31	Sep 15/2021	
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13	Sep 15/2021		34-33-00		
14	Sep 15/2021		1	Sep 15/2021	
15	Sep 15/2021		2	Sep 15/2021	

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5	Sep 15/2021		29	Sep 15/2021	
6	Sep 15/2021		30	Sep 15/2021	
7	Sep 15/2021		31	Sep 15/2021	
8	Sep 15/2021		32	Sep 15/2021	
9	Sep 15/2021		33	Sep 15/2021	
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11	Sep 15/2021		34-41-00		
12	Sep 15/2021		1	Sep 15/2021	
13	Sep 15/2021		2	Sep 15/2021	
R 14	Sep 15/2023		3	Sep 15/2021	
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17	Sep 15/2021		6	Sep 15/2021	
18	Sep 15/2021		7	Jan 15/2023	
19	Sep 15/2021		8	Sep 15/2021	
20	Sep 15/2021		9	Sep 15/2021	
21	Sep 15/2021		10	Sep 15/2021	
22	Sep 15/2021		11	Sep 15/2021	
23	Sep 15/2021		12	Sep 15/2021	
24	May 15/2023		13	Sep 15/2021	
25	Sep 15/2021		14	Sep 15/2021	
26	Sep 15/2021		15	Sep 15/2021	

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18	May 15/2022		41	Sep 15/2021	
19	Sep 15/2021		42	Sep 15/2021	
20	Sep 15/2021		43	Sep 15/2021	
21	Sep 15/2021		R 44	Sep 15/2023	
22	Sep 15/2021		45	Sep 15/2021	
23	Sep 15/2021		46	Sep 15/2021	
24	Sep 15/2021		47	Sep 15/2021	
25	Sep 15/2021		48	Sep 15/2021	
26	Sep 15/2021		49	Sep 15/2021	
27	Sep 15/2021		50	Sep 15/2021	
28	Sep 15/2021		51	Sep 15/2021	
29	Sep 15/2021		52	Sep 15/2021	
30	Sep 15/2021		53	Sep 15/2021	
31	Sep 15/2021		54	Sep 15/2021	
32	Sep 15/2021		55	May 15/2022	
33	Sep 15/2021		56	Sep 15/2021	
34	Sep 15/2021		57	Sep 15/2021	
35	Sep 15/2021		58	Sep 15/2021	
36	Sep 15/2021		59	Sep 15/2021	
37	Sep 15/2021		60	Sep 15/2021	
38	Sep 15/2021		61	Sep 15/2021	
			62	BLANK	

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3	Sep 15/2021		28	Sep 15/2021	
4	Sep 15/2021		29	Sep 15/2021	
5	Sep 15/2021		30	Sep 15/2021	
6	Sep 15/2021		31	Sep 15/2021	
7	Sep 15/2021		32	Sep 15/2021	
8	Sep 15/2021		33	Sep 15/2021	
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15	Sep 15/2021		40	Sep 15/2021	
16	Sep 15/2021		41	Sep 15/2021	
17	Sep 15/2021		42	Sep 15/2021	
18	Sep 15/2021		43	Sep 15/2021	
19	Sep 15/2021		44	Sep 15/2021	
20	Sep 15/2021		45	Sep 15/2021	
21	Sep 15/2021		46	Sep 15/2021	
22	Sep 15/2021		47	Sep 15/2021	
23	Sep 15/2021		48	BLANK	
24	Sep 15/2021				
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5	Jan 15/2023		30	Jan 15/2023	
6	Jan 15/2023		31	Jan 15/2023	
7	Jan 15/2023		32	Jan 15/2023	
8	Jan 15/2023		33	Jan 15/2023	
9	Jan 15/2023		34	Jan 15/2023	
10	Jan 15/2023		35	Jan 15/2023	
11	Jan 15/2023		36	Jan 15/2023	
12	Jan 15/2023		37	Jan 15/2023	
13	Jan 15/2023		38	Jan 15/2023	
14	Jan 15/2023		39	Jan 15/2023	
15	Jan 15/2023		40	Jan 15/2023	
16	Jan 15/2023		41	Jan 15/2023	
17	Jan 15/2023		42	Jan 15/2023	
18	Jan 15/2023		43	Jan 15/2023	
19	Jan 15/2023		44	Jan 15/2023	
20	Jan 15/2023		45	Jan 15/2023	
21	Jan 15/2023		46	Jan 15/2023	
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50	Jan 15/2023		74	Jan 15/2023	
51	Jan 15/2023		75	Jan 15/2023	
52	Jan 15/2023		76	Jan 15/2023	
53	Jan 15/2023		77	Jan 15/2023	
54	Jan 15/2023		78	Jan 15/2023	
55	Jan 15/2023		79	Jan 15/2023	
56	Jan 15/2023		80	Jan 15/2023	
57	Jan 15/2023		81	Jan 15/2023	
58	Jan 15/2023		82	Jan 15/2023	
59	Jan 15/2023		83	Jan 15/2023	
60	Jan 15/2023		84	Jan 15/2023	
61	Jan 15/2023		85	Jan 15/2023	
62	Jan 15/2023		86	Jan 15/2023	
63	Jan 15/2023		87	Jan 15/2023	
64	Jan 15/2023		88	Jan 15/2023	
65	Jan 15/2023		89	Jan 15/2023	
66	Jan 15/2023		90	Jan 15/2023	
67	Jan 15/2023		91	Jan 15/2023	
68	Jan 15/2023		92	Jan 15/2023	
69	Jan 15/2023		93	Jan 15/2023	
70	Jan 15/2023		94	Jan 15/2023	
71	Jan 15/2023		95	Jan 15/2023	
72	Jan 15/2023		96	Jan 15/2023	

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98	Jan 15/2023		20	Sep 15/2021	
98.1	Jan 15/2023		21	Sep 15/2021	
98.2	Jan 15/2023		22	Sep 15/2021	
34-51-00			23	Sep 15/2021	
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3	Sep 15/2021		26	Sep 15/2021	
4	Sep 15/2021		27	Sep 15/2021	
5	Sep 15/2021		28	Sep 15/2021	
6	Sep 15/2021		29	Sep 15/2021	
7	Sep 15/2021		30	Sep 15/2021	
8	Sep 15/2021		31	Sep 15/2021	
9	Sep 15/2021		32	Sep 15/2021	
10	Sep 15/2021		33	Sep 15/2021	
11	Sep 15/2021		34	Sep 15/2021	
12	Sep 15/2021		35	Sep 15/2021	
13	Sep 15/2021		36	Sep 15/2021	
14	Sep 15/2021		37	Sep 15/2021	
15	Sep 15/2021		38	Sep 15/2021	
16	Sep 15/2021		39	Sep 15/2021	
17	Sep 15/2021		40	Sep 15/2021	
18	Sep 15/2021		41	Sep 15/2021	
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44	Sep 15/2021		14	Sep 15/2021	
45	Sep 15/2021		15	Sep 15/2021	
46	Sep 15/2021		16	Sep 15/2021	
47	Sep 15/2021		17	Sep 15/2021	
48	Sep 15/2021		18	Sep 15/2021	
49	Sep 15/2021		19	Sep 15/2021	
50	Sep 15/2021		20	Sep 15/2021	
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10	Sep 15/2021		33	Sep 15/2021	
11	Sep 15/2021		34	Sep 15/2021	
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38	Sep 15/2021		16	Sep 15/2021	
39	Sep 15/2021		17	Sep 15/2021	
40	Sep 15/2021		18	Sep 15/2021	
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4	Sep 15/2021		27	Sep 15/2021	
5	Sep 15/2021		28	Sep 15/2021	
6	Sep 15/2021		29	Sep 15/2021	
7	Sep 15/2021		30	Sep 15/2021	
8	Sep 15/2021		31	Sep 15/2021	
9	Sep 15/2021		32	BLANK	
10	Sep 15/2021		34-57-00		
11	Sep 15/2021		1	Sep 15/2021	
12	Sep 15/2021		2	Sep 15/2021	
13	Sep 15/2021		3	Sep 15/2021	
14	Sep 15/2021		4	Sep 15/2021	

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34-57-00 (cont.)			34-57-00 (cont.)		
5	Sep 15/2021		29	Sep 15/2021	
6	Sep 15/2021		30	Sep 15/2021	
7	Sep 15/2021		31	Sep 15/2021	
8	Sep 15/2021		32	BLANK	
9	Sep 15/2021		34-58-00		
10	Sep 15/2021		1	Sep 15/2021	
11	Sep 15/2021		2	May 15/2022	
12	Sep 15/2021		3	Sep 15/2021	
13	Sep 15/2021		4	Sep 15/2021	
14	Sep 15/2021		5	Sep 15/2021	
15	Sep 15/2021		6	Sep 15/2021	
16	Sep 15/2021		7	Sep 15/2021	
17	Sep 15/2021		8	May 15/2022	
18	Sep 15/2021		9	May 15/2022	
19	Sep 15/2021		10	Sep 15/2021	
20	Sep 15/2021		11	Sep 15/2021	
21	Sep 15/2021		12	Sep 15/2021	
22	Sep 15/2021		13	Sep 15/2021	
23	Sep 15/2021		14	Sep 15/2021	
24	Sep 15/2021		15	Sep 15/2021	
25	Sep 15/2021		16	Sep 15/2021	
26	Sep 15/2021		17	Sep 15/2021	
27	Sep 15/2021		18	Sep 15/2021	
28	Sep 15/2021				

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19	Sep 15/2021		43	Sep 15/2021	
20	Sep 15/2021		44	Sep 15/2021	
21	Sep 15/2021		45	Sep 15/2021	
22	Sep 15/2021		46	Sep 15/2021	
23	Sep 15/2021		34-61-00		
24	Sep 15/2021		1	Sep 15/2021	
25	Sep 15/2021		2	May 15/2022	
26	Sep 15/2021		3	Sep 15/2021	
27	Sep 15/2021		4	May 15/2022	
28	Sep 15/2021		5	May 15/2022	
29	Sep 15/2021		6	May 15/2022	
30	Sep 15/2021		7	Sep 15/2021	
31	Sep 15/2021		8	Sep 15/2021	
32	Sep 15/2021		9	Sep 15/2021	
33	Sep 15/2021		R 10	Sep 15/2023	
34	Sep 15/2021		11	Jan 15/2022	
35	Sep 15/2021		12	Sep 15/2021	
36	Sep 15/2021		13	Sep 15/2021	
37	Sep 15/2021		14	Sep 15/2021	
38	Sep 15/2021		15	Sep 15/2021	
39	Sep 15/2021		16	Sep 15/2021	
40	Sep 15/2021		17	Sep 15/2021	
41	Sep 15/2021		18	Sep 15/2021	
42	May 15/2022				

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19	Sep 15/2021		43	Sep 15/2021	
20	Sep 15/2021		44	Sep 15/2021	
21	Sep 15/2021		45	Sep 15/2021	
22	Sep 15/2021		46	Sep 15/2021	
23	Sep 15/2021		47	May 15/2022	
24	Sep 15/2021		48	Sep 15/2021	
25	Sep 15/2021		49	May 15/2022	
26	Sep 15/2021		50	Sep 15/2021	
27	Sep 15/2021		51	Sep 15/2021	
28	Sep 15/2021		52	Sep 15/2021	
29	Sep 15/2021		53	Sep 15/2021	
30	Sep 15/2021		54	Sep 15/2021	
31	Sep 15/2021		55	Sep 15/2021	
32	Sep 15/2021		56	May 15/2022	
33	Sep 15/2021		57	Sep 15/2021	
34	Sep 15/2021		58	Sep 15/2021	
35	Sep 15/2021		59	May 15/2022	
36	Sep 15/2021		60	Sep 15/2021	
37	Sep 15/2021		61	Sep 15/2021	
38	Sep 15/2021		62	Sep 15/2021	
39	Sep 15/2021		63	Sep 15/2021	
40	Sep 15/2021		64	Sep 15/2021	
41	Sep 15/2021		65	Sep 15/2021	
42	May 15/2022		66	Sep 15/2021	

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67	Sep 15/2021		91	Sep 15/2021	
68	Sep 15/2021		92	Sep 15/2021	
69	Sep 15/2021		93	May 15/2022	
70	May 15/2022		94	May 15/2022	
71	May 15/2022		95	Sep 15/2021	
72	Sep 15/2022		96	Sep 15/2021	
73	Sep 15/2021		97	Sep 15/2021	
74	Sep 15/2021		98	May 15/2022	
75	Sep 15/2021		98.1	Sep 15/2021	
76	Sep 15/2021		98.2	May 15/2022	
77	May 15/2022		98.3	Sep 15/2021	
78	Sep 15/2021		98.4	May 15/2022	
79	Sep 15/2021		98.5	Sep 15/2021	
80	Sep 15/2021		98.6	May 15/2022	
81	Sep 15/2021		98.7	Sep 15/2021	
82	May 15/2022		98.8	Sep 15/2021	
83	Sep 15/2021		98.9	Sep 15/2021	
84	May 15/2022		98.10	Sep 15/2021	
85	May 15/2022		98.11	Sep 15/2021	
86	May 15/2022		98.12	Sep 15/2021	
87	Sep 15/2021		98.13	Sep 15/2021	
88	May 15/2022		98.14	Sep 15/2021	
89	May 15/2022		98.15	May 15/2022	
90	May 15/2022		98.16	Sep 15/2021	

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98.17	Sep 15/2021		R 98.41	Sep 15/2023	
98.18	Sep 15/2021		98.42	Sep 15/2021	
98.19	Sep 15/2021		98.43	Sep 15/2021	
98.20	May 15/2022		98.44	Sep 15/2021	
98.21	Sep 15/2021		98.45	Sep 15/2021	
98.22	Sep 15/2021		98.46	Sep 15/2021	
98.23	Sep 15/2021		98.47	Sep 15/2021	
98.24	Sep 15/2021		98.48	Sep 15/2021	
98.25	Sep 15/2021		98.49	Sep 15/2021	
98.26	Sep 15/2021		98.50	Sep 15/2021	
98.27	Sep 15/2021		98.51	Sep 15/2021	
98.28	Sep 15/2021		98.52	May 15/2022	
98.29	Sep 15/2021		98.53	Sep 15/2021	
98.30	Sep 15/2021		98.54	May 15/2022	
98.31	Sep 15/2021		98.55	Sep 15/2021	
98.32	Sep 15/2021		98.56	May 15/2022	
98.33	Sep 15/2021		98.57	Sep 15/2021	
98.34	Sep 15/2021		98.58	Jan 15/2023	
98.35	Sep 15/2021		98.59	Jan 15/2023	
98.36	Sep 15/2021		98.60	Jan 15/2023	
98.37	Sep 15/2021		98.61	Jan 15/2023	
98.38	Sep 15/2021		98.62	Jan 15/2023	
98.39	May 15/2022		98.63	Jan 15/2023	
98.40	Sep 15/2021		98.64	Jan 15/2023	

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98.65	Jan 15/2023				
98.66	Jan 15/2023				
98.67	Sep 15/2021				
98.68	Sep 15/2021				
98.69	Sep 15/2021				
98.70	Sep 15/2021				
98.71	Sep 15/2021				
98.72	Sep 15/2021				
98.73	Sep 15/2021				
98.74	Sep 15/2021				
98.75	Sep 15/2021				
98.76	Sep 15/2021				
98.77	Sep 15/2021				
98.78	Sep 15/2021				
98.79	Sep 15/2021				
98.80	Sep 15/2021				
98.81	Sep 15/2021				
98.82	May 15/2022				
98.83	Sep 15/2021				
98.84	May 15/2022				
98.85	Sep 15/2021				
98.86	Sep 15/2021				
98.87	Sep 15/2021				
98.88	Sep 15/2021				

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34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - GENERAL DESCRIPTION	4	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD EQUIPMENT COMPARTMENT	6	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT	8	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD CARGO COMPARTMENT	10	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - EXTERNAL	12	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - INTERFACE AND FUNCTIONAL DESCRIPTION	14	SIA ALL
34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - PITOT PROBE	16	SIA ALL
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34-11-00	STATIC AND TOTAL AIR PRESSURE SYSTEM - DRAIN FITTING	20	SIA ALL
34-16-00	OVERSPEED WARNING - INTRODUCTION	2	SIA ALL
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34-16-00	OVERSPEED WARNING - COMPONENT LOCATION	6	SIA ALL
34-16-00	OVERSPEED WARNING - INTERFACE	8	SIA ALL
34-16-00	OVERSPEED WARNING - MACH AIRSPEED WARNING TEST SWITCH	10	SIA ALL
34-21-00	AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION	1	SIA ALL
34-21-00	ADIRS - GENERAL DESCRIPTION	4	SIA ALL

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34-21-00	ADIRS - COMPONENT LOCATION - IRS MASTER CAUTION UNIT	8	SIA ALL
34-21-00	ADIRS - COMPONENT LOCATION - EE COMPARTMENT	10	SIA ALL
34-21-00	ADIRS - COMPONENT LOCATION - PITOT AIR DATA MODULES	12	SIA ALL
34-21-00	ADIRS - COMPONENT LOCATION - STATIC AIR DATA MODULES	14	SIA ALL
34-21-00	ADIRS - COMPONENT LOCATION - AOA SENSORS AND TAT PROBE	16	SIA ALL
34-21-00	ADIRS - POWER	18	SIA ALL
34-21-00	ADIRS - DC POWER OPERATION	20	SIA ALL
34-21-00	ADIRS - NO COOLING AND ON DC WARNING	22	SIA ALL
34-21-00	ADIRS - CONTROL AND WARNING	24	SIA ALL
34-21-00	ADIRS - SYSTEM INPUTS	27	SIA ALL
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34-21-00	ADIRS - LEFT AIR DATA OUTPUTS	43	SIA ALL
34-21-00	ADIRS - RIGHT AIR DATA OUTPUTS	47	SIA ALL
34-21-00	ADIRS - IR SIGNAL SWITCHING	50	SIA ALL
34-21-00	ADIRS - AIR DATA INERTIAL REFERENCE UNIT	52	SIA ALL
34-21-00	ADIRS - INERTIAL SYSTEM DISPLAY UNIT	54	SIA ALL
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34-21-00	ADIRS - IRS MASTER CAUTION UNIT	58	SIA ALL

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34-21-00	ADIRS - ANGLE OF ATTACK SENSOR	62	SIA ALL
34-21-00	ADIRS - TOTAL AIR TEMPERATURE PROBE	64	SIA ALL
34-21-00	ADIRS - ALTERNATE VMO/MMO SWITCH	66	SIA ALL
34-21-00	ADIRS - IR GENERAL THEORY 1	68	SIA ALL
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34-21-00	ADIRS - IR GENERAL THEORY 3	72	SIA ALL
34-21-00	ADIRS - IR GENERAL THEORY 4	74	SIA ALL
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34-21-00	ADIRS - IR GENERAL THEORY 6	78	SIA 005-999; SIA 001-004 POST SB 737-34-3141
34-21-00	ADIRS - ADIRU FUNCTIONAL DESCRIPTION	81	SIA ALL
34-21-00	ADIRS - PFD AND ND INDICATIONS DURING ALIGNMENT	84	SIA ALL
34-21-00	ADIRS - PFD AND ND INDICATIONS AFTER ALIGNMENT	86	SIA ALL
34-21-00	ADIRS - PFD AND ND INVALID ADIRS DATA	90	SIA ALL
34-21-00	ADIRS - BAROMETRIC CORRECTION INDICATION	92	SIA ALL
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34-21-00	ADIRS - SCRATCHPAD PRESENT POSITION ENTRY	98.8	SIA ALL
34-21-00	ADIRS - GPS PRESENT POSITION ENTRY	98.10	SIA ALL
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34-21-00	ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 2	98.22	SIA ALL
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34-21-00	ADIRS - ADIRS MAINTENANCE CODES	98.36	SIA ALL
34-21-00	ADIRS - SYSTEM SUMMARY 1	98.38	SIA ALL
34-21-00	ADIRS - SYSTEM SUMMARY 2	98.42	SIA ALL
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34-24-00	STANDBY ATTITUDE REFERENCE SYSTEM - INTERFACE	8	SIA ALL
34-24-00	STANDBY ATTITUDE REFERENCE SYSTEM - INTEGRATED STANDBY FLIGHT DISPLAY	11	SIA ALL
34-24-00	STANDBY ATTITUDE REFERENCE SYSTEM - ISFD DEDICATED BATTERY/CHARGER	14	SIA ALL
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34-31-00	ILS - SYSTEM SUMMARY	64	SIA ALL
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34-33-00	RA SYSTEM - DATA BUS OUTPUTS, DECISION HEIGHT INTERFACE	12	SIA ALL
34-33-00	RA SYSTEM - RA RECEIVER/TRANSMITTER	14	SIA ALL
34-33-00	RA SYSTEM - RA ANTENNA	16	SIA ALL
34-33-00	RA SYSTEM - OPERATION - 1	19	SIA ALL
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34-58-00	GPS - ANTENNA LOCATIONS	14	SIA ALL
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**STATIC AND TOTAL AIR PRESSURE SYSTEM - INTRODUCTION****General**

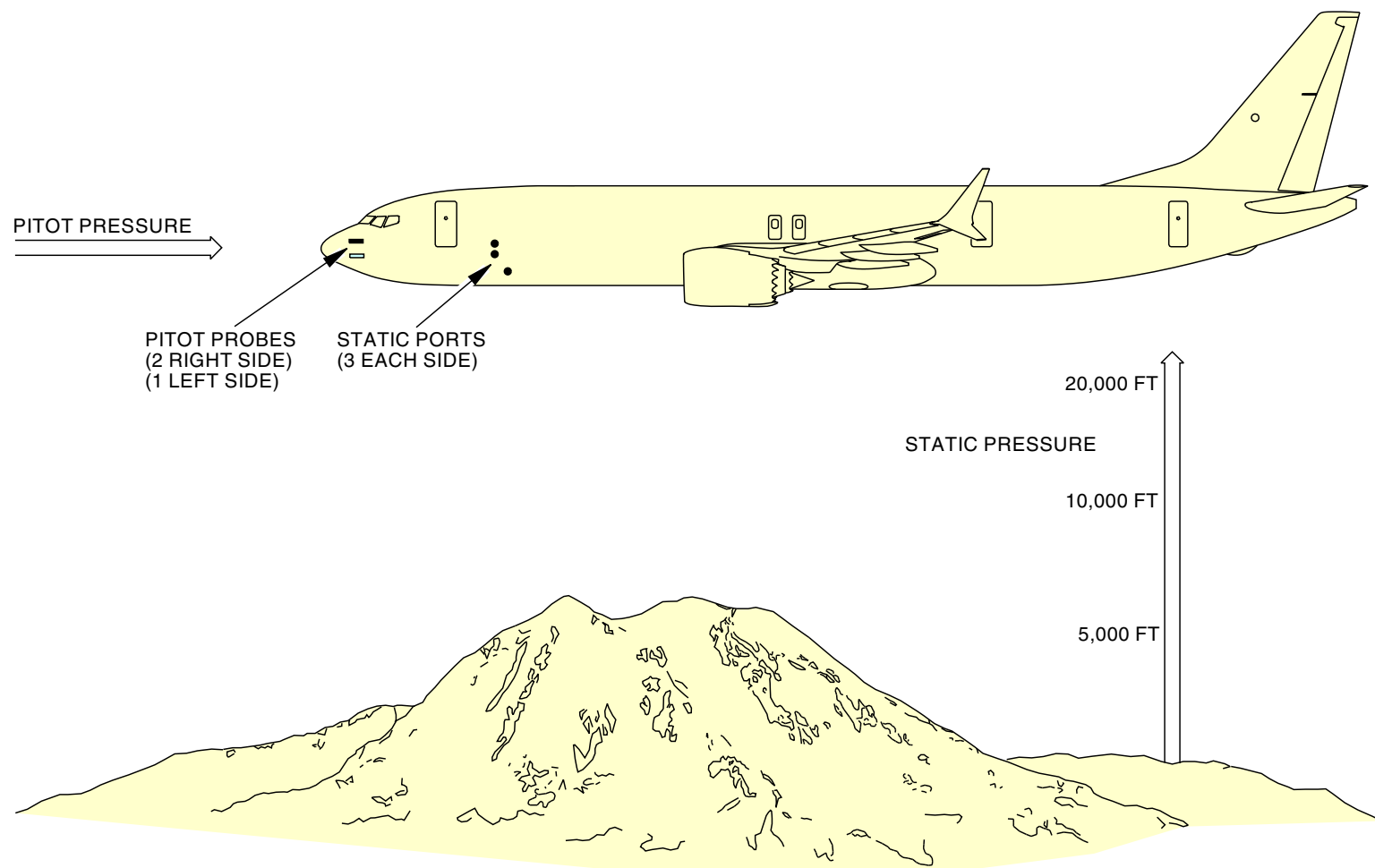
The purpose of the static and total air pressure system is to measure pitot and static air pressure. These pressures are used to calculate flight parameters such as airspeed and altitude.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- ADM - air data module
- altn - alternate
- ARINC - Aeronautical Radio Incorporated
- aux - auxiliary
- capt - captain
- diff - differential
- ft - feet
- F/O - first officer
- fwd - forward
- IND - indicator
- ISFD - Integrated Standby Flight Display
- L - left
- press - pressure
- R - right
- stdby - standby

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STATIC AND TOTAL AIR PRESSURE SYSTEM - INTRODUCTION



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STATIC AND TOTAL AIR PRESSURE SYSTEM - INTRODUCTION

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STATIC AND TOTAL AIR PRESSURE SYSTEM - GENERAL DESCRIPTION

General

The static and total air pressure system gets air pressure inputs from three pitot probes and six static ports on the airplane fuselage.

These are the two types of air pressure:

- Static air pressure is the ambient air pressure around the airplane
- Pitot air pressure is the air pressure on the pitot probe tube as a result of the forward motion of the airplane.

The static and total air pressure system has these components:

- Three pitot probes
- Six static ports
- Five drain fittings.

Flexible and hard pneumatic tubing are used to connect the pitot-static components.

The system drains are used to remove condensation in the pitot-static lines.

Primary Static and Total Air Pressure System

The two primary pitot probes connect to two pitot air data modules (ADMs). Two pairs of the primary static ports connect to two static ADMs.

The ADMs change the air pressures to electrical signals and send them to the air data inertial reference units (ADIRUs) on ARINC 429 data buses. The ADIRUs use the signals to calculate flight parameters such as airspeed and altitude.

Each primary pitot line and each primary static line has a drain fitting.

Alternate Static and Total Air Pressure System

The auxiliary pitot probe and the alternate static ports connect to the integrated standby flight display (ISFD). The alternate static ports also connect to the cabin differential pressure indicator.

The standby static line has a drain fitting.

The Auxiliary Pitot line does not have a drain fitting because the probe is the lowest point in the line.

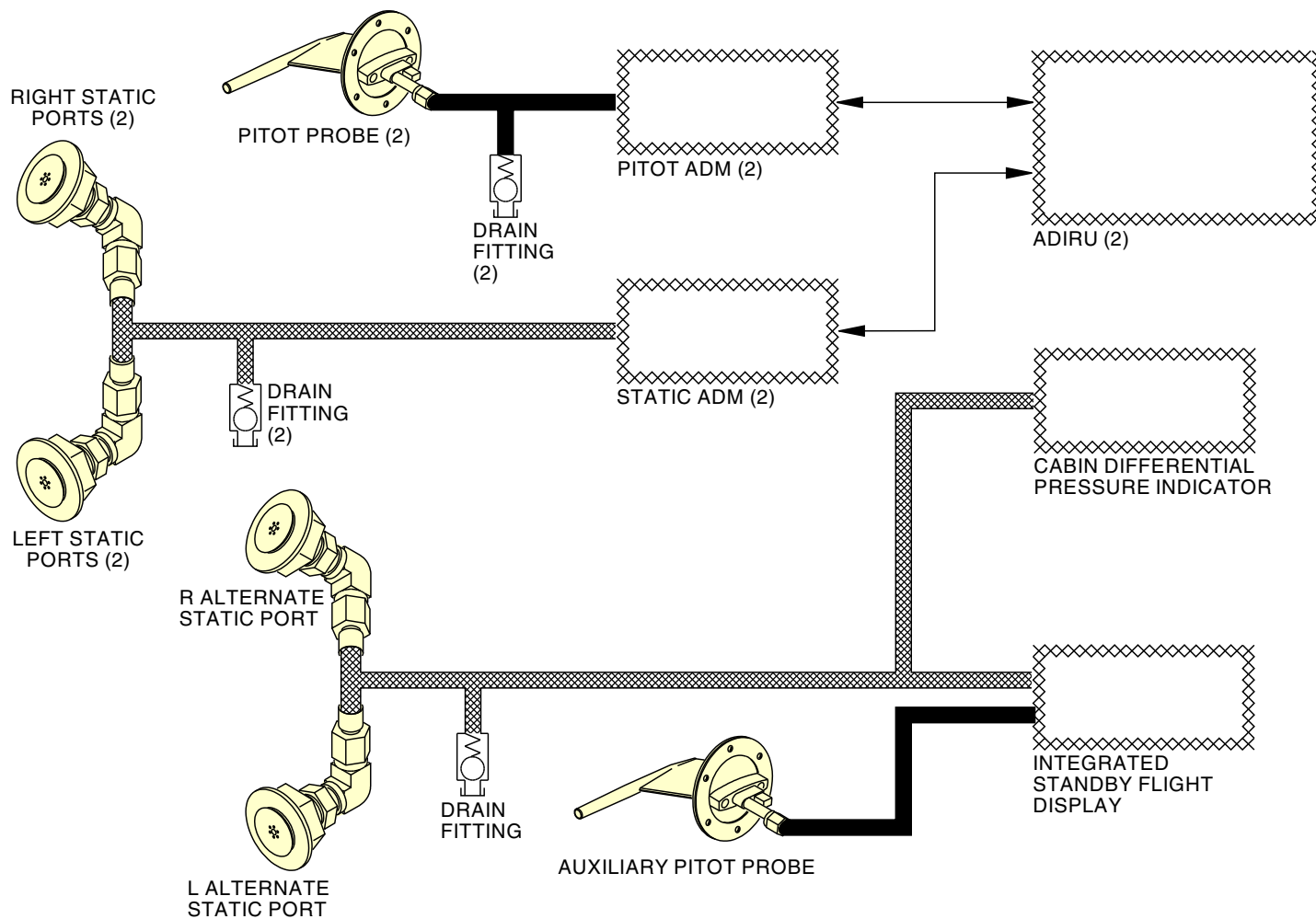
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STATIC AND TOTAL AIR PRESSURE SYSTEM - GENERAL DESCRIPTION



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STATIC AND TOTAL AIR PRESSURE SYSTEM - GENERAL DESCRIPTION

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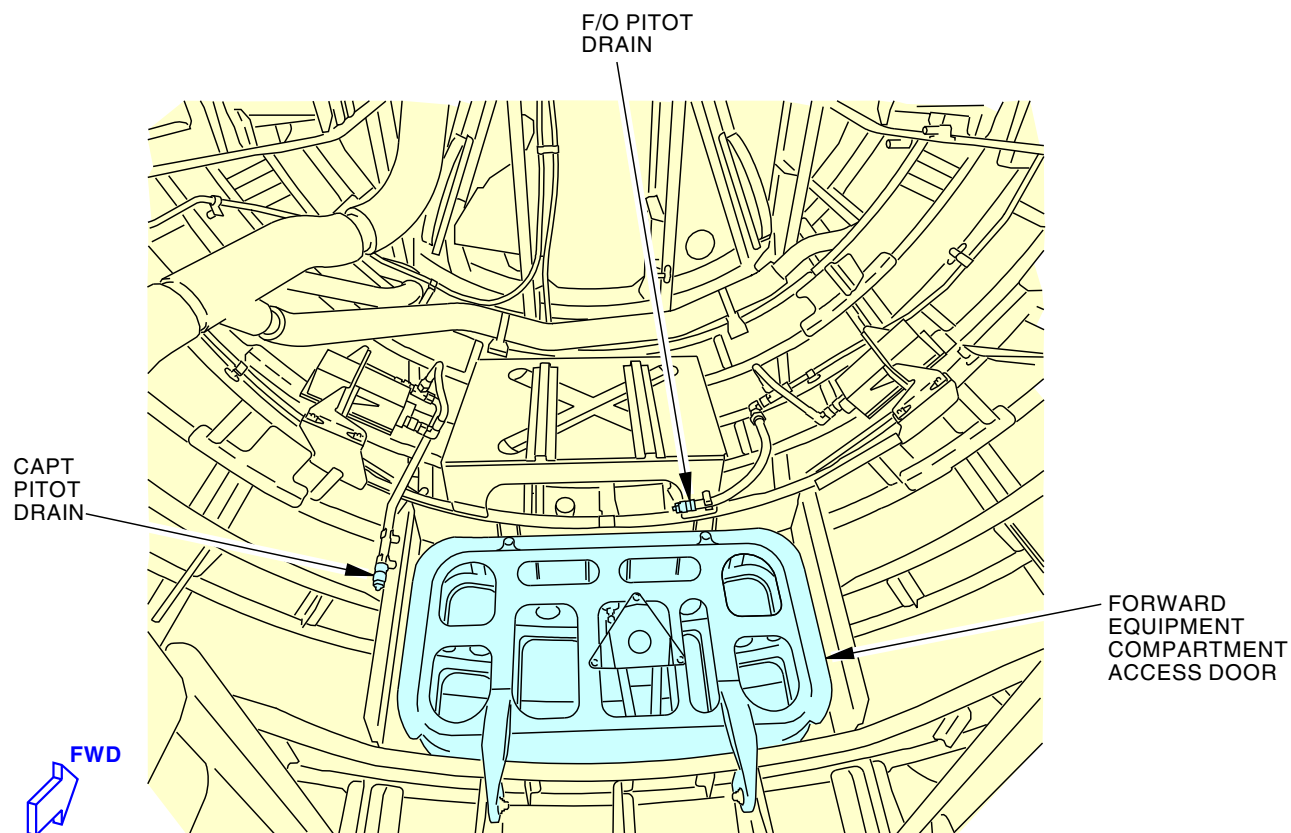
STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD EQUIPMENT COMPARTMENT

Primary Pitot Drain Fittings

The drain fittings for the captain and first officer pitot lines are in the forward equipment compartment adjacent to the compartment access door.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD EQUIPMENT COMPARTMENT



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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD EQUIPMENT COMPARTMENT

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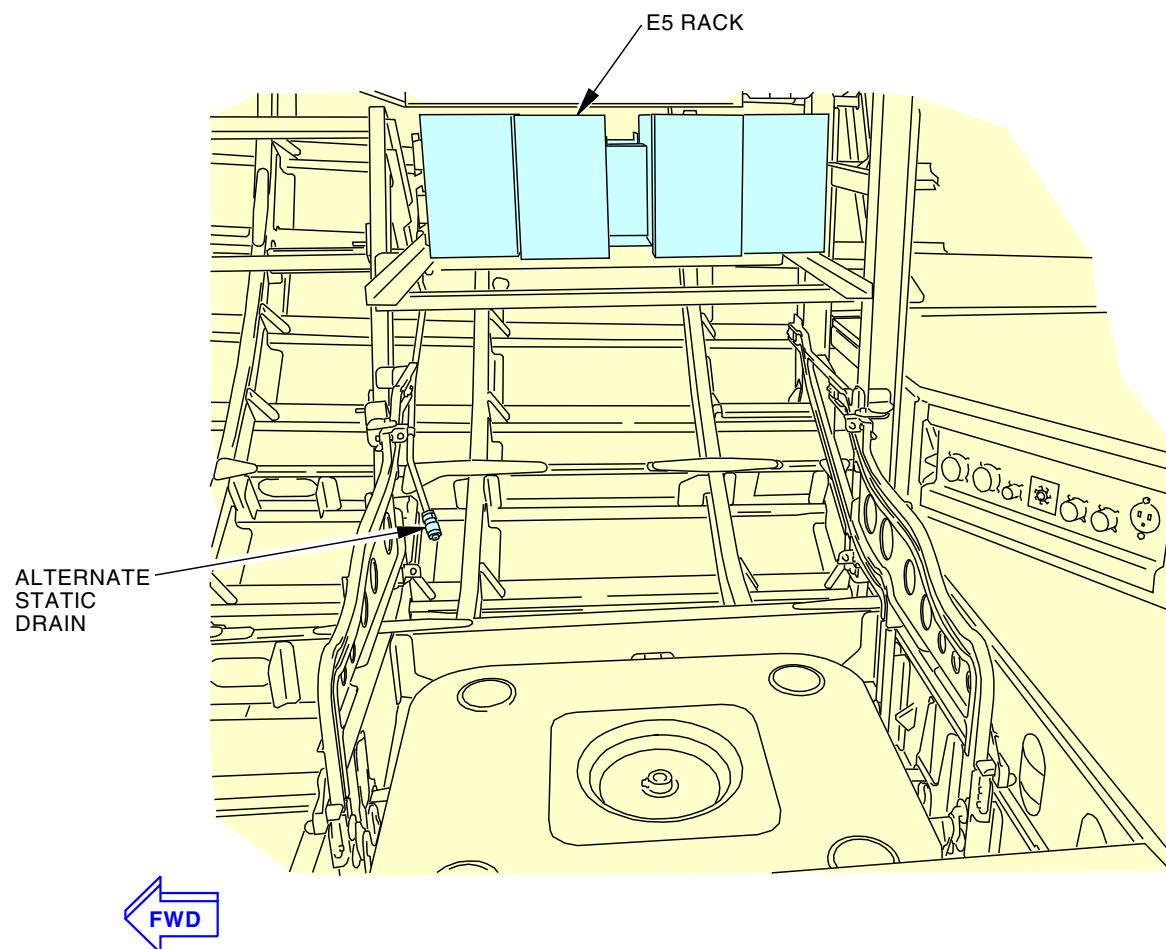
STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT

Alternate Static Drain Fitting

The drain fitting in the alternate static line is in the electronic equipment compartment below the E-5 rack.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT



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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT

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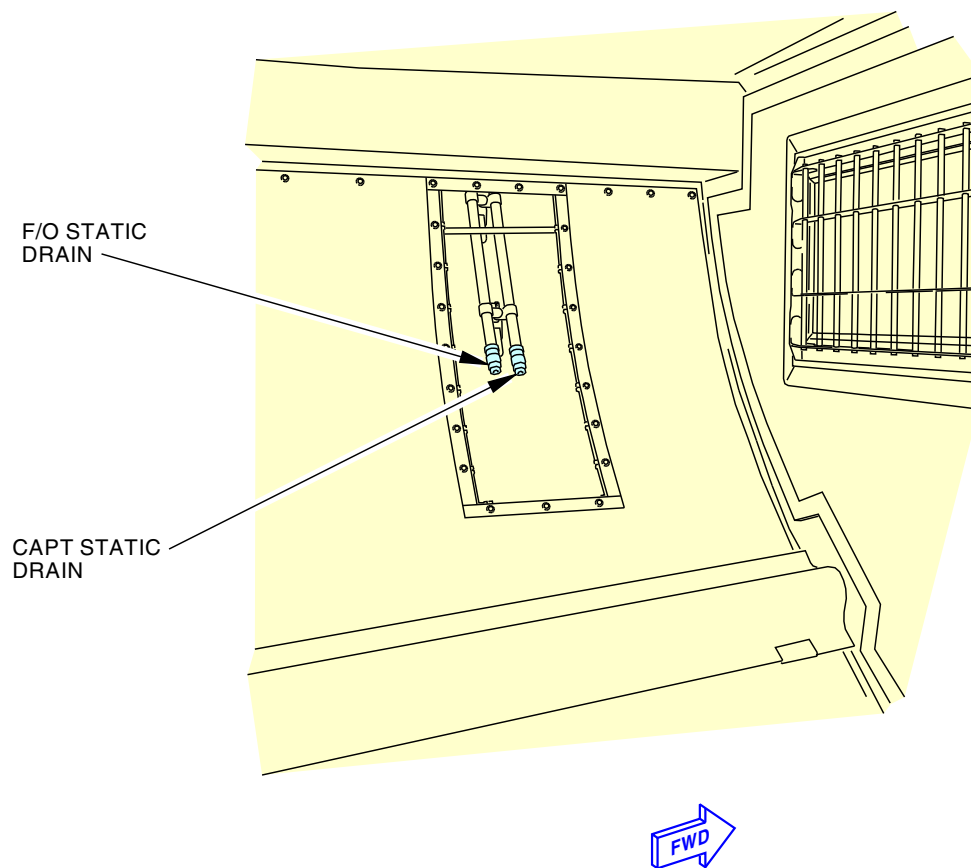
STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD CARGO COMPARTMENT

Primary Static Drain Fittings

The drain fittings in the captain and first officer static lines are in the forward cargo compartment along the left side of the airplane. You must remove an access panel to get to the drain fittings.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD CARGO COMPARTMENT



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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - FORWARD CARGO COMPARTMENT

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**STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - EXTERNAL****Pitot Probe Location**

The airplane has three pitot probes. The captain pitot probe is on the left side of the airplane. The first officer and the auxiliary pitot probes are on the right side of the airplane.

Static Port Location

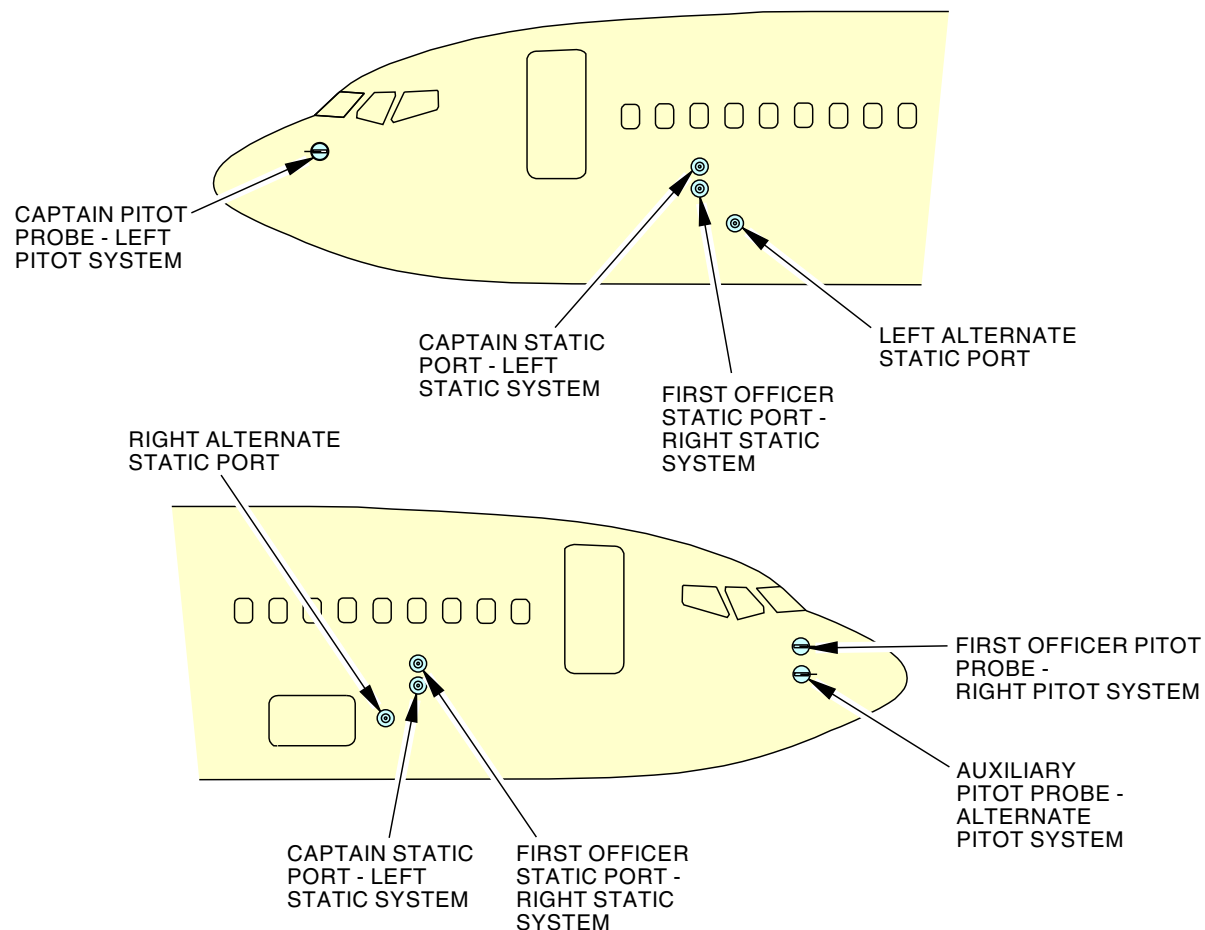
The airplane has six static ports. There is a captain, first officer, and an alternate static port on each side of the airplane.

Alternate Static Ports Location

The airplane has two alternate static ports. There is one port on each side of the airplane.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - EXTERNAL



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STATIC AND TOTAL AIR PRESSURE SYSTEM - COMPONENT LOCATION - EXTERNAL

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**STATIC AND TOTAL AIR PRESSURE SYSTEM - INTERFACE AND FUNCTIONAL DESCRIPTION****ARINC 429 Data**

These items send air pressure through pneumatic lines to the ADMs:

- Captain pitot probe
- First officer pitot probe
- Captain static ports
- First officer static ports.

The length of the pressure lines and the number of connectors are a minimum.

The left and right static ports are connected together. This gives an average ambient air pressure to the ADMs.

Pressure Lines

The pressure lines from the auxiliary pitot probe and the alternate static ports go to the standby altimeter/airspeed indicator. The pressure lines from the alternate static ports also go to the cabin differential pressure indicator.

The alternate static ports are connected together to give average ambient pressure.

Drain Fittings

Each static line has a drain fitting. The captain and first officer pitot lines also have drain fittings.

The auxiliary pitot line does not have a drain fitting. The probe is at the lowest part of the line so moisture can drain from the probe.

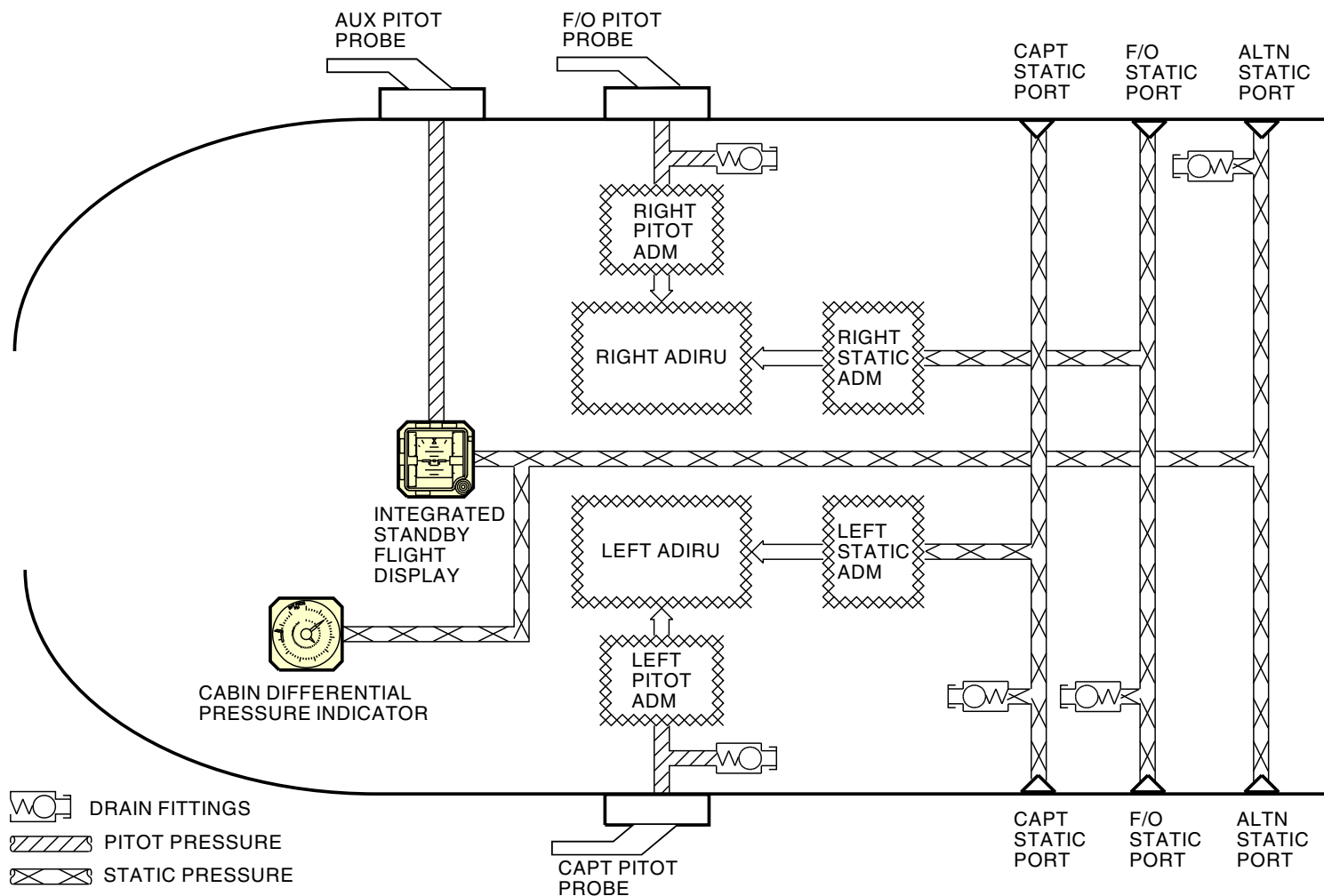
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STATIC AND TOTAL AIR PRESSURE SYSTEM - INTERFACE AND FUNCTIONAL DESCRIPTION



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STATIC AND TOTAL AIR PRESSURE SYSTEM - INTERFACE AND FUNCTIONAL DESCRIPTION

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**STATIC AND TOTAL AIR PRESSURE SYSTEM - PITOT PROBE****General**

The pitot probe measures pitot air pressure.

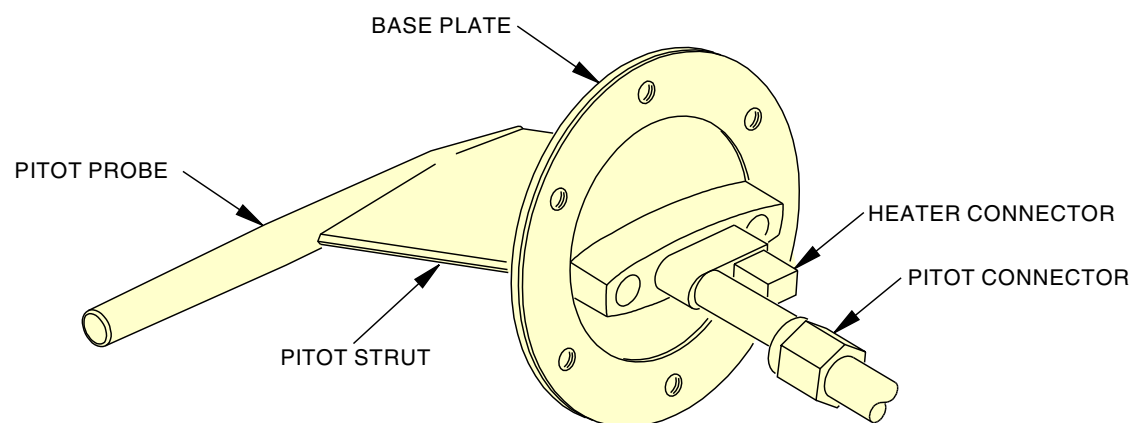
Physical Description

The pitot probe port points forward to measure pitot pressure. A strut moves the probe several inches from the airplane skin to decrease airflow turbulence effects. A base plate contains the electrical and pressure connectors. A gasket is between the probe base and the airplane structure to form a pressure seal.

An anti-icing heater is in the probe to prevent ice. The heater is attached to the electrical connector in the base plate.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - PITOT PROBE



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STATIC AND TOTAL AIR PRESSURE SYSTEM - PITOT PROBE

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STATIC AND TOTAL AIR PRESSURE SYSTEM - STATIC PORT

General

The static ports measure static (ambient) air pressure.

Physical Description

The static ports are flush-mounted on the fuselage skin. There is a circle around the port with a caution note.

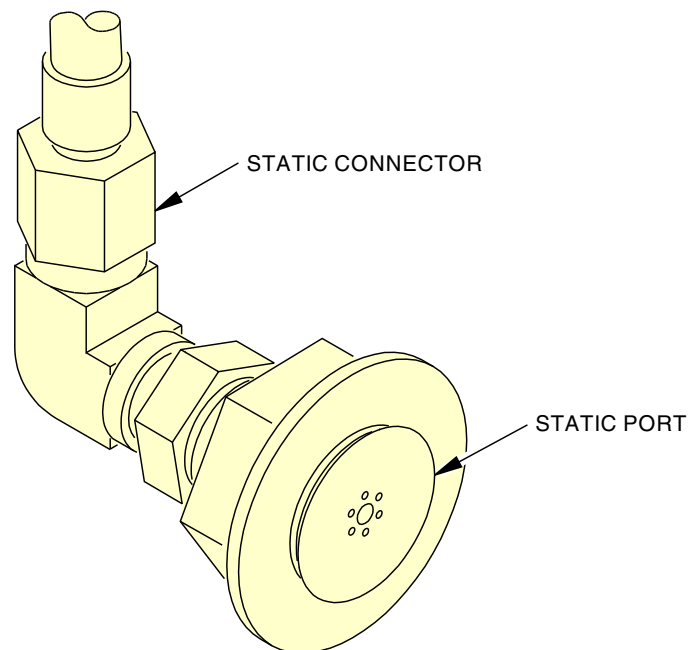


CAUTION

DO NOT PLUG OR DEFORM HOLES. INDICATED AREAS
MUST BE SMOOTH AND CLEAN.

The static ports do not have anti-icing heaters.

STATIC AND TOTAL AIR PRESSURE SYSTEM - STATIC PORT



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STATIC AND TOTAL AIR PRESSURE SYSTEM - STATIC PORT

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**STATIC AND TOTAL AIR PRESSURE SYSTEM - DRAIN FITTING****General**

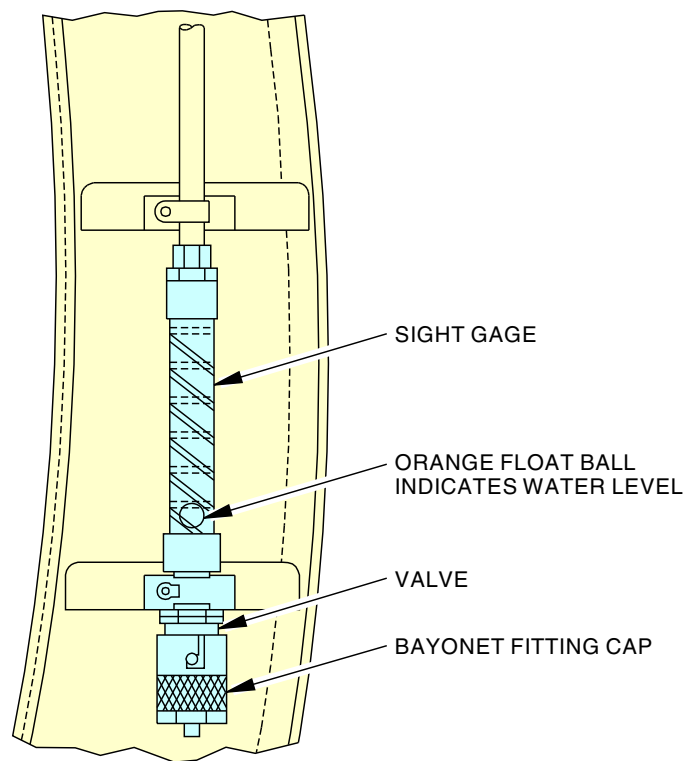
The system drains remove condensation that collects in the pitot-static lines. The drain fittings have a reinforced transparent section of tubing with an orange float. This forms a sight gage to show the level of fluid that collects in the sump.

Operation

The lower part of the drain contains a valve covered by a bayonet cap. To drain the pitot-static line, remove the cap and insert the valve depressor on the cap into the valve. The liquid in the sump drains by gravity when you push the valve.

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STATIC AND TOTAL AIR PRESSURE SYSTEM - DRAIN FITTING



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STATIC AND TOTAL AIR PRESSURE SYSTEM - DRAIN FITTING

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



OVERSPEED WARNING - INTRODUCTION

General

The 737 has an airspeed and a mach limit to protect the airframe. The mach airspeed warning system gives an aural warning that tells the flight crew when the airspeed is more than the mach or airspeed limit.

The airplane maximum operating limit speed (VMO) is 340 kts when the airplane is at or below an altitude of 25,968 ft. Above this altitude, the airplane is limited by mach number. The maximum operating mach (MMO) is 0.82.

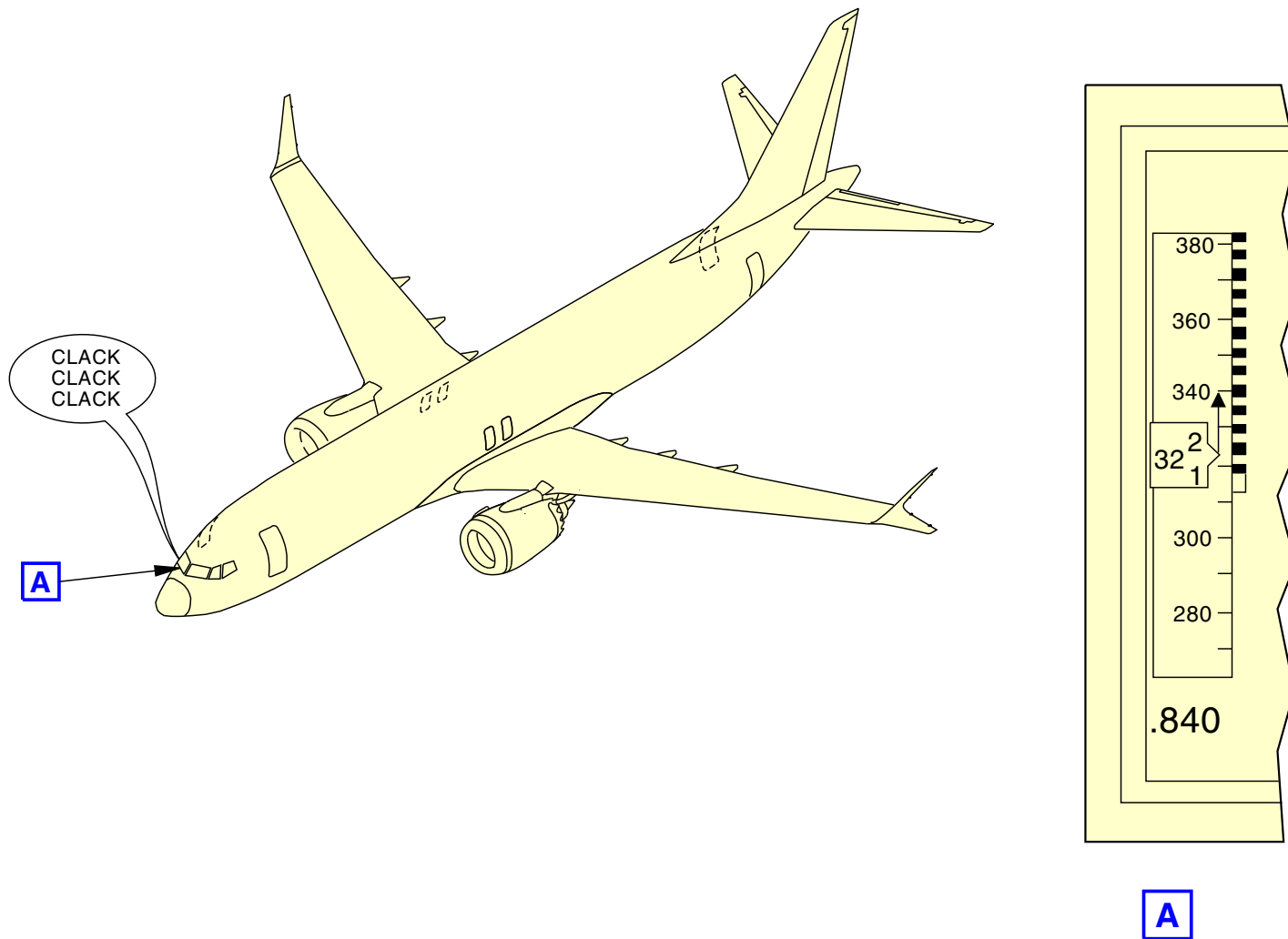
When the overspeed event occurs at 25,968 ft (7915 m) or below, it should be viewed in knots. Overspeed events above 25,968 ft (7915 m) should be viewed in mach.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- ADM - air data module
- CAPT - captain
- FO - first officer
- MMO - maximum operating mach
- O/SW - Overspeed/Stall Warning
- VMO - maximum operating limit speed
- kts - knots

EFFECTIVITY	
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OVERSPEED WARNING - INTRODUCTION



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OVERSPEED WARNING - INTRODUCTION

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SIA ALL	EFFECTIVITY

**OVERSPEED WARNING - GENERAL DESCRIPTION****VMO/MMO Overspeed Warning**

The mach airspeed warning system gets the overspeed warning signal from an Air Data Inertial Reference Unit (ADIRU). The signal means that the airspeed is more than the Maximum Operating Speed (VMO) or the Maximum Operating Mach (MMO). This signal turns on the clacker sound in the aural warning module.

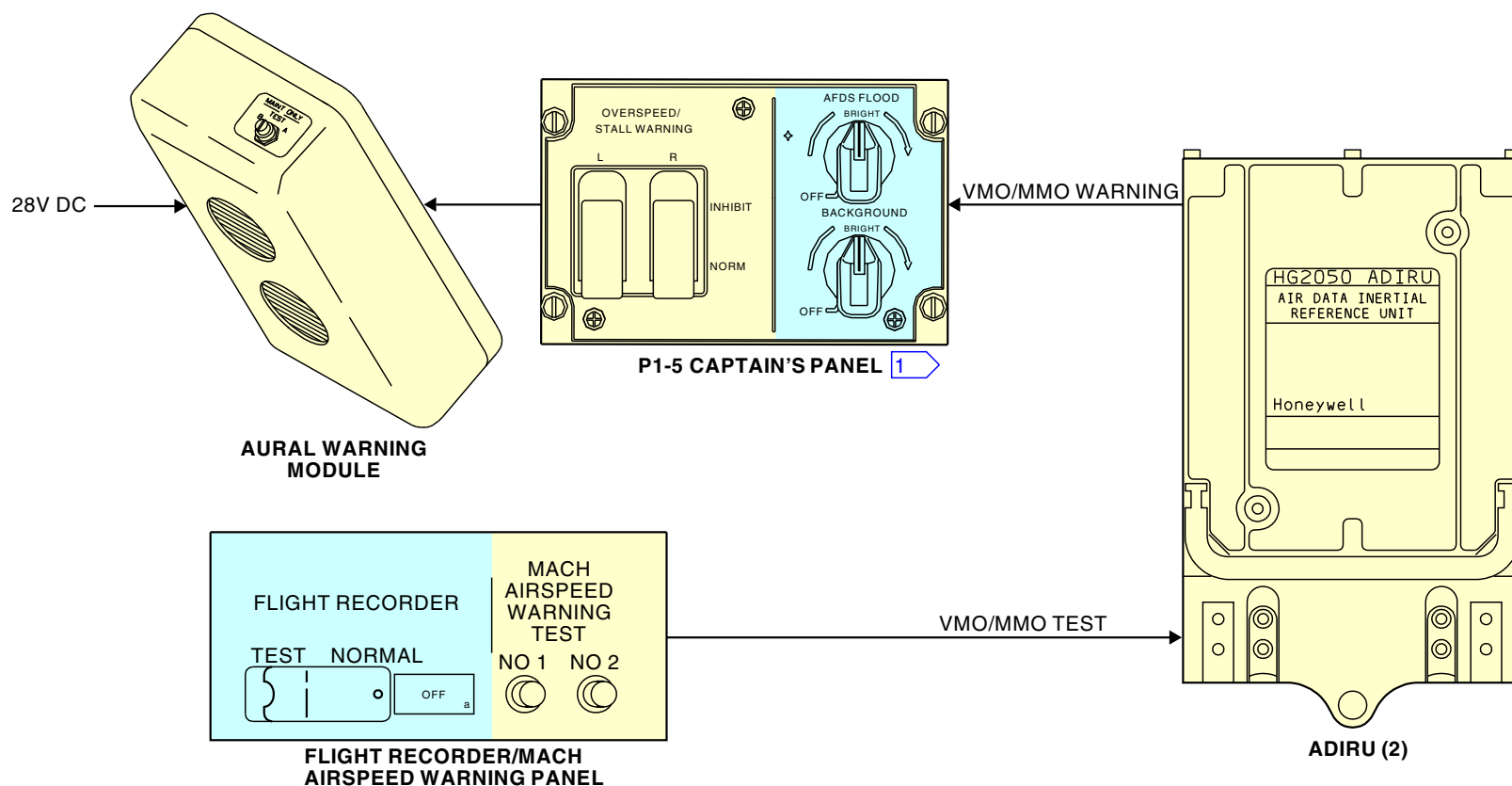
For Flights that must be dispatched with the gear down and locked, the altitude alert system can be enabled by setting the ALTERNATE VMO/MMO select switch in the main E/E bay to the ALTERNATE position. This simulates a landing gear not down and locked condition by opening the ALL GEARS DOWN and LOCKED discrete.

Test

The mach airspeed warning system has a mach airspeed warning test switch. It is part of the flight recorder/mach airspeed warning panel. Push one of the two mach airspeed warning test switches to start the clacker sound in the aural warning module. Test switch No. 1 does a test of the overspeed warning circuit in the left ADIRU. Test switch No. 2 does a test of the overspeed warning circuit in the right ADIRU.

EFFECTIVITY	
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OVERSPEED WARNING - GENERAL DESCRIPTION



1 IF APPLICABLE

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OVERSPEED WARNING - GENERAL DESCRIPTION

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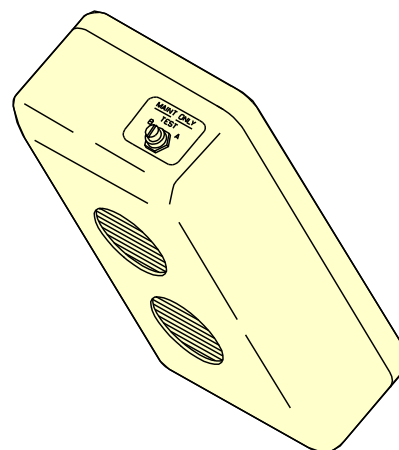
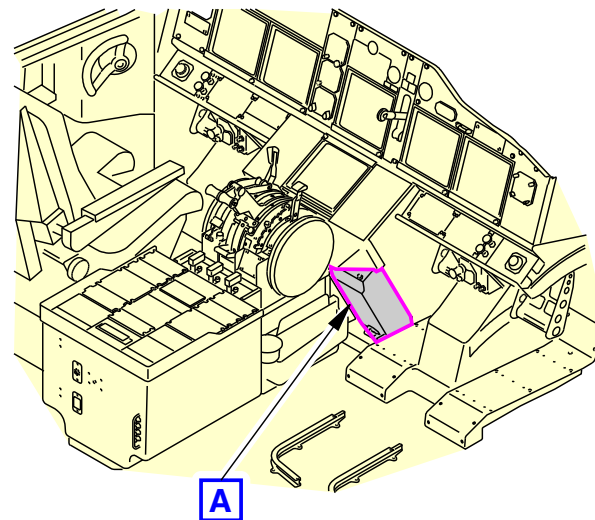
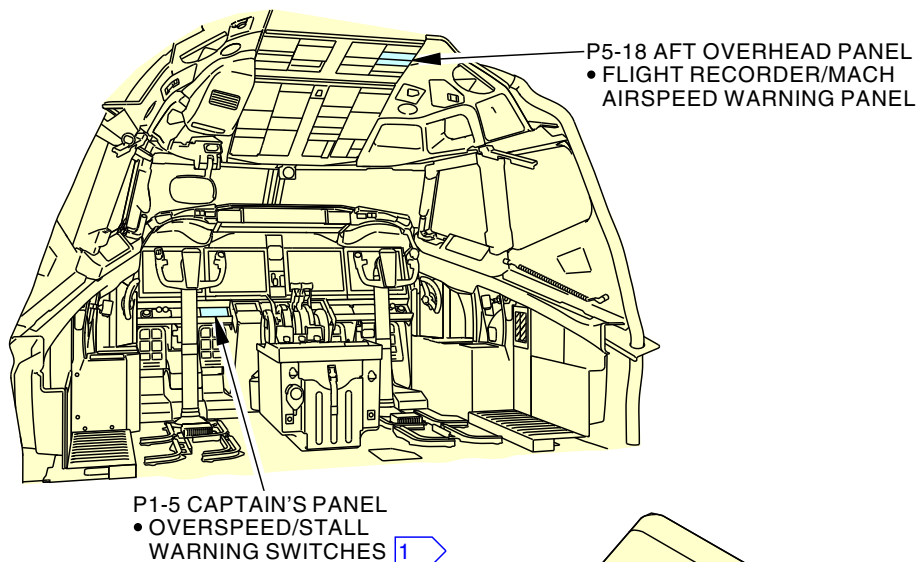
OVERSPEED WARNING - COMPONENT LOCATION

Flight Compartment

The flight recorder/mach airspeed warning panel is on the aft overhead panel. The aural warning module is on the bottom of the forward electronics panel.

SIA ALL	EFFECTIVITY
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OVERSPEED WARNING - COMPONENT LOCATION



AURAL WARNING MODULE

1 IF APPLICABLE

A

OVERSPEED WARNING - COMPONENT LOCATION

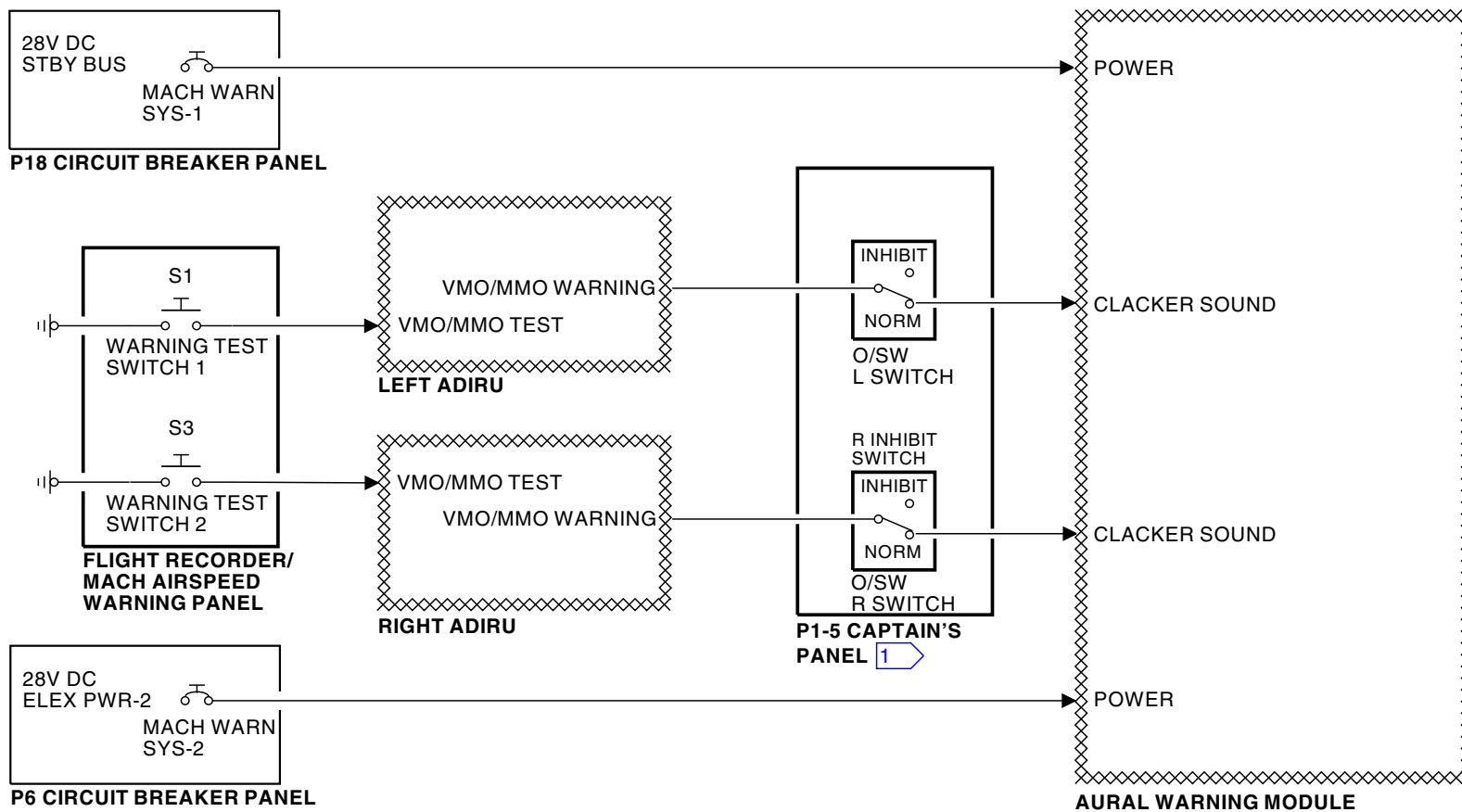
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**OVERSPEED WARNING - INTERFACE****General**

28v dc power goes to the aural warning module. When you push the test switch, a ground discrete goes to the air data inertial reference unit (ADIRU). The ADIRU sends an overspeed signal to the aural warning module. The aural warning module makes the clacker sound. Test switch 1 goes to the left ADIRU and test switch 2 goes to the right ADIRU.

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OVERSPEED WARNING - INTERFACE



1 IF APPLICABLE

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OVERSPEED WARNING - INTERFACE

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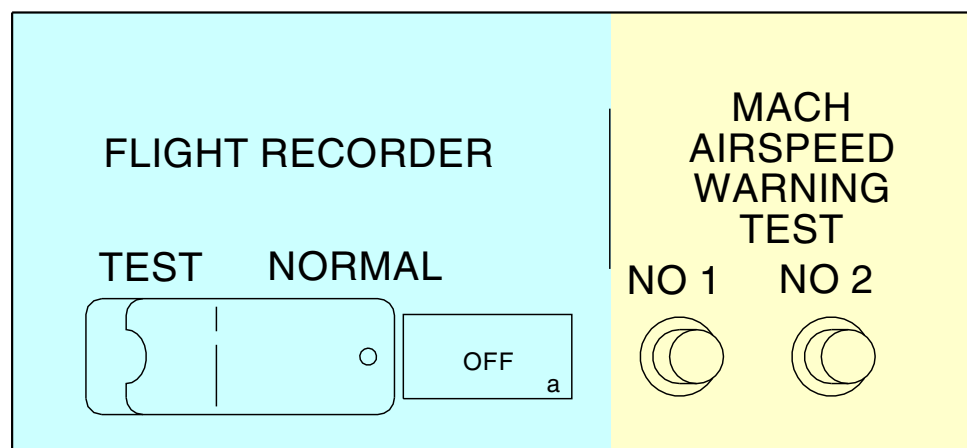
OVERSPEED WARNING - MACH AIRSPEED WARNING TEST SWITCH

General

There are two mach airspeed warning test switches. They are momentary push switches. When you push the test switch, a ground discrete goes to the air data inertial reference unit (ADIRU).

SIA ALL	EFFECTIVITY
	D633AM102-SIA

OVERSPEED WARNING - MACH AIRSPEED WARNING TEST SWITCH



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OVERSPEED WARNING - MACH AIRSPEED WARNING TEST SWITCH

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AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION

Purpose

The air data inertial reference system (ADIRS) has two primary functions:

- Air data reference (ADR)
- Inertial reference (IR).

The ADR function calculates airspeed and barometric altitude. The IR function calculates this data:

- Attitude
- Present position
- Groundspeed
- Heading.

Abbreviations and Acronyms

- AACU - antiskid autobrake control unit
- AC - alternating current
- A/D - analog to digital
- ADF - automatic direction finder
- ADI - attitude direction indication
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- ADM - air data module
- ADR - air data reference
- alt - altimeter
- alt - altitude
- AOA - angle of attack
- ARINC - Aeronautical Radio, inc.
- A/T - autothrottle
- ATC - air traffic control
- att - attitude
- bat - battery

- baro - barometric
- brt - brightness
- capt - captain
- CAS - computed airspeed
- CDU - control display unit
- clr - clear
- CPC - cabin pressure controller
- CPU - central processing unit
- DC - direct current
- DPC - display processing computer
- DU - display unit
- dspl - display
- EFIS - electronic flight instrument system
- elec - electronic
- elex - electrical
- ent - enter
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FMC - flight management computer
- FMCS - flight management computer system
- F/O - first officer
- FPV - flight path vector
- FSEU - flap slat electronics unit
- FWD - forward
- GPS - global positioning system
- GPWC - ground proximity warning computer
- GS - ground speed
- hdg - heading
- HPA - hecto-pascals
- IFSAU - integrated flight systems accessory unit

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SIA ALL EFFECTIVITY

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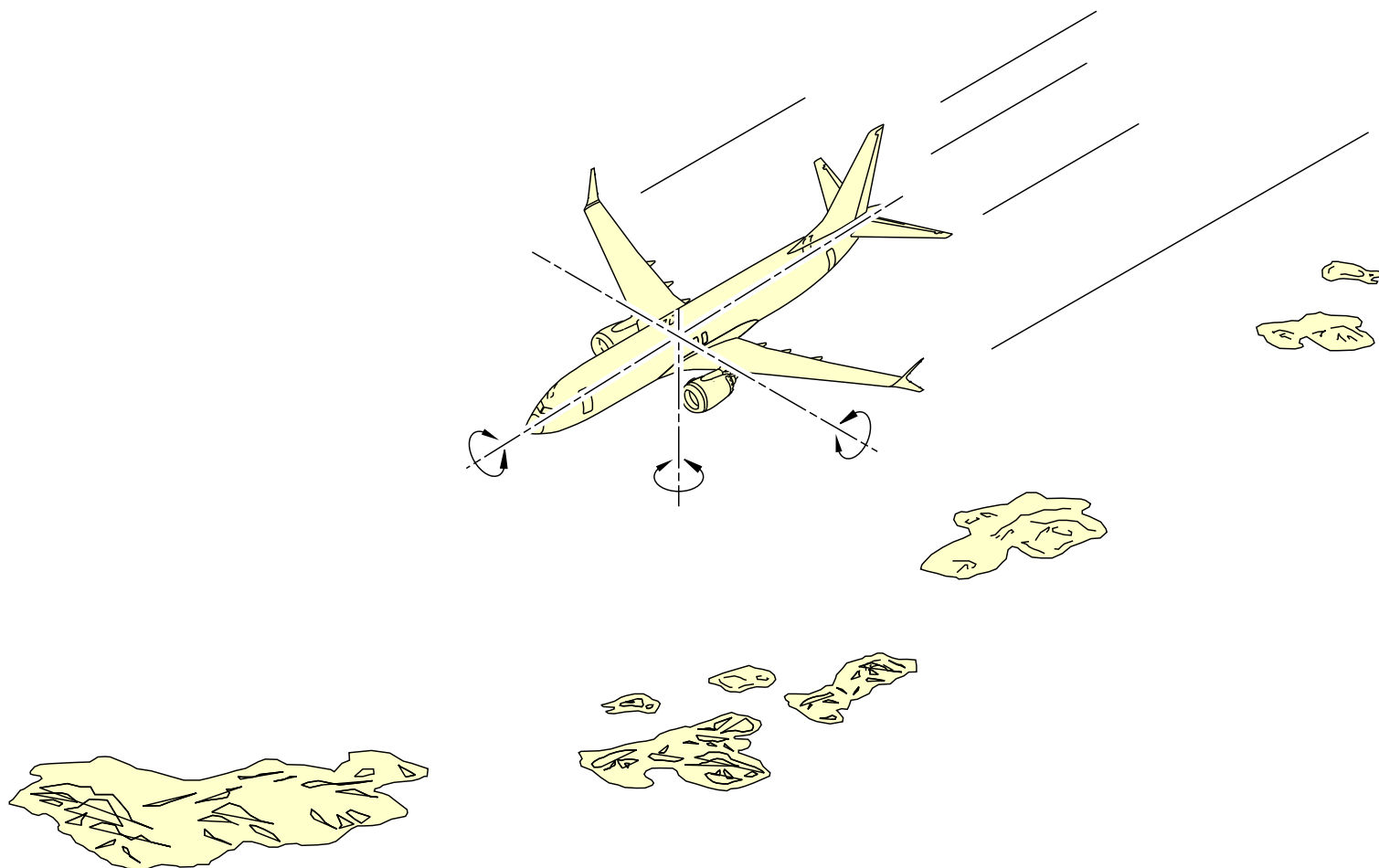
ECCN 9E991 BOEING PROPRIETARY - See title page for details



AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION

- in - inches
- init - initialization
- instr - instrument
- IR - inertial reference
- IRS - inertial reference system
- ISDU - inertial system display unit
- L - left
- LCD - liquid crystal display
- LSK - line select key
- MAG - magnetic
- MASI - mach airspeed indicator
- MCU - master caution unit
- MDS - max display system
- MMR - multi-mode receiver
- MSU - mode select unit
- nav - navigation
- NCD - no computed data
- ND - navigation display
- NVM - non-volatile memory
- PPOS - present position
- pos - position
- PSEU - proximity switch electronics unit
- R - right
- ref - reference
- RMI - radio magnetic indicator
- R/T - receiver transmitter
- SAT - static air temperature
- sel - select
- SMYD - stall management yaw damper
- spd - speed
- stby - standby
- STS - status
- sw - switched
- sys - system
- TAS - true airspeed
- TAT - total air temperature
- TCAS - traffic collision avoidance system
- TK - track
- trk - track
- tru - true
- V - volts
- VOR - VHF omnidirectional range
- VSI - vertical speed indication
- WXR - weather radar
- xfr - transfer

AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION



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AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION

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ADIRS - GENERAL DESCRIPTION

General

The air data inertial reference system (ADIRS) supplies these type of data to the aircrew and to the airplane systems:

- Altitude
- Airspeed
- Temperature
- Heading
- Attitude
- Present position.

The ADIRS has these components:

- Air data modules (ADMs) (4)
- Total air temperature (TAT) probe
- Angle of attack (AOA) sensors (2)
- Inertial system display unit (ISDU)
- Mode select unit (MSU)
- Air data inertial reference unit (ADIRU) (2)
- ALTERNATE VMO/MMO SWITCH
- IRS master caution unit.

Functional Description

The TAT probe measures the outside air temperature. It changes the temperature value to an electrical signal. The electrical signal goes to the ADIRUs.

The AOA sensors measure and convert angle of attack to electrical signals. The electrical signals go to the ADIRUs.

The ISDU supplies initial position and heading data to the ADIRUs. It also supplies this data to the flight crew:

- Present position
- Heading

- Navigation
- Performance
- Status.

The MSU gives mode selection data to the ADIRUs. It also shows system operational and fault status to the flight crew.

The two ADIRUs calculate and send air data and inertial reference information on ARINC 429 data buses. Each ADIRU has two parts. One part is the air data reference (ADR) part. The other is the inertial reference (IR) part.

The ADIRUs use these inputs to calculate air data:

- Pitot pressure
- Static pressure
- Total air temperature
- Angle of attack
- MDS barometric correction
- IR data.

Each ADIRU uses three accelerometers and three laser gyros to calculate inertial reference (IR) data. Initial present position information goes to the ADIRUs from the ISDU, or the flight management computer system (FMCS).

For airplanes with hybrid GPS-inertial reference data activated, the ADIRU automatically receives initial present position information from the MMR.

The IRS master caution unit sends fail discretes to the flight compartment master caution system.

The ALTERNATE VMO/MMO SWITCH (GEAR DOWN DISPATCH SWITCH) give the input to ALTERNATE VMO/MMO in the ADIRU. When the switch is pushed up to the ALTERNATE position, the ADIRU adjusts the Vmo/Mmo curve to compensate for a flight with the landing gear down.

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ADIRS - GENERAL DESCRIPTION

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**ADIRS - COMPONENT LOCATION - FLIGHT COMPARTMENT****General**

These are the ADIRS components in the flight compartment:

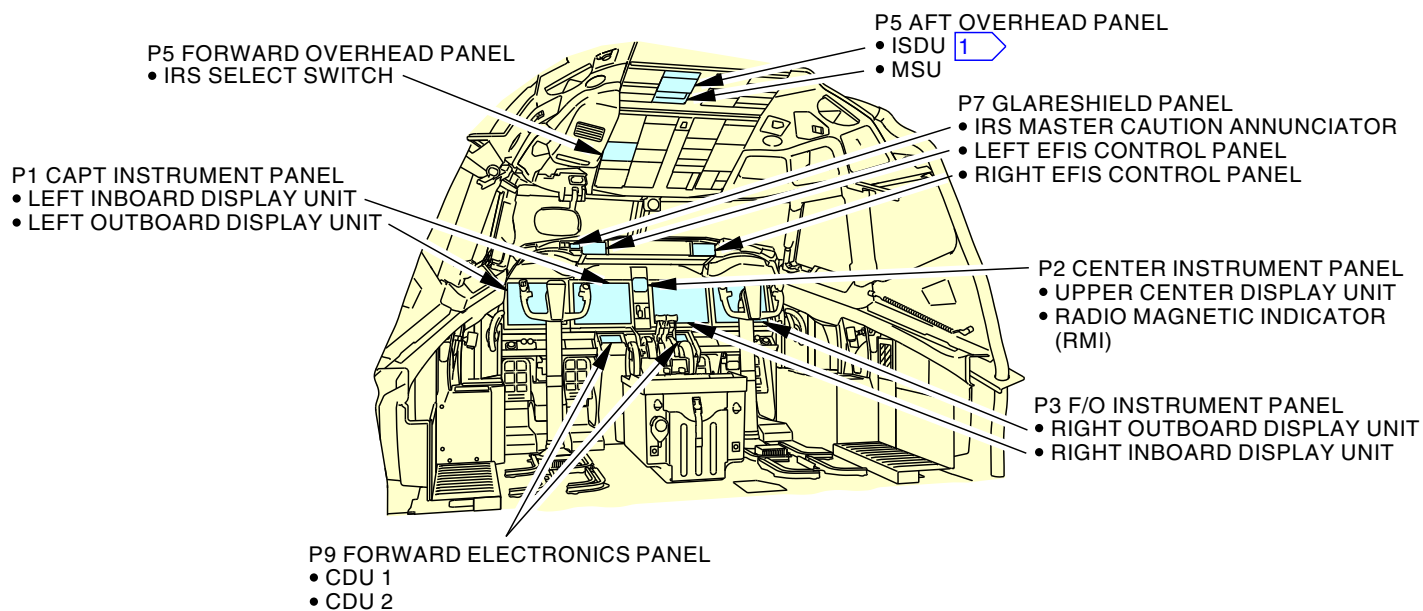
- Inertial system display unit (ISDU) if applicable.
- Mode select unit (MSU)
- IRS master caution annunciator.

These are the components in the flight compartment that have an interface with the ADIRS:

- Left inboard and outboard display units
- Right inboard and outboard display units
- Upper center display unit
- IRS select switch
- Control display unit (CDU) 1 and 2
- Radio magnetic indicator (RMI)
- Left and right EFIS control panels.

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ADIRS - COMPONENT LOCATION - FLIGHT COMPARTMENT



1 IF APPLICABLE

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ADIRS - COMPONENT LOCATION - FLIGHT COMPARTMENT

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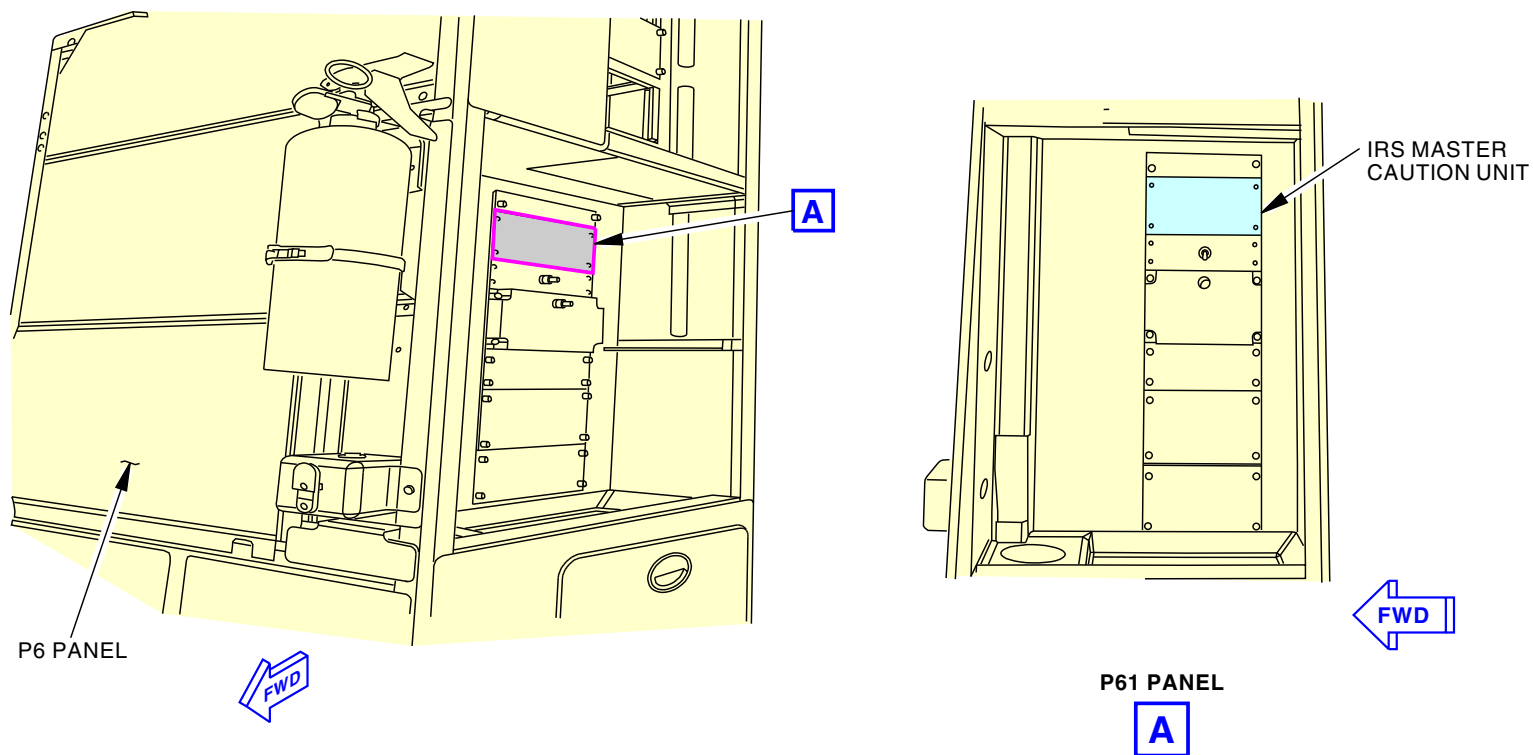
ADIRS - COMPONENT LOCATION - IRS MASTER CAUTION UNIT

General

THE IRS master caution unit is in the flight compartment on the P61 panel.

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ADIRS - COMPONENT LOCATION - IRS MASTER CAUTION UNIT



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ADIRS - COMPONENT LOCATION - IRS MASTER CAUTION UNIT

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ADIRS - COMPONENT LOCATION - EE COMPARTMENT

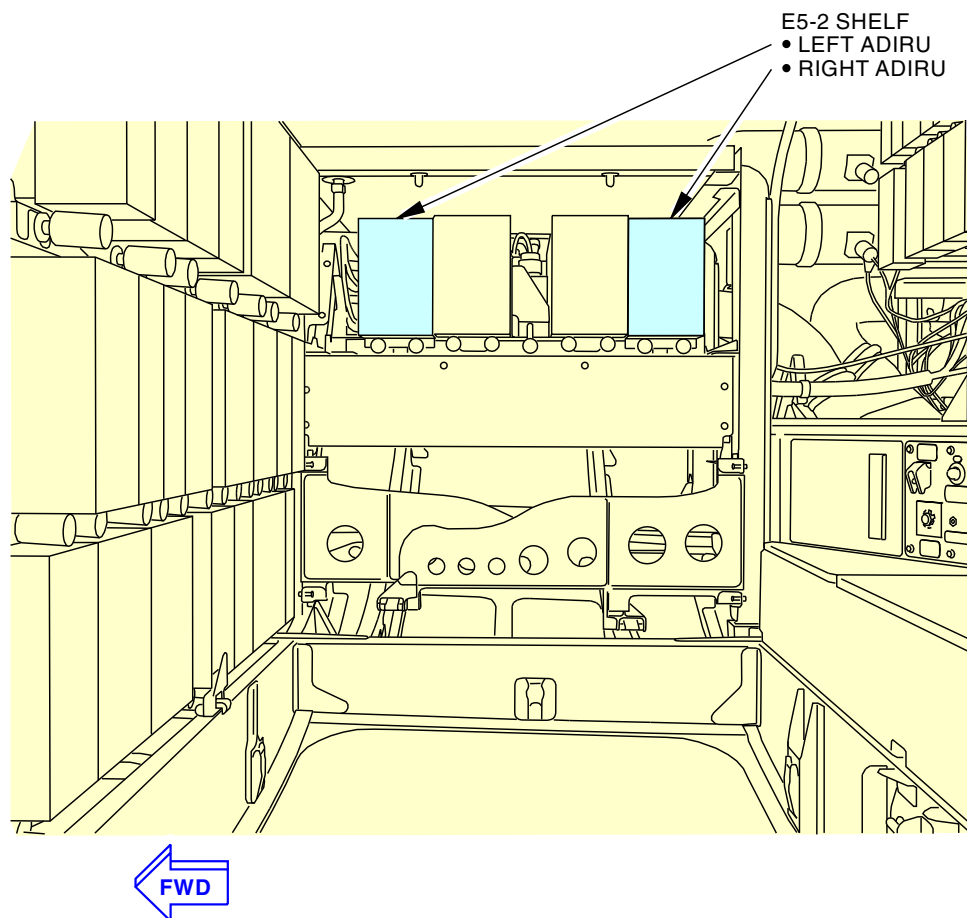
General

These are the ADIRS components in the electronic equipment (EE) compartment:

- Left air data inertial reference unit (ADIRU)
- Right ADIRU.
- ALTERNATE VMO/MMO.

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ADIRS - COMPONENT LOCATION - EE COMPARTMENT



ADIRS - COMPONENT LOCATION - EE COMPARTMENT

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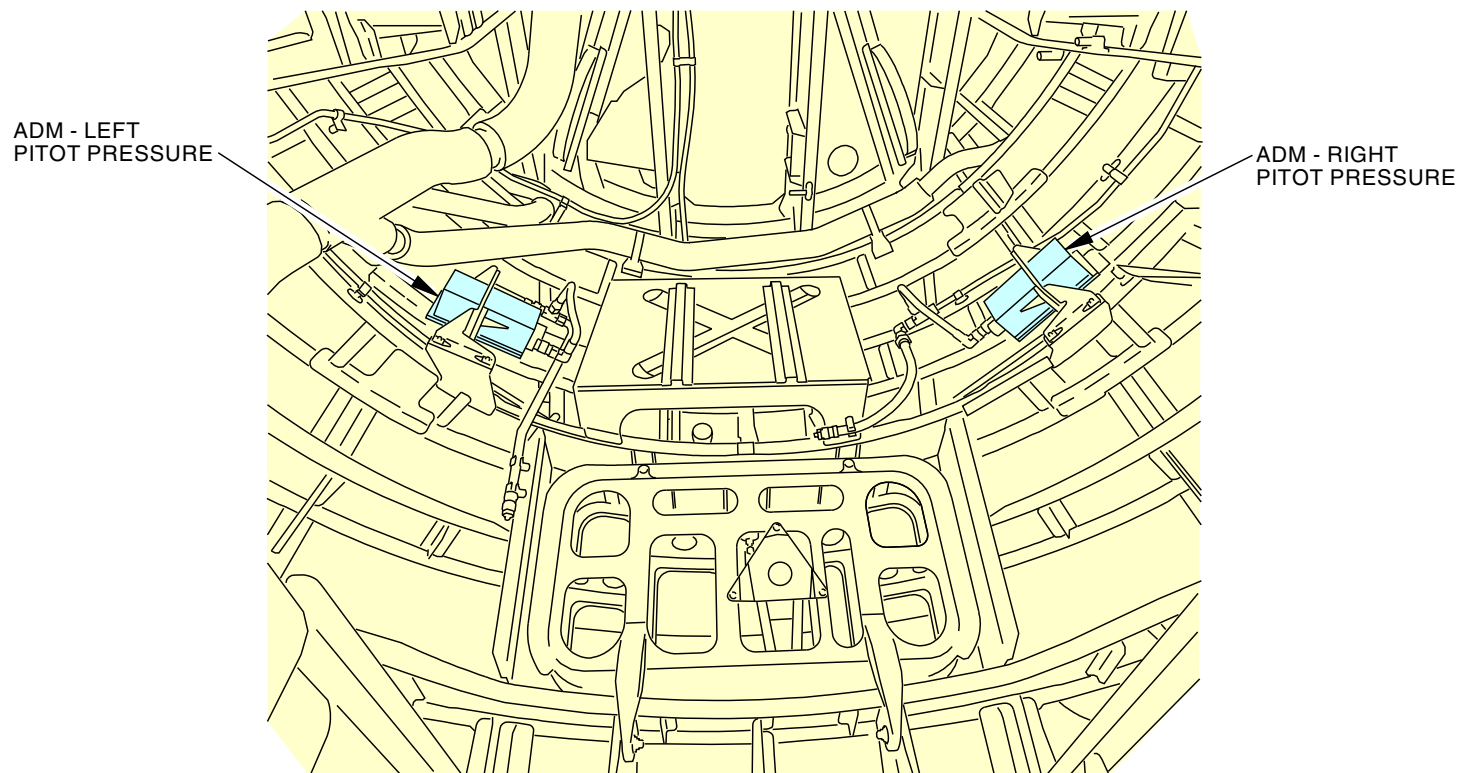
ADIRS - COMPONENT LOCATION - PITOT AIR DATA MODULES

General

The pitot pressure air data modules (ADM) are in the forward equipment compartment.

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ADIRS - COMPONENT LOCATION - PITOT AIR DATA MODULES



FORWARD EQUIPMENT COMPARTMENT
(VIEW IN THE FORWARD DIRECTION)

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ADIRS - COMPONENT LOCATION - PITOT AIR DATA MODULES

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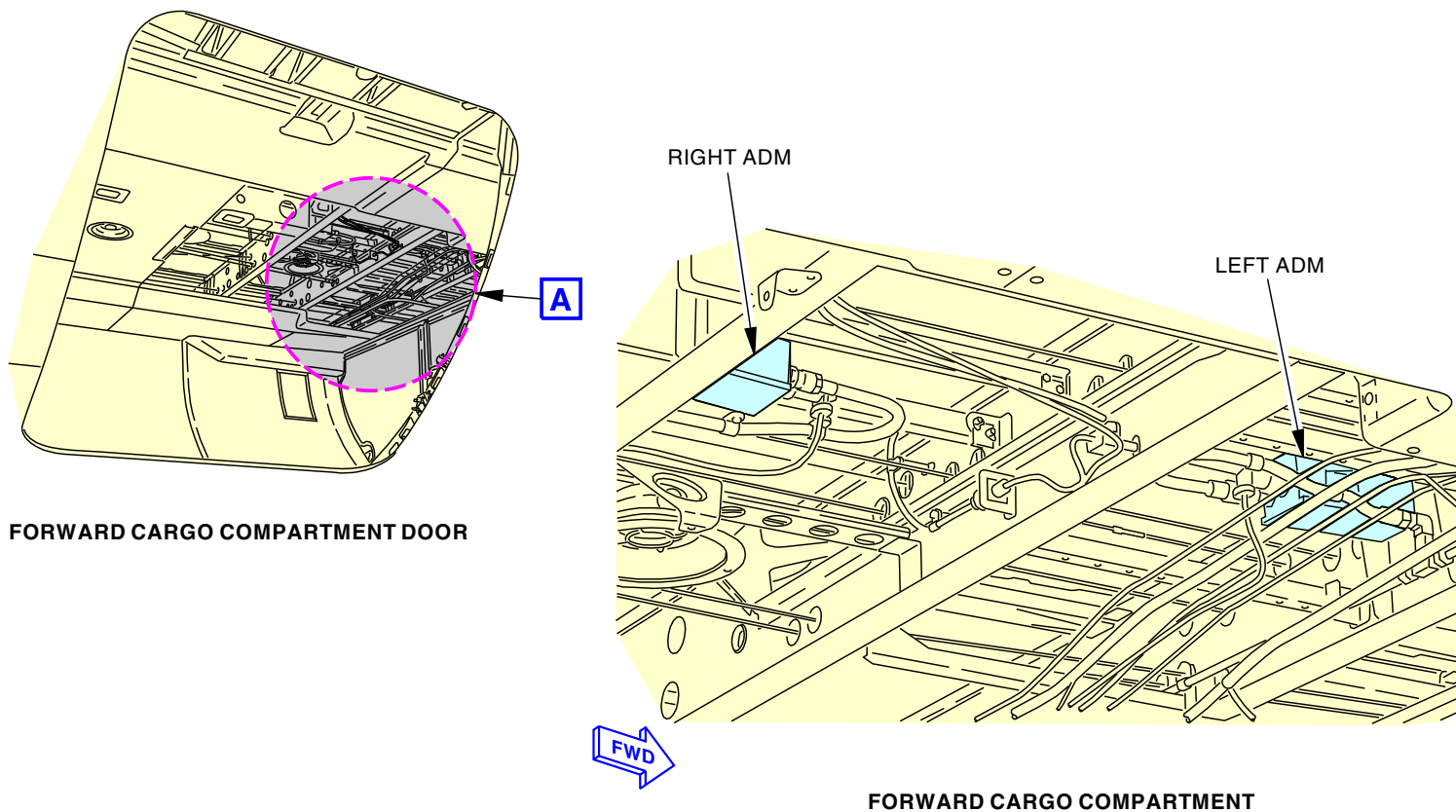
ADIRS - COMPONENT LOCATION - STATIC AIR DATA MODULES

General

The static pressure ADMs are in the forward cargo compartment, above the ceiling panels.

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ADIRS - COMPONENT LOCATION - STATIC AIR DATA MODULES



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ADIRS - COMPONENT LOCATION - STATIC AIR DATA MODULES

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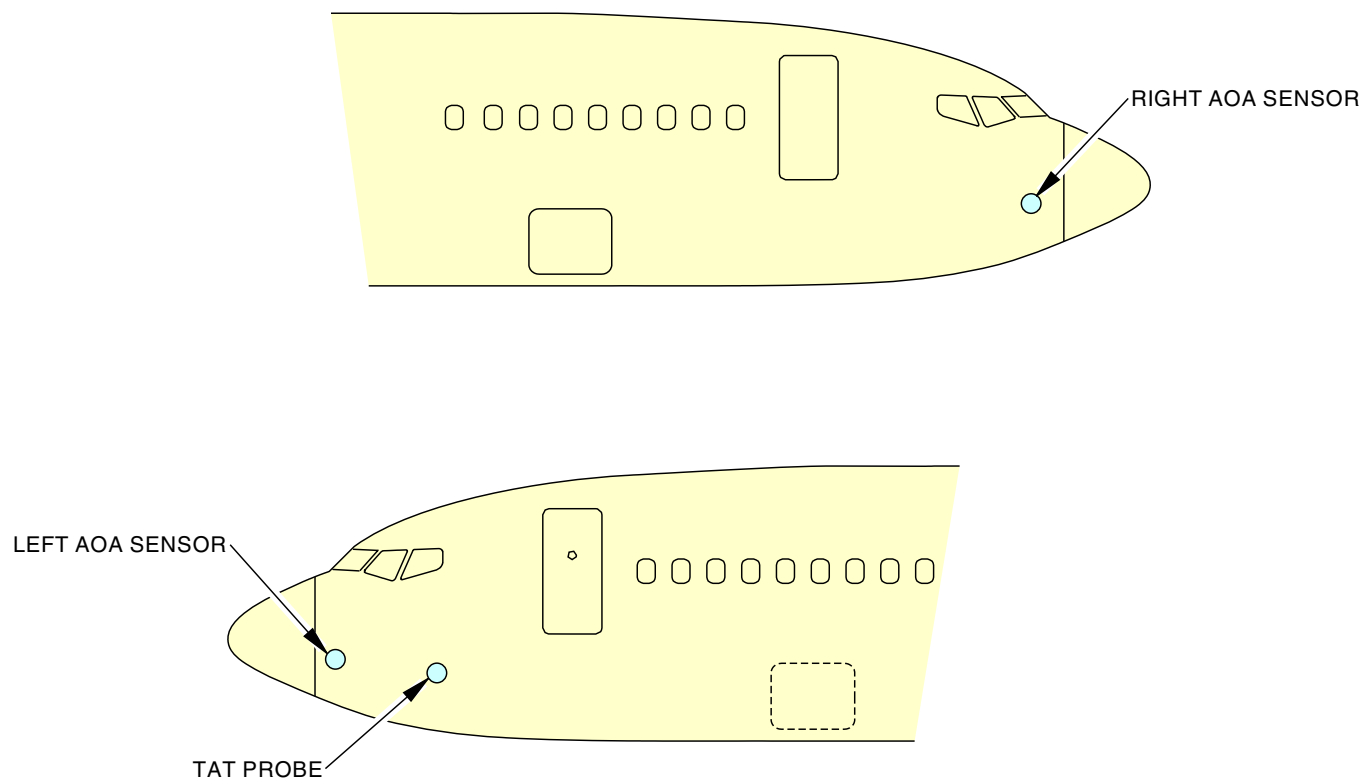
ADIRS - COMPONENT LOCATION - AOA SENSORS AND TAT PROBE

General

The angle of attack (AOA) sensors are on both sides of the fuselage. The total air temperature (TAT) probe is on the left side.

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ADIRS - COMPONENT LOCATION - AOA SENSORS AND TAT PROBE



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ADIRS - COMPONENT LOCATION - AOA SENSORS AND TAT PROBE

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SIA ALL	EFFECTIVITY
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**ADIRS - POWER****ADIRU**

The ADIRU operates with 115V AC or 28V DC. 115V AC is the normal power source.

Each ADIRU has a separate AC and DC power source. The left ADIRU gets power from these buses:

- 115V AC STBY bus
- 28V DC sw hot battery bus.

The right ADIRU gets power from these buses:

- 115V AC XFR bus 2
- 28V DC sw hot battery bus.

AC Reference Voltage

The 28V AC STBY bus supplies a servo reference voltage to the left ADIRU and to the left angle of attack (AOA) sensor. The 28V AC XFR bus 2 supplies servo reference voltage to the right ADIRU and to the right AOA sensor.

Integrated Flight Systems Accessory Unit

The integrated flight systems accessory unit (IFSAU) gets AC power from the 115V AC XFR bus 2. DC power comes from the 28V DC sw hot bat bus. The IFSAU uses these inputs to control power going to the right ADIRU and to supply power to the crew call horn when the ADIRUs operate with DC power on the ground.

Air Data Modules

The left ADIRU supplies 13.5V DC to the left pitot ADM and to the left static ADM. The right ADIRU supplies 13.5V DC to the right ADMs.

Inertial System Display Unit

The inertial system display unit (ISDU) gets 28V DC from the left and the right ADIRU.

IRS Master Caution Unit

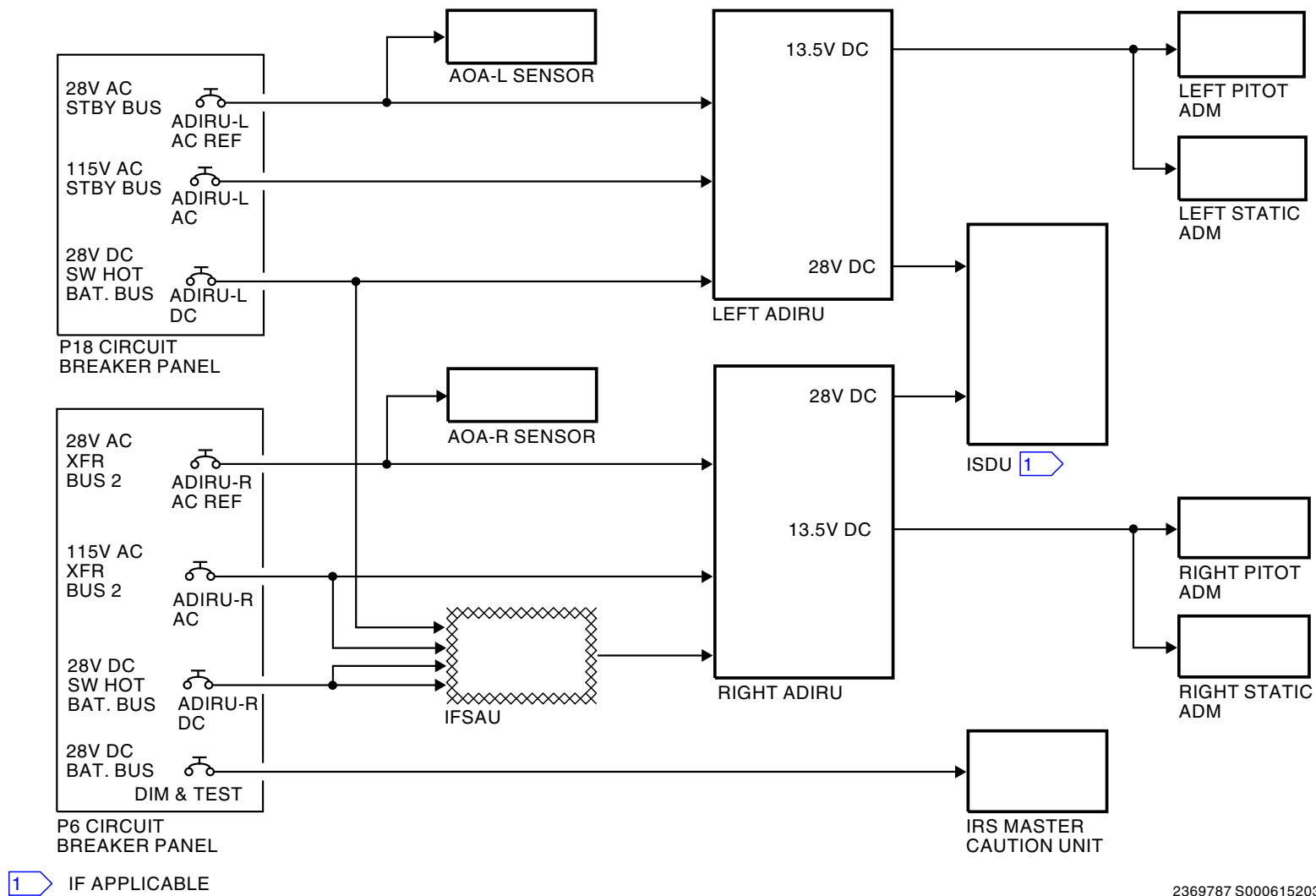
The IRS master caution unit gets power from the 28V DC bat bus.

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ADIRS - POWER



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ADIRS - POWER

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**ADIRS - DC POWER OPERATION****General**

The ADIRUs operates with AC or DC power. AC power is the normal power source. If the AC power source is not available, DC power from the airplane battery will supply power to the ADIRUs.

Left ADIRU DC Operation

When AC power is not available, the left ADIRU will operate on DC power from the 28V DC sw hot battery bus. The left ADIRU will continue to operate on DC power until the battery power is less than 18V DC.

Right ADIRU DC Operation

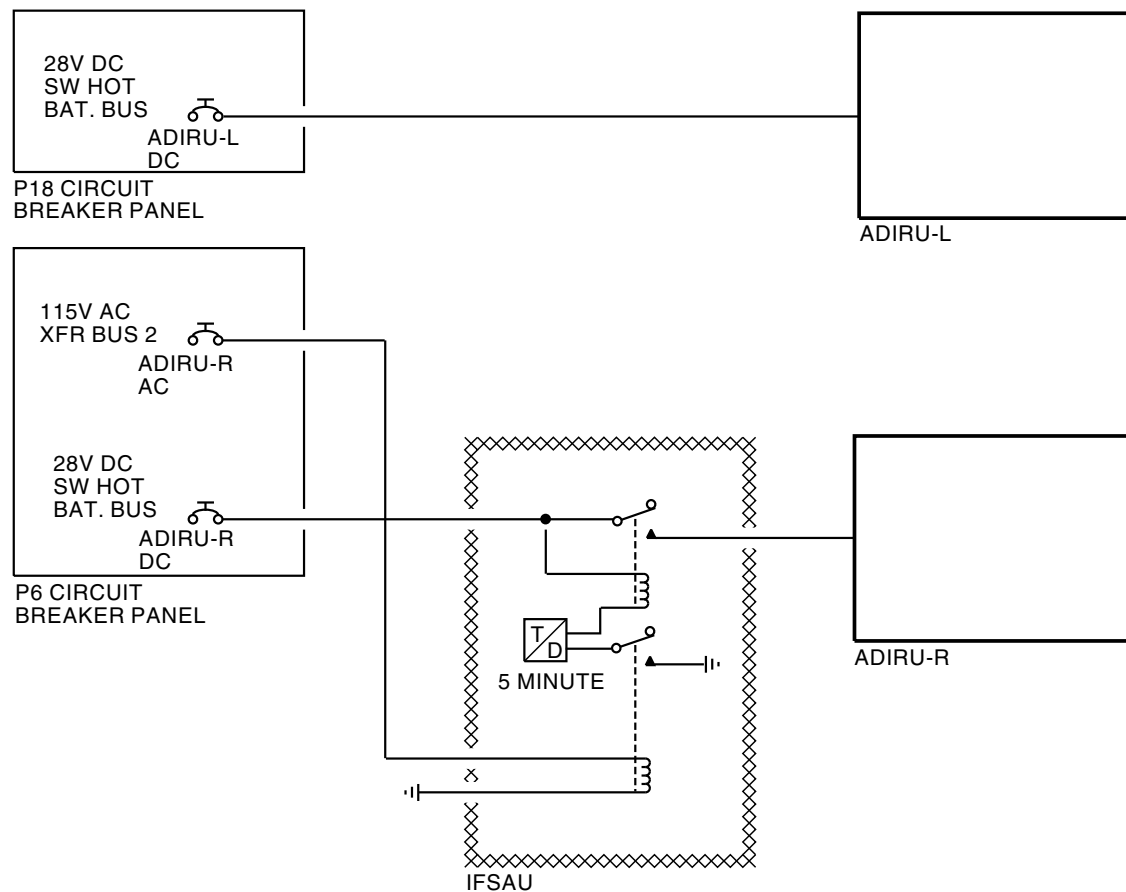
DC power to the right ADIRU goes through a time delay circuit in the integrated flight systems accessory unit (IFSAU). When AC power is not available, a 5 minute time delay keeps the DC power relay energized, and the right ADIRU operates on DC power. After 5 minutes continuous operation on DC power, the time delay circuit deenergizes the relay and DC power to the right ADIRU is removed. This feature allows the airplane battery to drain at a slower rate.

DC Fail Light

The DC FAIL light on the Mode Select Unit (MSU) will illuminate if the ADIRU's 28V DC input power drops below 18V DC. The ADIRU will continue to operate if AC power is available.

EFFECTIVITY	
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ADIRS - DC POWER OPERATION



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ADIRS - DC POWER OPERATION

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**ADIRS - NO COOLING AND ON DC WARNING****General**

The integrated flight systems accessory unit (IFSAU) contains a circuit which causes the ground crew call horn to tell maintenance personnel of unsafe ADIRU operation. This occurs when the airplane is on the ground and the ADIRUs are on DC power or when the equipment cooling system fails.

ADIRU DC Power Operation

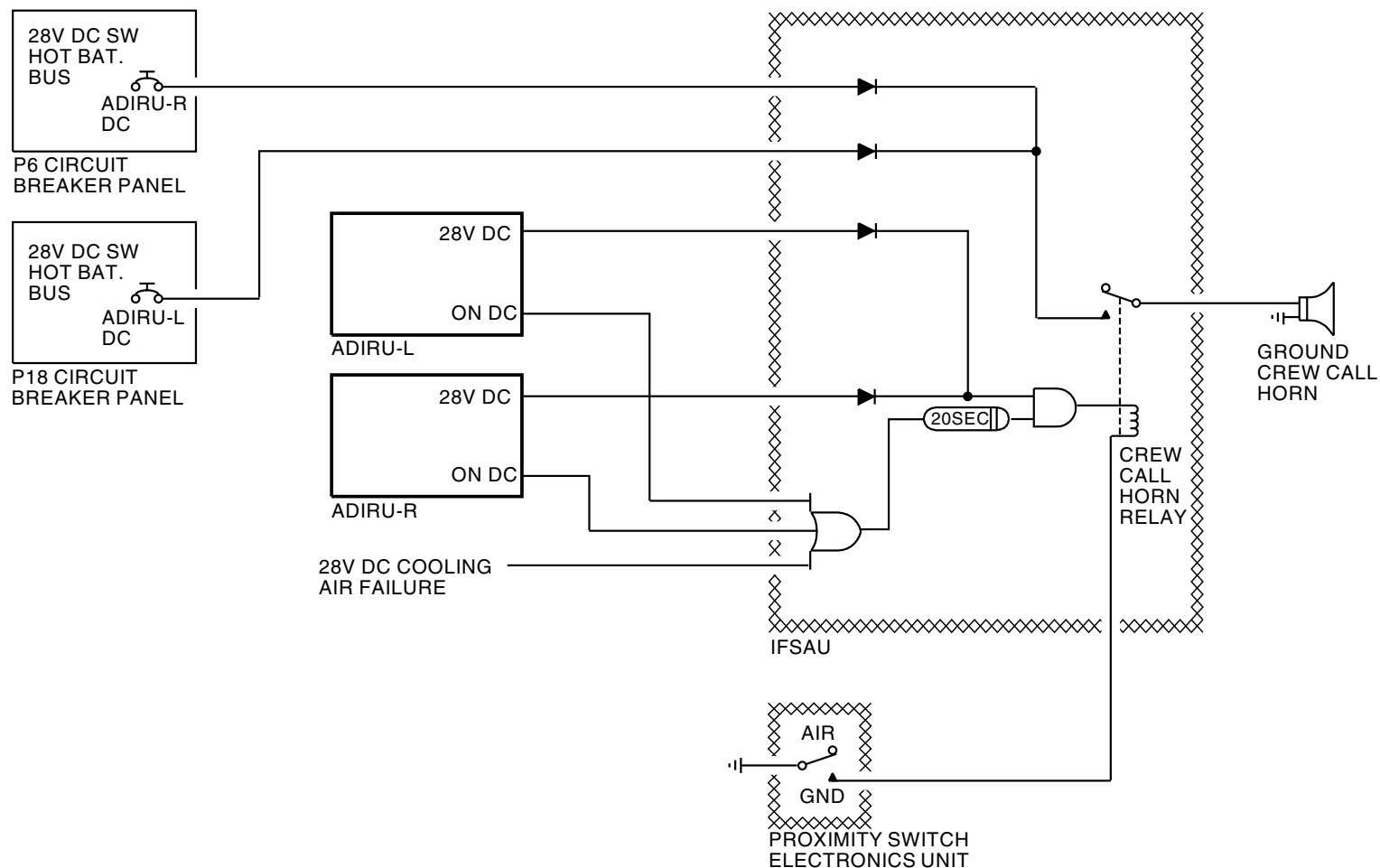
The ADIRUs send 28V DC to the AND logic circuit in the IFSAU. When an ADIRU senses that it is on DC power, it sends an ON DC discrete to the IFSAU. The discrete goes through a 20 second delay to the AND gate logic. After twenty seconds of DC operation, the AND gate supplies power to the crew call horn relay. The relay energizes when the AIR/GND relay is in the GND position. The energized crew call relay closes the relay switch, and 28V DC power causes the horn to operate.

Equipment Cooling Failure

Two equipment cooling sensors monitor the cooling air flow to the ADIRUs. A low flow relay in the sensor will close when the cooling air flow fails. The closed relay lets 28V DC go to the IFSAU. The 28V DC discrete goes through a 20 second delay to the AND gate logic. After twenty seconds, the AND gate supplies power to the crew call horn relay. The relay energizes when the AIR/GND relay is in the GND position. The energized crew call horn relay closes the relay switch, and 28V DC power causes the horn to operate.

EFFECTIVITY	
SIA ALL	

ADIRS - NO COOLING AND ON DC WARNING



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ADIRS - NO COOLING AND ON DC WARNING

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**ADIRS - CONTROL AND WARNING****General**

These are the units that interface to supply control and warning data to the pilots:

- ISDU
- MSU
- IRS master caution unit.

ISDU Interface

The ISDU supplies both ADIRUs with test discretes, heading data, and present position data. The ADIRUs supply IR data and fault data to the ISDU.

FMC Interface

The FMCs supply the ADIRUs with test discretes, heading data, and present position data. The ADIRUs supply ADR, IR, and fault data to the FMC.

MSU Interface

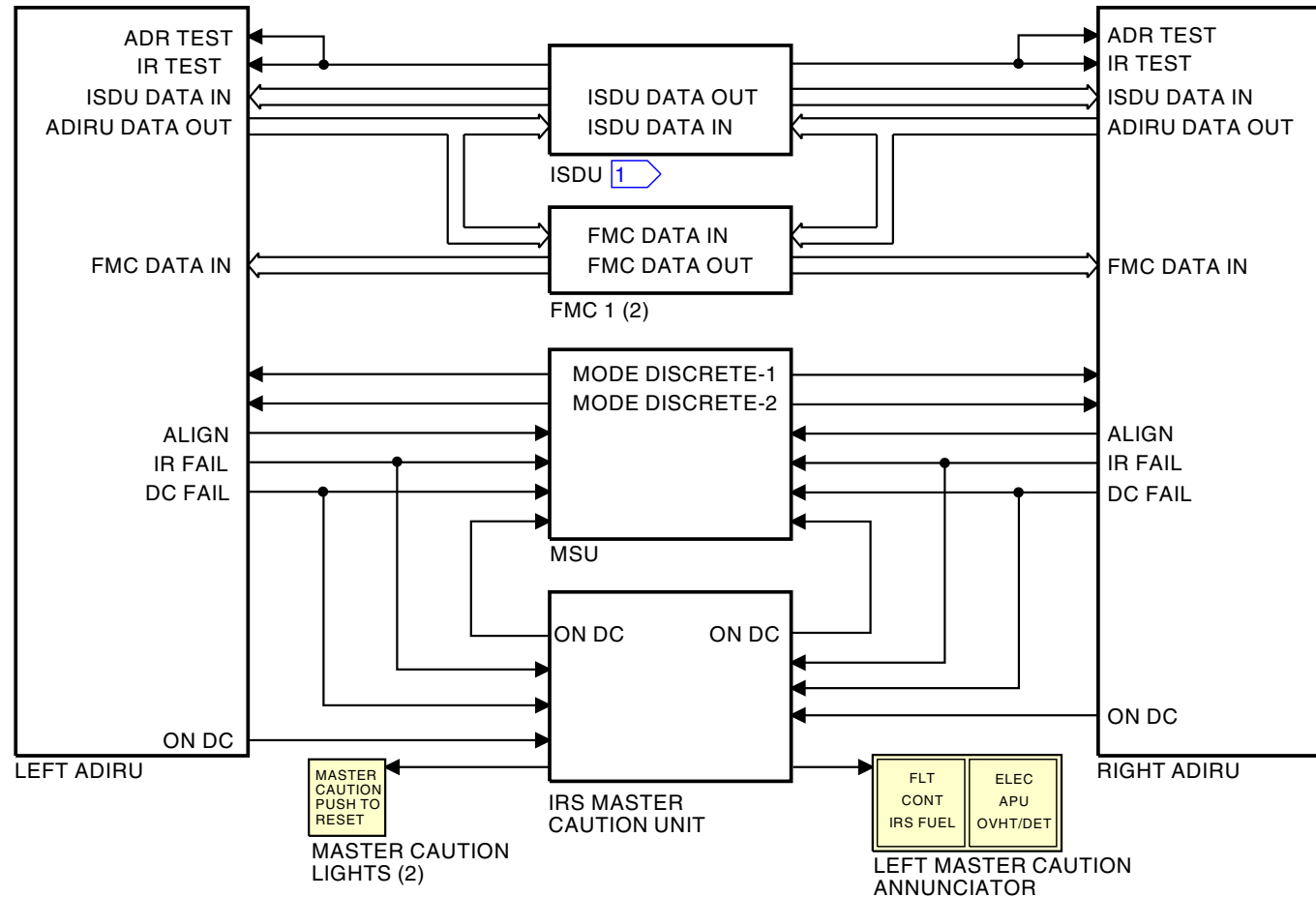
The MSU supplies mode discretes to the ADIRUs. The ADIRUs supply align and fail discretes to the MSU. The MSU also receives an ON DC discrete from the ADIRUs. The ON DC discrete goes through the IRS master caution unit.

IRS Master Caution Unit Interface

The IRS master caution unit receives fail and ON DC discretes from the ADIRUs. The IRS master caution unit supplies discrete outputs to the MSU and to the master caution lights and annunciators.

EFFECTIVITY	
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ADIRS - CONTROL AND WARNING



1 IF APPLICABLE

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ADIRS - CONTROL AND WARNING

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**ADIRS - SYSTEM INPUTS****General**

Each ADIRU receives inputs from these on-side components:

- AOA sensor
- Pitot ADM
- Static ADM.

The AOA sensor gives angle of attack information to the ADIRU. The ADIRU uses angle of attack to modify pitot and static values.

The pitot ADM gives the ADIRU total air pressure information. This is used to calculate airspeed and mach number.

The static ADM gives the ADIRU static air pressure information. This is used to calculate altitude and airspeed.

These components supply data to both ADIRUs:

- TAT probe
- DPC 1 and DPC2
- Window and pitot heat module
- Inertial system display unit (ISDU)
- FMC 1 and FMC 2

SIA 005-999; SIA 001-004 POST SB 737-34-3141

- MMR 1 and MMR 2

SIA ALL

- ALTERNATE VMO/MMO SWITCH.

The TAT probe gives total air temperature to the ADIRUs. The ADIRUs use TAT to compute TAS and SAT.

DPC 1 and DPC 2 give barometric correction to the ADIRUs. The ADIRUs use barometric correction to calculate corrected barometric altitude.

The window and pitot heat module sends a discrete signal to the ADIRUs when anti ice heat is on. The ADIRUs modify the input values of these components when anti ice heat is on:

- AOA sensor
- Pitot probe
- TAT probe.

The ISDU gives initial present position data and heading data to the ADIRUs. The ADIRUs use present position data during the align mode. Heading data is used during the attitude mode.

The FMC gives the ADIRUs this information:

- Present position
- Heading
- BITE command.

The ADIRUs use present position in the align mode. Heading data is used in the attitude mode. The BITE command starts the ADIRU Bite tests.

SIA 001-004 PRE SB 737-34-3141

Multi-mode receiver 1 (MMR 1) and MMR 2 have data buses to the ADIRUs. The MMRs do not supply any data to the ADIRUs. The data buses are for future use to send global positioning system (GPS) information.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

Multi-mode receiver 1 (MMR 1) and MMR 2 have data buses to the ADIRU's for global positioning system (GPS) information for hybrid GPS-Inertial functions. The GPS-inertial is capable of performing automatic alignment using GPS position on the ground and Align-in-Motion (AIM) while in the air, as well as outputting high integrity hybrid inertial reference data for other systems' to use such as hybrid velocity, hybrid heading, hybrid navigation, and others.



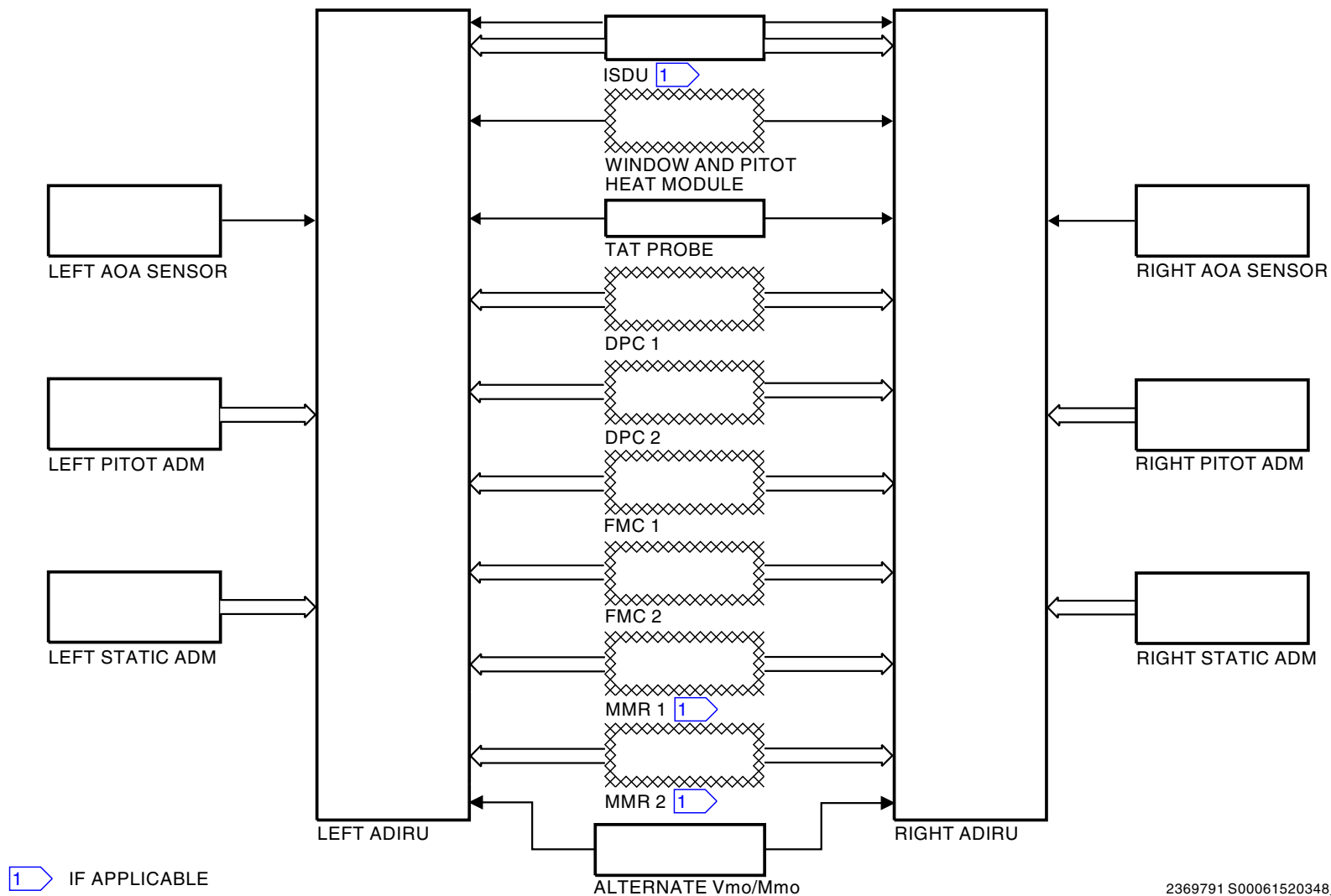
ADIRS - SYSTEM INPUTS

SIA ALL

The ALTERNATE VMO/MMO SWITCH is used to provide an input to the ADIRU to vary the Vmo/Mmo curve. This is done to compensate for a flight with the landing gear down.

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ADIRS - SYSTEM INPUTS



ADIRS - SYSTEM INPUTS

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**ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS****General**

The left ADIRU supplies inertial reference (IR) data to many systems and components. IR data goes out on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the IR section of the ADIRU to the air data reference (ADR) part.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

For airplanes with hybrid GPS-inertial reference data activated, the ADIRU additionally supplies GPS-inertial data to the IR bus.

SIA ALL

These are the components and systems that receive IR data from the left ADIRU:

- Display processing computer (DPC) 1 and 2
- Multi mode receiver (MMR) 1
- Stall management yaw damper (SMYD) 1 and 2
- Flight control computer (FCC) A and B
- Ground proximity warning computer (GPWC)
- Weather radar receiver transmitter (WXR R/T)
- TCAS computer
- Integrated flight systems accessory unit (IFSAU)
- Integrated standby flight display (ISFD)
- Inertial system display unit (ISDU)
- Anti skid autobrake control unit (AACU)
- Flight management computer (FMC) 1 and 2
- Air Traffic Control (ATC) 1
- Network File Server (NFS)
- Spoiler Control Electronics (SCE)

DPC

The DPCs use this IR data from the ADIRUs to show information on the display units:

- Present position
- Track angle
- Magnetic heading
- Wind direction
- True heading
- Ground speed
- Drift angle
- Flight path angle
- Flight path acceleration
- Pitch angle
- Roll angle
- Body pitch rate
- Body roll rate
- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Track angle rate
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Along track horizontal acceleration
- Cross track horizontal acceleration
- Vertical acceleration
- Inertial vertical speed
- N-S velocity
- E-W velocity.

34-21-00**SIA ALL EFFECTIVITY**

D633AM102-SIA

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**ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS****MMR**

The MMR 1 uses present position and inertial altitude from the left ADIRU for GPS calculations.

SMYD

SMYD 1 uses this IR data to calculate stall management and yaw damper values:

- Pitch angle
- Roll angle
- Body roll rate
- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Inertial vertical speed.

SMYD 2 uses this IR data to calculate yaw damper values:

- Roll angle
- Body roll rate
- Body yaw rate
- Body lateral acceleration.

DFCS

The flight control computers (FCC) use this IR data for autoflight calculations:

- Ground speed
- True track angle
- True heading
- Wind speed
- True wind direction

- Magnetic track angle
- Flight path angle
- Flight path acceleration
- Pitch angle
- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Track angle rate
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Along track horizontal acceleration
- Cross track horizontal acceleration
- Vertical acceleration
- Inertial vertical speed.

GPWS

The GPWC uses this IR data to calculate unsafe conditions:

- Latitude
- Longitude
- True track angle
- Magnetic track angle
- Groundspeed
- True heading
- Inertial vertical speed
- Pitch angle
- Roll angle
- Inertial altitude
- Body normal acceleration

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SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS**

- Body longitudinal acceleration
- Inertial vertical acceleration
- Body pitch rate
- IR in attitude mode discrete.

WXR R/T

The ADIRU sends this IR data to the WXR R/T:

- Pitch angle
- Roll angle.

TCAS

This IR data goes to the TCAS computer:

- Pitch attitude rate
- Roll attitude rate
- Magnetic heading.

TCAS does not use this data at this time.

IFSAU

The integrated flight systems accessory unit receives all IR data and sends it to the flight data acquisition unit for recording.

ISFD

The IR bus connects to the integrated standby flight display for an optional display of magnetic heading.

ISDU

The inertial system display unit receives this IR data to show on the IRS display:

- Present position
- True track

- Groundspeed
- Wind speed
- Wind direction
- True heading
- Time remaining until alignment complete
- Bite messages.

AACU

The anti-skid auto-brake control unit (AACU) uses this IR data for auto-brake calculations:

- Groundspeed
- Body longitudinal acceleration
- Pitch attitude.

FMCS

The ADIRU sends this IR data to the flight management computer system (FMCS):

- Present position
- Groundspeed
- True heading
- Magnetic heading
- Pitch angle
- Roll angle
- Inertial altitude
- Inertial vertical speed
- N-S velocity
- E-W velocity.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

- Hybrid Horizontal Integrity Limit (HIL)

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SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS

SIA 005-999; SIA 001-004 POST SB 737-34-3141 (Continued)

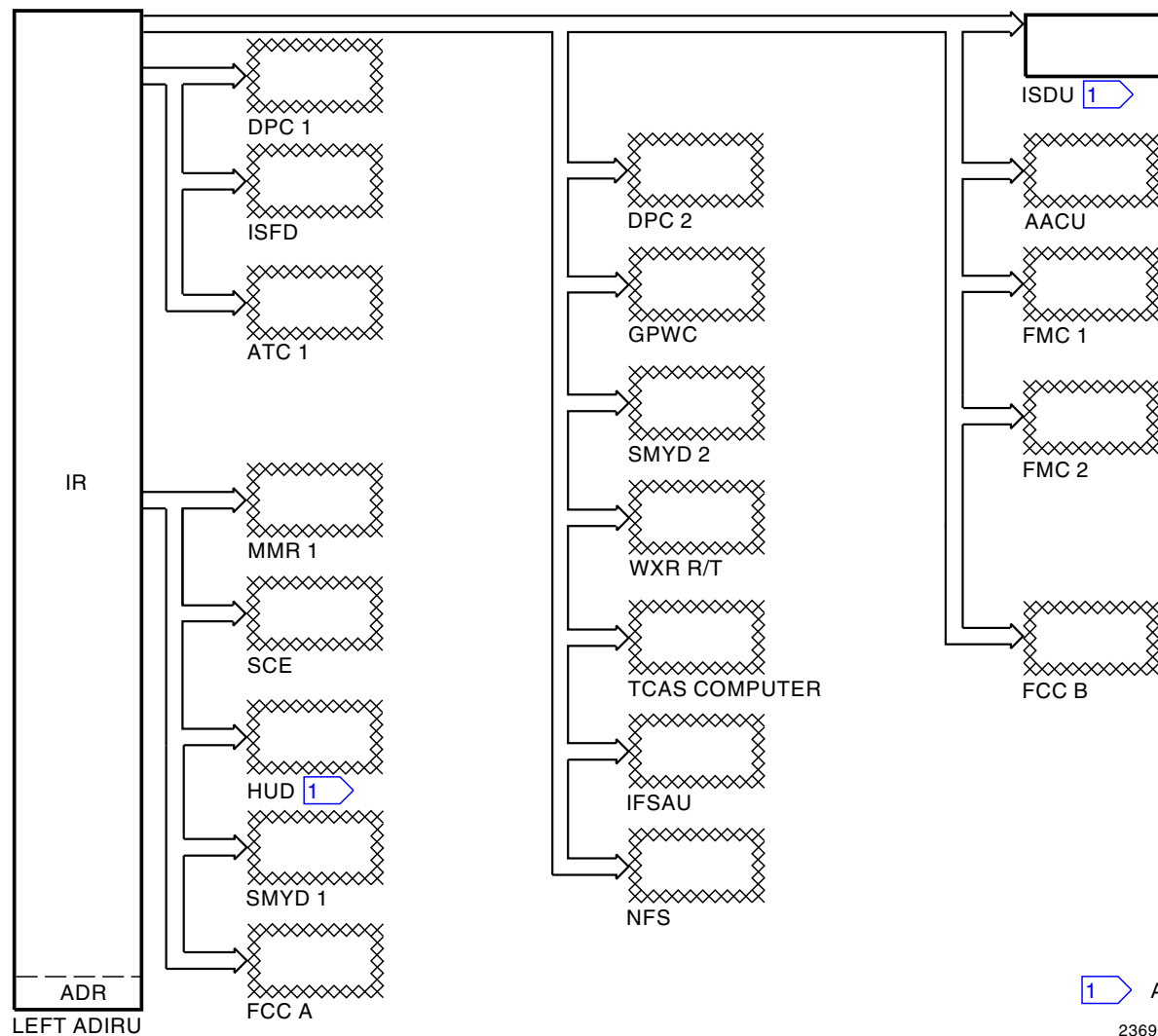
- Hybrid True Heading
- Hybrid Vertical Figure of Merit (FOM)
- Hybrid True Track Angle
- Date & UTC
- Hybrid Ground Speed
- Hybrid Present Position (Latitude/Longitude)
- Hybrid Altitude
- Hybrid Flight Path Angle
- Hybrid Horizontal FOM
- Hybrid North/South & East/West Velocities
- Hybrid Sensor Status
- Hybrid Vertical Velocity
- Hybrid GPS-inertial maintenance words

SIA ALL

The FMCS uses this data for performance and navigation calculations.

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ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS



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ADIRS - LEFT INERTIAL REFERENCE DIGITAL OUTPUTS



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ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS

General

The right ADIRU supplies inertial reference (IR) data to many systems and components. IR data goes out on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the IR part of the ADIRU to the air data reference (ADR) part.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

For airplanes with hybrid GPS-inertial reference data activated, the ADIRU additionally supplies GPS-inertial data to the IR bus.

SIA ALL

These are the components and systems that receive IR data from the right ADIRU:

- Display processing computer (DPC) 1 and 2
- Multi-mode receiver (MMR) 2
- Stall management yaw damper (SMYD) 1 and 2
- Flight control computer (FCC) A and B
- Ground proximity warning computer (GPWC)
- Weather radar receiver transmitter (WXR R/T)
- Integrated flight systems accessory unit (IFSAU)
- Antiskid autobrake control unit (AACU)
- Flight management computer (FMC) 1 and 2.
- Air Traffic Control (ATC) 2
- Digital Flight Data Acquisition Unit (DFDAU)
- Spoiler Control Electronics (SCE)
- Inertial system display unit (ISDU)

DPC

The DPCs use this IR data from the ADIRU to show information on the display units:

- Present position
- Track angle

- Magnetic heading
- Wind direction
- True heading
- Ground speed
- Drift angle
- Flight path angle
- Flight path acceleration
- Pitch angle
- Roll angle
- Body pitch rate
- Body roll rate
- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Track angle rate
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Along track horizontal acceleration
- Cross track horizontal acceleration
- Vertical acceleration
- Inertial vertical speed
- N-S velocity
- E-W velocity.

MMR

The MMR 2 uses present position and inertial altitude from the right ADIRU for GPS calculations.

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EFFECTIVITY	
SIA ALL	

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**ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS****SMYDs**

SMYD 1 uses this IR data to calculate yaw damper values:

- Roll angle
- Body roll rate
- Body yaw rate
- Body lateral acceleration.

SMYD 2 uses this IR data to calculate stall management and yaw damper values:

- Pitch angle
- Roll angle
- Body roll rate
- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Inertial vertical speed.

DFCS

The flight control computers (FCC) use this IR data for autoflight calculations:

- Ground speed
- True track angle
- True heading
- Wind speed
- True wind direction
- Magnetic track angle
- Flight path angle
- Flight path acceleration
- Pitch angle

- Body yaw rate
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Track angle rate
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Along track horizontal acceleration
- Cross track horizontal acceleration
- Vertical acceleration
- Inertial vertical speed.

WXR R/T

The ADIRU sends this IR data to the WXR R/T:

- Pitch angle
- Roll angle.

IFSAU

The integrated flight systems accessory unit receives all IR data and sends it to the flight data acquisition unit for recording.

ISDU

The inertial system display unit (ISDU) receives this IR data to show on the IRS display:

- Present position
- True track
- Groundspeed
- Wind speed
- Wind direction

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EFFECTIVITY	
SIA ALL	

**ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS**

- True heading
- Time remaining until alignment complete
- Bite messages.

AACU

The anti-skid auto-brake control unit (AACU) uses this IR data for auto-brake calculations:

- Groundspeed
- Body longitudinal acceleration
- Pitch attitude.

FMCS

The ADIRU sends this IR data to the flight management computer system (FMCS):

- Present position
- Groundspeed
- True heading
- Magnetic heading
- Pitch angle
- Roll angle
- Inertial altitude
- Inertial vertical speed
- N-S velocity
- E-W velocity.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

- Hybrid Horizontal Integrity Limit (HIL)
- Hybrid True Heading
- Hybrid Vertical Figure of Merit (FOM)
- Hybrid True Track Angle

- Date & UTC
- Hybrid Ground Speed
- Hybrid Present Position (Latitude/Longitude)
- Hybrid Altitude
- Hybrid Flight Path Angle
- Hybrid Horizontal FOM
- Hybrid North/South & East/West Velocities
- Hybrid Sensor Status
- Hybrid Vertical Velocity
- Hybrid GPS-inertial maintenance words

SIA ALL

The FMCS uses this data for performance and navigation calculations.

DFDAU

The ADIRU sends these parameters to the Digital Flight Data Acquisition Unit (DFDAU):

- AD/IR fault
- Excess motion error
- No IR initialization
- Align fault
- On DC
- IR fault
- ADC fault
- DC fail
- altitude invalid
- Set heading
- Nav mode
- Rev attitude mode
- Align mode not ready
- Auto nav realign

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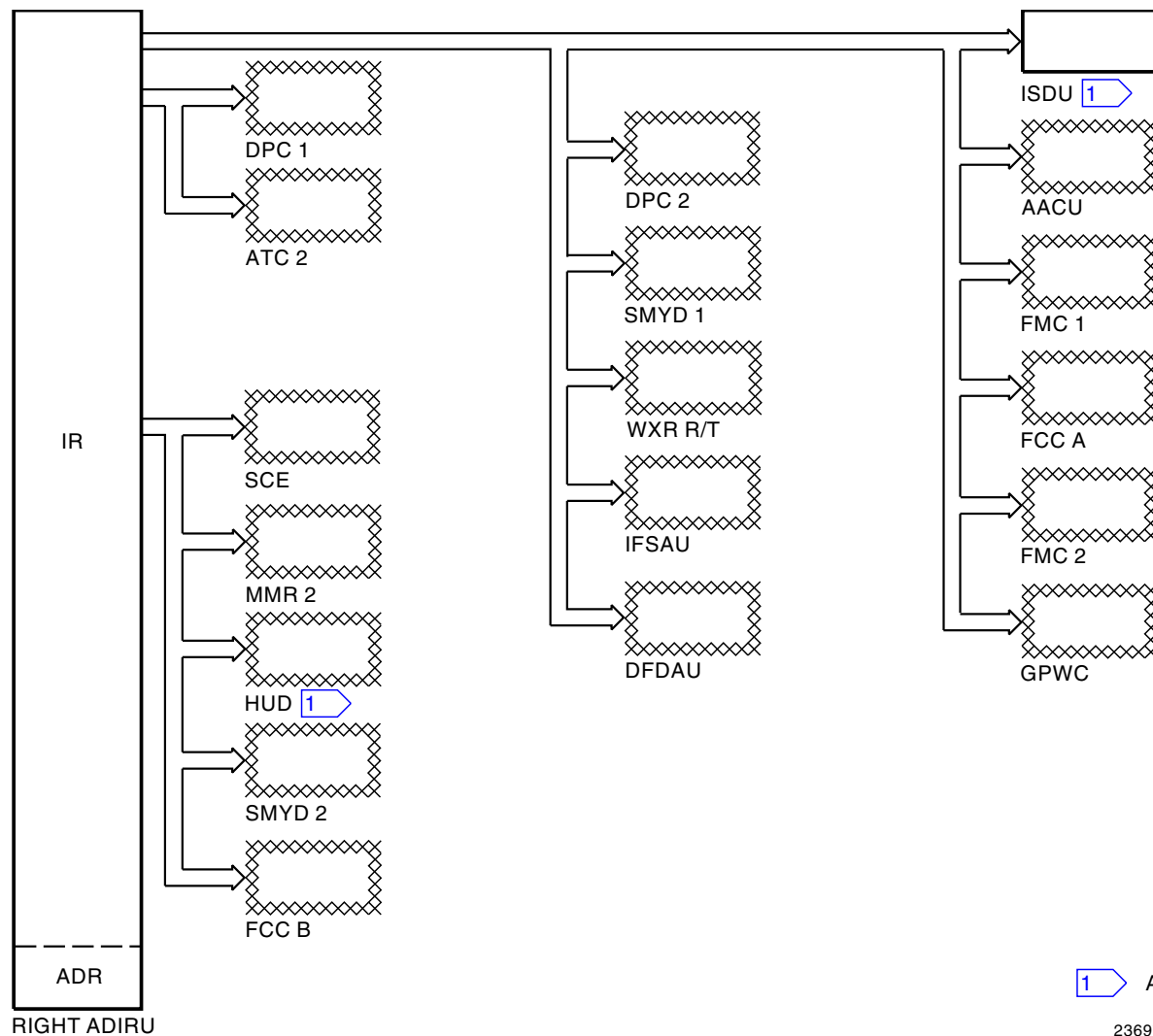


ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS

- IR A/C ident code invalid
- variable align select
- ADIRU select.

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ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS



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ADIRS - RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS



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**ADIRS - LEFT AIR DATA OUTPUTS****General**

The left ADIRU supplies air data reference (ADR) data to many systems and components. ADR data is on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the ADR section of the ADIRU to the IR section. These components and systems receive ADR data from the left ADIRU:

- Display processing computer (DPC) 1 and 2
- Flight control computer (FCC) A
- Flight data acquisition unit (FDAU)
- Air traffic control (ATC) 1 and 2
- Flap/slat electronics unit (FSEU)
- Ground proximity warning computer (GPWC)
- Stall management yaw damper (SMYD) 1
- Cabin pressure controller 1 and 2
- Weather radar receiver transmitter (WXR R/T)
- Flight management computer (FMC) 1 and 2.

DPC

The ADIRU sends this ADR data to the DPCs:

- Computed airspeed
- Mach
- True airspeed
- Total pressure
- Corrected barometric altitude
- Uncorrected barometric altitude
- Total air temperature
- Air data discretes
- Angle of Attack.

The DPC uses this data for display information and sends it on to other systems such as the electronic engine control (EEC).

FCC A

The ADIRU sends this ADR data to FCC A:

- Computed airspeed
- True airspeed
- Corrected baro altitude
- Uncorrected barometric altitude
- Altitude rate
- Static pressure
- Mach
- Angle of Attack.

FCC A uses this information for automatic flight control mode calculations.

FDAU

The ADIRU sends all ADR data to the flight data acquisition unit (FDAU). The FDAU selects and formats this data and then sends it to the digital flight data recorder (DFDR) to be recorded.

ATC Transponders

The ADIRU sends uncorrected baro altitude data to the ATC transponders for altitude reporting.

FSEU

The ADIRU sends computed airspeed to the flap slat electronics unit (FSEU) for flap load relief calculations and as part of its uncommanded motion detection logic.

GPWC

The ADIRU sends this ADR data to the GPWC:

- Computed airspeed
- Altitude rate
- Corrected baro altitude

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SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADIRS - LEFT AIR DATA OUTPUTS

- Uncorrected baro altitude
- True airspeed.

The FMCS uses this data for performance calculations.

The GPWC uses this data to detect unsafe flight conditions.

SMYD 1

The ADIRU sends this data to SMYD 1:

- Mach
- True airspeed
- Computed airspeed
- Impact pressure.

The SMYD 1 uses this data for stall management and yaw damper calculations.

CPC

The ADIRU sends this ADR data to cabin pressure controller (CPC) 1 and 2 to calculate pressurization values:

- Corrected baro altitude
- Uncorrected baro altitude
- Static pressure.

FMCS

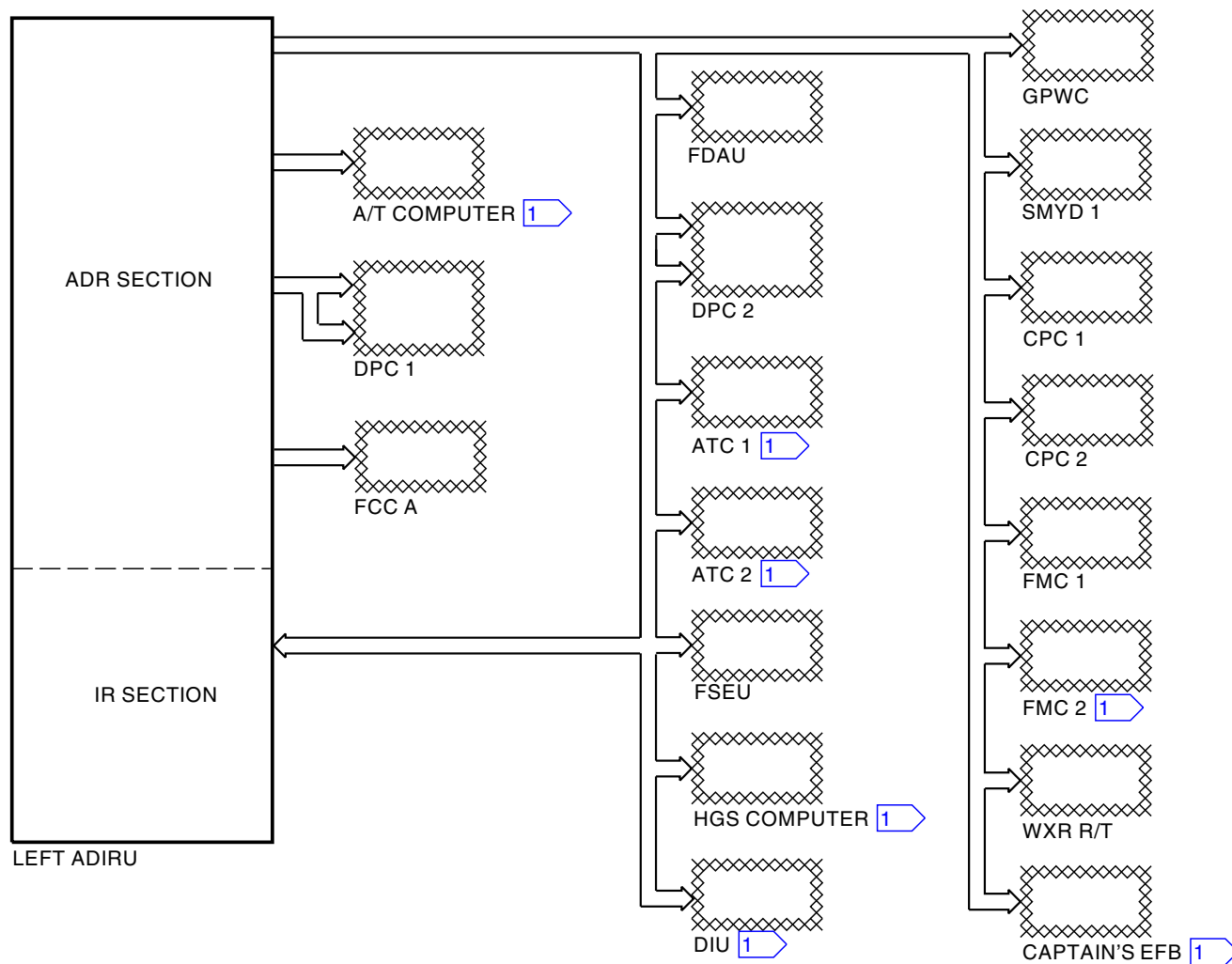
The ADIRU sends this ADR data to the FMCS:

- Computed airspeed
- True airspeed
- Mach
- Corrected baro altitude
- Uncorrected baro altitude
- Total air temperature
- Static air temperature.

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ADIRS - LEFT AIR DATA OUTPUTS



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ADIRS - LEFT AIR DATA OUTPUTS



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**ADIRS - RIGHT AIR DATA OUTPUTS****General**

The right ADIRU supplies air data reference (ADR) data to many systems and components. ADR data is on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the ADR section of the ADIRU to the IR section. These components and systems receive ADR data from the right ADIRU:

- Display processing computer (DPC) 1 and 2
- Flight control computer (FCC) B
- Air traffic control (ATC) 1 and 2
- Ground proximity warning computer (GPWC)
- Stall management yaw damper (SMYD) 2
- Cabin pressure controller 1 and 2
- Weather radar receiver transmitter (WXR R/T)
- Flight management computer (FMC) 1 and 2.

DPC

The ADIRU sends this ADR data to the DPCs:

- Computed airspeed
- Mach
- True airspeed
- Total pressure
- Corrected barometric altitude
- Uncorrected barometric altitude
- Total air temperature
- Air data discretes
- Angle of Attack.

The DPCs use this data for display information and sends it on to other systems such as the electronic engine control (EEC).

FCC B

The ADIRU sends this ADR data to FCC B:

- Computed airspeed
- True airspeed
- Corrected baro altitude
- Uncorrected barometric altitude
- Altitude rate
- Static pressure
- Mach
- Angle of Attack.

FCC B uses this information for automatic flight control mode calculations.

ATC Transponders

The ADIRU sends uncorrected baro altitude data to the ATC transponders for altitude reporting.

GPWC

The ADIRU sends this ADR data to the GPWC:

- Computed airspeed
- Altitude rate
- Corrected baro altitude
- Uncorrected baro altitude
- True airspeed.

The GPWC uses this data to detect unsafe flight conditions.

SMYD 2

The ADIRU sends this data to SMYD 2:

- Mach
- True airspeed

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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADIRS - RIGHT AIR DATA OUTPUTS

- Computed airspeed
- Impact pressure.

The SMYD 2 uses this data for stall management and yaw damper calculations.

CPC

The ADIRU sends this ADR data to cabin pressure controller (CPC) 1 and 2 to calculate pressurization values:

- Corrected baro altitude
- Uncorrected baro altitude
- Static pressure.

FMCS

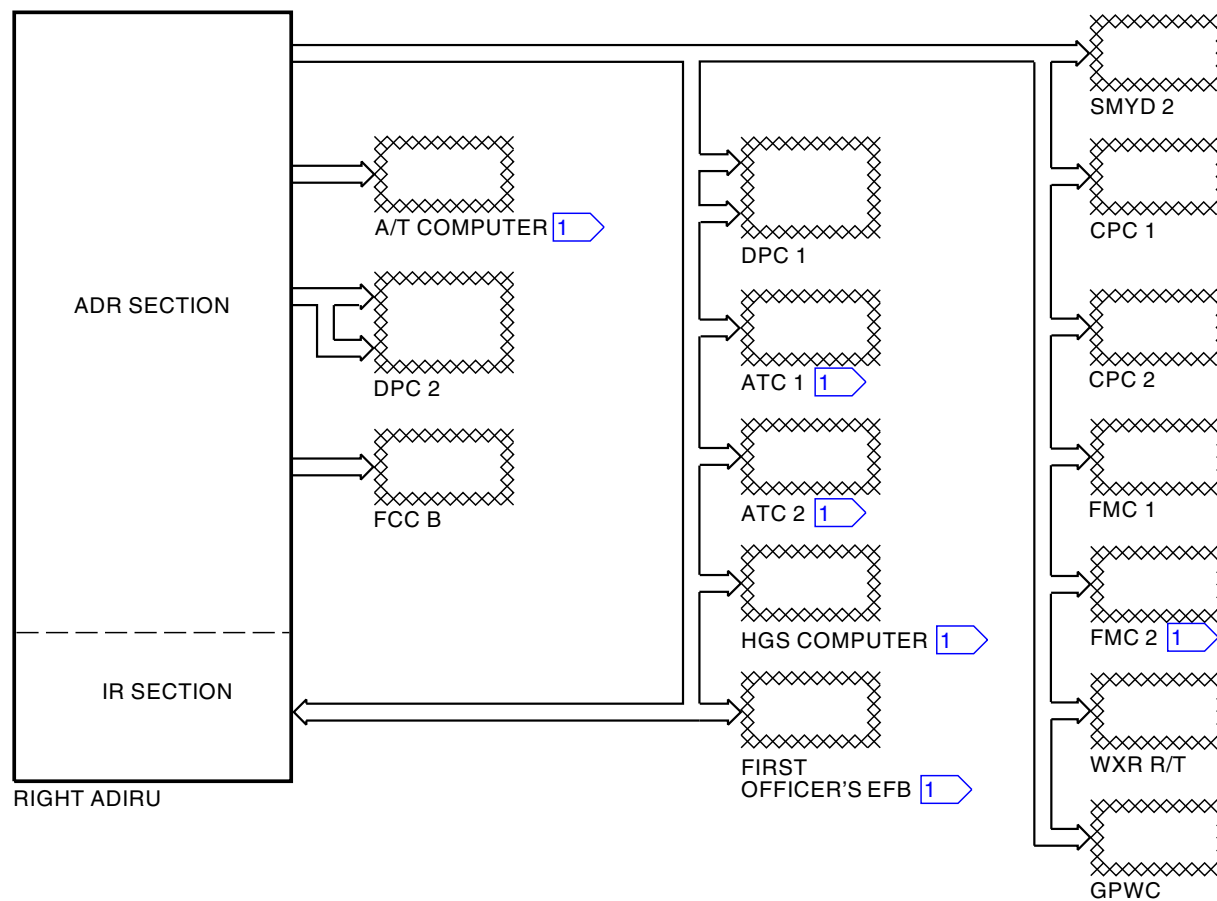
The ADIRU sends this ADR data to the FMCS:

- Computed airspeed
- True airspeed
- Mach
- Corrected baro altitude
- Uncorrected baro altitude
- Total air temperature
- Static air temperature.

The FMCS uses this data for performance and guidance calculations.

EFFECTIVITY	
SIA ALL	

ADIRS - RIGHT AIR DATA OUTPUTS



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ADIRS - RIGHT AIR DATA OUTPUTS



ADIRS - IR SIGNAL SWITCHING

General

The IRS transfer switch on the instrument switching module selects the ADIRU to supply inertial reference (IR) data to components and systems. The IRS transfer switch does not affect air data reference (ADR) signals.

IRS Transfer Switch

The IRS transfer switch is a three-position switch. These are the three positions:

- Normal
- Both on L
- Both on R.

The normal position sends discrete signals that tell the components to use their usual source of IR data.

The BOTH ON L and BOTH ON R switch positions tell the components to use only left IR data or only right IR data.

The MDS display processing computers (DPCs) cause the INSTR SWITCH message to show on the display units when the IRS transfer switch is in the BOTH ON L or BOTH ON R position.

IFSAU Relay

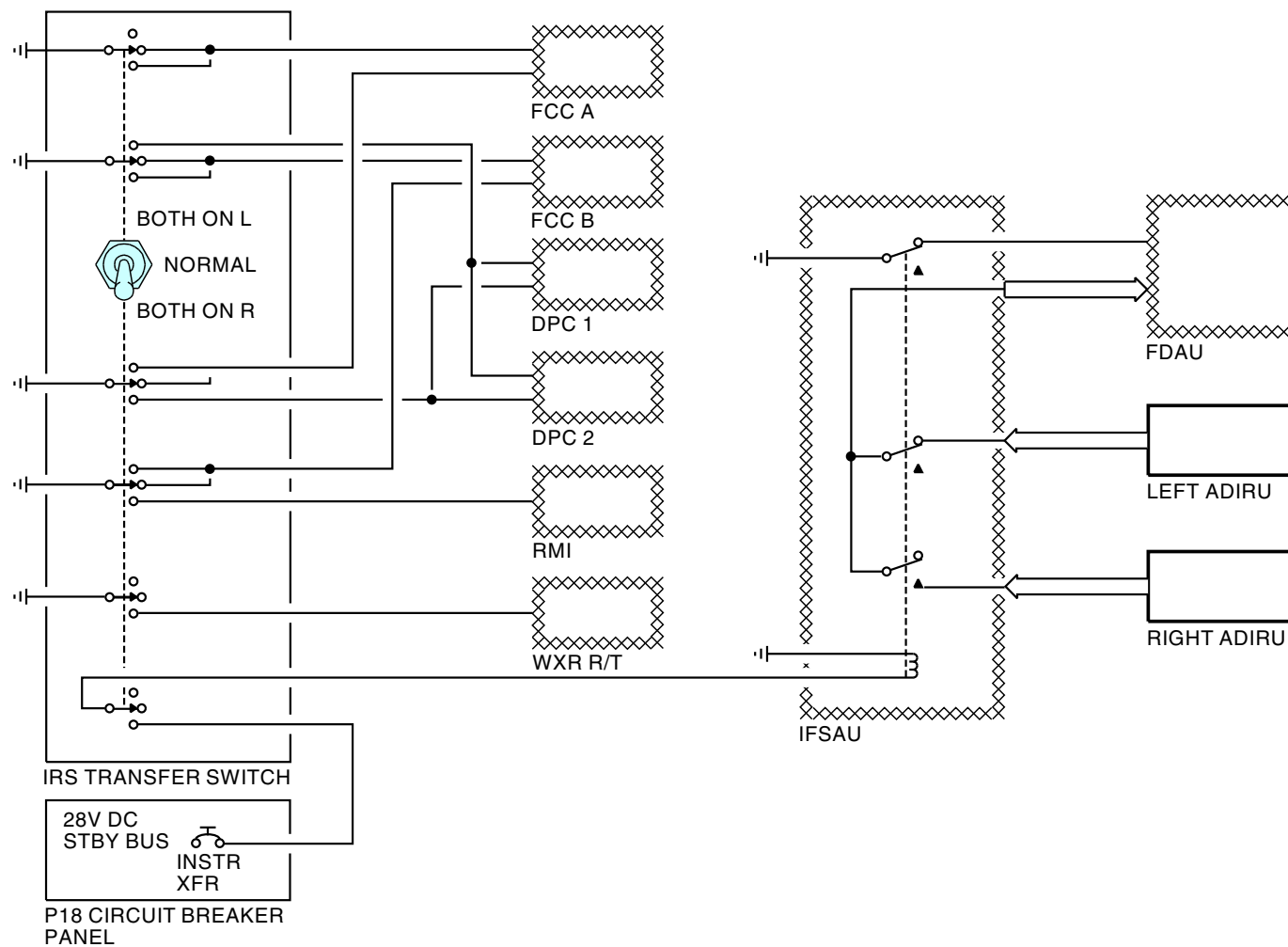
The position of a relay in the integrated flight systems accessory unit (IFSAU) sets the source of IR data to the flight data acquisition unit (FDAU). The usual source of IR data is the left ADIRU. Set the IRS transfer switch to BOTH ON R to energize the relay in the IFSAU. The energized relay sets the IR data source to the right ADIRU.

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ADIRS - IR SIGNAL SWITCHING



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ADIRS - IR SIGNAL SWITCHING

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EFFECTIVITY

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**ADIRS - AIR DATA INERTIAL REFERENCE UNIT****General**

The air data inertial reference unit (ADIRU) has two functions:

- Air data reference (ADR) calculations
- Inertial reference (IR) calculations.

The ADIRU has three parts. These are the three parts:

- Power supply
- Air data
- Inertial reference.

Physical Properties

These are the physical properties of the ADIRU:

- Length - 15.12 in. (38.40 cm)
- Width - 4.88 in. (12.40 cm)
- Height - 7.64 in. (19.41 cm)
- Weight - 28 lb (13 kg)
- Power - 69 watts AC, 64 watts DC steady state.

Power Supply

The power supply is the only part of the ADIRU used by both the ADR function and the IR function. The power supply receives 115v ac and 28v dc from the airplane buses and supplies operating voltages to the ADR and IR.

Air Data Reference

The ADR function receives digital inputs of pitot and static pressure from the air data modules and temperature inputs from the total air temperature probe. It uses these inputs to calculate the air data parameters. It also receives analog inputs from the AOA vane for error correction.

Inertial Reference

The inertial reference function has three accelerometers and three laser gyros which sense motion and angular movements. The IR function uses these sensor signals to calculate these and other parameters:

- Airplane attitude
- Heading
- Acceleration
- Position.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

The inertial reference function uses GPS data from the MMR to calculate hybrid GPS-inertial parameters.

SIA ALL

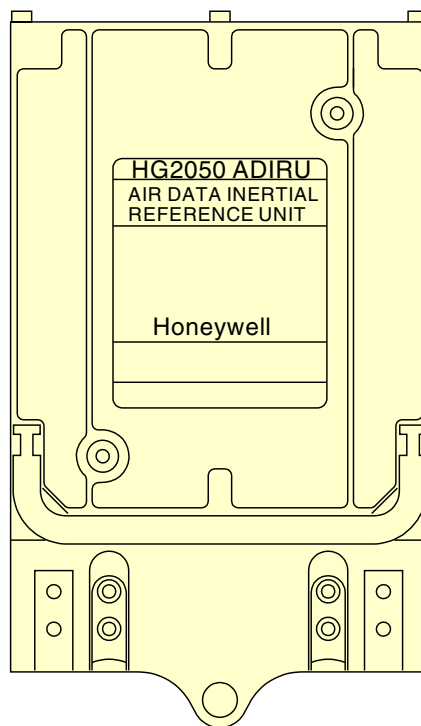
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - AIR DATA INERTIAL REFERENCE UNIT



ADIRS - AIR DATA INERTIAL REFERENCE UNIT

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**ADIRS - INERTIAL SYSTEM DISPLAY UNIT****Purpose**

The inertial system display unit (ISDU) has an interface with the ADIRUs. You can send digital data to the ADIRUs and show digital information and maintenance information from the ADIRUs.

Physical Properties

These are the properties of the ISDU:

- Height - 4.5 in. (11.4 cm)
- Width - 5.75 in. (14.60 cm)
- Depth - 5.25 in. (13.34 cm)
- Weight - 3.7 lb (1.7 kg)
- Power - 11 watts steady state.

Features

Use the keyboard on the front panel to enter latitude, longitude, and heading data.

The SYS DSPL switch selects left or right ADIRU data to show on the IRS display.

The IRS display is a 13-character display that can show numbers and the letters N, S, E, and W. The characters are incandescent filaments. Each character is line replaceable.

The DSPL SEL switch selects the data to show from the ADIRU. The DSPL SEL switch has these positions:

- TEST - When switch is held in TEST position, all the lights in the data displays and the MSU illuminate momentarily then execute a 10 second internal self test. The switch is spring loaded to return to the TK/GS position.
- TK/GS (track/ground speed) - The left display indicates true track and the right display indicates Ground Speed in knots.
- PPOS (present position) - The airplane's present position is displayed as latitude and longitude

- WIND (wind speed/wind direction) - The left display window indicates true wind speed and the right display window indicates true wind direction inflight.
- HDG/STS (heading/status) - The left window displays true heading and the right window display any maintenance status codes. During alignment, the right window displays time remaining until alignment is completed. For alignment times that exceed 15 minutes, the display will show 15 minutes until the remaining time goes below 15 minutes. The display then counts down in increments of one minute.

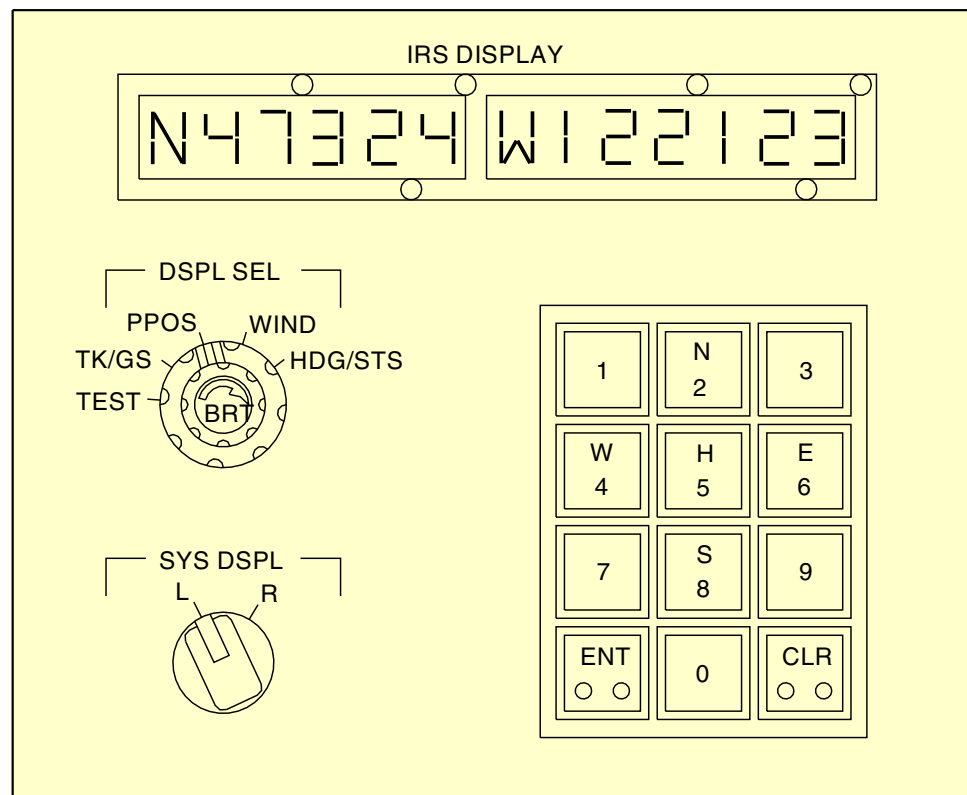
A BRT control is on the center of the DSPL SEL switch. Use the BRT control to adjust the brightness of the ISDU display and back lights.

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EFFECTIVITY	
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D633AM102-SIA

ADIRS - INERTIAL SYSTEM DISPLAY UNIT



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ADIRS - INERTIAL SYSTEM DISPLAY UNIT

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SIA ALL	EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - MODE SELECT UNIT

Purpose

The mode select unit (MSU) sends IR mode selection instructions to the ADIRUs. It also gives visual indications of ADIRS operation and failures.

- DC FAIL. An amber annunciator that comes on steady when the DC power source is less than 18v dc.

Physical Properties



CAUTION YOU MUST PULL AND TURN SOME SWITCHES. IF YOU TRY TO TURN THESE SWITCHES BEFORE YOU PULL THEM, YOU CAN DAMAGE THE SWITCH.

The MSU has two mode selectors. One for the left ADIRU, and one for the right ADIRU. Each mode selector has four positions. These are the four positions:

- OFF. Causes the ADIRU not to operate
- ALIGN. Causes the ADIRU to start the alignment process
- NAV. Causes the ADIRU to enter the navigation mode after a successful alignment
- ATT. Causes the ADIRU to enter the attitude mode.

The mode selectors have a feature to decrease the risk that the flight crew will accidentally put the ADIRU in a mode that will disable its operation. When the selector is in the NAV position, the operator must pull the knob to put it in the ATT mode. When the selector is in the ALIGN position, the operator must pull the knob to put the selector in the OFF position. All other position changes do not require the operator to pull the knob.

The MSU has two sets of annunciators. One set is for the left ADIRU and one set is for the right ADIRU. Each set has these annunciators:

- ALIGN. A white annunciator that comes on steady during ADIRU alignment. The annunciator will flash when the ADIRU needs information.
- ON DC. An amber annunciator that comes on steady when the ADIRU is on the 28v dc power source.
- FAULT. An amber annunciator that comes on steady when the IR function of the ADIRU fails.

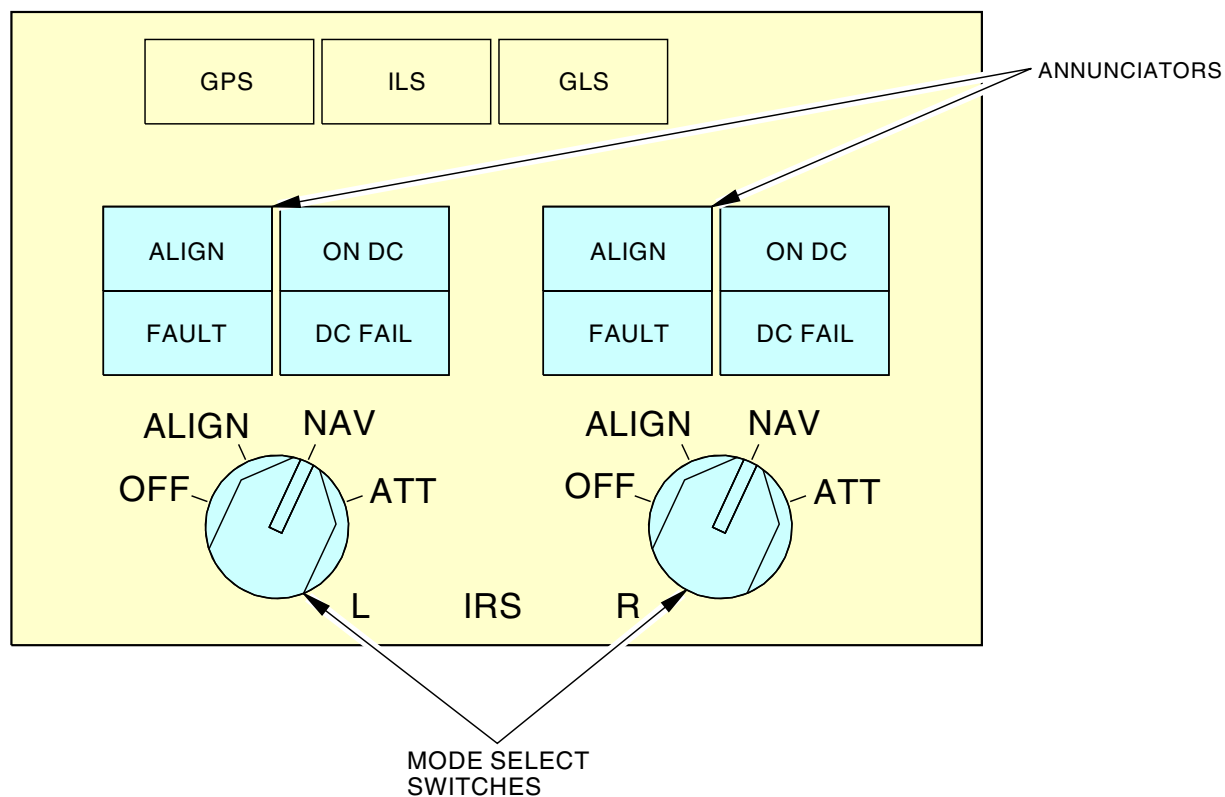
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EFFECTIVITY	
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - MODE SELECT UNIT



ADIRS - MODE SELECT UNIT

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**ADIRS - IRS MASTER CAUTION UNIT****Purpose**

The IRS master caution unit monitors the ADIRS for unsatisfactory conditions. It controls the IRS light on the master caution annunciator and it supplies discrete signals to the master caution lights.

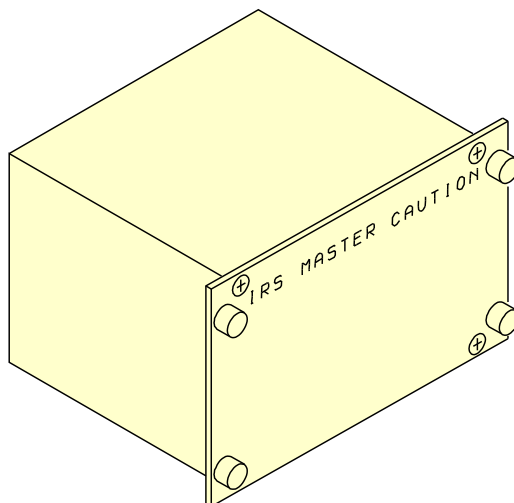
Physical Properties

The IRS master caution unit contains circuit cards. The cards do these functions:

- Monitors ON DC, IR FAULT, and DC FAIL logic from the ADIRUs
- Controls the IRS light on the master caution annunciator.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ADIRS - IRS MASTER CAUTION UNIT



ADIRS - IRS MASTER CAUTION UNIT

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-21-00



ADIRS - AIR DATA MODULE

General

The ADIRS has four air data modules (ADMs). One ADM is for each of these components:

- Captain's pitot probe
- Captain's static port
- First officer's pitot probe
- First officer's static port.

Purpose

The ADM measures air pressure and changes the measured value to ARINC 429 data. The ADM transmits the data to the ADIRU.

Physical Properties

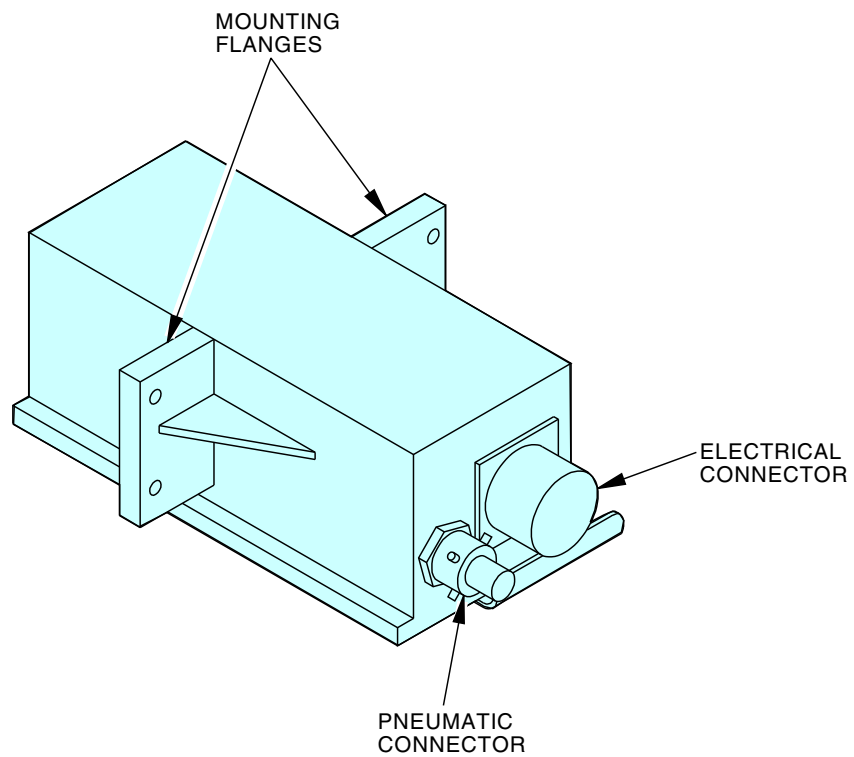
The ADM has these dimensions:

- Height - 2.5 in. (6.35 cm)
- Width - 3 in. (7.62 cm)
- Length - 6 in. (15.24 cm).

The ADM mounts to the airframe with the two flanges on the sides of the unit. The ADM weighs less than 2 pounds. It does not need to be cooled. The ADMs are interchangeable.

EFFECTIVITY	
SIA ALL	

ADIRS - AIR DATA MODULE



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ADIRS - AIR DATA MODULE

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-21-00



ADIRS - ANGLE OF ATTACK SENSOR

General

The angle of attack (AOA) sensor measures the direction of airflow relative to the fuselage.

NOTE: When the AOA sensors are static with no air passing over them as in flight, it is normal to observe the values fluctuate from wind, people movement on the airplane, and vibration from engine runs.

Physical Properties

These are the physical properties of the AOA sensor:

- Length - 7.5 in. (19 cm)
- Diameter - 3.2 in. (8.1 cm)
- Weight - 2.5 lb (1.1 kg).

Resolvers

There are two resolvers in each AOA sensor.

The AOA data from the two resolvers in the left AOA sensor go to the left ADIRU and to the stall management yaw damper (SMYD) 1. The AOA data from the two resolvers in the right AOA sensor goes to the right ADIRU and to the SMYD 2.

Electrical Connector

The angle of attack sensor has two electrical connectors. One connector receives heater power and supplies resolver 1 data to the SMYD. The other connector supplies resolver 2 data to the ADIRU.

Installation

You install the AOA sensor from the outside of the airplane.

There are two alignment pins on the AOA sensor. Make sure the pins fit in their holes when you install the AOA sensor.

SIA 001, 007-010; SIA 002-006 POST SB 737-31-1860

AOA Cross Compare

AOA DISAGREE alert message appears on PFD when the left and right AOA vane positions differ from each other by more than 10 degrees and this condition lasts longer than 10 seconds. This alert is not displayed on the ground.

During takeoff, the AOA DISAGREE alert is inhibited until the airplane is above 400 feet Radio altitude. Above 400 feet radio altitude, the alert is displayed when the AOA disagree conditions are met and will stay displayed the whole duration of the flight.

During landing, at 400 feet radio altitude, the AOA DISAGREE will latch the current display state of the annunciation until the airplane is on the ground. If the annunciation is displayed and the airplane is below 400 feet radio altitude, the AOA DISAGREE will remain displayed even when the disagree condition no longer exist. If the annunciation is not displayed and the airplane goes below 400 feet radio altitude, the AOA DISAGREE annunciation will not be displayed even if the disagree conditions are met. When the airplane is on the ground, the AOA DISAGREE will not be displayed.

SIA ALL

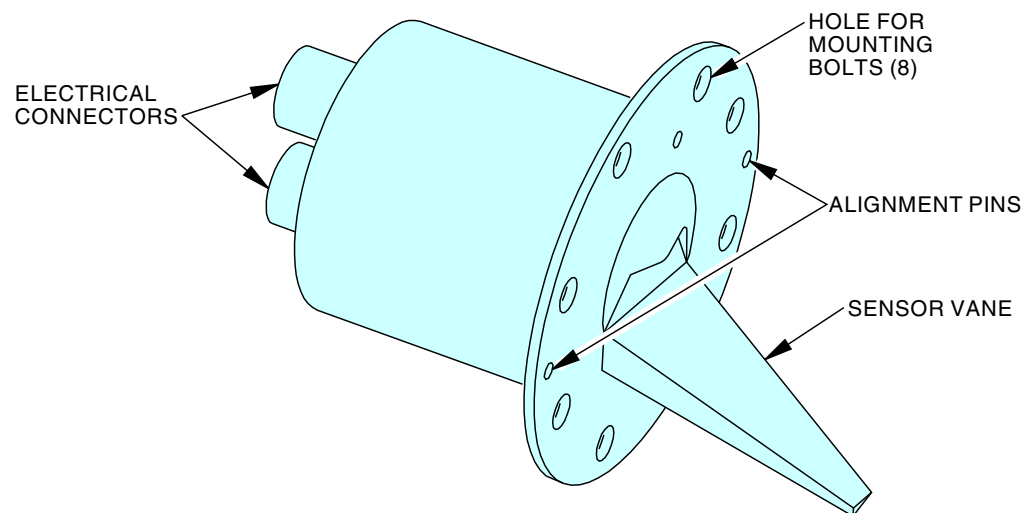
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - ANGLE OF ATTACK SENSOR



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ADIRS - ANGLE OF ATTACK SENSOR

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SIA ALL	EFFECTIVITY
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ADIRS - TOTAL AIR TEMPERATURE PROBE

General

The total air temperature (TAT) probe measures the air temperature outside the airplane. An opening in the front of the sensor lets air flow through and around the sensing elements and exit through ports in the rear of the probe.

Sensing Elements

There are two sense elements in the TAT probe. Each sense element is a resistive element. The value of resistance changes when the temperature of the air flow across the element changes.

Bleed Air

The TAT probe gets bleed air from the APU duct in the keel beam. See the bleed air chapter for more information. (CHAPTER 36)

Bleed air into the probe makes a negative pressure inside the probe. The negative pressure pulls outside air across the sensing elements. This permits accurate temperature measurement when the airplane is on the ground or moving at low speed.

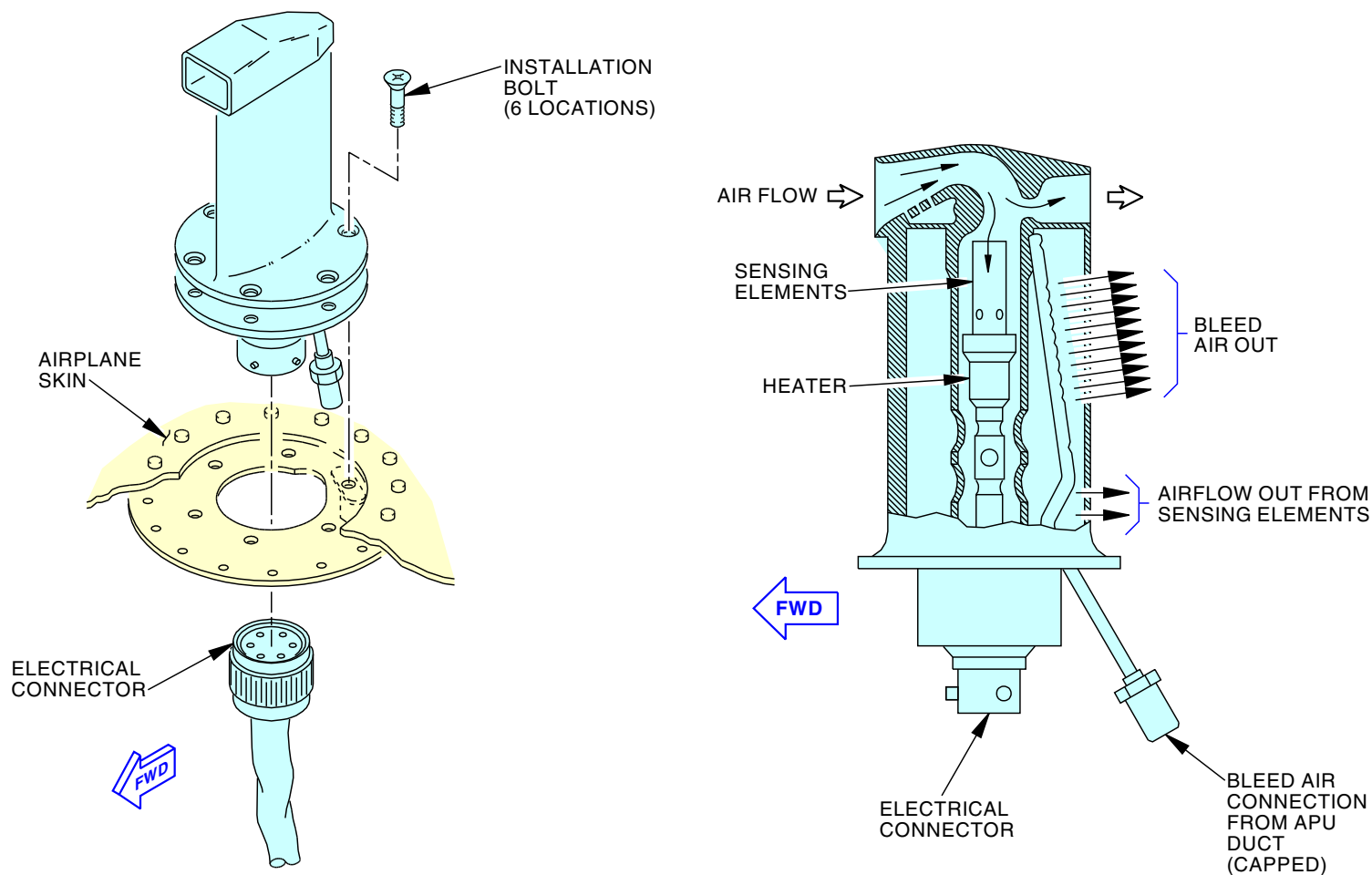
NOTE: If the bleed air is not used. The bleed air connection is capped. The temperature measurement is accurate only when the airplane is in flight.

Electrical Connector

The analog connection to the ADIRUs and to the heater power connection comes through the electrical connector. The heater in the TAT probe prevents ice.

EFFECTIVITY	
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ADIRS - TOTAL AIR TEMPERATURE PROBE



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ADIRS - TOTAL AIR TEMPERATURE PROBE

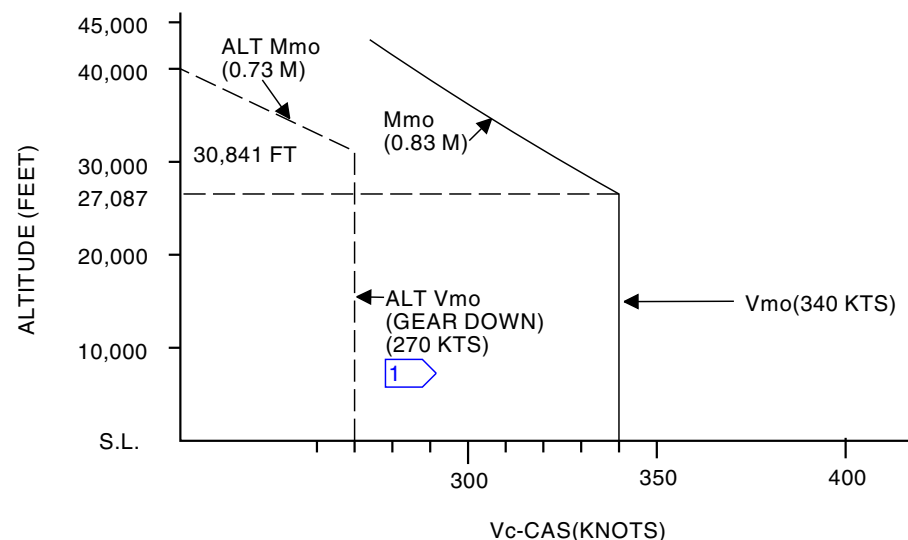
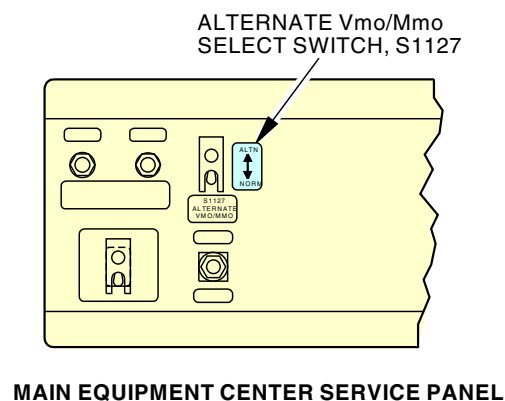
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**ADIRS - ALTERNATE VMO/MMO SWITCH****ALTERNATE VMO/MMO SWITCH**

The ALTERNATE VMO/MMO get the signal from the ALTERNATE VMO/MMO SWITCH(Gear Down Dispatch Switch). The ALTERNATE VMO/MMO switch input is provided to the ADIRU. When the switch is pushed up to the ALTERNATE position, the ADIRU adjusts the Vmo/Mmo curve to compensate for a flight with the landing gear down. The ALTERNATE VMO/MMO is located in the E/E bay on the Main Equipment Center Service Panel.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ADIRS - ALTERNATE VMO/MMO SWITCH



Vmo/Mmo OVERSPEED DISCRETE ACTUATION POINTS
NORMAL $V_c \geq 341 \pm 0.25$ KNOTS
 $M_c \geq 0.823 \pm 0.0005$ MACH

ALTERNATE Vmo/Mmo OVERSPEED
SWITCH ACTUATION POINTS

$V_c \geq 271.0 \pm 0.25$ KNOTS
 $M_c \geq 0.742 \pm 0.0005$ MACH

Vmo = MAX OPERATING AIRSPEED
Vc = COMPUTED AIRSPEED OUTPUT, OF ACTUATION POINT, KNOTS
Mc = MACH NUMBER OUTPUT OF ACTUATION POINT
Mmo = MAX OPERATING MACH

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ALTERNATE VMO/MMO SWITCH

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SIA ALL

EFFECTIVITY

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ADIRS - IR GENERAL THEORY 1

General

The inertial reference function of the ADIRU supplies heading and attitude information. The ADIRU calculates this information with accelerometer and laser gyro sensed data.

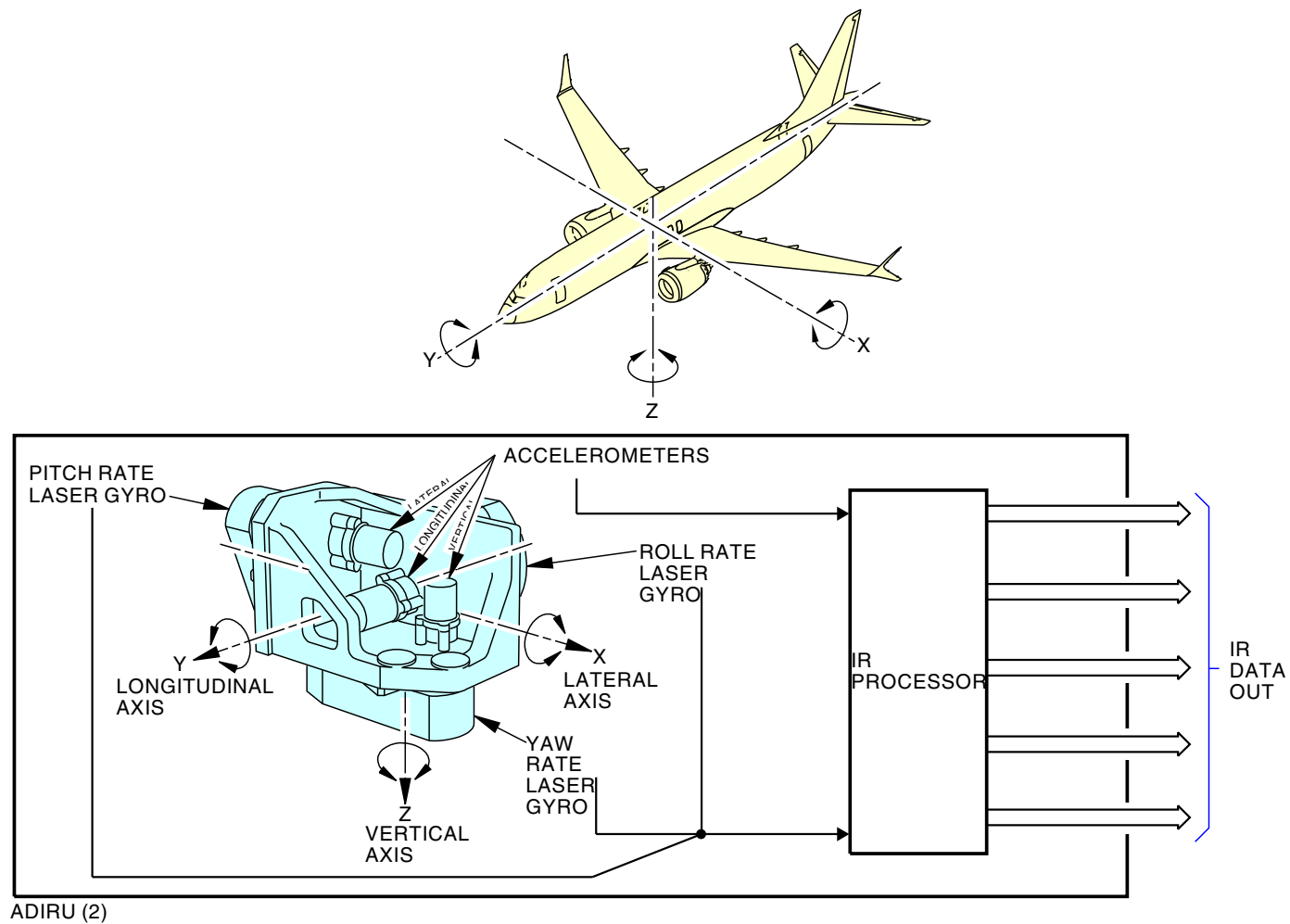
The ADIRU has three accelerometers and three laser gyros. The accelerometer orientation in the ADIRU is on the x, y, and z axes of the airplane. This orientation allows the ADIRU to sense accelerations in each of the three axes. The three laser gyros sense pitch, roll, and yaw rotation around the x, y, and z axes.

The accelerometers and laser gyros are in a strap-down configuration. This means that their orientation is on the x, y, and z axes of the airplane and they move with the airplane when it moves around or along the axes.

The IR processor in the ADIRU uses the sensor signals to calculate IR data.

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ADIRS - IR GENERAL THEORY 1



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ADIRS - IR GENERAL THEORY 1

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**ADIRS - IR GENERAL THEORY 2****General**

The ADIRU uses three accelerometers to sense motion along the x, y, and z axes. Each accelerometer senses acceleration along one axis. The accelerometer can sense very large and very small accelerations along this axis.

Each accelerometer measures acceleration along a different axis than the other two accelerometers.

Operation

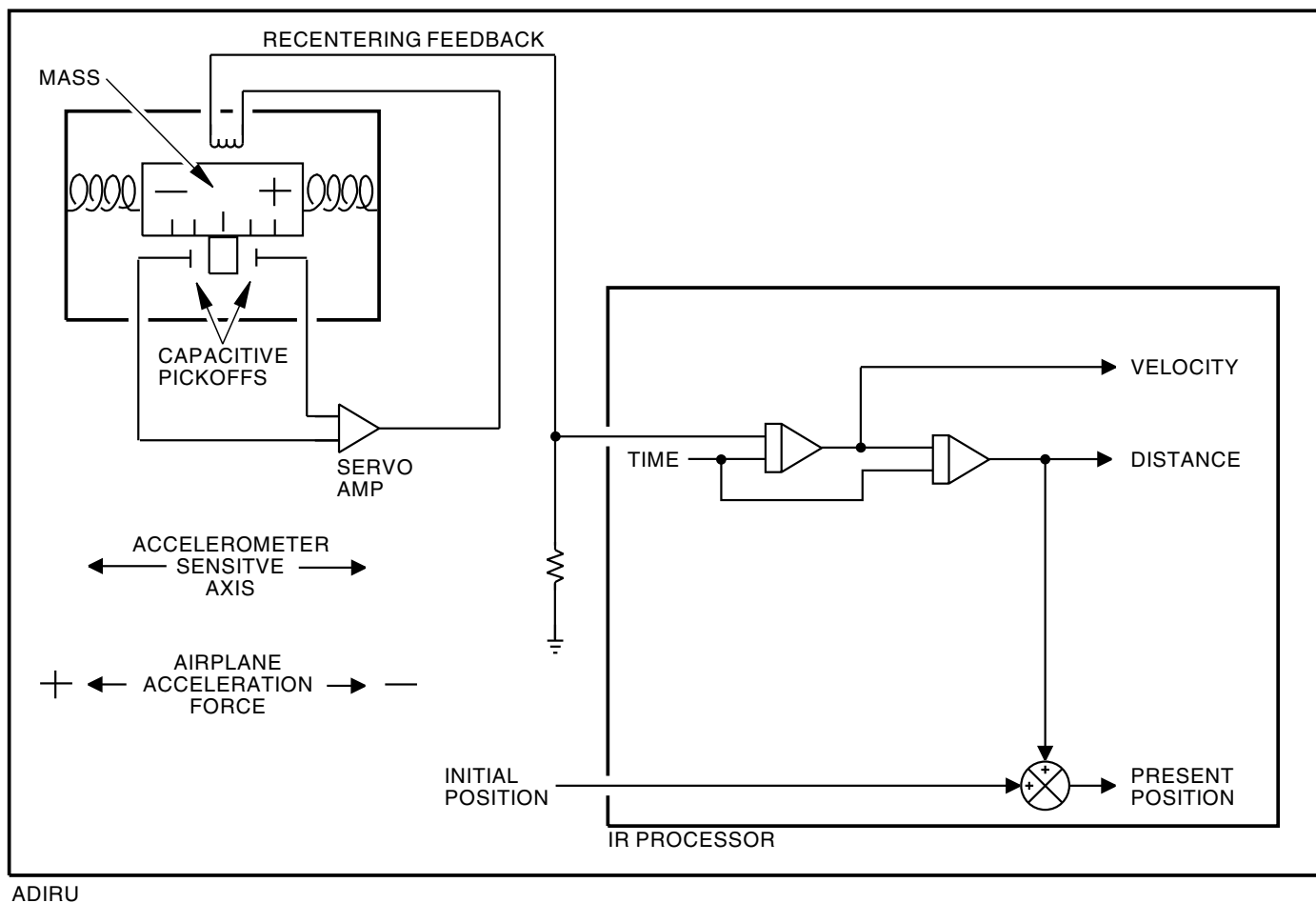
The accelerometer is a mass centered in an outer case by two springs. When the airplane accelerates, the mass moves from the center and makes an electrical signal through the pickoffs. An amplifier then amplifies this signal and sends it to the recentering coil which moves the mass back to center. The amount of the signal necessary to keep the mass centered is proportional to airplane acceleration.

The IR processor integrates the feedback signal with time to calculate velocity and then integrates the calculated velocity with time to calculate distance flown.

The IR processor then adds distance flown to the initial position to calculate present position.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ADIRS - IR GENERAL THEORY 2



ADIRU

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ADIRS - IR GENERAL THEORY 2

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SIA ALL EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADIRS - IR GENERAL THEORY 3

General

Each gyro is a triangular shaped, helium-neon laser that creates two light beams. One light beam travels in the clockwise direction. The other light beam travels in the counter-clockwise direction.

Laser Beam Generation

Light beam production, or lasing, occurs when a high voltage discharge between the anodes and the cathode causes ionization of a low pressure mixture of helium-neon gas in the gas discharge region of the gyro. The ionized particles in the gas discharge region begin to glow creating light. Mirrors in each corner of the triangle reflect this light around the triangle creating the clockwise and counter-clockwise light beams. One of the corners of the gyro contains a partially silvered mirror and a corner prism which lets the two light beams mix together to form a fringe pattern on the detector.

Operation

While the gyro is stationary, the fringe pattern is also stationary because the frequencies of both light beams are the same. When the gyro turns around the axis perpendicular to the lasing plane, the two light beam phases become slightly different. The phase of the two light beams are different during the turn because of the rotation rate. The difference in light beam phase causes the fringe pattern to move left or right depending on the direction of gyro movement. Photo diodes in the detector change the fringe pattern movement into a signal that is equal to the rotation rate of the gyro.

The measured rotation rate is integrated with time to calculate the attitude of the airplane.

Dither Motor

During low gyro rotation rates the two light beams can get coupled together in a condition called laser lock-in. To prevent a loss of information at low rotation rates, a piezo-electric dither motor vibrates the gyro assembly through the lock in region. The gyro sensed signals that are caused by these vibrations, are de-coupled from the gyro output to prevent errors during operation.

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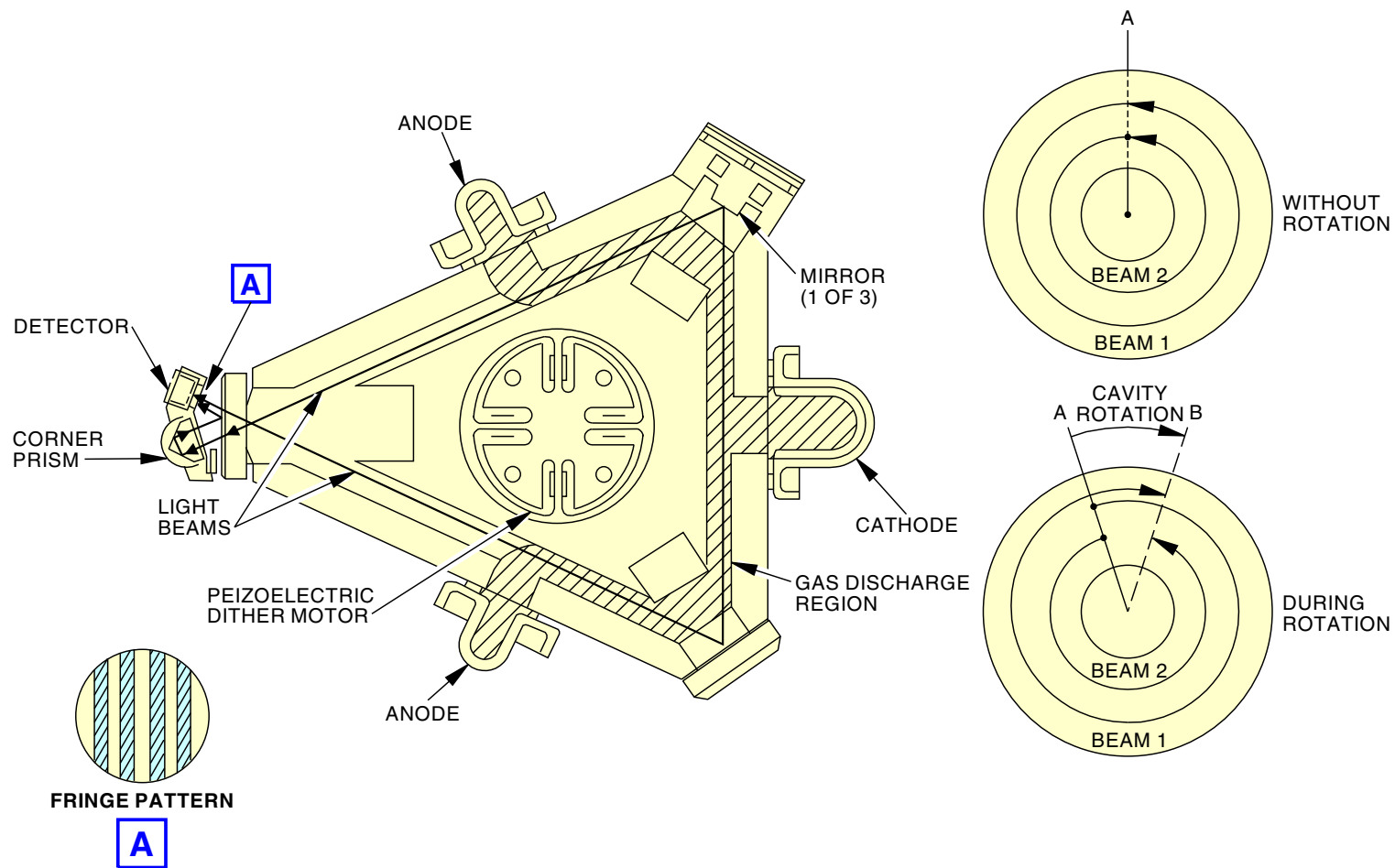
EFFECTIVITY

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ADIRS - IR GENERAL THEORY 3



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ADIRS - IR GENERAL THEORY 3

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**ADIRS - IR GENERAL THEORY 4****Alignment**

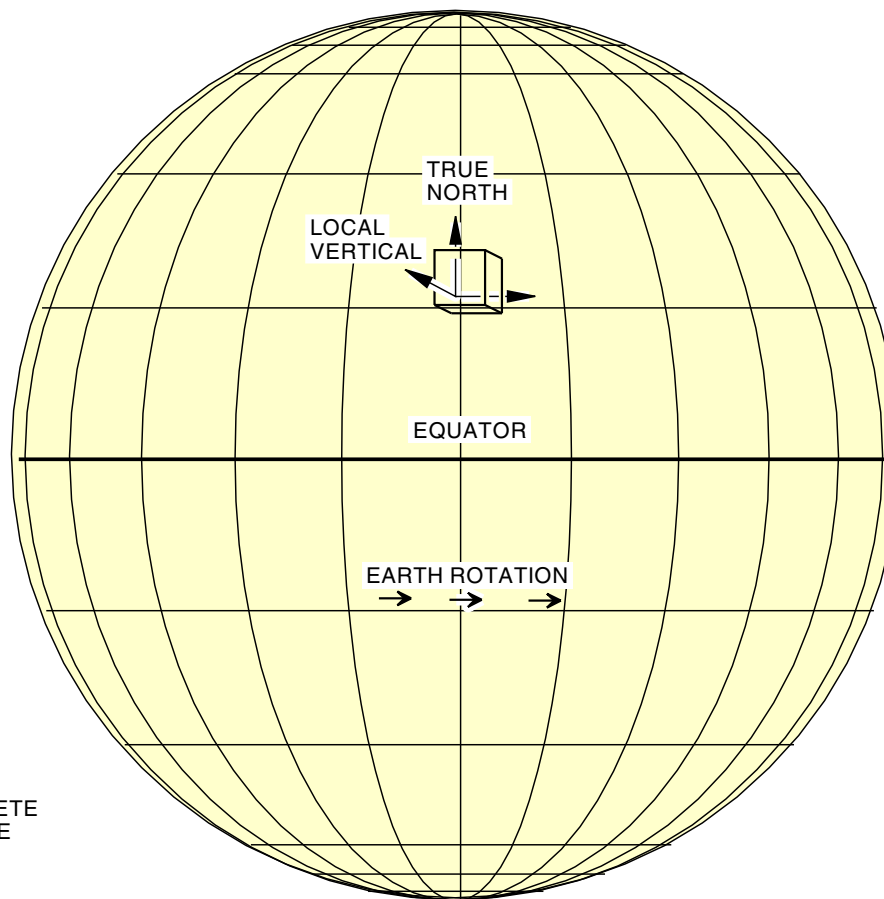
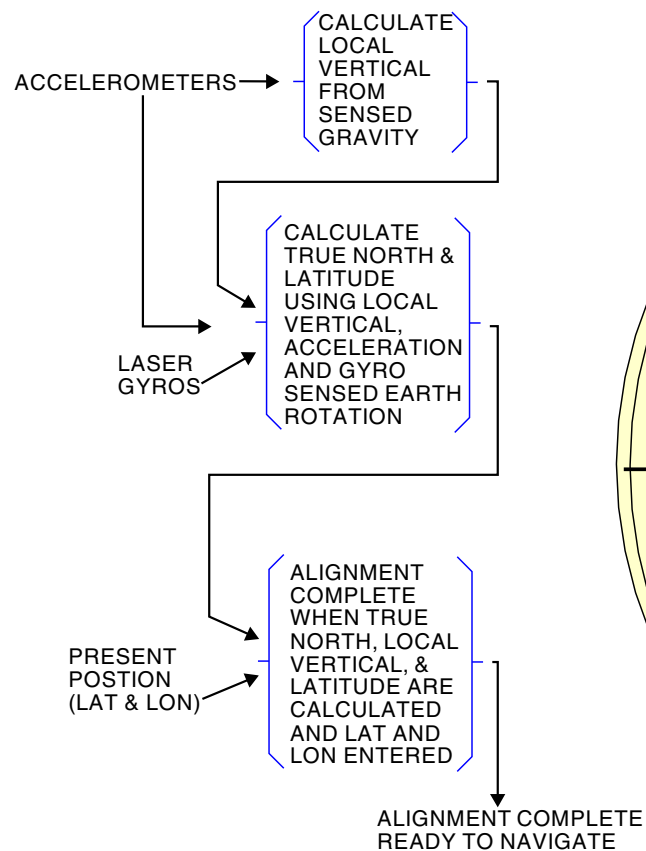
The ADIRU uses accelerometers and gyros to sense the earth rotation rate and gravity. Earth rate and gravity are then used to calculate:

- Local vertical
- True north
- Present position latitude.

After the ADIRU has measured these values and present position (latitude and longitude) is entered, the ADIRU completes its alignment to true north and is then ready to navigate. ADIRS alignment time will vary based on local latitude.

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ADIRS - IR GENERAL THEORY 4



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ADIRS - IR GENERAL THEORY 4

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ADIRS - IR GENERAL THEORY 5

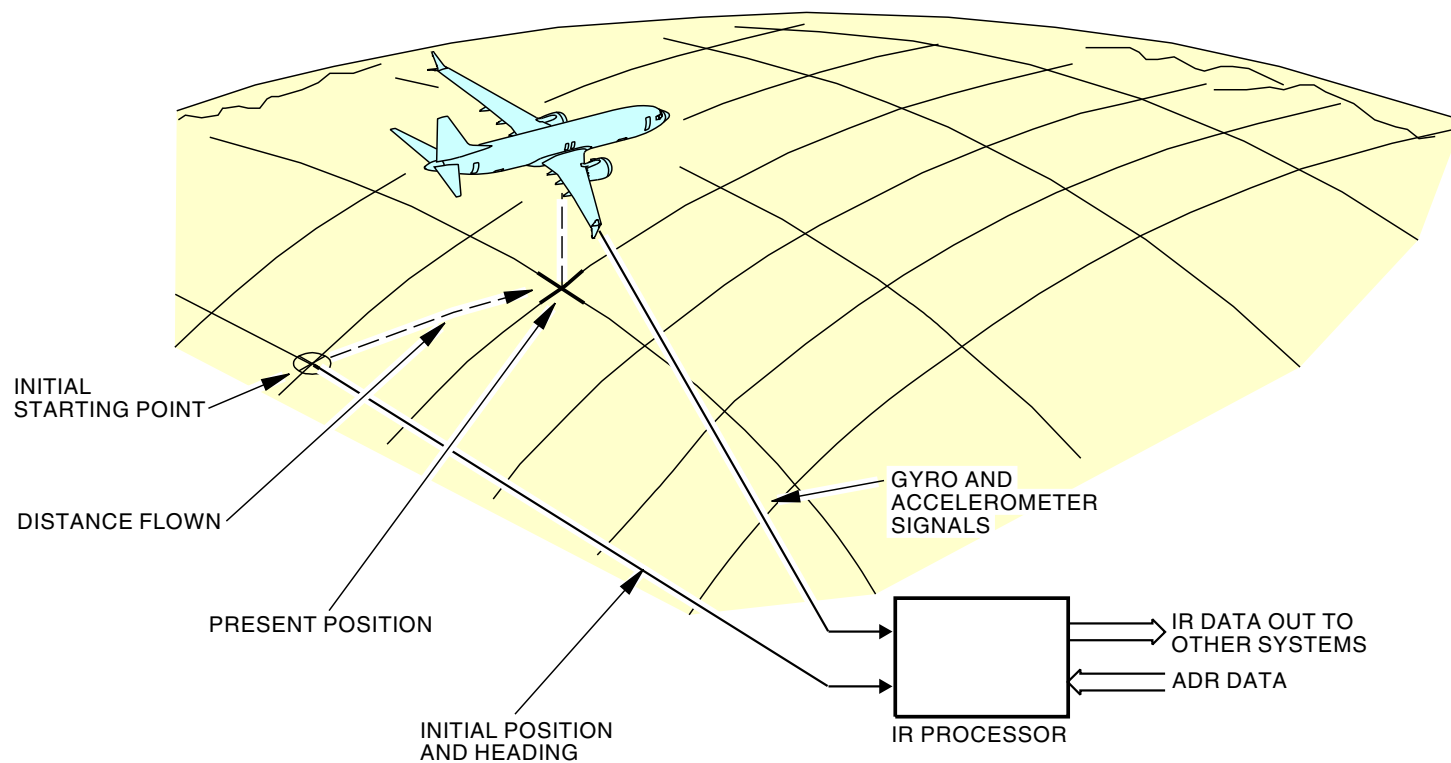
General

In the navigation mode, the IR processor uses the initial starting point and gyro and accelerometer values to calculate attitude, heading, velocity, and distance flown. The IR processor continuously updates this data over time to calculate present position and all other IR data values.

The IR processor also gets data from the ADR section of the ADIRU. The IR processor uses this input to calculate some of its IR data values.

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ADIRS - IR GENERAL THEORY 5



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ADIRS - IR GENERAL THEORY 5

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EFFECTIVITY

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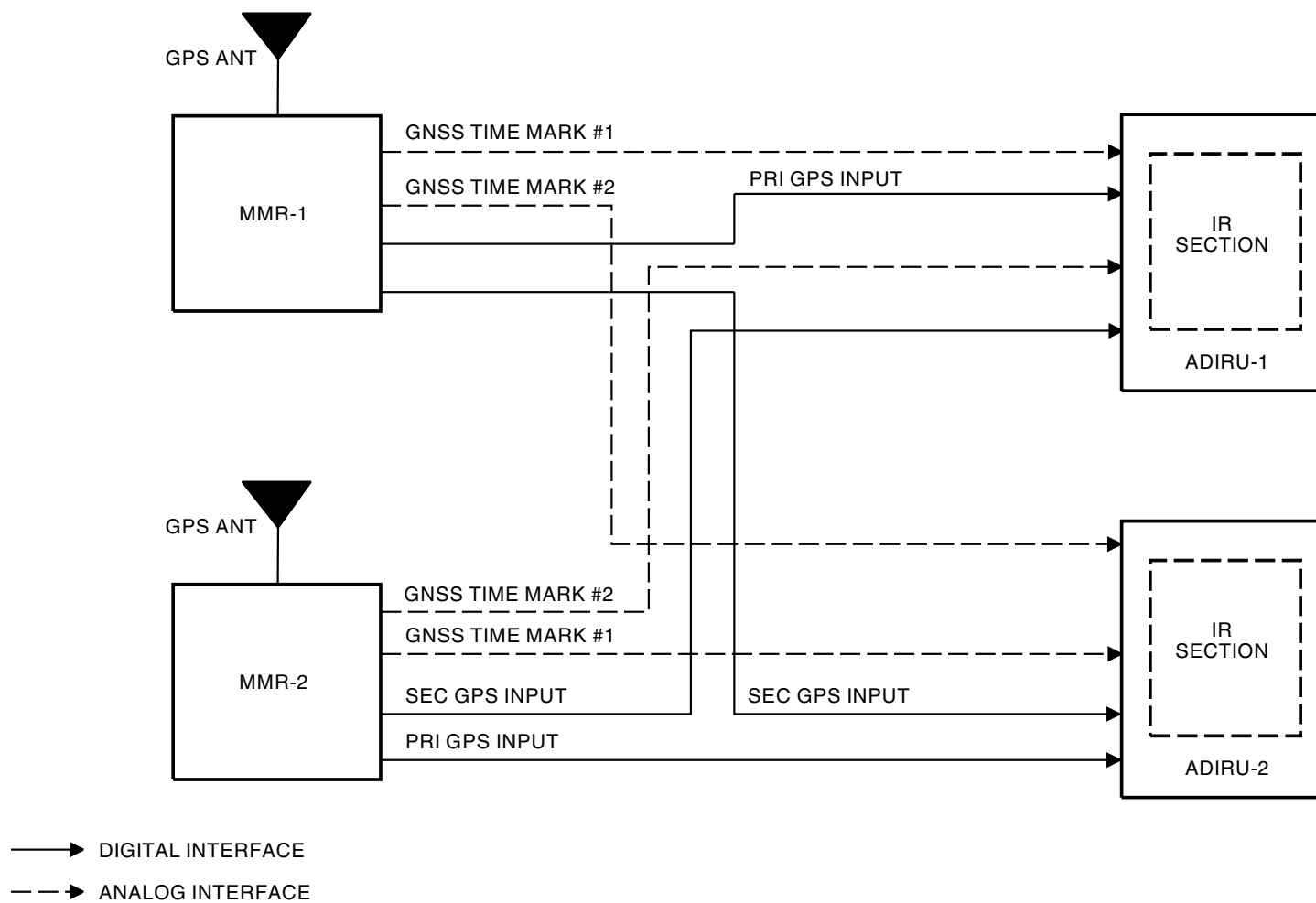
**ADIRS - IR GENERAL THEORY 6****General**

The IRS provides hybrid GPS-inertial function using the ADIRU, MMR and program pin configuration.

The hybrid GPS function receives satellite measurement data, autonomous navigation data, status data, and a 1Hz time mark signal from up to two GPS sensors inside the MMR. The GPS data are transmitted between the MMR and the ADIRU through high speed, ARINC 429 buses. The GPS sensor time mark signals are transmitted between the MMR and the ADIRU through independent RS-422 connections.

The hybrid GPS function combines the validated GPS data with inertial sensor and ADR altitude data to calculate hybrid navigation data. The hybrid GPS data is provided in addition to the basic IR navigation data.

ADIRS - IR GENERAL THEORY 6



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ADIRS - IR GENERAL THEORY 6

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ADIRS - ADIRU FUNCTIONAL DESCRIPTION

General

The ADIRU has these three parts:

- Power supply
- Inertial reference (IR)
- Air data reference (ADR).

Power Supply

The power supply receives 115V AC and 28V DC. The ADIRU operates with either power source. The power supply gives power to the ADR and the IR. Power also goes to the ADMs.

Power also goes to the ISDU.

The power supply monitor sends BITE data to the IR section. The power supply monitors for these conditions:

- AC power failure
- DC power failure.

Inertial Reference

The ISDU or the FMC supplies bite commands and initial position data to the IR processor.

The mode of operation comes from the MSU. The gyros and accelerometers supply movement data to the IR processor. The ADR data bus gives altitude, altitude rate, and true airspeed to the IR processor. The IR uses this ADR data as part of its inertial altitude, vertical speed and wind calculations.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

For airplanes with hybrid GPS-inertial reference data activated, the IR processor automatically receives position data from the MMR.

SIA ALL

The IR processor calculates these IR data values:

- Pitch

- Roll
- Yaw
- Latitude
- Longitude
- True heading
- Magnetic heading
- Inertial velocity vectors
- Linear accelerations
- Angular rates
- Track angle
- Wind speed and direction
- Inertial altitude
- Vertical speed and acceleration
- Ground speed
- Drift angle
- Flight path angle and acceleration.

The IR data goes out on ARINC 429 data buses.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

Additional hybrid IR data goes out on ARINC 429 data buses.

SIA ALL

The IR processor sets the ALIGN discrete during the alignment mode.

Air Data Reference

Static and pitot air pressure come from the air data modules (ADMs). Barometric correction comes from the MDS.

The ISDU and the IR data bus supply bite commands to the ADR processor.

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EFFECTIVITY	
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - ADIRU FUNCTIONAL DESCRIPTION**

The IR data bus also gives pitch, roll, vertical speed, and acceleration to the ADR processor. The ADR uses this IR data to calculate thrust and ground effect compensation values. The ADR then uses the calculated thrust and ground effect compensation values as part of its static source error correction calculation.

Total air temperature (TAT) and angle of attack (AOA) data is converted from analog data to digital data by the A/D converter before the data is received by the ADR processor.

The ADR processor calculates these values:

- Altitude
- Baro-corrected altitude
- Altitude rate
- Computed airspeed
- Maximum allowable airspeed
- Mach
- True airspeed
- Static air temperature
- Total air temperature
- Impact pressure
- Static pressure
- Total pressure
- Indicated AOA.

The ADR data goes out on ARINC 429 data buses.

BITE

The IR processor monitors and reports BITE. Detected faults from the ADR or power supply go to the IR processor for processing and storage. The IR processor sends fault data and status data out on ARINC 429 data buses.

IR faults cause the IR processor to set the FAULT discrete.

Power supply faults cause the IR processor to set the DC FAIL or the ON DC discrettes.

Alignment problems cause the IR processor to set the ALIGN discrete to an intermittent flash.

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EFFECTIVITY	
SIA ALL	

D633AM102-SIA



The diagram illustrates the functional architecture of the IR/ADR Processor, divided into two main sections: the IR Processor and the ADR Processor.

Power Supply Module: Receives 115V AC and 28V DC inputs. It provides ADP, IR, and ADM power to the Power Supply Monitor. The Power Supply Monitor outputs IR Power to the Gyros and Accelerometers.

IR Processor:

- Inputs:** MSU, MMR (via FMC), FMC, ADP Data, ISDU (via FMC), Inertial Reference, Gyros, Accelerometers, and IR Power.
- Outputs:** IR Data Out, ALIGN, FAULT, DC FAIL, and ON DC (all grouped under MSU).
- Internal:** Includes a BITE (Built-In Test Equipment) block.

ADR Processor:

- Inputs:** PITOT ADM, STATIC ADM, BARO CORRECTION, IR Data, TAT, AOA, and A/D Converter (which receives ADR Power).
- Output:** ADP Data Out.
- Internal:** Includes a BITE block.

Inter-Processor Connections: The IR Processor BITE is connected to the ADR Processor BITE via a dashed line. The ADR Processor BITE also provides feedback to the IR Processor BITE.

Legend: A blue box with the number '1' indicates 'IF APPLICABLE'.

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ADIRS - ADIRU FUNCTIONAL DESCRIPTION

**ADIRS - PFD AND ND INDICATIONS DURING ALIGNMENT****General**

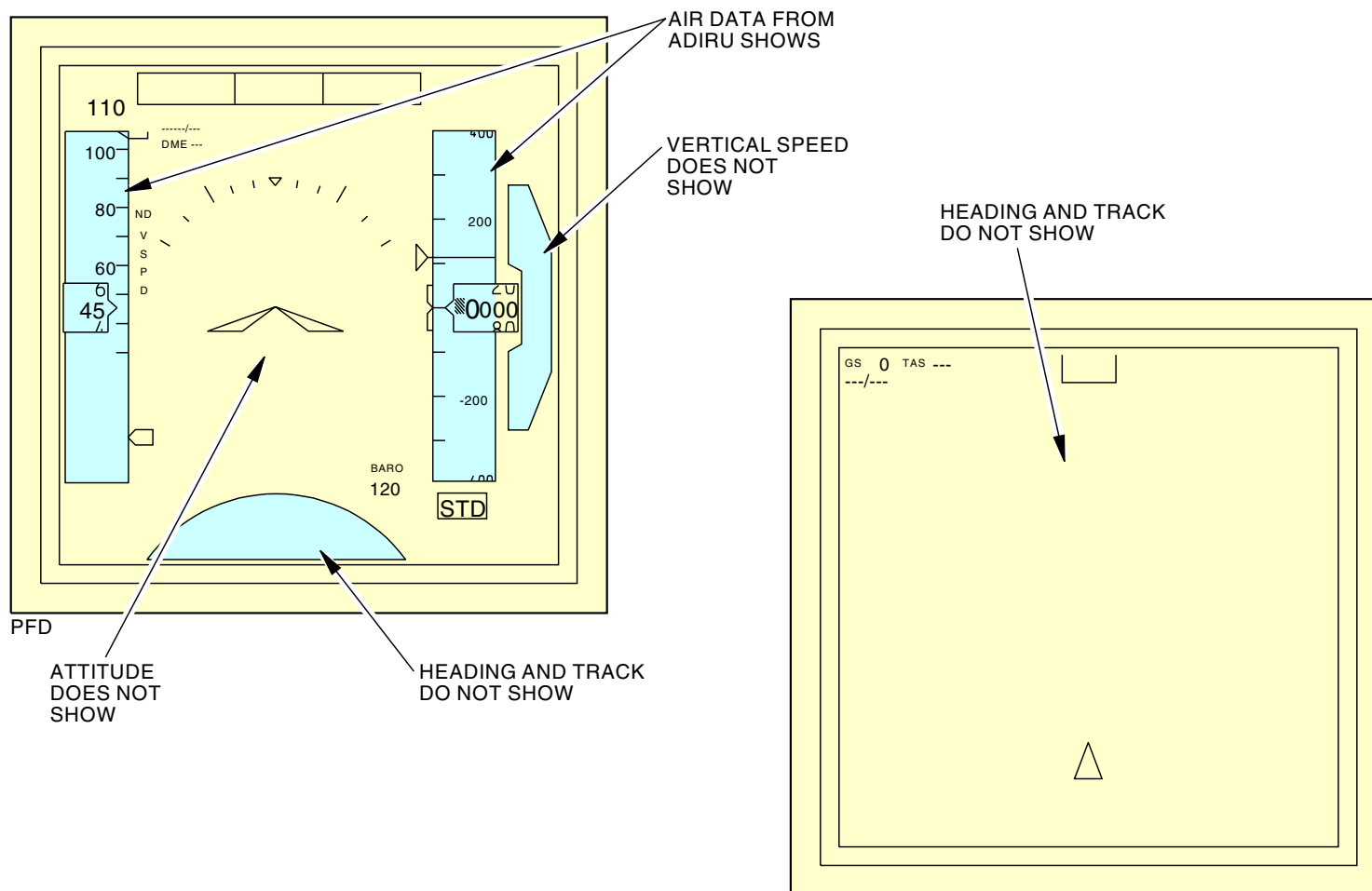
| These are the indications on the MDS when the ADIRU is in the align mode:

- The PFD shows no computed data (NCD) indications for attitude, heading, and track data
- The PFD shows NCD indication for vertical speed
- The ND shows NCD indications for track and heading data.

Air data from the ADIRU is not affected by the inertial reference (IR) mode of operation. The PFD shows air data information on the speed tape and altitude tape.

SIA ALL	EFFECTIVITY
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ADIRS - PFD AND ND INDICATIONS DURING ALIGNMENT



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ADIRS - PFD AND ND INDICATIONS DURING ALIGNMENT

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EFFECTIVITY
SIA ALL

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADIRS - PFD AND ND INDICATIONS AFTER ALIGNMENT

General

When the ADIRU alignment is complete and the ADIRU is in the NAV mode, the PFD and ND show ADIRU inertial reference (IR) data. The PFD shows this data:

- Horizon and sky/ground shading
- Pitch scale
- Bank (roll) pointer
- Slip/skid indicator
- Heading pointer
- Track line
- Flight path vector
- Selected heading
- Mag/Tru annunciation
- Vertical speed scale.
- Angle of attack indication.

The ND shows this data:

- Heading or track
- Magnetic or true annunciation
- Track/heading scale
- Selected heading
- Ground speed
- Track line.

In flight, the ND also shows this data:

- True airspeed
- Wind speed
- Wind direction.
- Angle of attack indication.

Display Source Priority

Track and ground speed data comes from the FMC and the ADIRS. The data that shows on the MDS is normally FMC track and FMC ground speed. If the FMC fails, the MDS shows ADIRS track and ground speed.

True Airspeed and Wind Speed and Direction

True airspeed does not show on the ND until TAS is more than 100 kts. The normal display when TAS is 100 kts or less is three dashes. This is the NCD indication.

Wind speed and direction does not show until TAS is more than 100 kts. When TAS is 100 kts or less, wind speed and direction is blank.

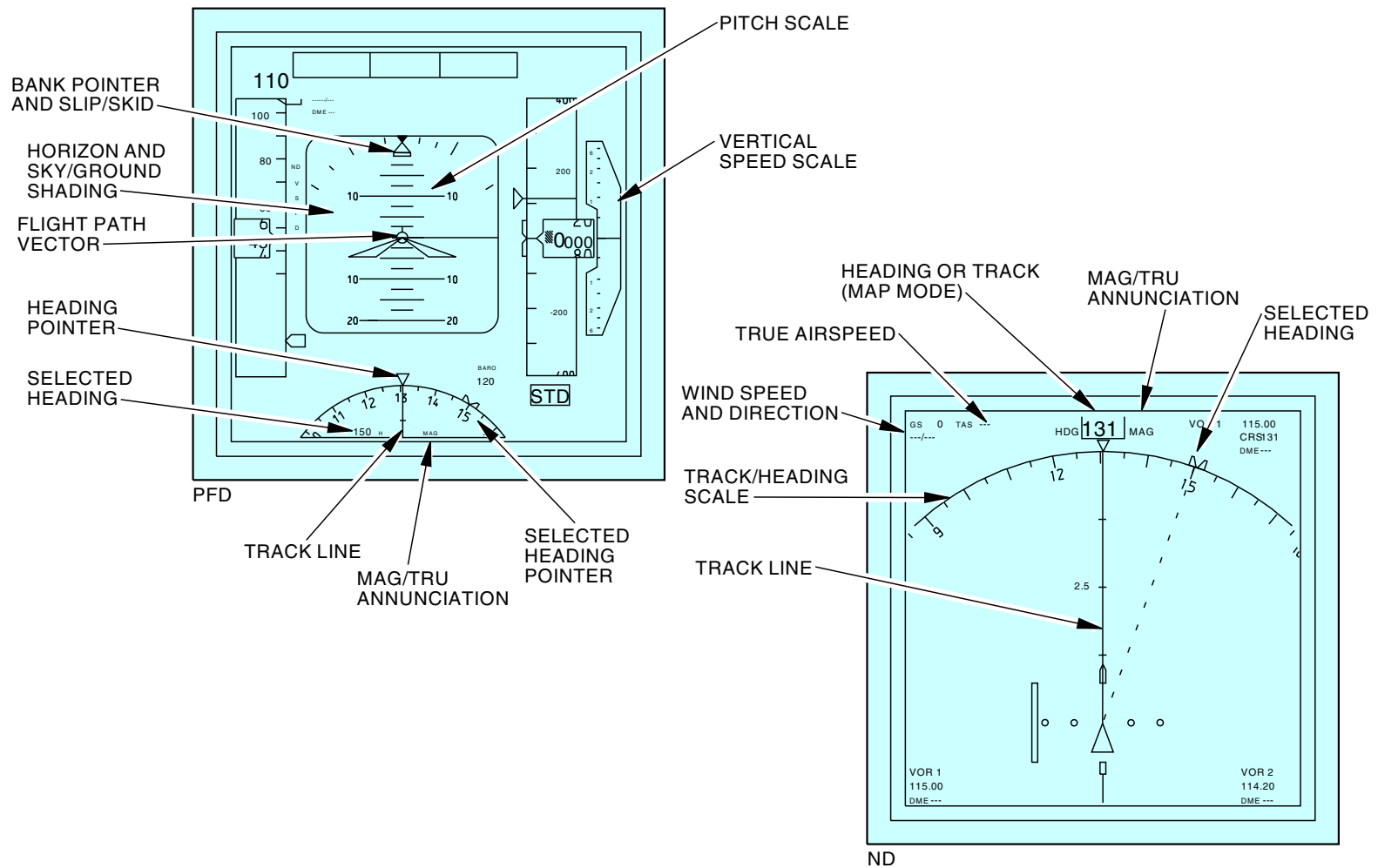
Flight Path Vector

The flight path vector (FPV) shows on the PFD when you make a selection on the EFIS control panel. The flight path vector symbol shows the motion of the airplane relative to the horizon and the airplane heading. The FPV moves perpendicular to the horizon to show flight path angle and moves parallel to the horizon to show drift angle. On the ground, the flight path vector is centered on the horizon line.

Heading or Track Up Display

The ND reference is airplane heading in the VOR and APP modes. The ND reference is airplane track in the MAP and Plan modes.

ADIRS - PFD AND ND INDICATIONS AFTER ALIGNMENT



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ADIRS - PFD AND ND INDICATIONS AFTER ALIGNMENT

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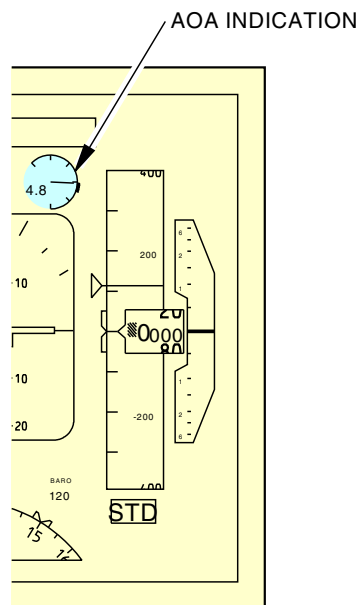
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ADIRS - PFD AND ND INDICATIONS AFTER ALIGNMENT



ADIRS - PFD AND ND INDICATION AFTER ALIGNMENT WITH AOA INDICATION

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**ADIRS - PFD AND ND INVALID ADIRS DATA****General**

Failure flags show on the PFD and ND for invalid inertial reference (IR) or invalid air data reference (ADR) conditions.

The PFD shows these flags for invalid ADIRS data:

- ATT for invalid attitude data
- ALT for invalid baro altitude data
- FPV for invalid flight path vector data
- HDG for invalid heading data
- SPD for invalid airspeed data
- VERT for invalid vertical speed data.

The ND shows the HDG flag for invalid heading data in the VOR and APP modes. The TRK flag will show in the MAP mode or PLAN mode.

Attitude Flag

When attitude data from the ADIRU is invalid, the PFD shows the ATT flag. The PFD does not show these values:

- Horizon line
- Sky/ground shading
- Bank pointer
- Slip/skid indicator
- Pitch scale.

Altitude Flag

The ALT flag shows on the PFD for invalid altitude data from the ADIRU. The PFD does not show the altitude tape.

Flight Path Vector Flag

The FPV flag will show on the PFD when attitude data from the ADIRU is invalid. The PFD does not show the flight path vector.

Heading/Track Flag

The HDG flag shows on the PFD, and the HDG or TRK flag shows on the ND when the ADIRU heading data is invalid. Heading and track data do not show.

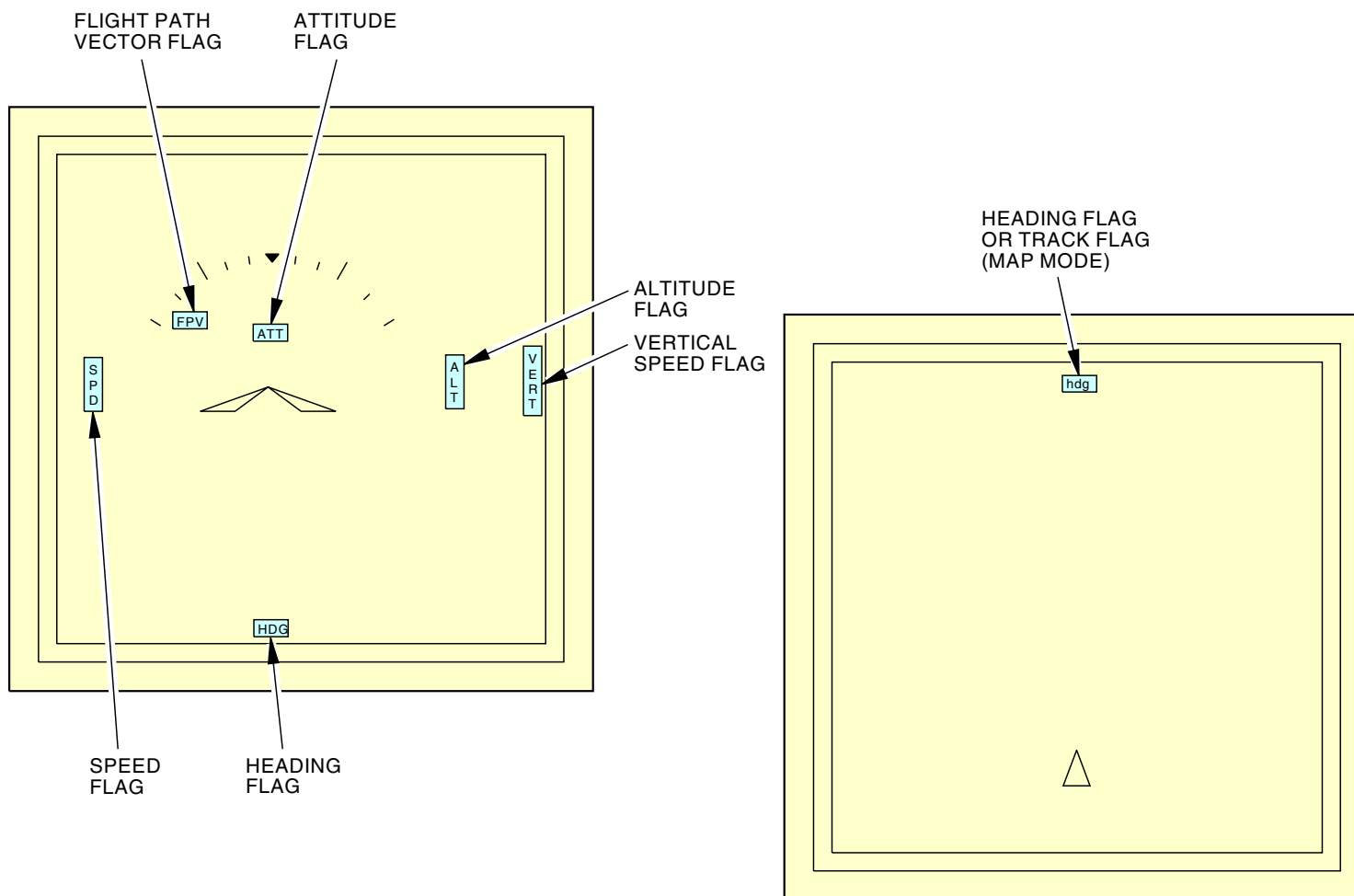
Speed Flag

The SPD flag shows on the PFD when ADIRS airspeed data is invalid. The Speed tape does not show on the PFD.

Vertical Speed Flag

The VERT flag shows on the PFD when ADIRS vertical speed data is invalid. The vertical speed scale and pointer do not show on the PFD.

ADIRS - PFD AND ND INVALID ADIRS DATA



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ADIRS - PFD AND ND INVALID ADIRS DATA

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**ADIRS - BAROMETRIC CORRECTION INDICATION****General**

Barometric correction adjusts the barometric altitude value that shows on the altimeter indication. This adjusts for changes in barometric pressure.

Barometric Correction Controls

The barometric correction controls are on the EFIS control panels. The controls select and set barometric correction reference, values, and displays. These are the barometric controls:

- Barometric reference selector - selects inches of mercury (IN) or hectopascals (hPa) as the barometric reference
- Barometric correction selector - sets the value of barometric correction
- Barometric standard (STD) switch - push the switch to set the barometric standard to 29.92 in hg, 1013 hPa.

Barometric Correction Display

Barometric correction shows on the PFD below the altitude tape. The barometric correction shows in hg or hPa. The EFIS control panel barometric reference selector determines the format that shows.

Barometric Correction Adjustment

Push the STD switch to show standard barometric correction. STD is shown on the PFD when standard barometric correction is active. When a new barometric correction value is set and STD is active, the new value will show below STD. Push the STD switch to set the new value as active.

When a barometric error occurs, the barometric correction value is boxed and changes to amber.

During climb, the barometric error indication is set when:

- Current barometric altitude is more than 300 feet above transition altitude, and
- FCC selected altitude is above FMC transition altitude, and
- Barometric correction is not set to STD.

During approach, the barometric error indication is set when:

- Current barometric altitude is more than 300 feet below transition altitude, and
- FCC selected altitude is below FMC transition altitude, and
- Barometric correction is set to STD.

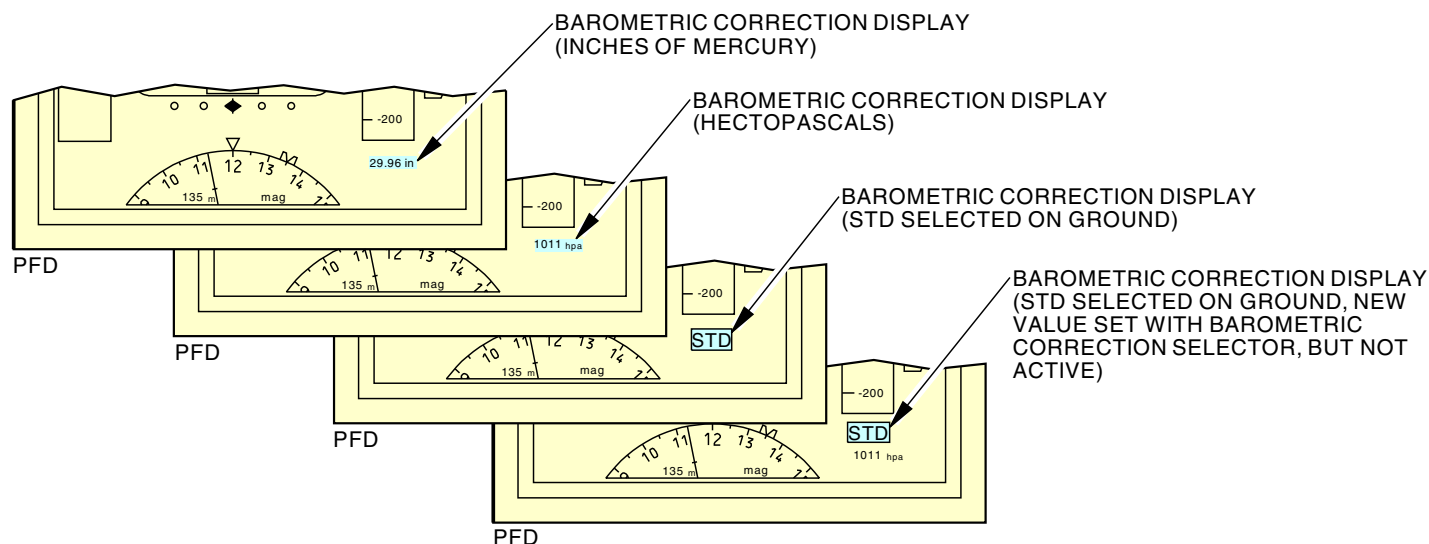
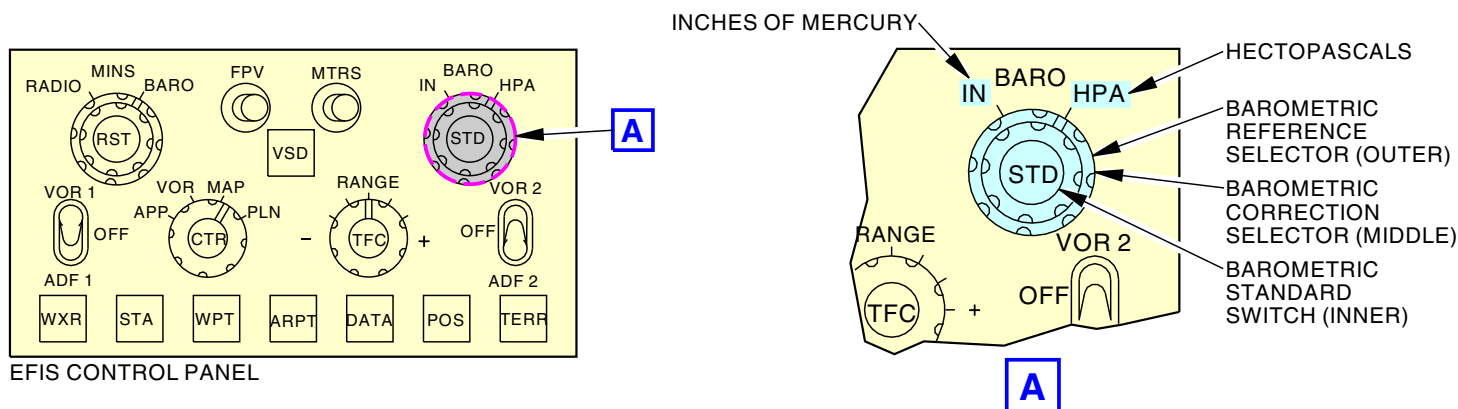
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ADIRS - BAROMETRIC CORRECTION INDICATION



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ADIRS - BAROMETRIC CORRECTION INDICATION



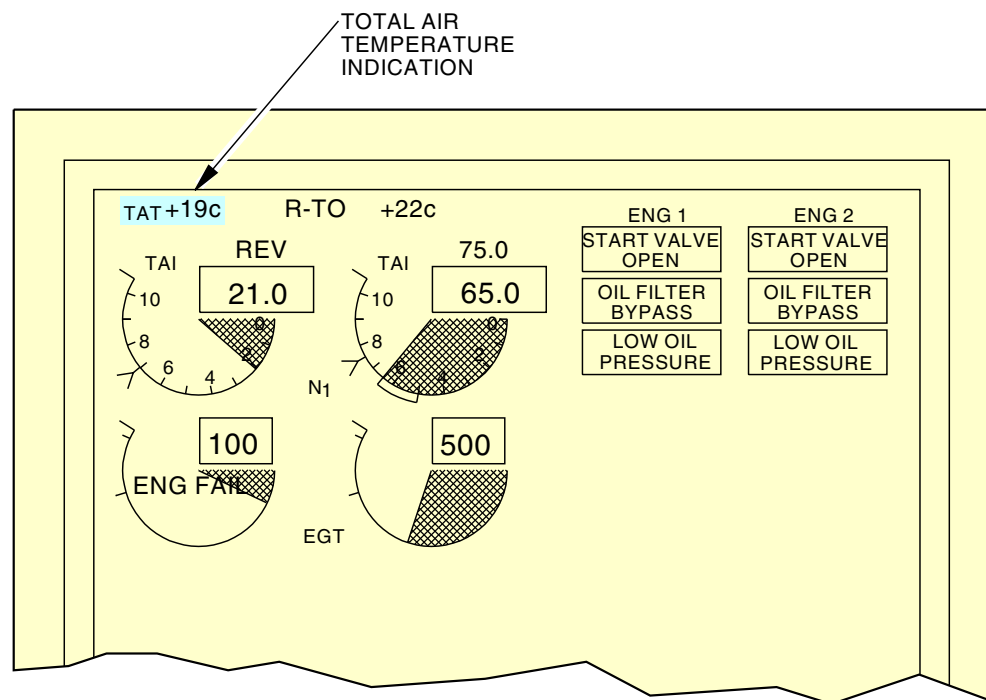
ADIRS - TAT INDICATION

General

Total air temperature (TAT) from the ADIRUs shows on the top of the engine display. The TAT value that shows is from the left ADIRU. When the left ADIRU TAT is invalid, the right ADIRU TAT value shows. TAT goes out of view when the data from both ADIRUs is invalid.

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ADIRS - TAT INDICATION



ENGINE DISPLAY

ADIRS - TAT INDICATION

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**ADIRS - ALIGNMENT PROCEDURE 1****General**

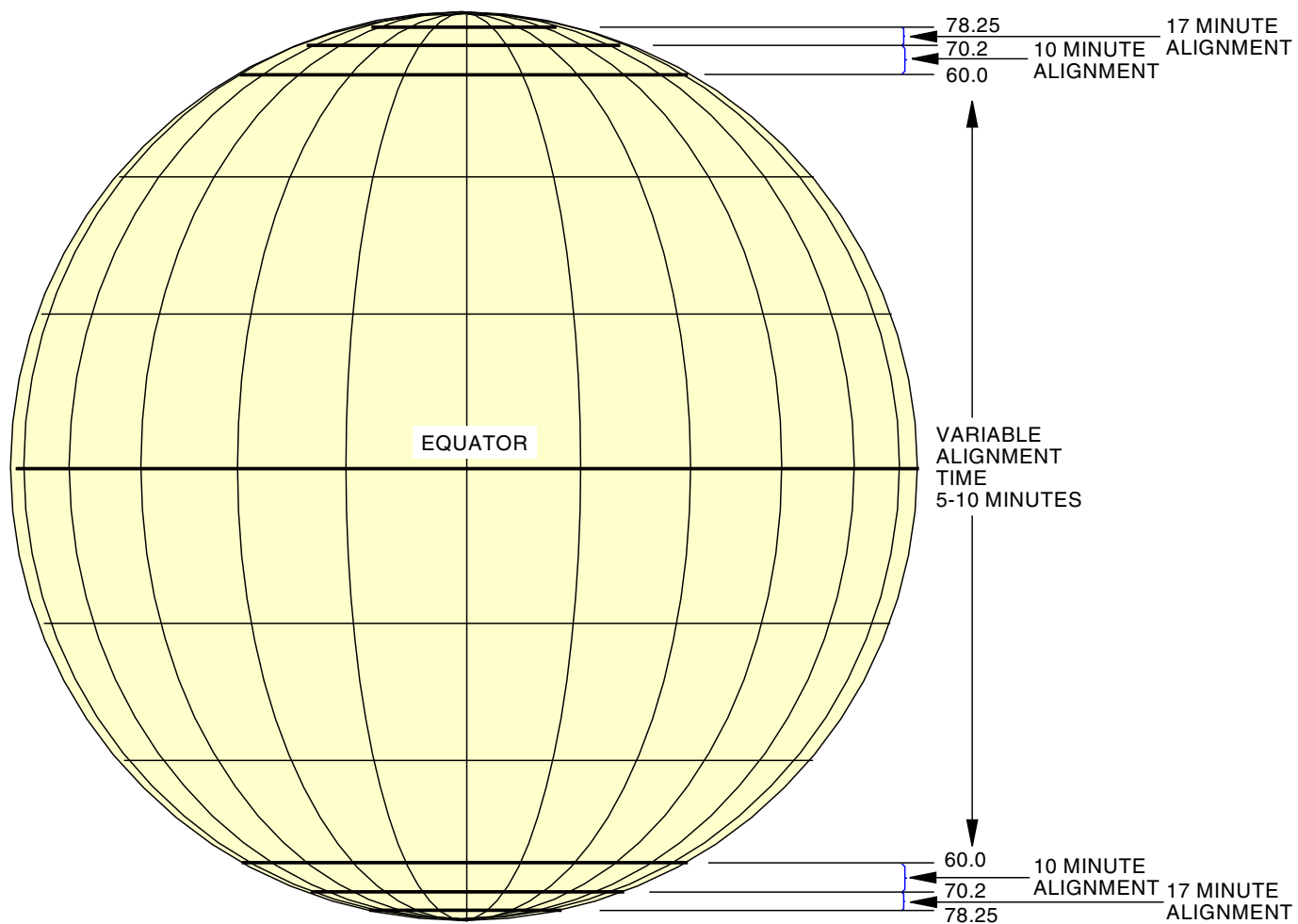
The ADIRS alignment time will change between a minimum of 5 minutes at the equator to 17 minutes maximum at 78.25 degrees, north or south latitudes.

The alignment time will not be more than 10 minutes if the present position latitude is between 60.0 degrees north or south. The alignment time is fixed at 10 minutes between latitudes of 60.0 and 70.2 degrees north or south. The alignment time is fixed at 17 minutes between latitudes of 70.2 and 78.25 degrees north or south.

The ADIRU will not align at a latitude more than 78.25 north or south.

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ADIRS - ALIGNMENT PROCEDURE 1



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ADIRS - ALIGNMENT PROCEDURE 1

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SIA ALL

EFFECTIVITY

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ADIRS - ALIGNMENT PROCEDURE 2**Alignment Mode**

YOU MUST PULL AND TURN SOME SWITCHES. IF YOU TRY TO TURN THESE SWITCHES BEFORE YOU PULL THEM, YOU CAN DAMAGE THE SWITCH.

Use the mode selector on the MSU to start the ADIRU alignment. Move the selector from OFF to NAV. The left selector controls the left ADIRU and the right selector controls the right ADIRU.

The ON DC light comes on for 5 seconds. During this time, the ADIRU does a check of its dc power source. After 5 seconds, the ON DC light goes off and the ALIGN light comes on. The ADIRU is now in the alignment mode.

Training Information Point

If the ADIRU detects airplane movement during the alignment mode, the alignment process will stop. After the motion stops, a new alignment will start.

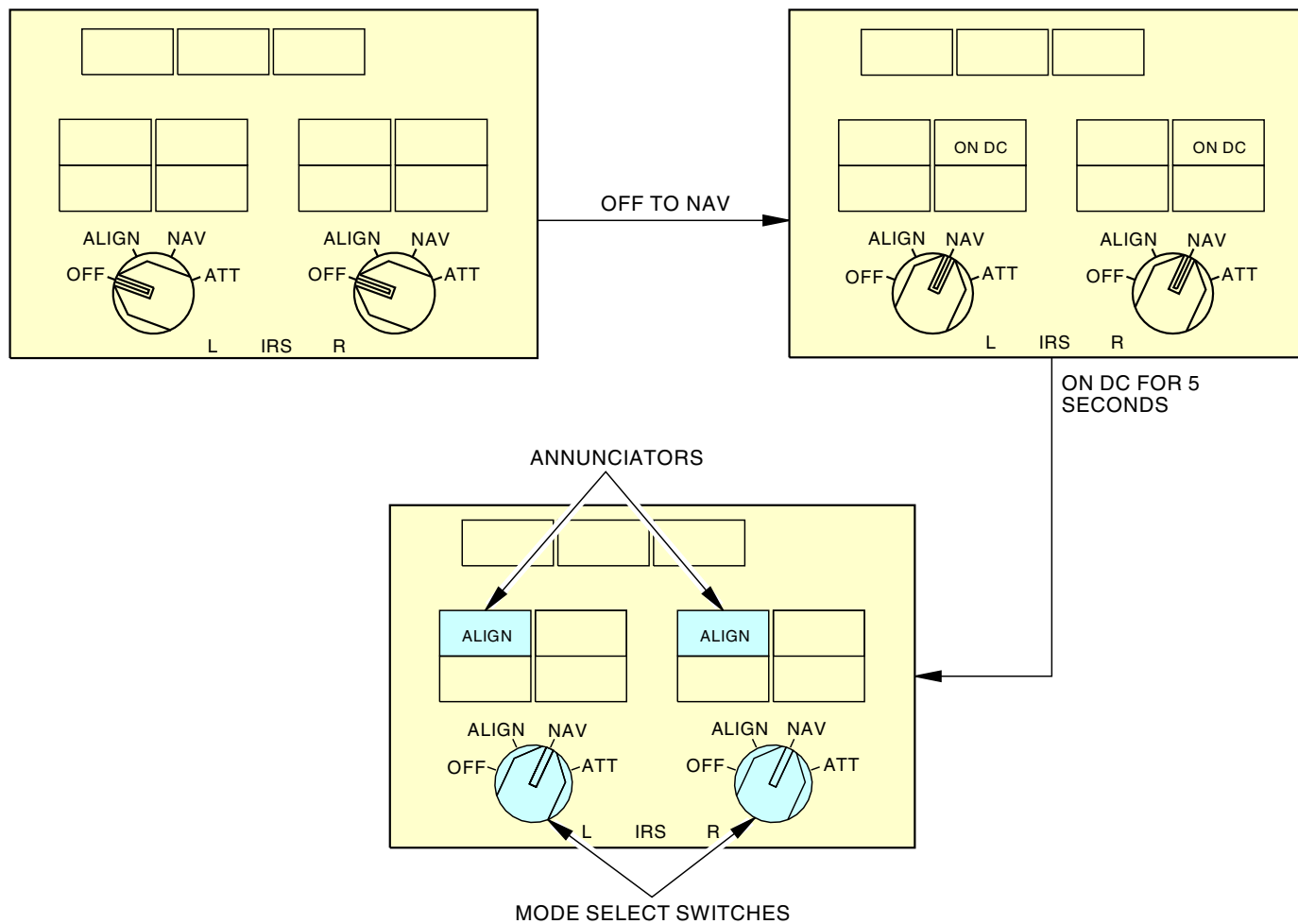
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ADIRS - ALIGNMENT PROCEDURE 2



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ADIRS - ALIGNMENT PROCEDURE 2

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SIA ALL

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**ADIRS - ALIGNMENT PROCEDURE 3****Present Position Entry**

You must enter present position data for the ADIRU during alignment. The ADIRU calculates present position latitude but it cannot calculate present position longitude. The ADIRU uses your entry for latitude and longitude. The ADIRU compares your latitude entry to its calculated value to make sure its calculation of latitude is correct.

You can use the ISDU or the FMC CDU to enter present position data.

When both ADIRUs are in alignment mode, you only need to enter the data one time. The data goes to both ADIRUs. If you make a wrong entry, you can enter the data again. The ADIRUs use the last data entry that you make.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

The MDS displays present position data using the hybrid GPS-inertial function.

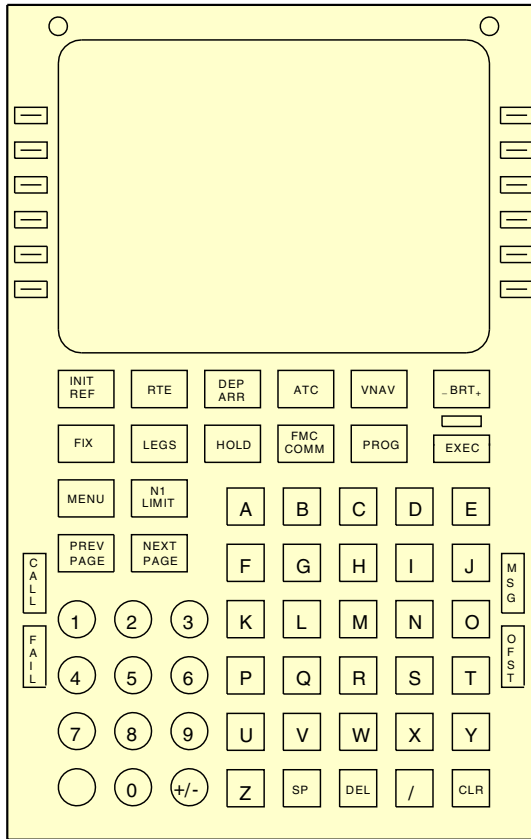
If the MSU switch is set to ALIGN or NAV, ADIRU with the hybrid GPS-inertial function automatically accept valid GPS position data from the MMR as present position data during alignment. This position data can be overridden by manually entering present position data before the IRS enters NAV mode. If present position data is used, the GPS position data from the MMR will not be automatically used until a flight is completed.

SIA ALL**34-21-00**

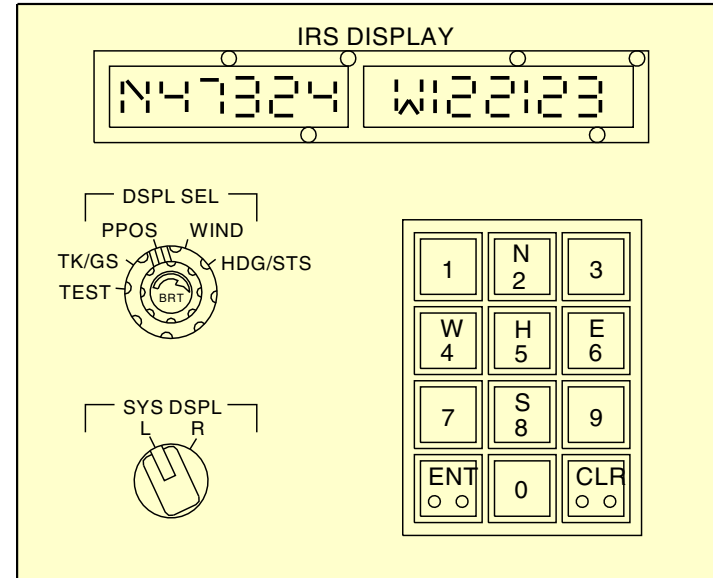
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ADIRS - ALIGNMENT PROCEDURE 3



FMCS CDU



ISDU

1

1 IF APPLICABLE

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ADIRS - ALIGNMENT PROCEDURE 3

**ADIRS - LAST POSITION PRESENT POSITION ENTRY****CDU Present Position Entry**

ADIRS present position can be set using the FMC CDU. Push the INIT/REF key on the CDU to show the position initialization (POS INIT) page. From this page, there are three procedures that you can use to enter present position for the ADIRUs:

- Transfer position data from LAST POS line
- Transfer position data from REF AIRPORT line
- Enter position data using CDU keyboard.

You can also transfer GPS present position from the CDU POS REF page.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

ADIRU with the hybrid GPS-inertial function automatically accept valid GPS position data from the MMR as present position data. This position data can be overridden by manually entering the present position.

SIA ALL**LAST POS Transfer**

Do this to transfer position data from the LAST POS line on the CDU to the ADIRUs:

- Push line select key (LSK) 1R. The position data moves to the scratchpad
- Push LSK 4R. Position data moves from scratchpad to the SET IRS POS boxes.

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Diagram illustrating the structure of a data stream, showing three sequential frames (1/3, 2/3, 3/3) connected by arrows, indicating a flow or sequence.

Frame 1 (1/3):

```

POS INIT
1/3
LAST POS
REF AIRPORT
N40°38.0 W073°46.4
-----
GATE
-----
SET IRS POS
GMT-MON/DY
1432.2z 11/29
-----
<INDEX ROUTE>
  
```

Frame 2 (2/3):

```

POS INIT
1/3
LAST POS
REF AIRPORT
N40°38.0 W073°46.4
-----
GATE
-----
SET IRS POS
GMT-MON/DY
1432.2z 11/29
-----
<INDEX ROUTE>
  
```

Frame 3 (3/3):

```

POS INIT
1/3
LAST POS
REF AIRPORT
N40°38.0 W073°46.4
-----
GATE
-----
SET IRS POS
GMT-MON/DY
1432.2z 11/29
-----
<INDEX ROUTE>
  
```

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ADIRS - LAST POSITION PRESENT POSITION ENTRY

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**ADIRS - REFERENCE AIRPORT PRESENT POSITION ENTRY****REF AIRPORT Transfer**

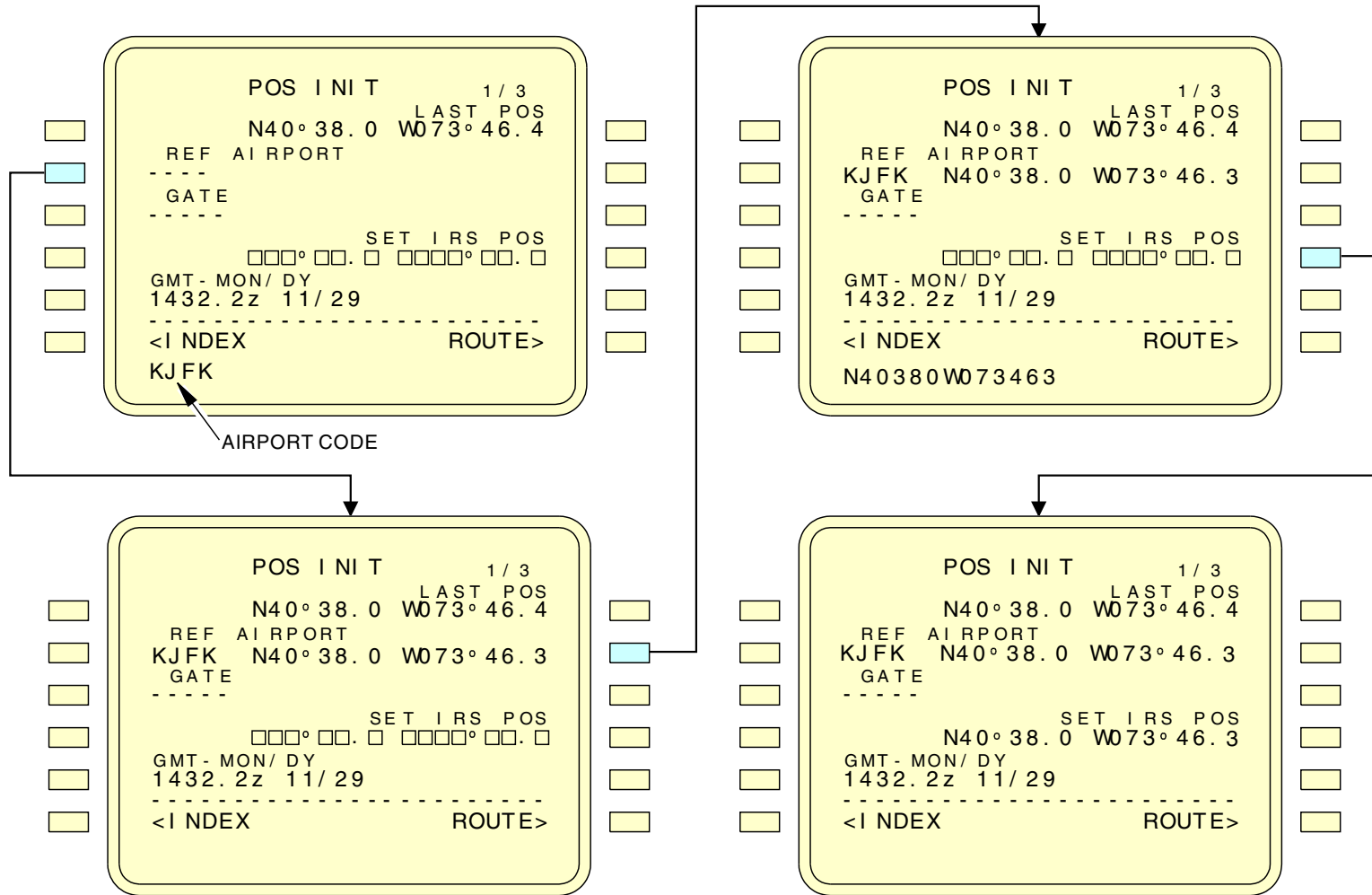
Do this to transfer position data from the REF AIRPORT line on the CDU to the ADIRUs:

- Use the CDU keyboard to enter the airport code in the scratchpad.
- Push LSK 2L. The airport code moves to REF AIRPORT and airport position data shows.
- Push line select key (LSK) 2R. The position data moves to the scratchpad.
- Push LSK 4R. The position data moves from the scratchpad to the SET IRS POS boxes.

NOTE: Some reference airports also have the position of gates. Enter the gate number in the scratchpad after you push LSK 2L. Push LSK 3L and the gate position will show. This position may be used as present position.

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ADIRS - REFERENCE AIRPORT PRESENT POSITION ENTRY



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ADIRS - REFERENCE AIRPORT PRESENT POSITION ENTRY

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ADIRS - SCRATCHPAD PRESENT POSITION ENTRY

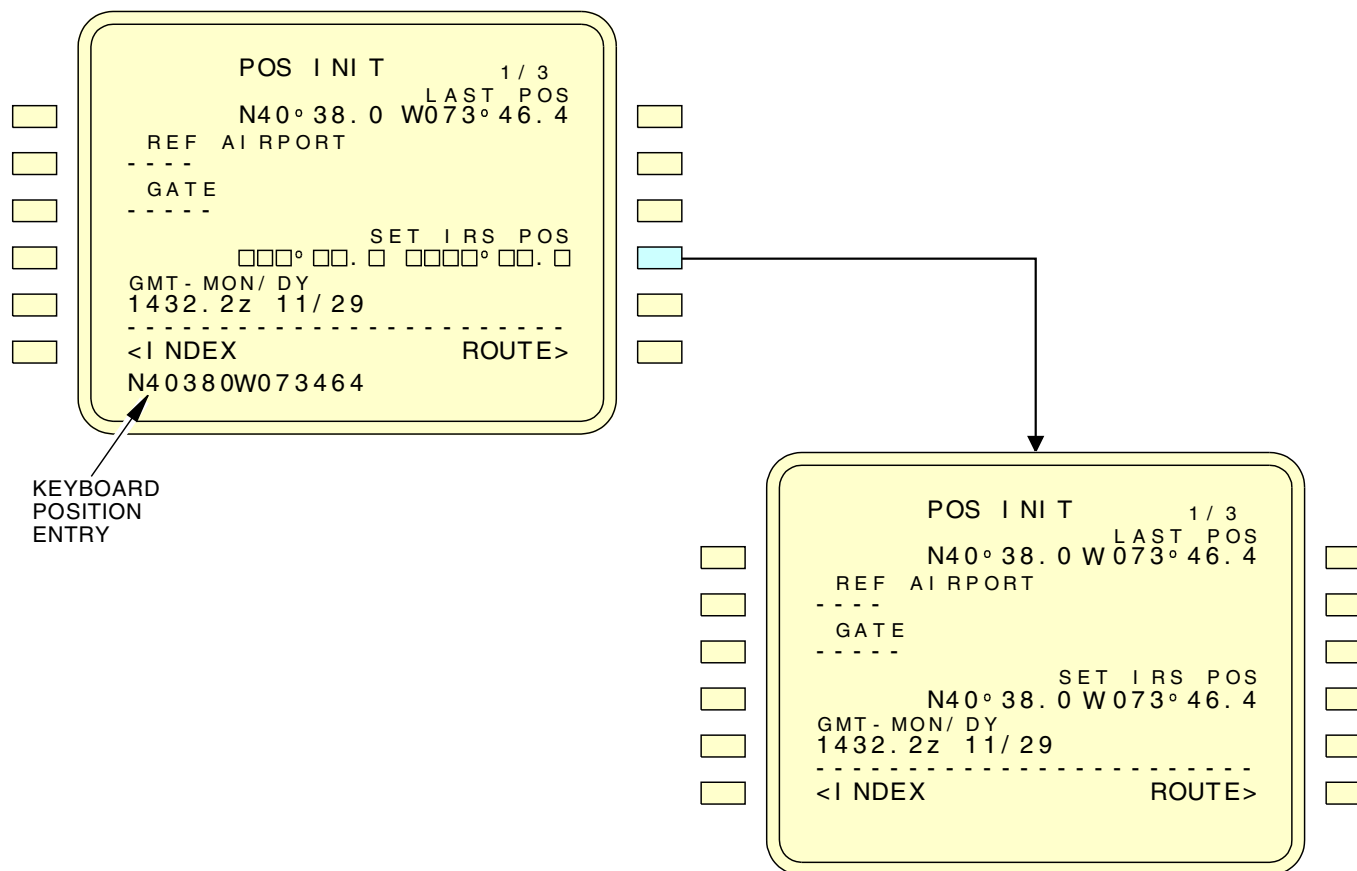
CDU Keyboard Entry

Do this to enter position data from the keyboard on the CDU to the ADIRUs:

- Use the keyboard to enter the position data into the scratchpad. You do not need to use spaces or decimal points (.)
- Push LSK 4R. Position data moves from the scratchpad to the SET IRS POS boxes.

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ADIRS - SCRATCHPAD PRESENT POSITION ENTRY



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ADIRS - SCRATCHPAD PRESENT POSITION ENTRY

34-21-00

SIA ALL	EFFECTIVITY

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**ADIRS - GPS PRESENT POSITION ENTRY****GPS Position Transfer**

Do this to transfer GPS position data from the POS REF page on the CDU to the ADIRUs:

- Push the NEXT PAGE key on the CDU. The INIT REF page changes to the POS REF page.
- Push LSK 4L, or LSK 5L. The GPS L or GPS R position data moves to the scratchpad.
- Push the PREV PAGE key on the CDU. The POS REF page changes to the INIT REF page. The GPS position data stays in the scratchpad.
- Push LSK 4R. The GPS position data moves from the scratchpad to the SET IRS POS boxes.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

ADIRU with the hybrid GPS-inertial function automatically accept valid GPS position data from the MMR as present position data. This position data can be overridden by manually entering the present position.

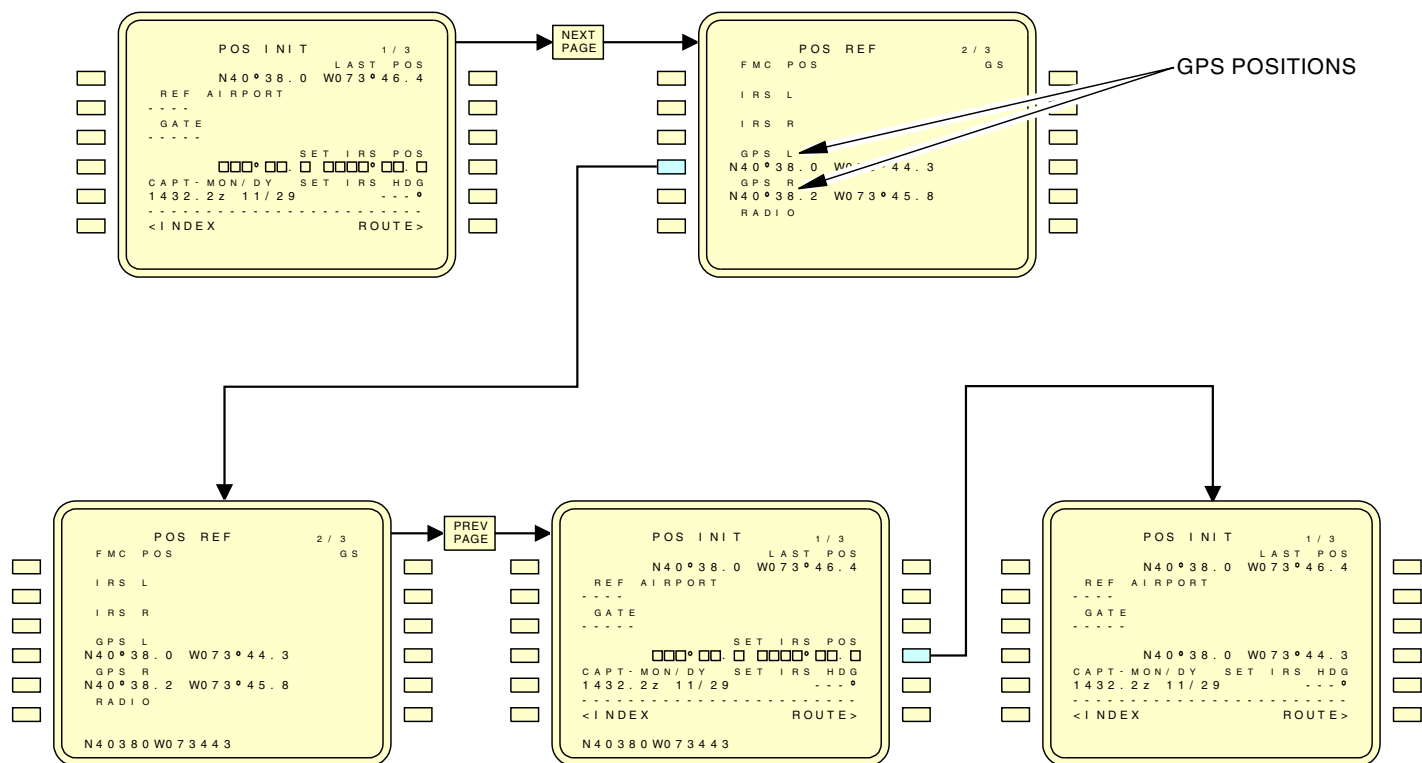
To check if the GPS position has been automatically accepted by the ADIRU:

- Make sure that LAT/LONG is automatically entered on the ISDU PPOS display window
- Make sure that LAT/LONG is automatically entered on the FMC CDU POS REF page under IRS L and IRS R
- Make sure that the IRS L and IRS R positions are the same as the GPS L and GPS R positions on the FMC CDU POS REF page.

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ADIRS - GPS PRESENT POSITION ENTRY



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ADIRS - GPS PRESENT POSITION ENTRY

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EFFECTIVITY

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**ADIRS - ISDU PRESENT POSITION ENTRY****ISDU Present Position Entry**

You can use the ISDU keyboard to enter present position data for the ADIRUs. The display selector (DSPL SEL) can not be in TEST. You can enter latitude or longitude first.

Latitude Entry

Push the N2 or S8 key to enter latitude. The letter N or S shows in the left IRS DISPLAY and the light on the ENT key comes on. Push the keys to enter the latitude data. When you push each key, the number appears at the far right of the left IRS DISPLAY. Numbers entered before will shift one space to the left. Push the ENT key to send the data to the ADIRUs. The light on the ENT key goes off. If the display selector is in a position other than PPOS, the IRS DISPLAY will change to the information that showed before you started the position entry.

Longitude Entry

The longitude entry is similar to the latitude entry. Push the W4 or E6 key to enter longitude. The longitude data will show in the right IRS DISPLAY.

Invalid Position Entry

These keyboard entries cause the CLR key light to come on when you push the ENT key:

- Latitude greater than 90 degrees
- Longitude greater than 180 degrees
- Minute value greater than 59.9.

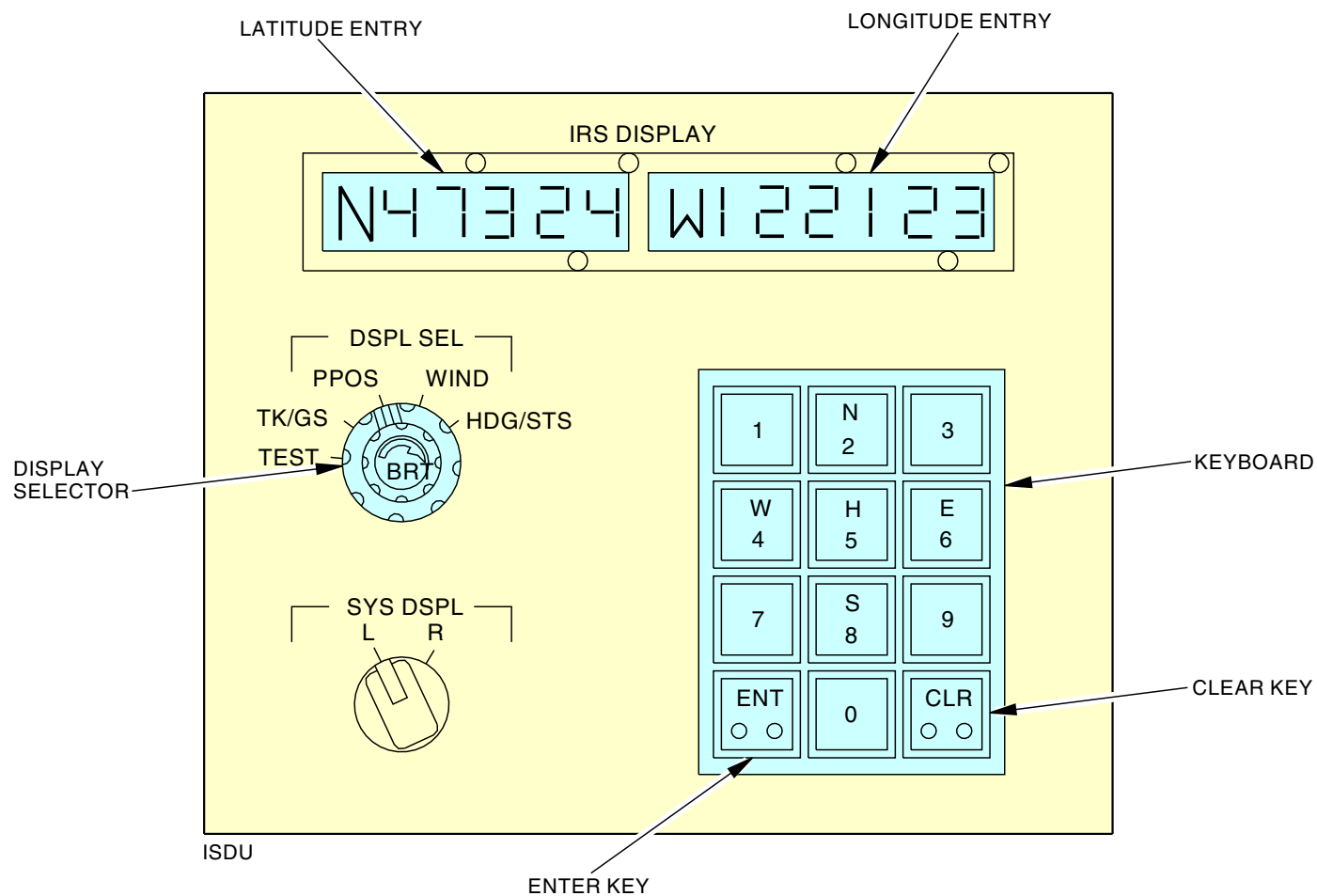
Push the CLR key to clear the invalid position entry.

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ADIRS - ISDU PRESENT POSITION ENTRY



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ADIRS - ISDU PRESENT POSITION ENTRY

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**ADIRS - ALIGNMENT TIME****General**

You can see the time remaining to alignment on the ISDU. Set the DSPL SEL switch to the HDG/STS position. The right IRS DISPLAY shows the time in minutes until the ADIRU is aligned. For 17 minute alignments, 15 shows in the right IRS DISPLAY for the first three minutes. After three minutes, the display counts down to zero.

The "TIME TO ALIGN" caption will be displayed in the upper left hand corner of the ND, under the groundspeed readout. The Time to Align readout is in minutes and reflects the longest time of both IRU's to align and will be limited to a maximum of 15 minutes. The Time to Align caption can be displayed both on-ground and in-air while either IRU is aligning

SIA 005-999; SIA 001-004 POST SB 737-34-3141

When AIM mode is selected, alignments are 10 to 20 minutes. Alignments can be greater than 20 minutes if:

- There are no changes in heading during alignment
- There are no changes in acceleration during alignment
- The airplane is flying in an east to west direction such that the sensed rotational rates are close to zero.

SIA ALL

The ADIRU goes to the navigation mode at the end of the alignment time if the mode select switch is in the NAV position and present position has been entered.

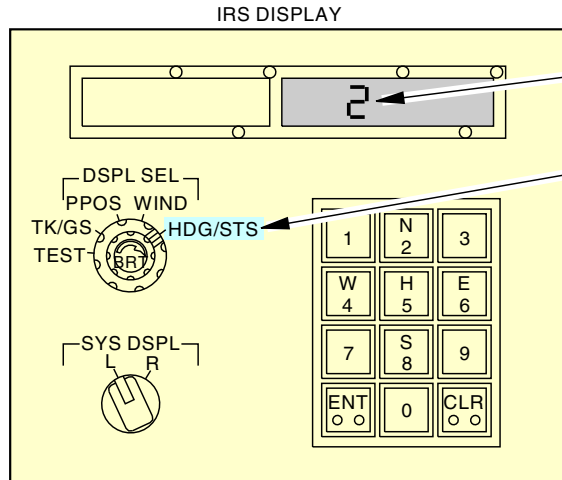
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ADIRS - ALIGNMENT TIME

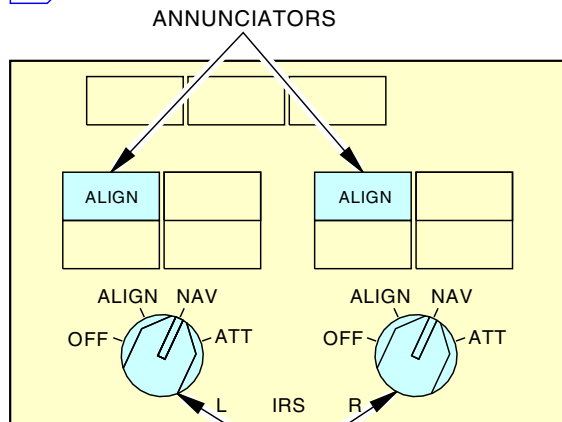


A

SELECT
HDG/STS

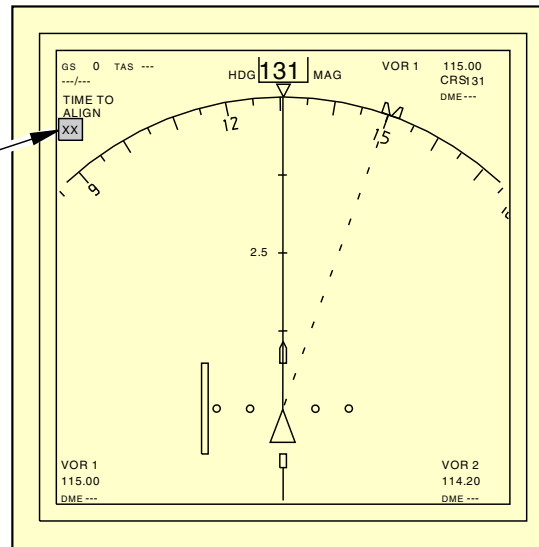
A

1



MODE SELECT SWITCHES

1 IF APPLICABLE



TIME TO ALIGN ANNUNCIATION ON ND

A

MINUTES REMAINING	NUMBER SHOWN
>15	15
15	15
14	14
13	13
12	12
11	11
10	10
9	9
8	8
7	7
6	6
5	5
4	4
3	3
2	2
1	1
0	0

ADIRS - ALIGNMENT TIME

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ADIRS - IRS MOTION

General

When the ADIRUs are in the alignment mode and the ADIRUs detect airplane movement, the alignment mode stops.

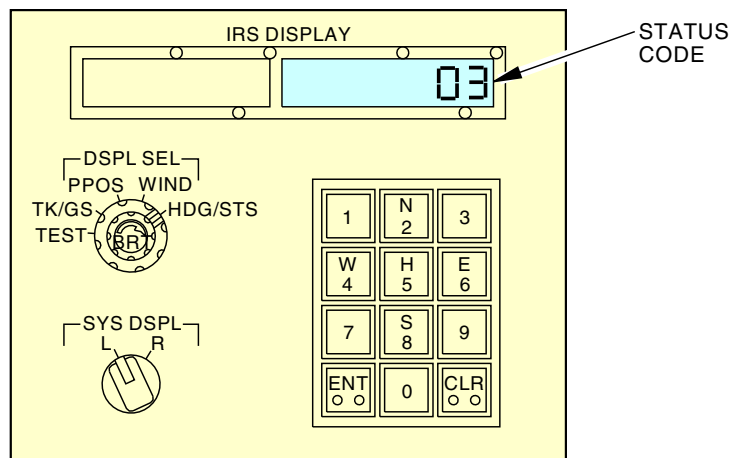
A status code 3 shows on the ISDU.

IRS MOTION will show on the CDU scratchpad. After 30 seconds, the ADIRUs do a check for airplane motion. When the motion stops, the ADIRUs start new alignments. When the new alignment starts, the status code 3 goes out of view. You push the CLR key on the CDU to remove the IRS MOTION message from the CDU scratchpad.

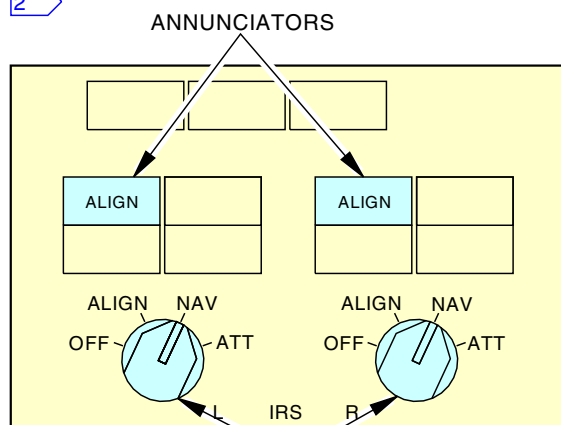
NOTE: The display selector must be in the HDG/STS position to see the status code 3.

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ADIRS - IRS MOTION

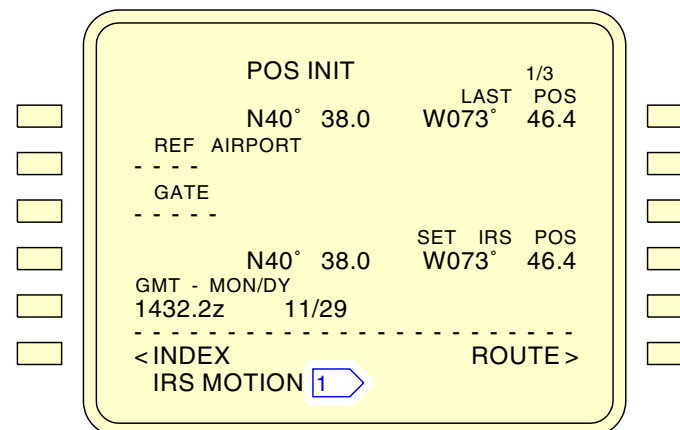


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MODE SELECT SWITCHES

- 1 MESSAGE SHOWS ON ALL CDU PAGES
- 2 IF APPLICABLE



ADIRS - IRS MOTION

2528710 S0000597121_V2

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**ADIRS - POSITION DIFFERENCE DURING ALIGNMENT****General**

The ADIRU keeps a record of its last position. You must enter position data during the alignment mode. When you enter position data that is more than 1 degree different than the recorded latitude or 1 degree different than the recorded longitude, these things occur:

- ALIGN light flashes
- Status code 4 shows on ISDU
- ENTER IRS POSITION shows on CDU.

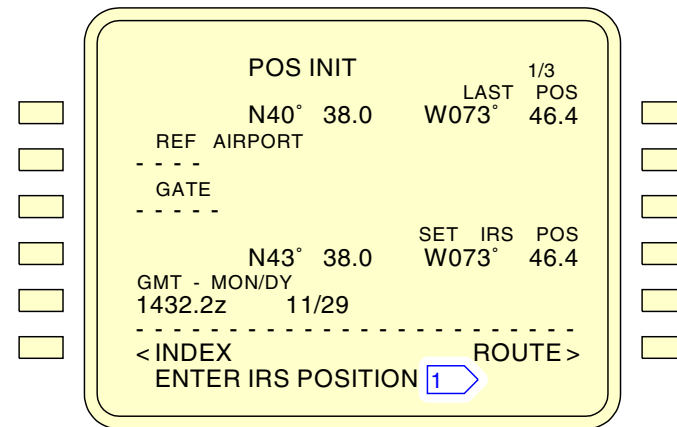
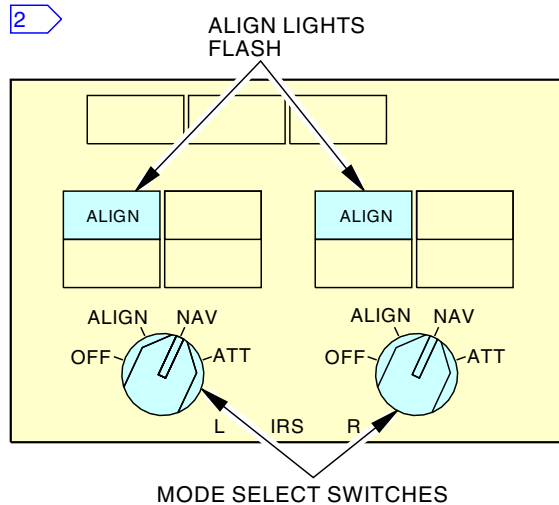
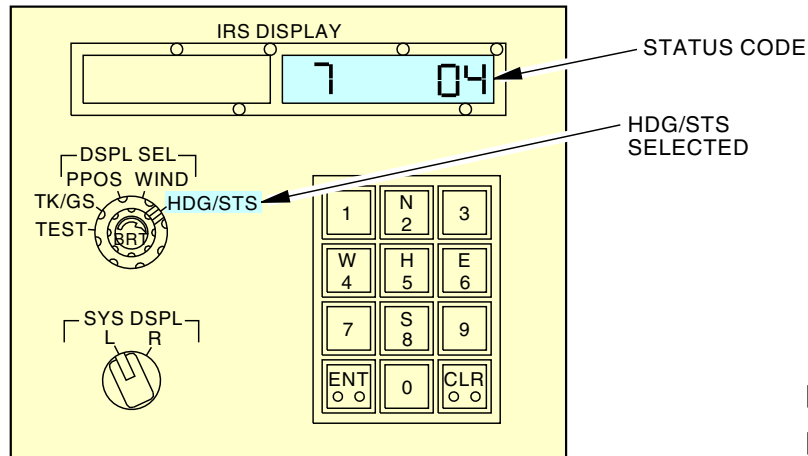
Enter the same position data again to cause these to occur:

- Align light on (no flash)
- Status code 4 goes out of view
- ENTER IRS POSITION goes out of view.

NOTE: The ADIRU does not calculate longitude. The ADIRU will not detect an incorrect longitude entry after alignment is complete.

EFFECTIVITY	
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ADIRS - POSITION DIFFERENCE DURING ALIGNMENT



- 1 MESSAGE SHOWS ON ALL CDU PAGES
- 2 IF APPLICABLE

ADIRS - POSITION DIFFERENCE DURING ALIGNMENT

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**ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 1****General**

At the end of the alignment period, if the ADIRU calculated latitude is different than the latitude you entered, you will see these conditions:

- ALIGN light flash
- SET IRS POSITION shows on CDU
- Alignment time shows 0 on ISDU.
- Alignment time shows 0 on ND.
- Status code out of view on ISDU.

If you enter the same latitude again, you will see these conditions:

- ALIGN light on
- FAULT light on
- SET IRS POSITION on CDU goes out of view
- Alignment time shows 0 on ISDU.
- Alignment time shows 0 on ND.
- Status code 2 shows on ISDU.

One of these will cause a latitude difference:

- ADIRU calculated latitude error
- Latitude entry error.

ADIRU Calculated Latitude Error

A calculated latitude error usually will occur in one ADIRU. If the position difference is in one ADIRU, start a new alignment. If the new alignment has a position difference, refer to troubleshooting procedures in part two of the maintenance manual.

Latitude Entry Error

A latitude entry error gives the wrong latitude to both ADIRUs. If the position difference is in the left and right ADIRU, correct position can be entered without starting a new alignment.

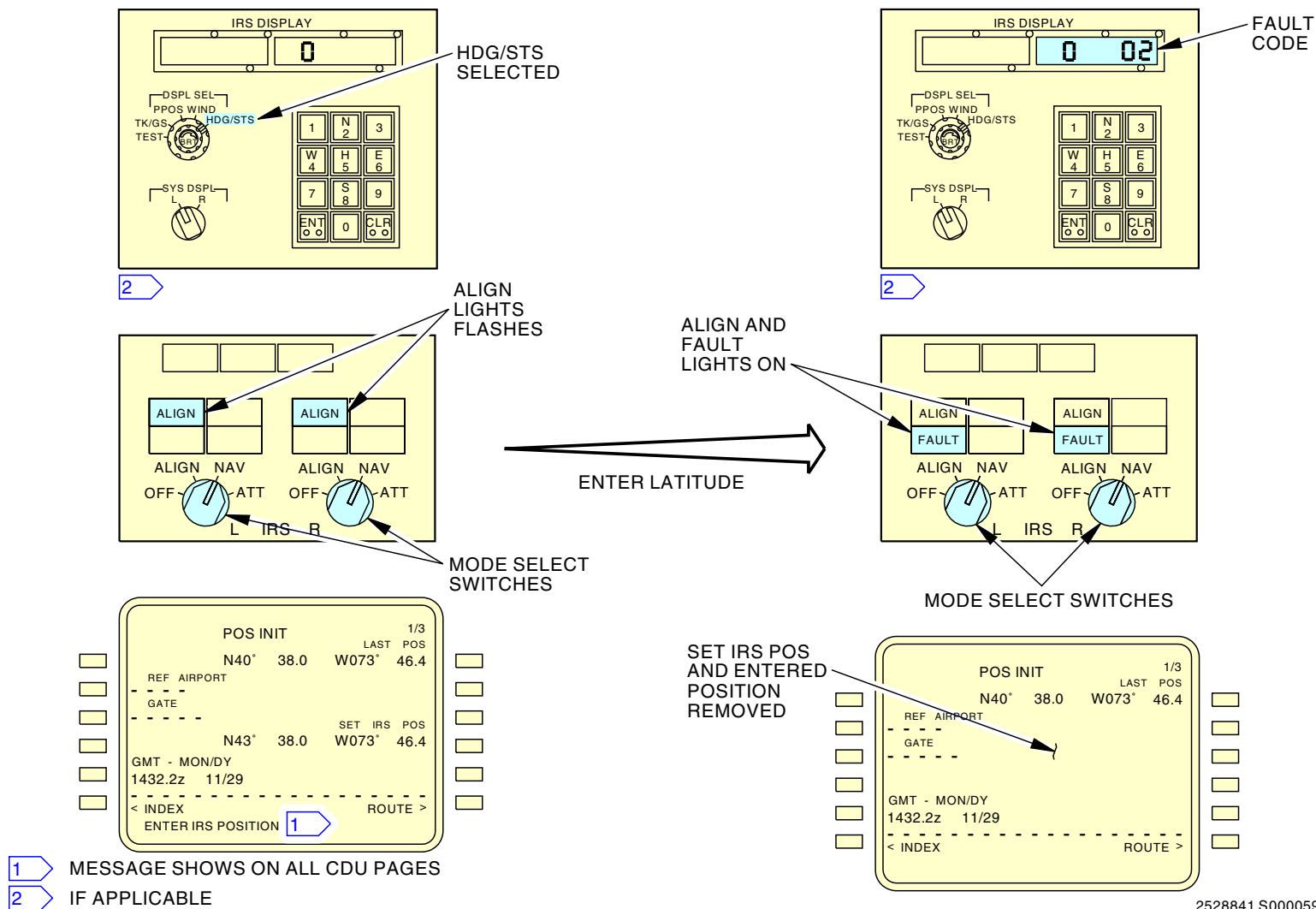
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 1



2528841 S0000597134_V2

ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 1

34-21-00

SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 2****Correct Position Entry**

Move the mode selector on the MSU to ALIGN.

Use the keyboard on the ISDU or the FMC CDU to enter the correct latitude and longitude.

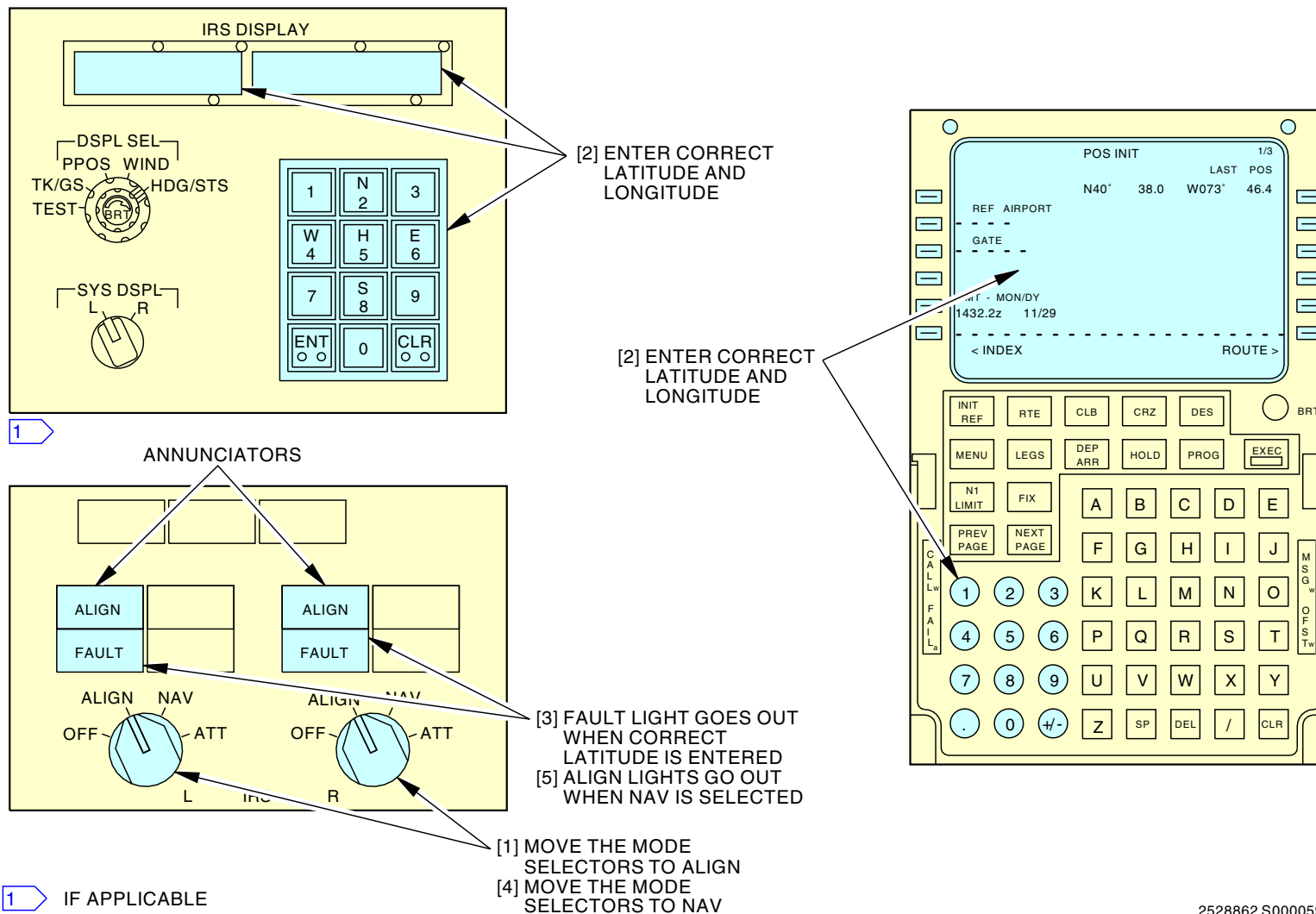
The FAULT light goes off when the correct latitude is entered.

Move the mode selector to NAV. The ALIGN lights go out and the ADIRUs enter navigation mode.

If the ADIRUs do not enter the navigation mode, start a new alignment. Refer to the fault isolation manual (FIM) section 34-21 for troubleshooting procedures.

SIA ALL	EFFECTIVITY

ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 2



2528862 S0000597135_V2

ADIRS - POSITION DIFFERENCE AFTER ALIGNMENT 2

34-21-00

SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - NO PRESENT POSITION ENTRY****General**

You must enter present position during the alignment period. If the alignment period ends and present position has not been entered, these conditions show:

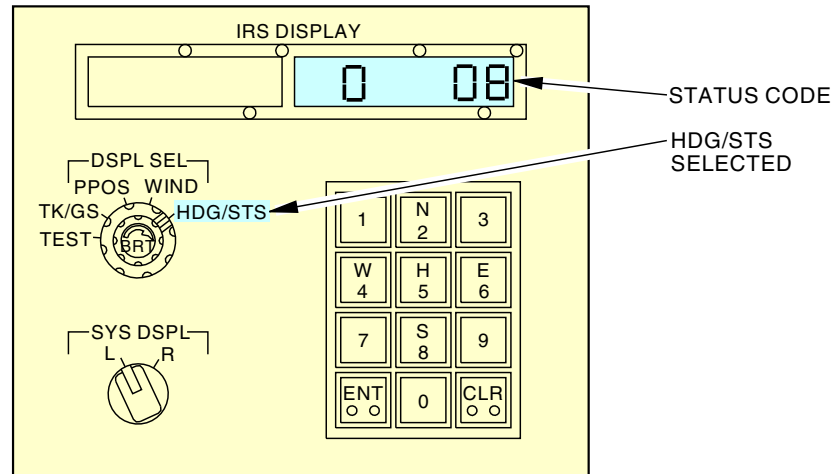
- ALIGN light flashes
- Status code 8 shows on ISDU
- ENTER IRS POSITION shows on CDU.

Use the ISDU or CDU to enter present position. When you enter present position these conditions show:

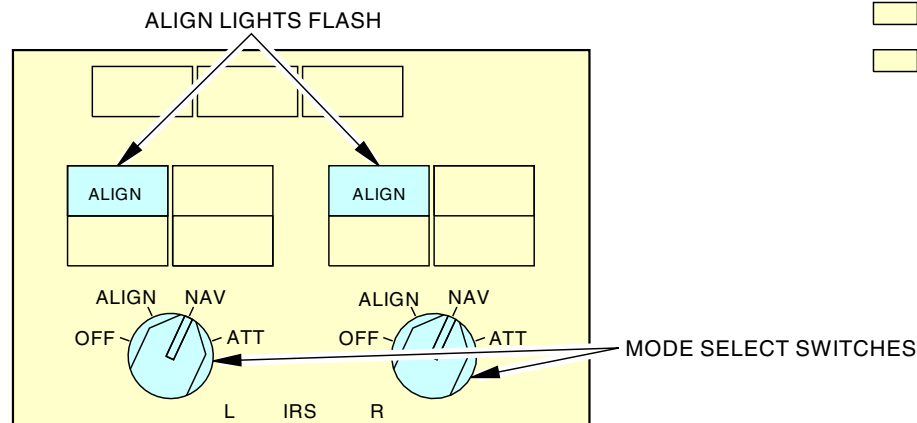
- ALIGN light goes off
- Status code 8 goes out of view
- ENTER IRS POSITION goes out of view.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ADIRS - NO PRESENT POSITION ENTRY



2



- 1 MESSAGE SHOWS ON ALL CDU PAGES
- 2 IF APPLICABLE

POS INIT		1/3
N40° 38.0		LAST POS
W073° 46.4		
REF AIRPORT		
GATE		
SET IRS POS		
GMT - MON/DY		
1432.2z 11/29		
< INDEX ROUTE >		
ENTER IRS POSITION 1		

ADIRS - NO PRESENT POSITION ENTRY

2528894 S0000597136_V2

34-21-00

**ADIRS - ATTITUDE MODE****General**

Use the attitude (ATT) mode when you only need pitch and roll data, or when the navigation function of the ADIRU fails. You can select the attitude mode on the ground or in the air.

Attitude Mode Selection

Move the mode selector to ATT to select the attitude mode. The ADIRU goes to the attitude mode 2 seconds after the mode is selected. The two second delay prevents accidental selection of the mode.

Attitude Alignment

When you select the attitude mode, the ALIGN light comes on for 30 seconds. During this time, the ADIRU calibrates to 0 degrees in pitch and roll. If the airplane is in the air, the pilot must keep the airplane straight and level and not accelerate until the ALIGN light goes off.

Heading Entry

The ADIRU uses manual heading in the ATT mode.

Status code 9 shows on the ISDU until you enter magnetic heading. Enter magnetic heading with the ISDU or CDU. On the ISDU, push the H5 key and the number keys. Heading shows on the IRS DISPLAY. Push the ENT key to enter the heading in the ADIRU.

On the CDU, enter the three digit heading value in the scratchpad. Use the line select key (LSK) 5R to enter the heading in the ADIRU. The heading shows on the CDU.

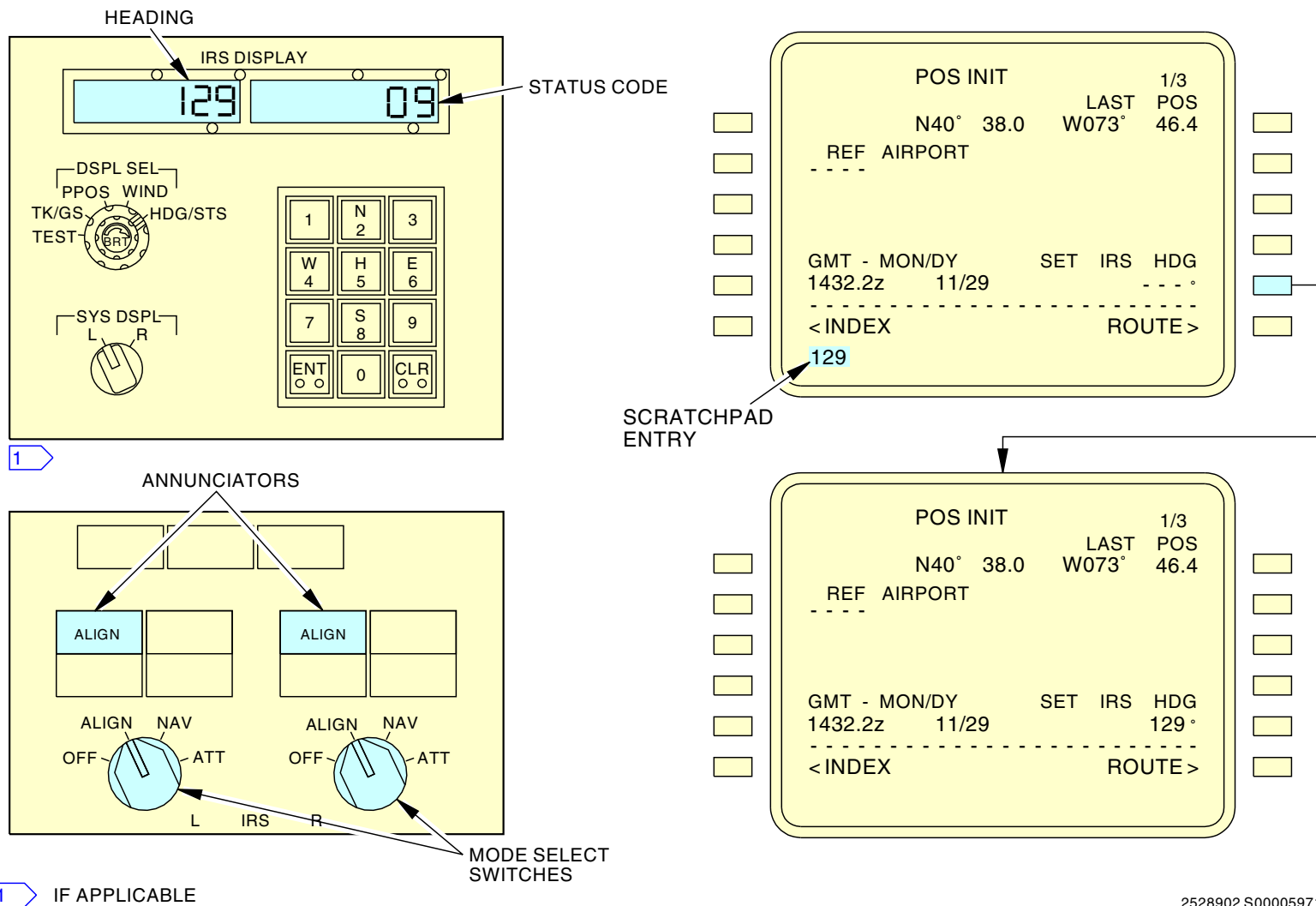
34-21-00

EFFECTIVITY	
SIA ALL	

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADIRS - ATTITUDE MODE



ADIRS - ATTITUDE MODE

2528902 S0000597142_V2

34-21-00

**ADIRS - ALIGN-IN-MOTION****General**

The IR is capable of performing Align-in-Motion (AIM) in-flight while the aircraft is in motion and returns to full inertial navigation functionality once AIM is completed. AIM mode should be used when there is a power loss to the ADIRU or cycling of the MSU from OFF while in-flight.

AIM Mode Selection

The ADIRU will enter AIM mode if valid GPS data is available, and the aircraft is in-flight or the ADIRU detects GPS ground speeds greater than 30 knots. The absence, or loss, of valid GPS data can inhibit AIM mode, or result in a restart of the alignment when valid data is received. AIM mode is accomplished by turning the applicable MSU switch to OFF, then back to NAV position.

AIM Alignment

The airplane must be level and in non-accelerated flight to allow the ADIRU to align to the airplane vertical axis for subsequent pitch and roll sensor outputs. During the alignment, the ALIGN light on the MSU is on and the IRS L and IRS R positions are blank on the FMC CDU POS REF page.

Before AIM alignment is completed, the IR operates in AIM attitude mode which provides improved pitch and roll attitude performance and set heading function similar to normal attitude mode.

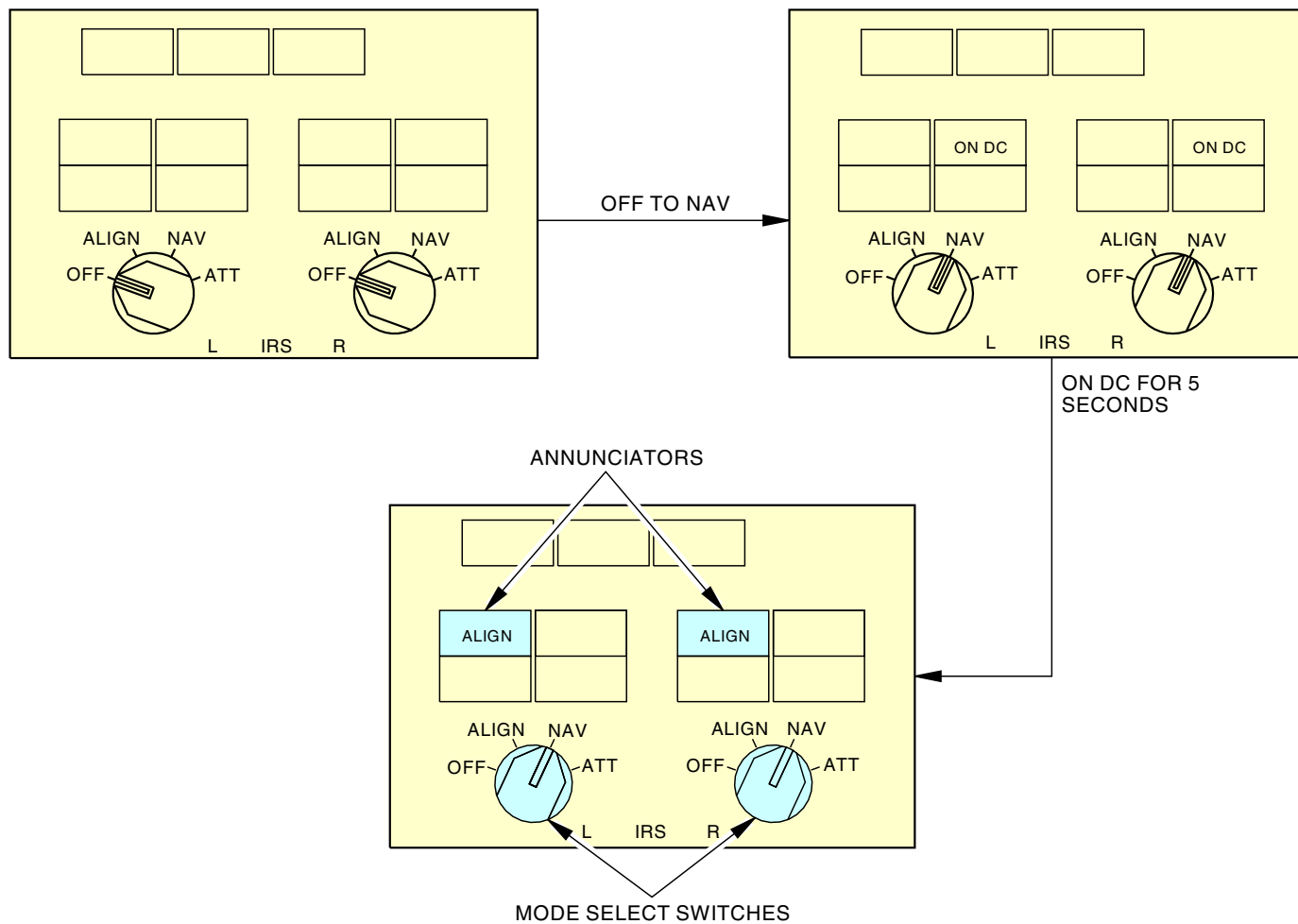
When AIM alignment completes, full navigation functionality is restored.

EFFECTIVITY**SIA 005-999; SIA 001-004 POST SB 737-34-3141****D633AM102-SIA**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-21-00

ADIRS - ALIGN-IN-MOTION



2528074 S0000597119_V1

ADIRS - ALIGN-IN-MOTION

34-21-00



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D633AM102-SIA

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**ADIRS - AUTOMATIC NAVIGATION REALIGNMENT****General**

The Automatic Navigation Realignment (ANR) is performed while the IR is in NAV mode. The purpose of the ANR function is to automatically perform realignment corrections and navigation resets while the aircraft is motionless on ground. Navigation resets allow navigation accuracy to be maintained over long periods of time without performing a normal full alignment.

ANR Activation

A long period of no detected motion is required before the first reset is performed. Resets are then performed at one minute intervals until aircraft motion is detected. When motion is detected, resets will not occur until after another long period of no detected motion. Multiple ANR can occur before a flight or following a flight.

There are four different types of ANR:

- Extended Alignment
- Pre-flight
- Post-flight
- Extended Align Downmode (Extended Fast Alignment).

The IR accepts present position entry from the FMC CDU, ISDU or GPS when ANR is actively correcting the navigation values. Manually entered present position is accepted and used to update the navigation mode outputs provided that the entered latitude and longitude are both within ± 0.5 degrees of the computed navigation mode latitude and longitude.

GPS position inputs are automatically accepted and used to update the navigation mode outputs if a manually entered position has not already been accepted. To prevent the override of manually entered position data made during the last ALIGN mode, automatic acceptance of GPS position during ANR is inhibited following completion of ALIGN mode until a flight has been completed.

Extended Alignment

After a full stationary alignment and transition to NAV mode, when motion is not detected, the IR activates the Extended Alignment ANR and performs navigation resets at one minute intervals, starting at one minute after full alignment, until motion is detected. When motion is detected, the IR exits the Extended Alignment ANR. If there is another long period of no detected motion, 7.5 to 15 minutes depending on latitude, the IR re-activates and transitions to pre-flight ANR.

During the Extended Alignment ANR, the IR does not allow for automatic present position updates.

Pre-flight

The pre-flight ANR is activated after the following occur:

- The airplane is on ground
- Before a flight during IR NAV mode, the airplane detected motion and then no motion
- A long period of no detected motion (7.5 to 15 minutes).

When pre-flight ANR conditions are met, the IR performs the first navigation reset to prevent accumulation of drift errors while motionless on ground. After the first reset, if the airplane still remains motionless, the IR performs successive navigation resets at one minute intervals until motion is detected. Multiple pre-flight ANR can occur before a flight if motion is detected and the pre-flight ANR conditions occur again.

During the pre-flight ANR, the IR does not allow automatic present position updates.

Post-flight

The post-flight ANR is activated when the following occur:

- The airplane is on ground
- A completion of a flight that ends while in NAV mode
- The airplane remains in NAV mode for a long period of no detected motion (7.5 to 15 minutes).

34-21-00**EFFECTIVITY****SIA 005-999; SIA 001-004 POST SB 737-34-3141**

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - AUTOMATIC NAVIGATION REALIGNMENT**

When post-flight ANR conditions are met, the IR performs the first navigation reset to remove drift errors accumulated during flight. After the first reset, if the airplane still remains motionless, the IR performs successive navigation resets at one minute intervals until motion is detected. Multiple post-flight ANR can occur if motion is detected and the post-flight ANR conditions occur again.

Post-flight ANR will be exited and inhibited until another flight is completed if a full stationary alignment is performed to fully reset the IRS. Alternatively, a transition to IR align downmode (or fast alignment) can be performed, which will cause the IR to exit the post flight ANR.

When ADIRU are connected to the MMR, the ADIRU automatically accept valid GPS position and update present position data during post-flight ANR.

Extended Align Downmode (Extended Fast Alignment)

The extended fast alignment ANR is activated when the following occur:

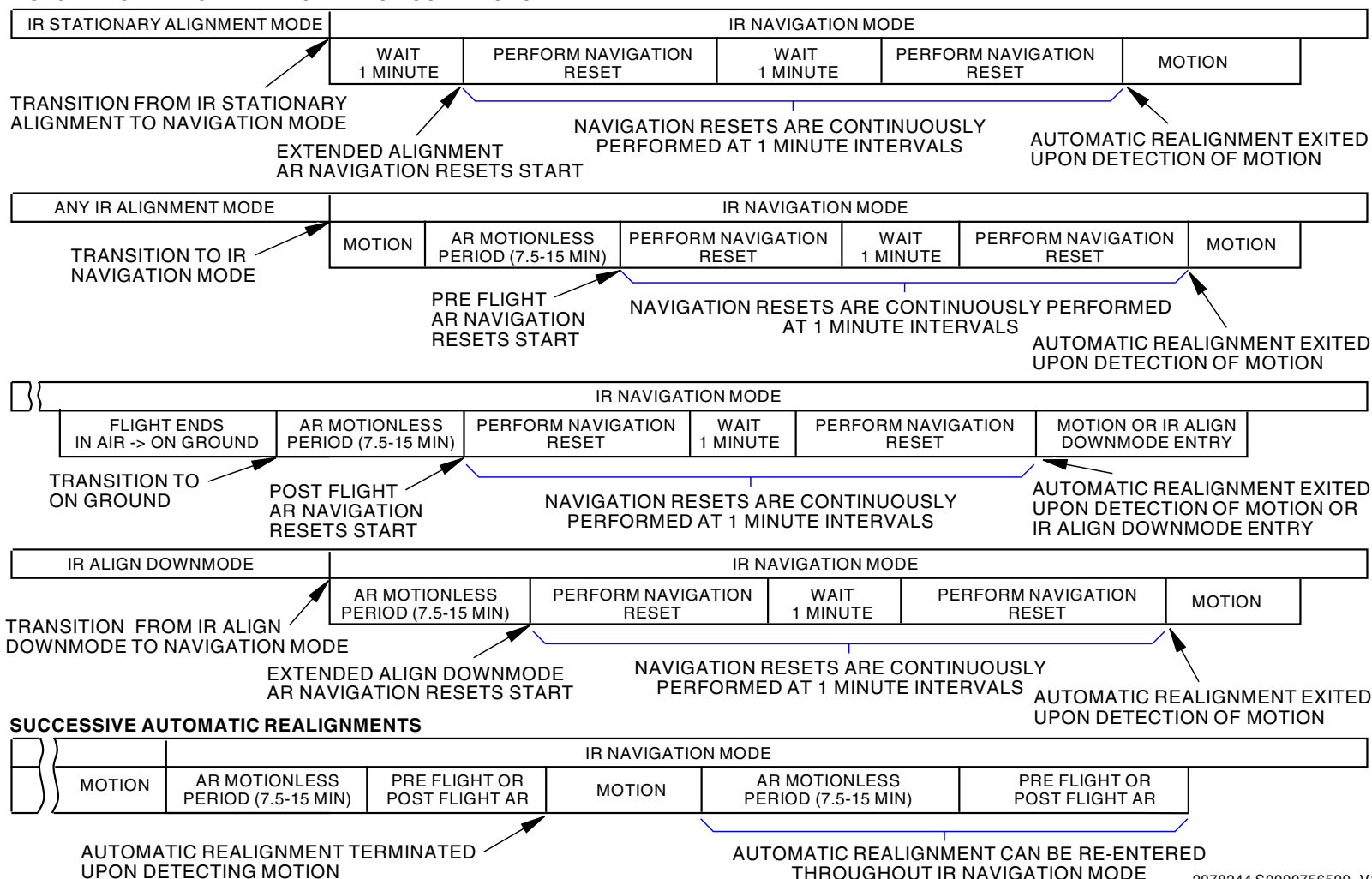
- The airplane is on ground
- IR NAV mode is entered from the align downmode
- A long period of no detected motion (7.5 to 15 minutes).

When the extended fast alignment ANR conditions are met, the IR performs the first navigation reset to prevent accumulation of drift errors while motionless on ground. After the first reset, if the airplane still remains motionless, the IR performs successive navigation resets at one minute intervals until motion is detected.

During the extended fast alignment ANR, the IR does not allow automatic present position updates.

ADIRS - AUTOMATIC NAVIGATION REALIGNMENT

AUTOMATIC REALIGNMENT ACTIVATION CONDITIONS



2978244 S0000756599_V1

ADIRS - AUTOMATIC NAVIGATION REALIGNMENT



ADIRS - IR MODES

GENERAL

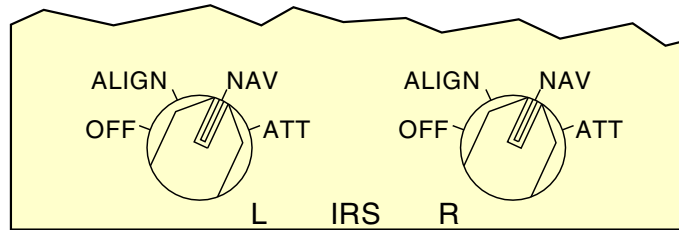
The chart shows the mode sequences of the MSU mode selector.

34-21-00-054

EFFECTIVITY	
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ADIRS - IR MODES



MODE SELECT SWITCH SEQUENCE	RESULT
OFF TO ALIGN (AIRPLANE NOT MOVING)	ADIRU GOES TO ALIGNMENT MODE. ALIGN LIGHT COMES ON.
OFF TO NAV (AIRPLANE NOT MOVING)	ADIRU GOES TO ALIGNMENT MODE. ADIRU AUTOMATICALLY GOES TO NAV MODE AT END OF ALIGNMENT PERIOD IF PRESENT POSITION IS ENTERED.
NAV TO ALIGN TO NAV (AIRPLANE NOT MOVING)	ADIRU VELOCITY SET TO 0. RESET LEVEL. ALIGN LIGHT COMES ON FOR 30 SECONDS.
NAV TO ALIGN (AIRPLANE NOT MOVING)	SETS VELOCITY TO 0. RESETS LEVEL AND HEADING. ALIGN LIGHT COMES ON.
OFF, ALIGN, OR NAV TO ATT	ADIRU GOES TO ATTITUDE MODE AFTER 2 SECONDS. ALIGN LIGHT COMES ON FOR 30 SECONDS. HEADING CAN BE ENTERED.
ATT TO NAV OR ALIGN	ADIRU IN ATTITUDE MODE UNTIL SWITCH IS MOVED TO OFF.
ATT TO OFF	ALIGN LIGHT COMES ON FOR 30 SECONDS. AFTER 30 SECONDS, ADIRU GOES OFF.
NAV OR ALIGN TO OFF	ALIGN LIGHT COMES ON FOR 30 SECONDS. FAULTS AND POSITION DATA STORED IN MEMORY. AFTER 30 SECONDS, ADIRU GOES OFF.

2369834 S00061520432_V1

ADIRS - IR MODES

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34-21-00-054

EFFECTIVITY
SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADIRS - ADIRS MAINTENANCE CODES****General**

ADIRS maintenance codes show on the IRS DISPLAY of the ISDU when DSPL SEL switch is set to HDG/STS position. Maintenance code is displayed on the right display window. Some codes give the condition of ADIRS components and signals. Some codes give instructions.

Two or more codes cause the ISDU CLR key light to come on. Push the CLR key to show the codes in sequence.

The ADIRS maintenance codes come from the ADIRUs. Put the SYS DSPL selector in the L position to see codes from left ADIRU. The right shows codes from the right ADIRU.

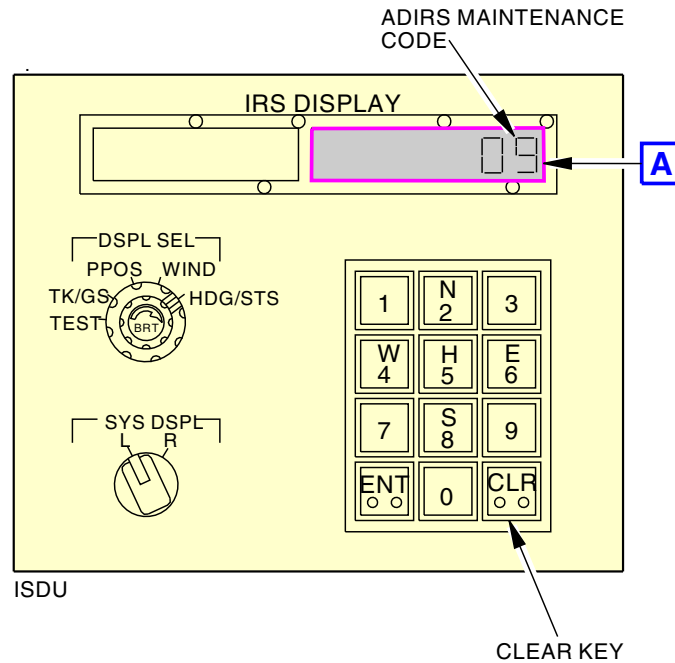
NOTE: Maintenance codes 26 and 36 are not used.

CDU Display Pages

You can see the list of ADIRS maintenance codes on the CDU. The list is a part of the ADIRS BITE.

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	D633AM102-SIA

ADIRS - ADIRS MAINTENANCE CODES



CODE TABLE	
01	ISDU FAIL
02	IR FAILURE
03	EXCESSIVE MOTION
04	ALIGN FAULT
07	ADR DATA INVLD
08	ENTER PPOS
09	ENTER HEADING
10	ISDU POWER LOSS
18	NO ADR DATA
19	IR PROG PIN INVLD
20	ADR FAIL
21	ADR PROG PIN INVLD
22	TAT PROBE SIGNAL FAIL
23	AOA SIGNAL FAIL
24	NO AOA REF SIGNAL
26	NO BARO 3 REF SIGNAL
27	NO PITOT ADM DATA
28	NO STATIC ADM DATA
29	NO BARO 1 DATA
30	NO BARO 2 DATA
31	NO IR DATA
32	PITOT ADM DATA INVLD
33	STATIC ADM DATA INVLD
34	BARO 1 DATA INVLD
35	BARO 2 DATA INVLD
36	BARO 3 SIGNAL FAIL
37	IR DATA INVLD
38	AIR/GND LOGIC INVLD

1 NOT USED

A

2369835 S00061520434_V1

ADIRS - ADIRS MAINTENANCE CODES

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EFFECTIVITY	
SIA ALL	



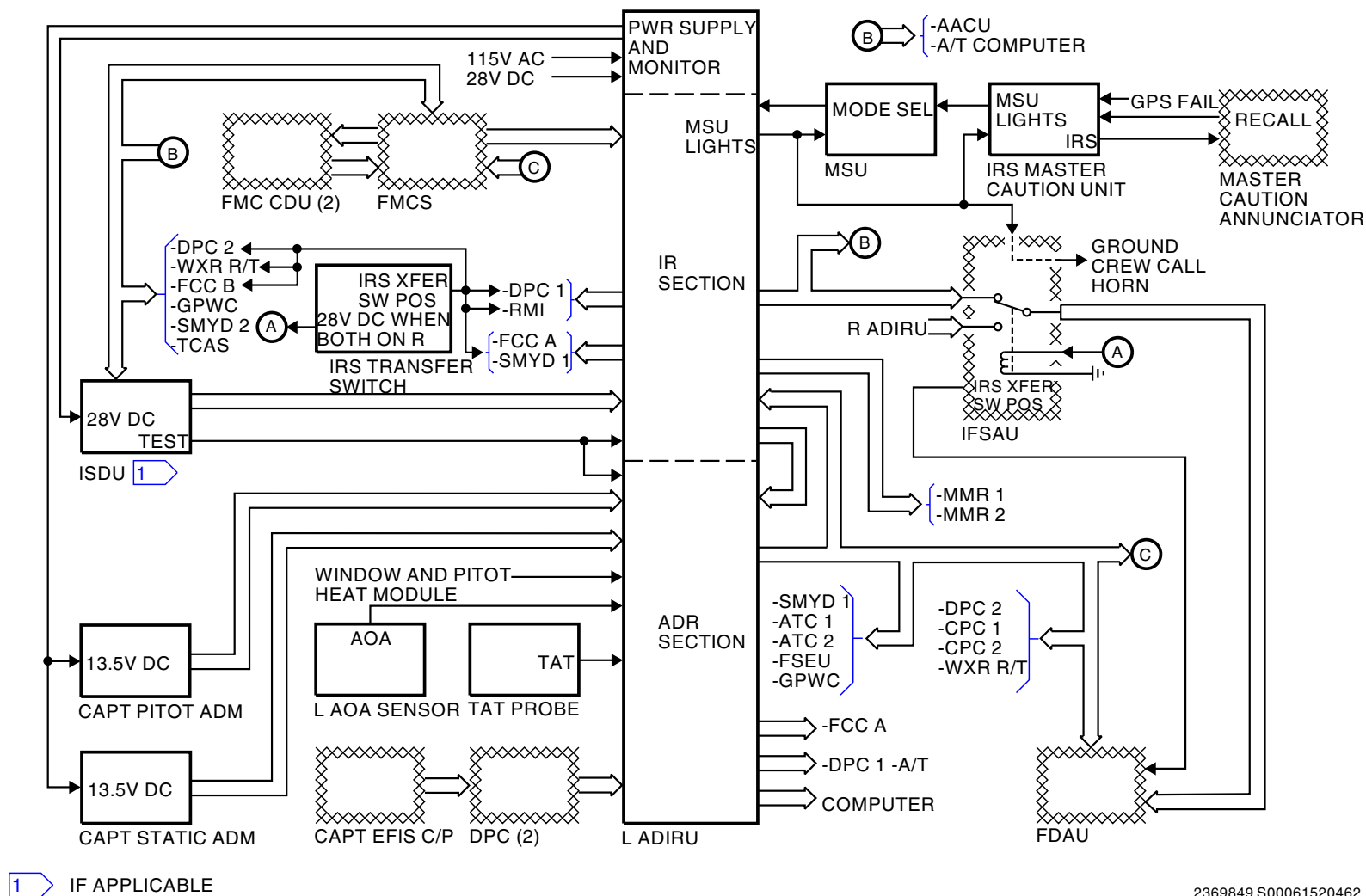
ADIRS - SYSTEM SUMMARY 1

General

This page is for reference.

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	D633AM102-SIA

ADIRS - SYSTEM SUMMARY 1



2369849 S00061520462_V3

ADIRS - SYSTEM SUMMARY 1

34-21-00

EFFECTIVITY
SIA 001-004 PRE SB 737-34-3141

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2978348 S0000756727 V2

ADIRS - SYSTEM SUMMARY 1

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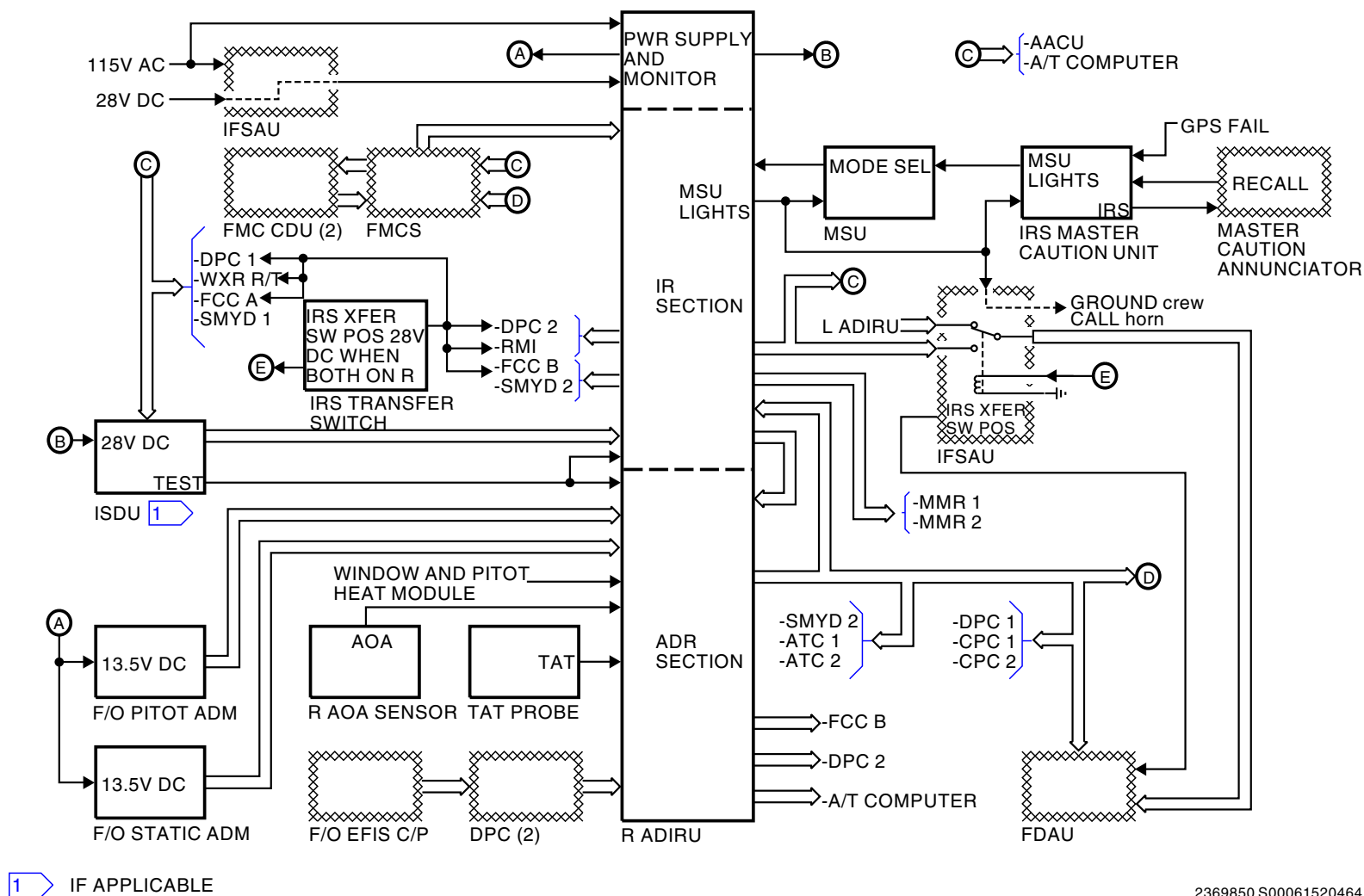
ADIRS - SYSTEM SUMMARY 2

General

This is for reference.

EFFECTIVITY	
SIA ALL	

ADIRS - SYSTEM SUMMARY 2



2369850 S00061520464_V3

ADIRS - SYSTEM SUMMARY 2

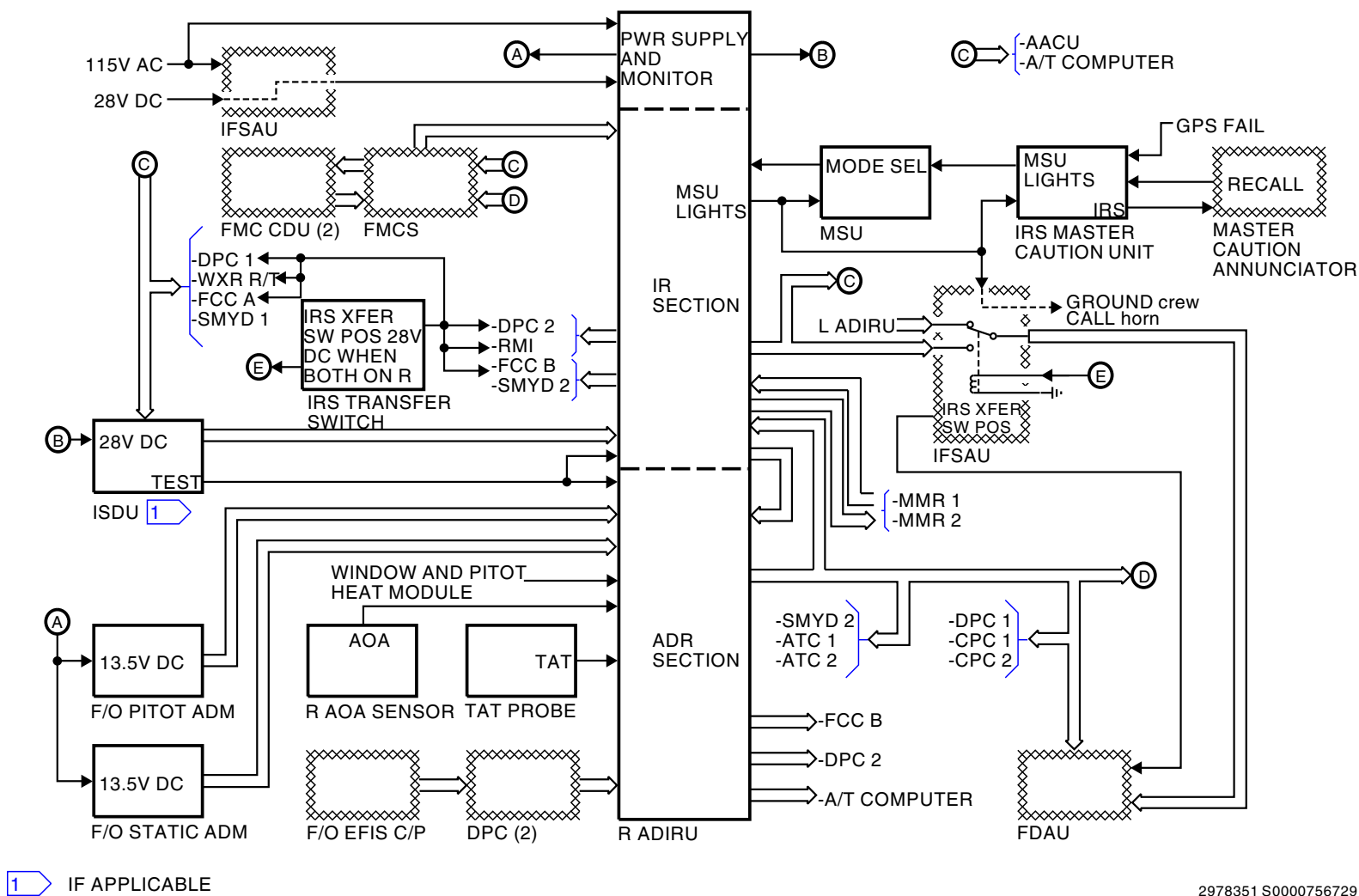
34-21-00

EFFECTIVITY
SIA 001-004 PRE SB 737-34-3141

D633AM102-SIA

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ADIRS - SYSTEM SUMMARY 2



2978351 S0000756729_V2

ADIRS - SYSTEM SUMMARY 2

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EFFECTIVITY
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D633AM102-SIA

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STANDBY MAGNETIC COMPASS

Purpose

The standby magnetic compass is a backup magnetic heading reference.

Location

The standby magnetic compass is below the P5 forward overhead panel.

Power

The standby magnetic compass has a 28v dc light bulb. A lamp access cover permits replacement of the bulb.

Characteristics

The standby magnetic compass has a circular heading indicator card. The card floats in a case filled with liquid. The liquid does not permit the card to move quickly.

There are two magnets in the standby magnetic compass. The magnets are parallel to each other, and they are in the horizontal plane. The magnets align the compass with the magnetic flux lines of the earth.

Adjustment

The standby magnetic compass has N-S (north-south) and E-W (east-west) compensation screws. These screws change the position of the magnets.

Use the compensation screws to correct for magnetic deviation. Use only non-magnetic tools to turn the compensation screws.

There is a compass correction card near the compass. Use this card to write small errors that the compensation screws cannot remove.

Training Information Point

Four screws hold the standby magnetic compass in place. Use only non-magnetic tools and screws to remove and install the standby magnetic compass.

You must do a compass swing after you replace the standby magnetic compass.

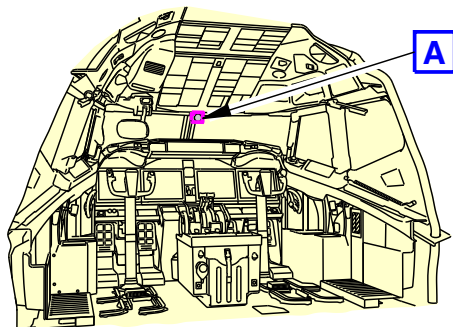
34-23-00

EFFECTIVITY	
SIA ALL	

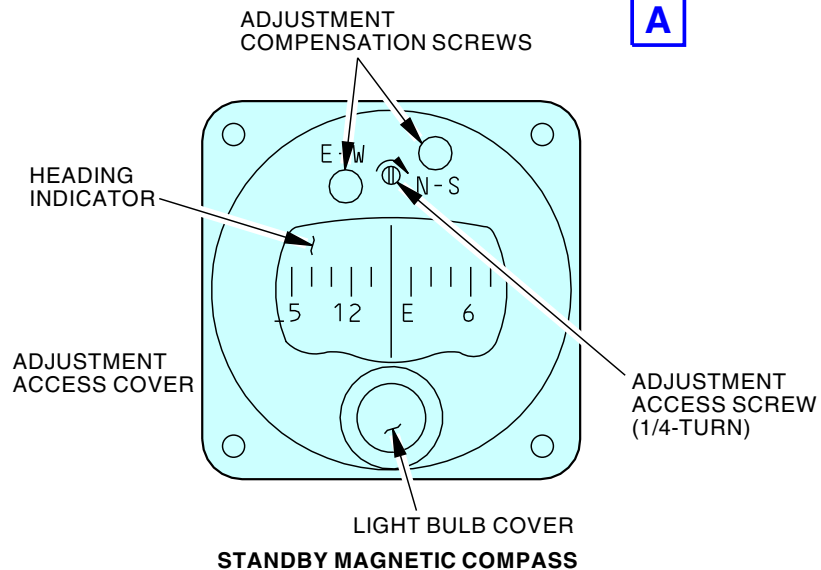
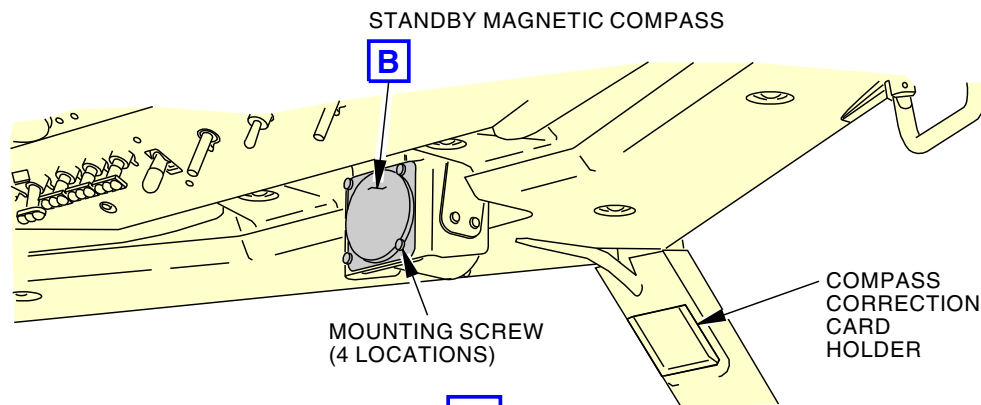
D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

STANDBY MAGNETIC COMPASS



FLIGHT COMPARTMENT



STANDBY MAGNETIC COMPASS

2369856 S00061520480_V2

STANDBY MAGNETIC COMPASS



STANDBY ATTITUDE REFERENCE SYSTEM - INTRODUCTION

Purpose

The standby attitude reference system is a backup system. It shows the pilots these data:

- Pitch attitude
- Roll attitude
- Altitude
- Heading
- Indicated Airspeed (IAS)
- ILS localizer and glideslope deviation.

General

For all data except heading, the standby attitude reference system operates independently of the air data inertial reference system.

Abbreviations and Acronyms

- AC - alternating current
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- ARINC - Aeronautical Radio, Inc.
- alt - altitude
- amp - amperes
- app - approach
- att - attitude
- baro - barometric
- bat - battery
- BCRS - back course
- BITE - built-in test equipment
- C - degrees Celsius
- DC - direct current
- F - degrees Fahrenheit

- fail warn - failure warning
- fwd - forward
- g - grams
- g - acceleration due to gravity
- G/S - glideslope
- GLS - GNSS landing system
- hdg - heading
- HP - hectopascal
- hPa - hectopascal
- IAS - indicated airspeed
- ident - identification
- ILS - instrument landing system
- IN - inches of mercury
- in Hg - inches of mercury
- init - initialization
- IR - inertial reference
- IRS - inertial reference system
- ISFD - integrated standby flight display
- kg - kilograms
- kts - knots
- LCD - liquid crystal display
- LOC - localizer
- LRU - line replaceable unit
- m - meters
- mbar - millibars
- mm - millimeters
- MMR - multi-mode receiver
- NCD - no computed data
- P/N - hardware part number
- rst - reset

34-24-00

SIA ALL EFFECTIVITY

D633AM102-SIA

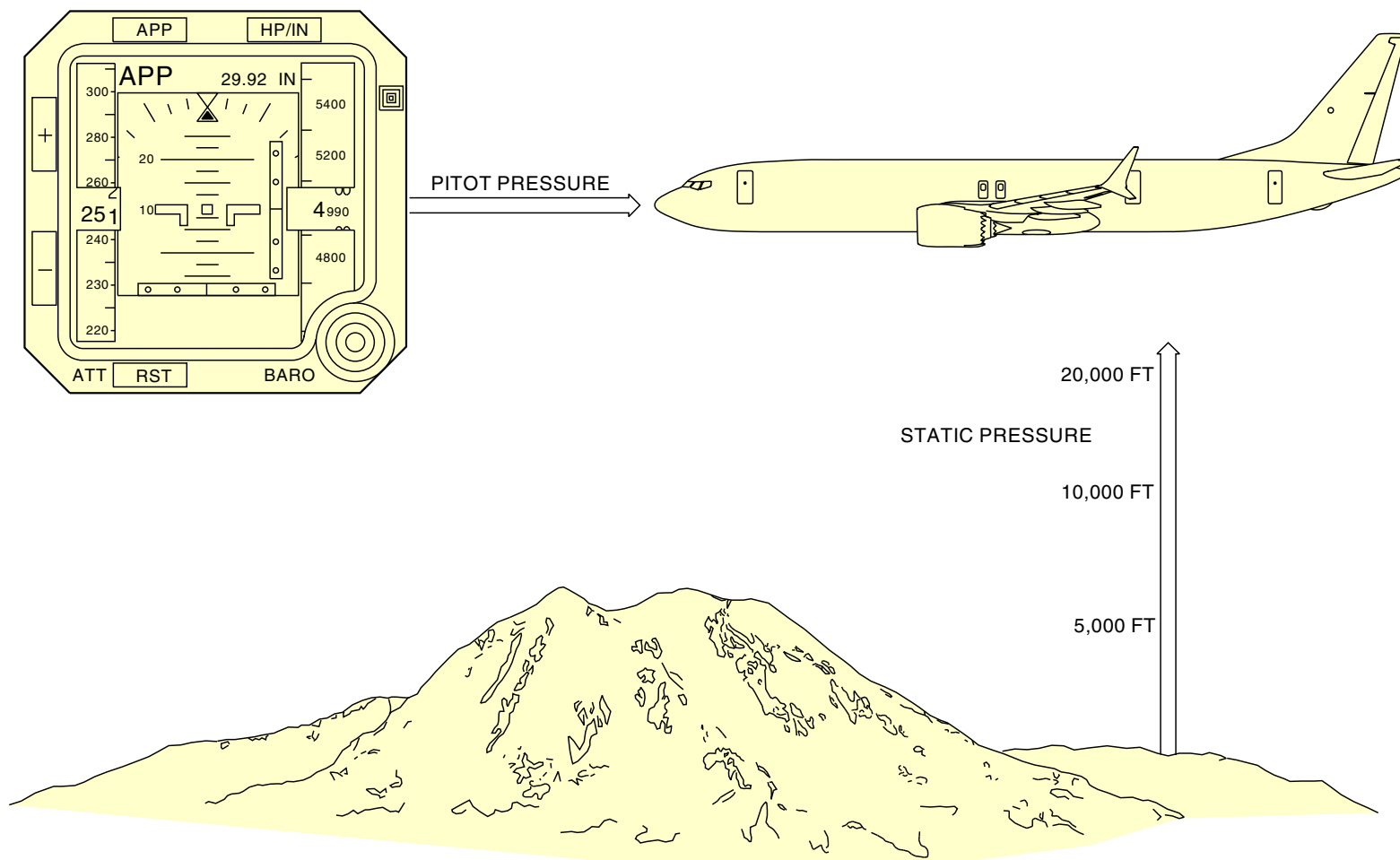
ECCN 9E991 BOEING PROPRIETARY - See title page for details



STANDBY ATTITUDE REFERENCE SYSTEM - INTRODUCTION

- s - seconds
- S/N - software part number
- spd - airspeed
- V - volts
- wrg - wiring

STANDBY ATTITUDE REFERENCE SYSTEM - INTRODUCTION



2369857 S00061520484_V3

STANDBY ATTITUDE REFERENCE SYSTEM - INTRODUCTION

34-24-00

SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**STANDBY ATTITUDE REFERENCE SYSTEM - GENERAL DESCRIPTION****General**

The standby attitude reference system has an Integrated Standby Flight Display (ISFD) and an ISFD dedicated battery/charger.

The ISFD shows these standby data:

- Airspeed
- Attitude
- Altitude
- Heading
- Localizer & glideslope deviations.

The display is a color Liquid Crystal Display (LCD).

Power

Airplane power goes through the ISFD dedicated battery/charger to the ISFD. The battery bus supplies the 28v dc.

The battery switch on the electrical meters, battery, and galley power module controls the power to the ISFD.

When the battery switch is on, the battery/charger sends power to the ISFD. The battery bus supplies power to the ISFD through the battery/charger. The battery bus also supplies a charge for a battery in the battery/charger.

If there is not sufficient power on the battery bus to operate the ISFD, the battery in the battery/charger supplies power to the ISFD.

When the battery switch is off, the battery/charger removes power to the ISFD.

Attitude

Pitch and roll attitude come from the inertial sensors in the ISFD.

Pitch and roll attitude show as an attitude ball in the center of the display.

Altitude and Airspeed

The ISFD is a pneumatic altimeter and airspeed indicator.

The ISFD gets static pressure from the alternate static ports and pitot pressure from the alternate pitot probe.

The ISFD uses pitot and static pressure to show Indicated Airspeed (IAS). IAS shows on the airspeed tape on the left side of the display.

The ISFD uses static pressure to show barometric altitude. Barometric altitude shows on the altitude tape on the right side of the display.

Heading

The Air Data Inertial Reference System (ADIRS) supplies heading to the ISFD from the left Air Data Inertial Reference Unit (ADIRU).

Heading shows on the compass rose on the bottom of the display.

Localizer and Glideslope Deviation

The standby attitude reference system also shows data from the Instrument Landing System (ILS) and the GNSS Landing System (GLS).

When you select the approach (APP) mode on the ISFD, the localizer deviation scale shows on the bottom of the attitude ball, and the glideslope deviation scale shows on the right side of the attitude ball.

Push the approach mode switch (APP) two times to select the back course mode. When you select the Back Course (BCRS) mode on the ISFD, the localizer deviation scale shows on the bottom of the attitude ball. The ISFD also moves the localizer deviation pointer to the opposite side of the scale. The glideslope deviation scale does not show.

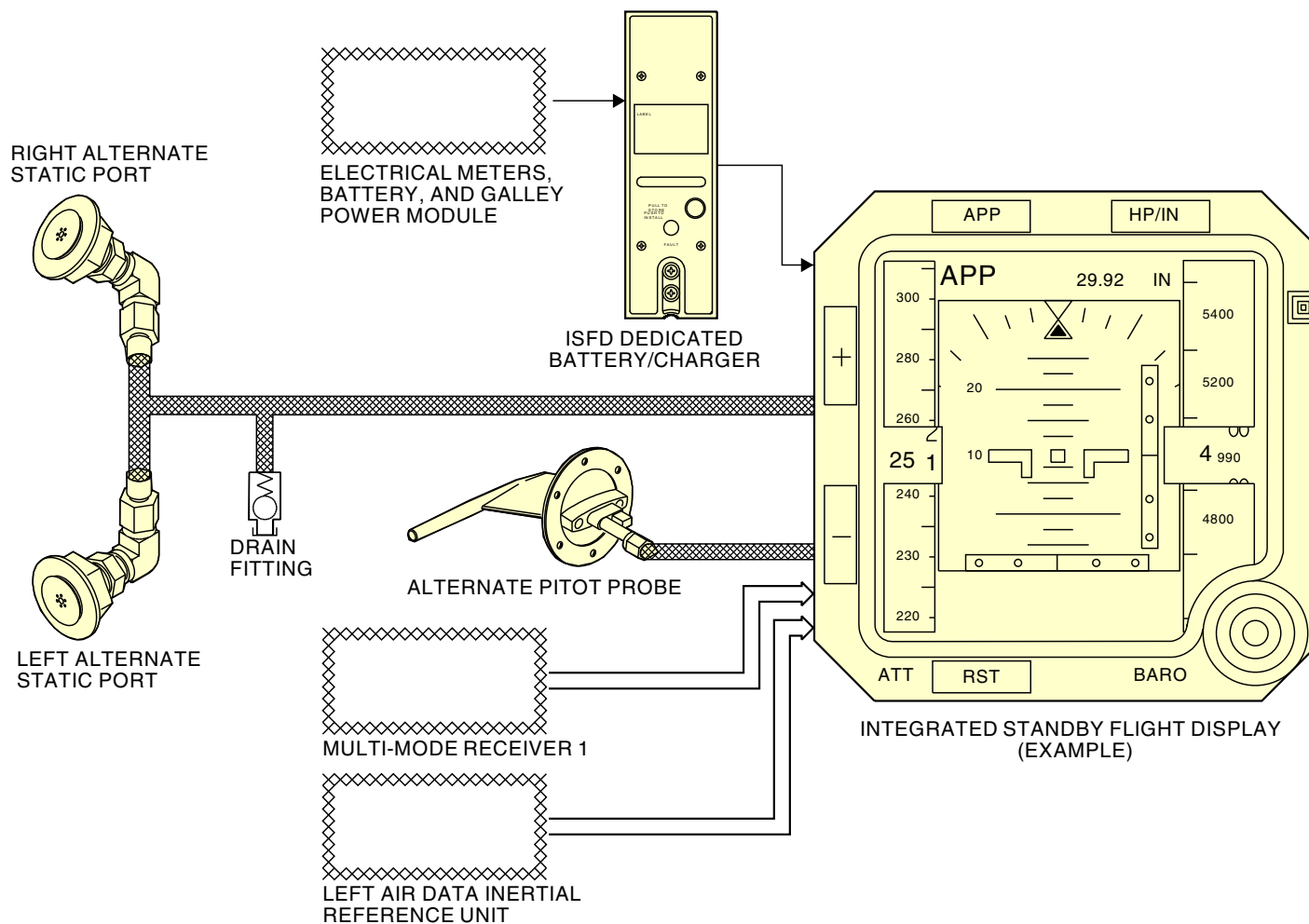
Multimode Receiver (MMR) 1 sends localizer and glideslope deviation to the ISFD.

Air Data Inertial Reference Unit

The ADIRU sends inertial reference data to the ISFD.

The ISFD uses ground speed to sense when the airplane is on the ground.

STANDBY ATTITUDE REFERENCE SYSTEM - GENERAL DESCRIPTION



2369858 S00061520486_V3

STANDBY ATTITUDE REFERENCE SYSTEM - GENERAL DESCRIPTION

34-24-00



STANDBY ATTITUDE REFERENCE SYSTEM - COMPONENT LOCATION

General

The components for the standby attitude reference system are in the flight compartment and the electronic equipment compartment.

Flight Compartment

The Integrated Standby Flight Display (ISFD) is on the P2 center instrument panel.

Electronic Equipment Compartment

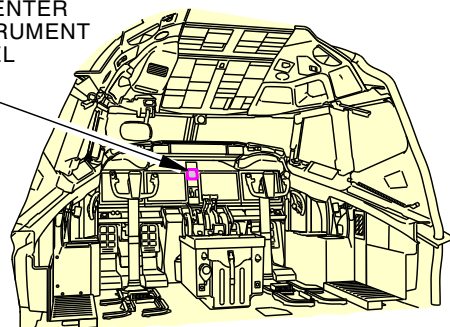
The ISFD dedicated battery/charger is in the electronic equipment compartment on the E5 rack.

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	D633AM102-SIA

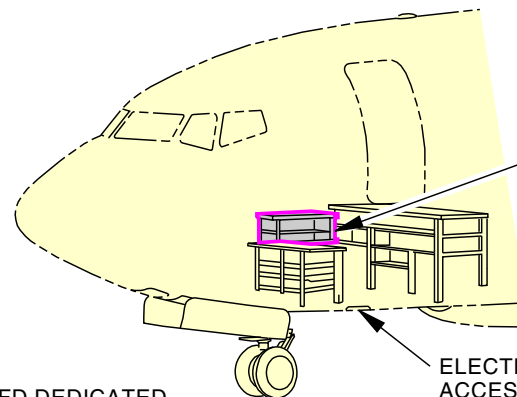
STANDBY ATTITUDE REFERENCE SYSTEM - COMPONENT LOCATION

P2 CENTER
INSTRUMENT
PANEL

A



FLIGHT COMPARTMENT



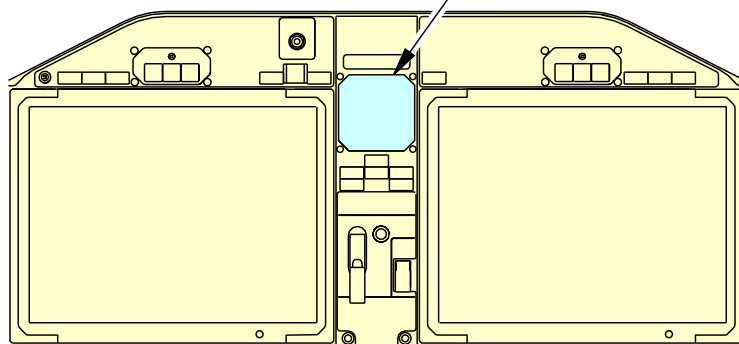
ELECTRONIC
EQUIPMENT
RACK, E5

B

ELECTRONIC EQUIPMENT
ACCESS DOOR, 117A

ISFD DEDICATED
BATTERY

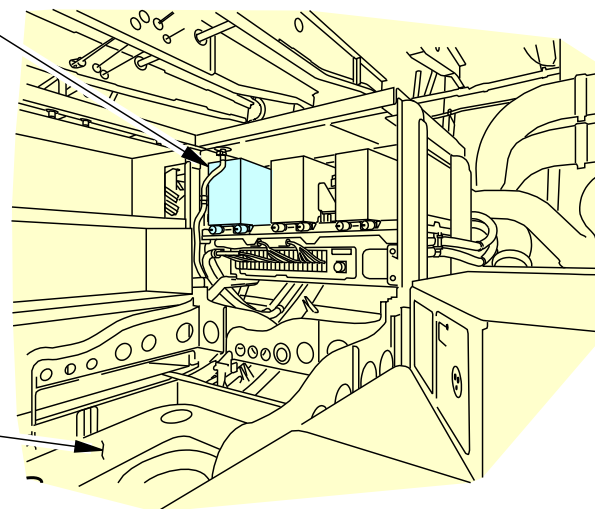
INTEGRATED STANDBY
FLIGHT DISPLAY



P2 CENTER INSTRUMENT PANEL

A

ELECTRONIC
EQUIPMENT
ACCESS
DOOR, 117A



ELECTRONIC EQUIPMENT RACK, E5

B



STANDBY ATTITUDE REFERENCE SYSTEM - COMPONENT LOCATION

2574966 S0000618879_V1

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**STANDBY ATTITUDE REFERENCE SYSTEM - INTERFACE****Power**

The Integrated Standby Flight Display (ISFD) gets 28v dc from the ISFD dedicated battery/charger.

The ISFD dedicated battery/charger gets 28v dc from the battery bus. The battery/charger sends the 28v dc power to the ISFD. The battery/charger also uses the 28v dc power to charge its internal battery.

A signal from the battery switch on the electrical meters, battery, and galley power module goes to the battery/charger. When the battery switch is on, the battery/charger supplies 28v dc power to the ISFD. When the battery switch is off, the ISFD does not receive 28v dc power

The ISFD gets 5v ac for the front panel lights from the master dim and test circuit.

Pitot-Static Interface

The alternate pitot probe sends pitot pressure to the ISFD.

The alternate static ports send static pressure to the indicator.

The ISFD uses static pressure to show barometric altitude. The ISFD uses pitot and static air pressure to show Indicated Airspeed (IAS).

Instrument Landing System (ILS) and GNSS Landing System (GLS) Interface

Multimode Receiver (MMR) 1 sends localizer deviation and glideslope deviation to the ISFD on an ARINC 429 data bus.

The ISFD shows localizer and glideslope deviation on the attitude display.

Air Data Inertial Reference System (ADIRS) Interface

The left Air Data Inertial Reference Unit (ADIRU) sends inertial reference data to the ISFD on an ARINC 429 data bus.

The ISFD uses magnetic heading data to show on the compass rose on the bottom of the display.

The ISFD uses ground speed to sense when the airplane is on the ground.

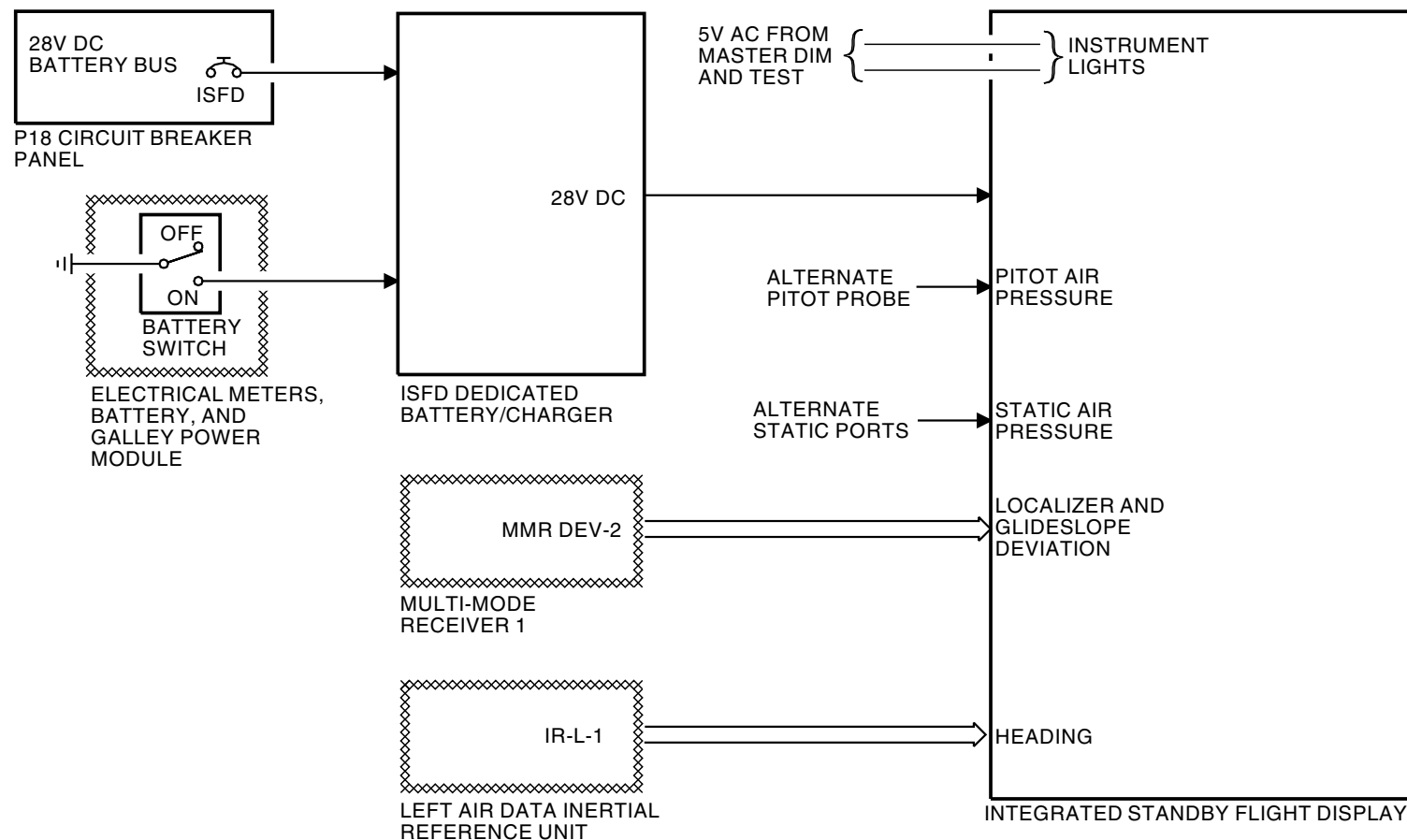
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STANDBY ATTITUDE REFERENCE SYSTEM - INTERFACE



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STANDBY ATTITUDE REFERENCE SYSTEM - INTERFACE

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**STANDBY ATTITUDE REFERENCE SYSTEM - INTEGRATED STANDBY FLIGHT DISPLAY****General**

The Integrated Standby Flight Display (ISFD) provides the flight crew a single integrated display of these parameters:

- Pitch and roll attitude
- Indicated airspeed
- Altitude
- Heading

The ISFD is a single unit which has these components

- Color liquid crystal display
- Solid state rate sensors
- Accelerometers
- Pitot and static air pressure sensors.

The ISFD calculates attitude, altitude, and airspeed internally.

The ISFD receives heading data from the Air Data Inertial Reference Unit (ADIRU).

The ISFD receives localizer and glideslope deviation data from the Multimode Receiver (MMR).

Physical Properties

These are the physical properties of the ISFD:

- Length - 11.4 in. (289.6 mm)
- Width - 3.27 in. (83.1 mm)
- Height - 3.27 in. (83.1 mm)
- Weight - 4.41 lb (2.00 kg)
- Power - 20 watts dc.

The ISFD has three connectors at the rear of the unit. One electrical connector supplies the wiring interface for all electrical power and interface signals. Two pneumatic connectors are for the pitot air pressure and the static air pressure inputs to the ISFD.

The ISFD is passively cooled. Forced air cooling is not necessary.

Controls

The ISFD has these controls on the front of the display:

- Display brightness switches (+, -)
- Barometric reference switch (HP/IN)
- Barometric control (BARO)
- Standard select switch
- Attitude reset switch (ATT RST).

Display Brightness Switches (+, -)

Use the display brightness switches to adjust the intensity of the display manually. Push the + switch to increase the intensity. Push the - switch to decrease the intensity.

The ISFD uses the light sensor on the front of the display to control the intensity of the display automatically.

Barometric Reference Switch (HP/IN)

The barometric reference switch controls the units for the barometric correction. The barometric correction shows in units of hectopascals or inches of mercury. Push the switch to change the reference between hectopascals and inches of mercury. The display shows HP for hectopascals (hPa) and IN for inches of mercury (in Hg).

Barometric Control (BARO)

The barometric control is a rotary knob and a push-button switch.

Turn the control to set the barometric correction. The barometric correction shows on the top right side of the display in units of hectopascals (hPa) or inches of mercury (in Hg). The range of the barometric correction is 22.00 to 32.48 in Hg (745 to 1100 hPa).

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**STANDBY ATTITUDE REFERENCE SYSTEM - INTEGRATED STANDBY FLIGHT DISPLAY****Standard Select Switch**

Push the standard select switch in the center of the BARO control to set the standard barometric correction of 29.92 in Hg (1013 hPa). The ISFD shows STD in place of the barometric correction. Push the switch again to set the barometric correction manually.

Attitude Reset Switch (ATT RST)

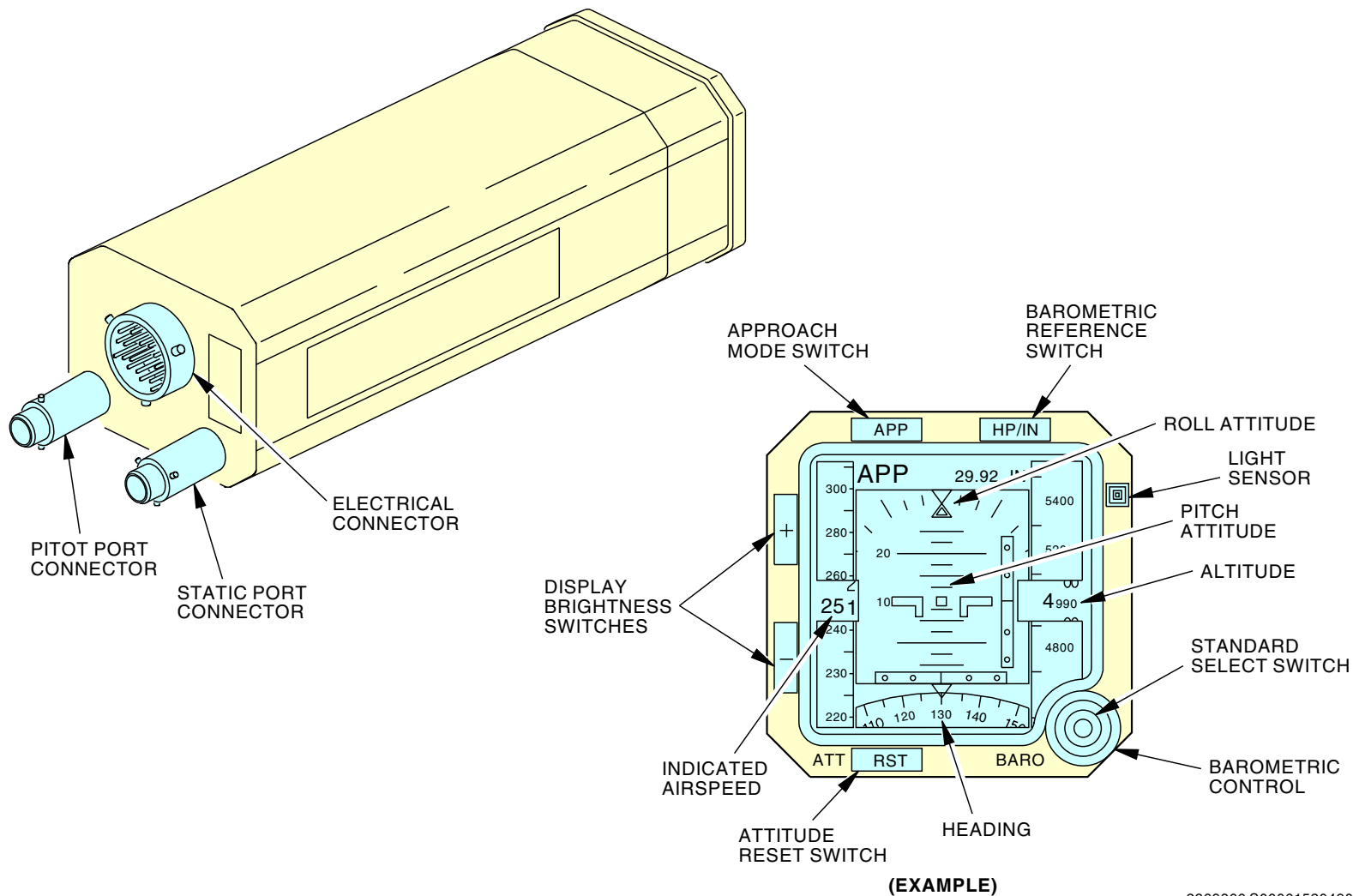
The attitude reset switch controls the alignment of the attitude display manually.

Built-in Test Equipment

[The ISFD has Built-In-Test Equipment (BITE) which monitors inputs to the ISFD and internal circuits.

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STANDBY ATTITUDE REFERENCE SYSTEM - INTEGRATED STANDBY FLIGHT DISPLAY



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STANDBY ATTITUDE REFERENCE SYSTEM - INTEGRATED STANDBY FLIGHT DISPLAY

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**STANDBY ATTITUDE REFERENCE SYSTEM - ISFD DEDICATED BATTERY/CHARGER****General**

The Integrated Standby Flight Display (ISFD) dedicated battery/charger provides power to the ISFD when the power from the airplane battery bus is not available.

The battery/charger is a single unit which has a battery pack and battery charger circuits.

Physical Properties

These are the physical properties of the battery/charger:

- Length - 12.5 in. (317.5 mm)
- Width - 2.3 in. (58.4 mm)
- Height - 7.8 in. (198.1 mm)
- Weight - 11 lb (5 kg).

The battery/charger has one connector at the rear of the unit.

The battery pack in the battery/charger contains 11 lead-acid cells which are bonded together and covered in a sleeve.

Operation

The charger circuits in the battery/charger keep the battery pack charged while there is electrical power on the airplane battery bus.

The battery/charger also uses the power from the airplane battery bus to supply power to the ISFD.

If the airplane battery bus goes off, the battery pack can provide 28v dc power to the ISFD for 150 minutes.

When the battery switch in the flight compartment is set to OFF, the battery/charger removes the battery pack from the circuit. This causes no power to go to the ISFD and the ISFD goes off.

Controls and Indication

The battery/charger has these components on the front of the unit:

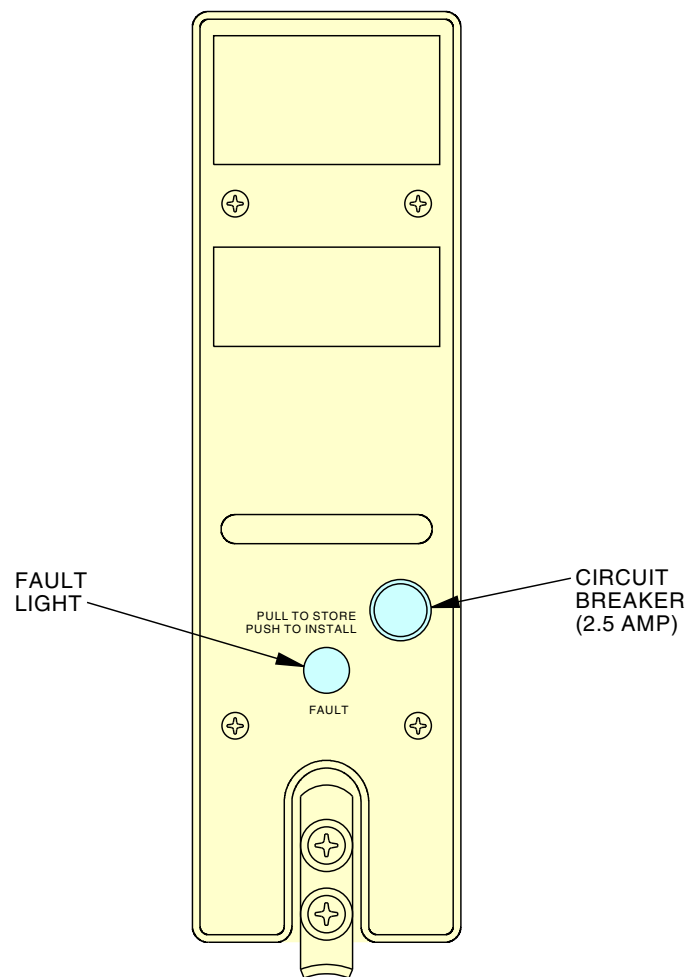
- Circuit breaker (2.5 amp)
- Fault light.

Fault Light

If there are failures in the battery/charger, the fault light comes on. The fault light comes on if one of these conditions occur:

- Operating temperature is more than the maximum or less than the minimum. The maximum operating temperature is 180°F (82°C). The minimum operating temperature is 5°F (-15°C).
- Battery charger circuits do not give the correct output voltage.
- Voltage levels of the cells in the battery pack are not equal.

STANDBY ATTITUDE REFERENCE SYSTEM - ISFD DEDICATED BATTERY/CHARGER



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STANDBY ATTITUDE REFERENCE SYSTEM - ISFD DEDICATED BATTERY/CHARGER

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STANDBY ATTITUDE REFERENCE SYSTEM - FUNCTIONAL DESCRIPTION

General

The components of the standby attitude reference system are the Integrated Standby Flight Display (ISFD) and the dedicated battery/charger.

The ISFD shows these parameters from the Air Data Inertial Reference System (ADIRS):

- Altitude
- Attitude
- Airspeed
- Magnetic heading.

The ISFD also shows these parameters from other sources on the airplane:

- Localizer deviation from the Instrument Landing System (ILS)
- Glideslope deviation from the ILS.

The battery/charger uses airplane power to charge an internal battery and to supply power to the ISFD. If airplane power is not available, the battery/charger uses its battery to supply power to the ISFD.

Power

The battery bus supplies 28v dc to the battery/charger. The 28v dc goes through a diode and a 2.5 amp circuit breaker in the battery/charger to the ISFD.

NOTE: The 2.5 amp circuit breaker is on the front face of the battery/charger.

The battery bus also supplies 28v dc to charge the battery in the battery/charger.

The monitors and switch logic in the battery/charger measures the input voltage from the input power. When the voltage on the input power decreases to less than 20v dc, the monitors and switch logic closes the switch that connects the battery to the output circuitry of the battery/charger. This lets the battery in the battery/charger supply power to the ISFD.

The battery in the battery/charger is a pack of 11 lead-acid cells. The battery pack can supply power to the ISFD for a maximum of 150 minutes.

The power supply in the ISFD supplies these voltages for internal components:

- +/- 5v dc
- +/- 15v dc
- +28v dc.

Program Pins

The program pins give the ISFD the airplane model and the optional parameters.

The program pins that identify the airplane model set these parameters:

- Tilt angle - to correct the attitude as a function of the angle of the main instrument panel
- Static source error correction - to correct the static pressure as a function of the Mach number
- Air data aiding - to correct the attitude as a function of airspeed.

NOTE: The 737 MAX-7/8/9 airplanes require no static source error correction.

Other program pins identify display options.

The ISFD uses one program pin (parity pin) to make sure the airplane model and optional functions are correct. The sum of all the program pins and the parity pin must be an even number. If the sum is odd, there is a fault and the ISFD shows the message PROGRAM PIN ERROR.

ARINC 429 Interfaces

The ISFD receives data from these components on ARINC 429 data buses:

- Multimode Receiver (MMR) 1 - localizer deviation and glideslope deviation

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**STANDBY ATTITUDE REFERENCE SYSTEM - FUNCTIONAL DESCRIPTION**

- Left Air Data Inertial Reference Unit (ADIRU) - magnetic heading and ground speed

The ISFD sends attitude information to the Flight Control Computers (FCCs) for CATIIIB autoland system operation.

Pneumatic Inputs

There are two pneumatic sensors in the ISFD that sense pitot and static pressures.

One sensor receives pitot pressure from the alternate pitot probe. The other sensor receives static pressure from the alternate static ports.

Pitot and static pressure data goes to the data control and system processing. The processor uses static pressure to calculate altitude and airspeed. The processor uses pitot pressure to calculate airspeed.

Inertial Sensors

The ISFD has inertial sensors that sense angular rate and linear acceleration. The ISFD uses the inertial sensors to calculate pitch and roll attitude.

The angular rate data comes from solid-state quartz rate sensors. Movement about the sensor axis gives a dc voltage that is in proportion to the angular rate.

The linear acceleration data comes from silicon accelerometers. Each accelerometer has a single silicon crystal. Gravity and acceleration forces change the capacitance of the crystal. The accelerometer gives a dc voltage that is in proportion to the acceleration.

Bezel Controls

The front face of the ISFD has five push-buttons and one rotary knob to control the operation.

There is one light sensor on the bezel. The ISFD uses the light sensor to control the intensity of the display as the ambient light changes.

Data Control and System Processing

All inputs and controls go to the data control and system processing section of the ISFD. The processor does these functions:

- Calculates airspeed and altitude from the pressure sensor signals
- Calculates pitch and roll attitude from the inertial sensor signals
- Changes calculated data to graphics data
- Controls brightness
- Changes the display in response to inputs from the bezel controls.

Graphics Processing and Display

The graphics processor does these functions:

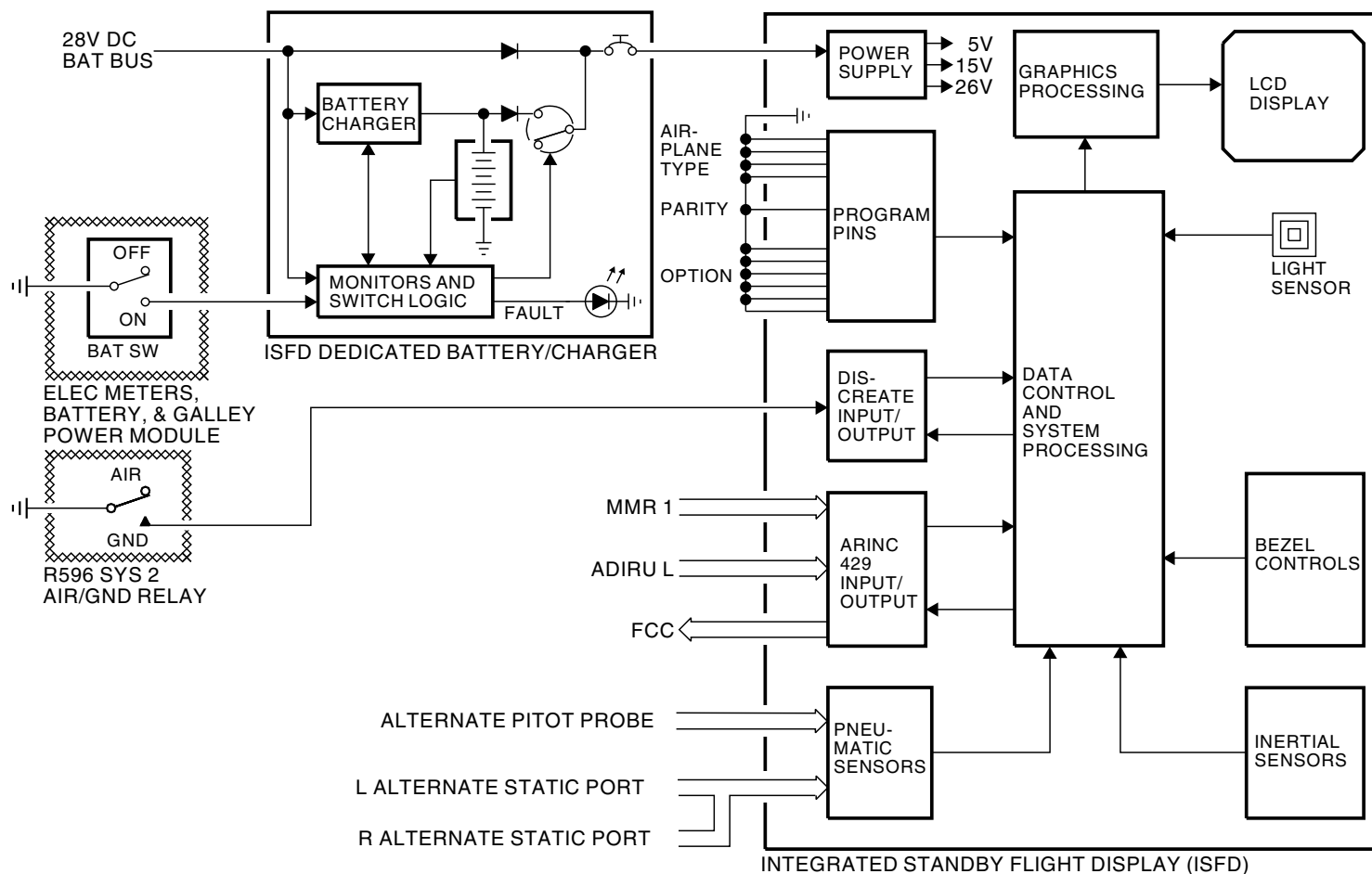
- Calculates graphic data for each parameter from the system processor
- Controls the Liquid Crystal Display (LCD) matrix drivers
- Does a refresh of the display.

The display has a color active matrix LCD and a back-lighting box. The back-lighting box has these components:

- Three fluorescent tubes
- Reflector
- Diffuser.

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STANDBY ATTITUDE REFERENCE SYSTEM - FUNCTIONAL DESCRIPTION



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STANDBY ATTITUDE REFERENCE SYSTEM - FUNCTIONAL DESCRIPTION

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INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION

Purpose**SIA 001-005**

The multi-mode receiver (MMR) contains the instrument landing system (ILS), global positioning system (GPS), and an optional GNSS landing system (GLS) function. This section only gives information on the ILS function.

SIA 006-999

The integrated multi-mode receiver (IMMR) contains the instrument landing system (ILS), global positioning system (GPS), an optional GNSS landing system (GLS), and a VHF omnidirectional ranging/marker beacon (VOR/MB) function. This section only gives information on the ILS function.

SIA ALL

The ILS provides lateral and vertical position data necessary to put the airplane on the runway for approach. The system uses signals from a glideslope ground station and a localizer ground station.

The glideslope ground station transmits signals to give the airplane the vertical deviation for a descent path to the touchdown point on the runway. The localizer ground station transmits signals to give the airplane lateral guidance to the runway centerline.

SIA 006-999

The GLS uses both satellite and ground based navigation stations to provide lateral and vertical guidance during an approach to a runway.

The IMMR calculates position using GPS data which is corrected using differential correction data from a ground based augmentation station (GBAS) or a satellite based augmentation system (SBAS).

SIA ALLAbbreviations and Acronyms

- AC - alternating current
- ACP - audio control panel

- AI - attitude indication
- ANT - antenna
- ARINC - Aeronautical Radio, Inc.
- BITE - built-in test equipment
- CAPT - captain
- DC - direct current
- DFCS - digital flight control system
- DFDAU - digital flight data acquisition unit
- DME - distance measurement equipment
- DPC - display processor computer
- F/O - first officer
- FCC - flight control computer
- FMC - flight management computer
- FWD - forward
- GBAS - ground based augmentation system
- GLS - GNSS landing system
- GNSS - global navigation satellite system
- G/S - glideslope
- ILS - instrument landing system
- ISFD - integrated standby flight display
- LCD - liquid crystal display
- LED - light emitting diode
- LOC - localizer
- LRU - line replaceable unit
- MCP - mode control panel
- MHz - megahertz
- MKR - marker beacon
- MMR - multi-mode receiver
- MSU - mode select unit
- NAV - navigation

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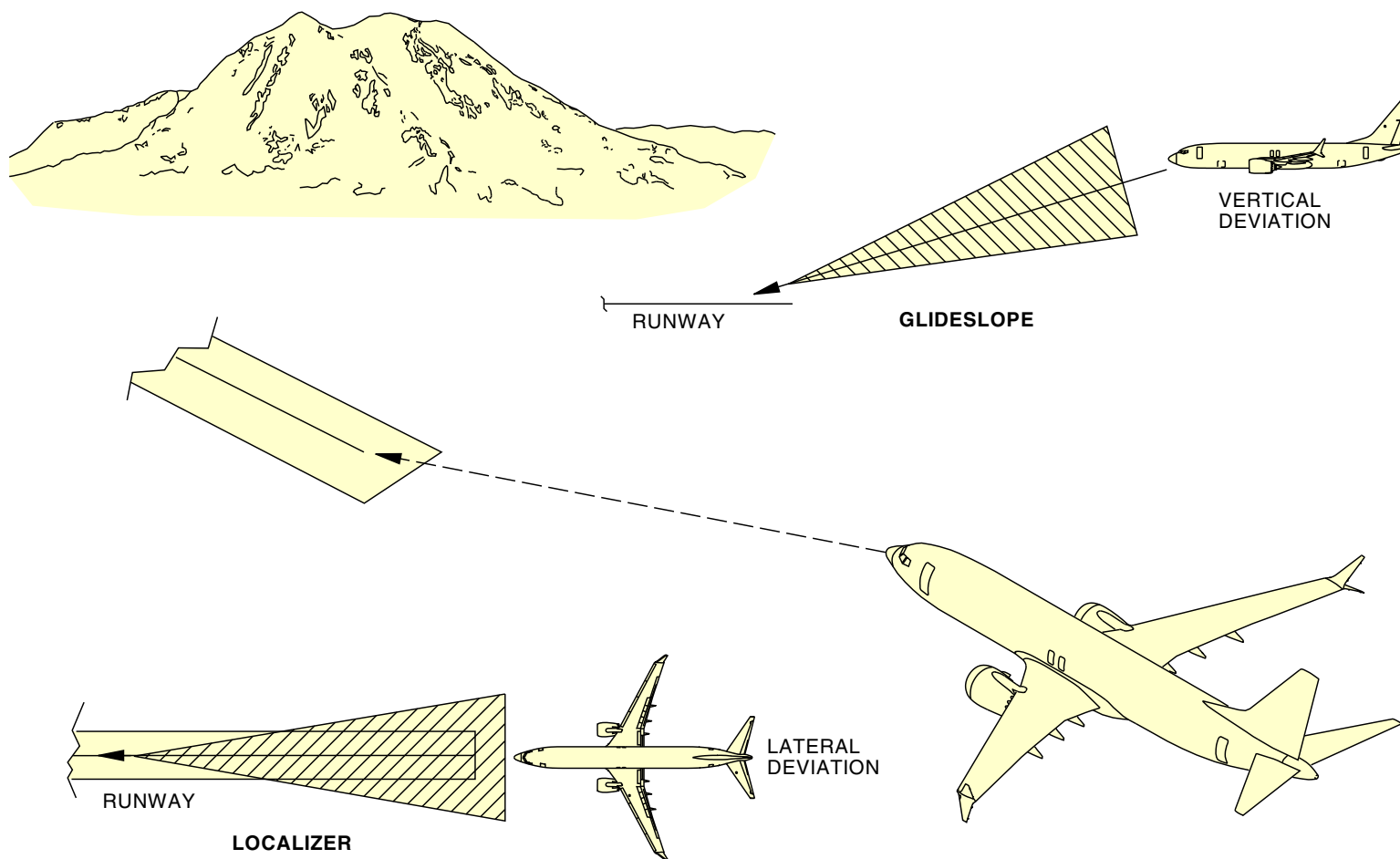
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INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION

- NCD - no computed data
- NCP - navigation control panel
- ND - navigation display
- PFD - primary flight display
- REU - remote electronics unit
- RF - radio frequency
- SBAS - satellite based augmentation system
- TOGA - take off / go around
- V - volts
- VOR - VHF omnidirectional ranging

INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION



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INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION

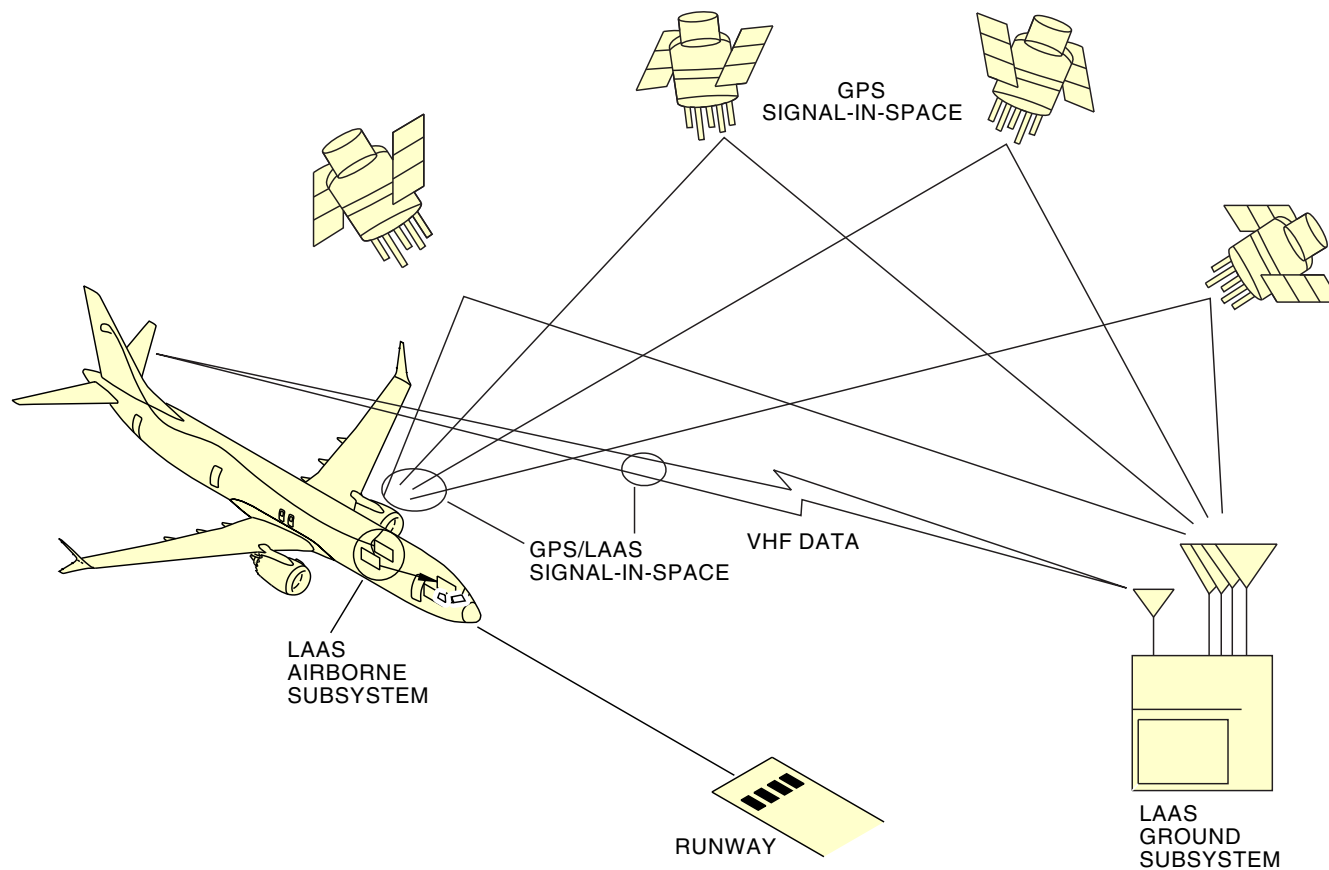
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INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION



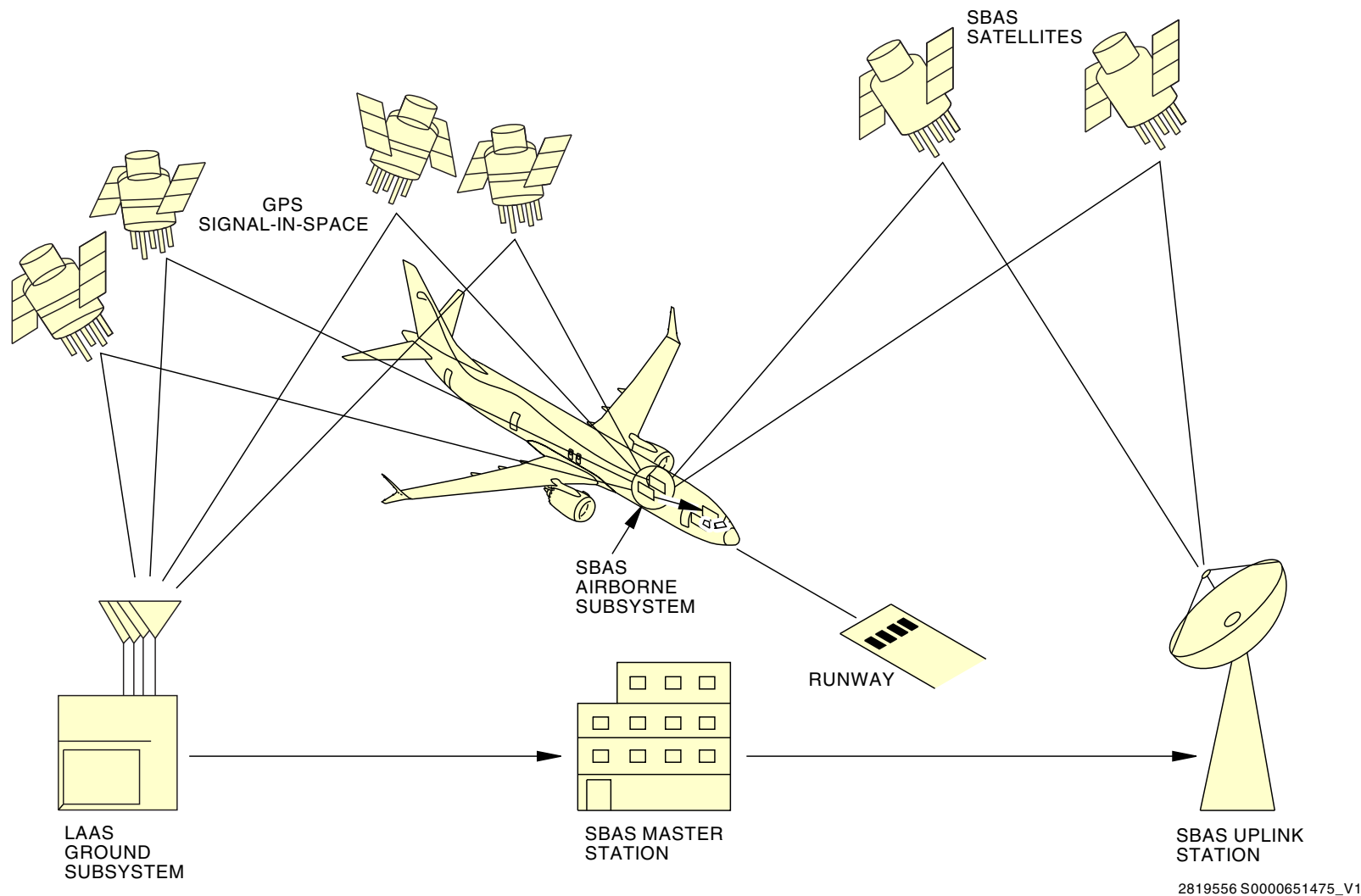
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GNSS LANDING SYSTEM (GLS) - INTRODUCTION

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INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION



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GNSS LANDING SYSTEM (GLS) - INTRODUCTION

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ILS - GENERAL DESCRIPTION

General**SIA 001-005**

The instrument landing system (ILS) has two multi-mode receivers (MMRs) that contain the ILS function. The ILS function in the MMRs receives inputs from these antennas:

SIA 006-999

The instrument landing system (ILS) has two integrated multi-mode receivers (IMMRs) that contain the ILS function. The ILS function in the IMMRs receives inputs from these antennas:

SIA ALL

- Dual VOR/LOC antenna
- Dual Localizer antenna
- Dual Glideslope antenna.

SIA 006-999

The GNSS landing system (GLS) uses satellite and ground-based navigation stations to give lateral and vertical guidance during an approach to a runway. The GLS uses two integrated multi-mode receivers (IMMRs) that contain the GLS function.

These are the primary components of the GLS:

- Dual VOR/LOC antenna
- Integrated multi-mode receiver (IMMR)
- Navigation control panels (NCP)
- Global positioning system (GPS) antennas (2).

The GLS receives GPS signals through the GPS antennas. These give position, velocity, and time data for the GLS function.

In Differential GNSS mode, the GNSS receiver will correct the GNSS navigation data using differential corrections data received from the GBAS ground station or from the SBAS uplink station to enhance the accuracy of the GNSS position, velocity, and time data during all phases of flight.

The NCPs give on-side channel selection for the GLS function. The air data inertial reference units (ADIRUs) give inertial data for the GLS guidance function.

The GLS function uses ILS and GPS output buses to send the data to the user systems.

The IMMRs send GLS channel/identifier and deviation data to these line replaceable units (LRUs) on the ILS output buses:

SIA 001-005

The MMRs send ILS frequency/identifier and deviation data to these LRUs:

SIA 006-999

The IMMRs send ILS frequency/identifier and deviation data to these LRUs:

SIA ALL

- Display processor computers (DPCs)
- Enhanced ground proximity warning computer (EGPWC)
- Flight control computers (FCCs)
- Digital Flight data acquisition unit (DFDAU)
- Flight management computers (FMCs)
- Integrated standby flight display (ISFD)

SIA 006-999

- Headup guidance system

SIA ALL

- IRS master caution unit.

SIA 001-005

The remote electronic unit (REU) receives voice and Morse code identification tones from the MMRs.

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ILS - GENERAL DESCRIPTION

SIA 006-999

The remote electronic unit (REU) receives voice and Morse code identification tones from the IMMRs.

SIA ALL**Description**

The receivers get manual tune inputs from the navigation control panels (NCPs).

SIA 006-999

The dual VOR/LOC antenna sends the received localizer signals directly to the IMMRs. The dual localizer antenna and the dual glideslope antenna send localizer and glideslope signals directly to the IMMRs.

SIA 001-005

The VOR/LOC antenna and the localizer antenna send localizer signals through the localizer antenna switches to the MMRs. The localizer antenna switches select the VOR/LOC antenna or the localizer antenna as the source of RF input to the MMR. The glideslope antenna sends glideslope signals to the multi mode receivers.

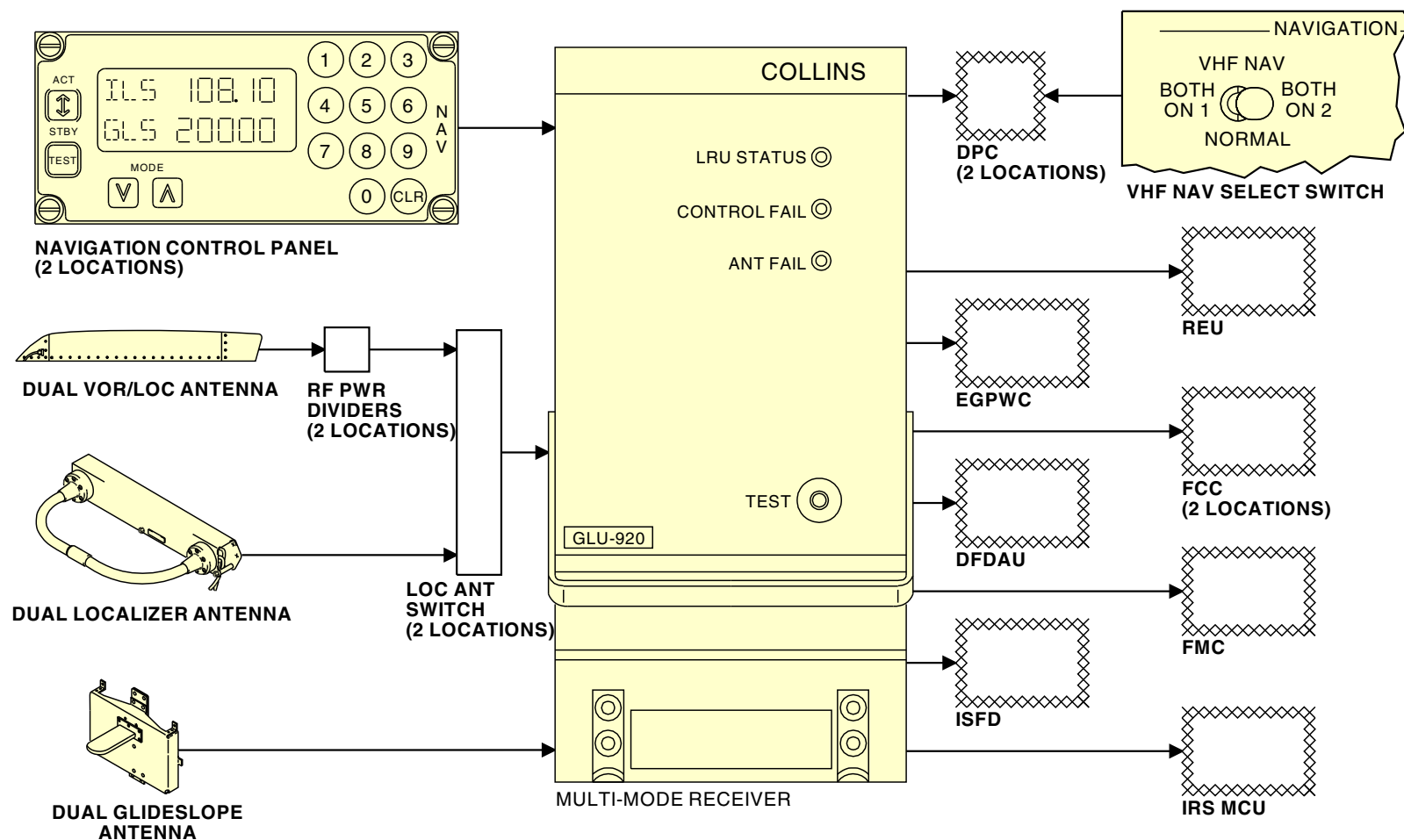
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ILS - GENERAL DESCRIPTION

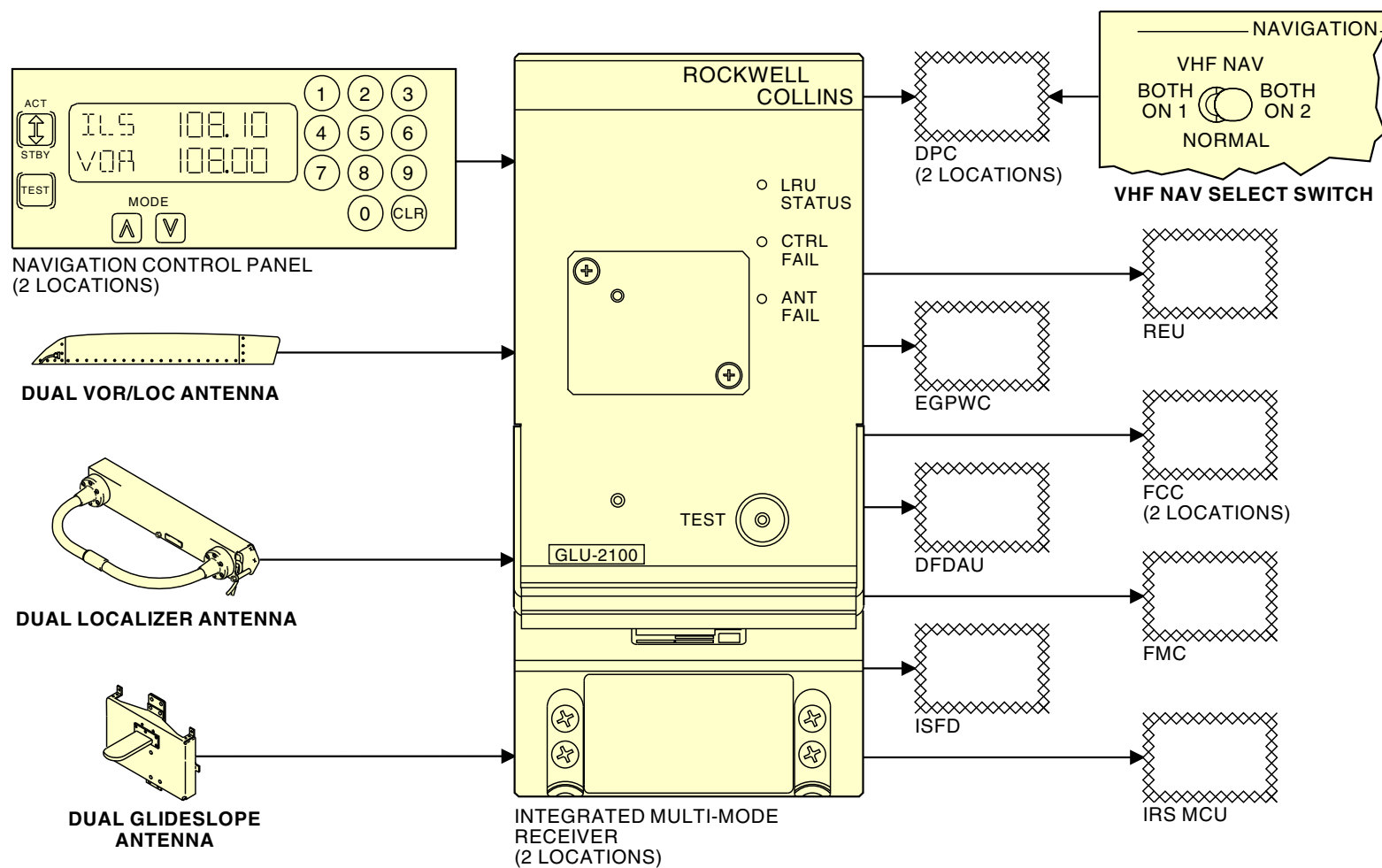


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ILS - GENERAL DESCRIPTION

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ILS - GENERAL DESCRIPTION



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ILS - GENERAL DESCRIPTION

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ILS - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT - COMPONENT LOCATION

Electronic Equipment Compartment

SIA 001-005

The multi-mode receivers (MMRs) are in the electronic equipment compartment. MMR 1 is on the E1-2 shelf. MMR 2 is on the E1-4 shelf.

SIA 006-999

The integrated multi-mode receivers (IMMRs) are in the electronic equipment compartment. IMMR 1 is on the E1-2 shelf. IMMR 2 is on the E1-4 shelf.

SIA 001-005

The LOC antenna switches are on the right side of the E1 rack.

SIA ALL

Nose Radome

The glideslope and localizer antennas are on the forward bulkhead, under the nose radome. The dual glideslope antenna is above the weather radar antenna. The dual localizer antenna is below the weather radar antenna.

VOR/LOC Antenna

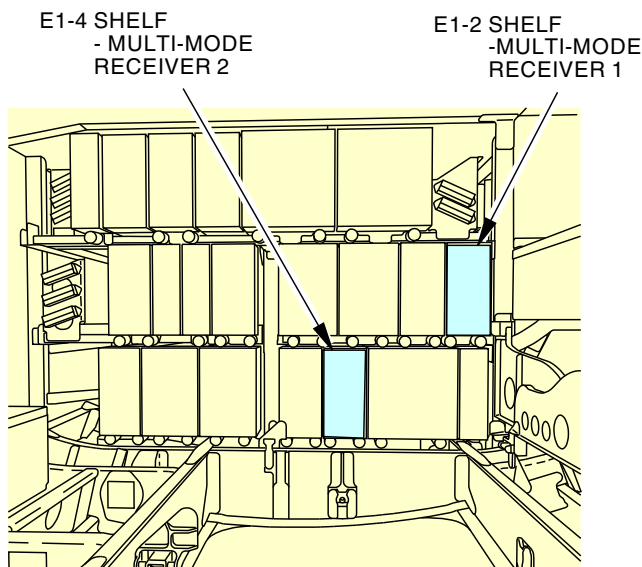
The dual VHF omnidirectional ranging/localizer (VOR/LOC) antenna is at the top of the vertical stabilizer.

G/S Director Bar

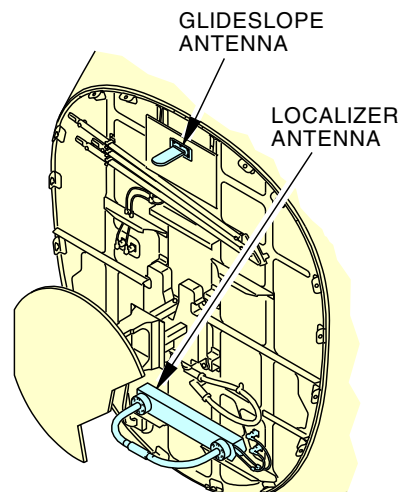
The G/S director bar is on the inside, upper center of the nose radome.

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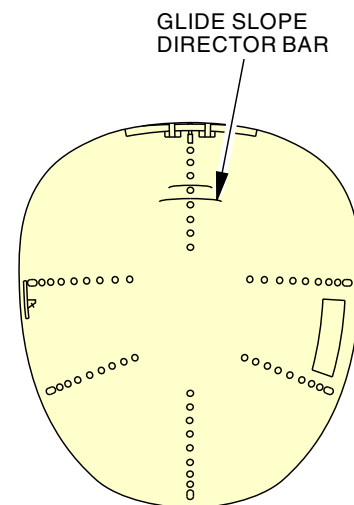
ILS - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT - COMPONENT LOCATION



**ELECTRONIC EQUIPMENT COMPARTMENT
(VIEW IN THE FORWARD DIRECTION)**



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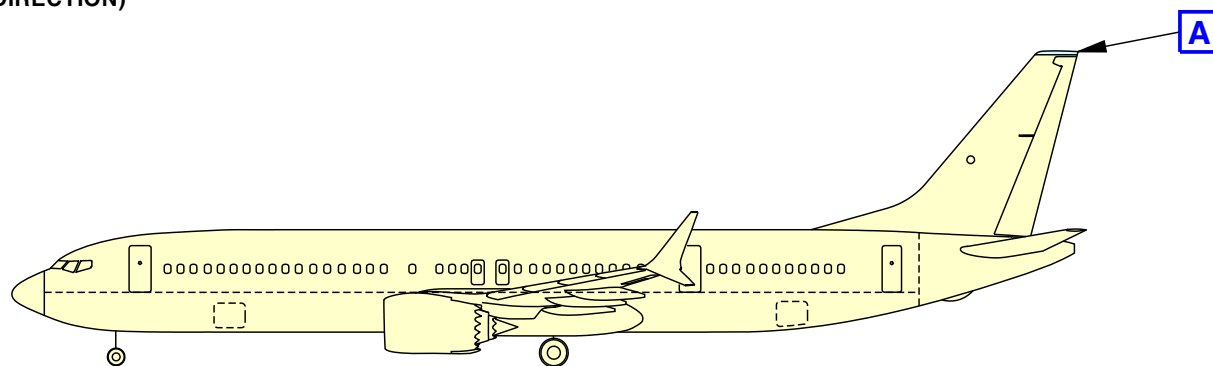


**NOSE RADOME
(VIEW IN THE FORWARD DIRECTION)**



DUAL VOR/LOC ANTENNA

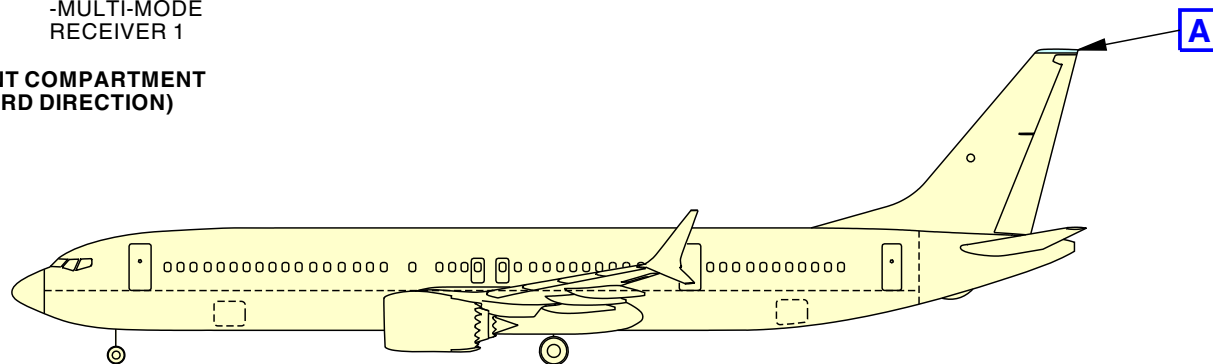
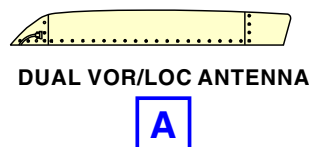
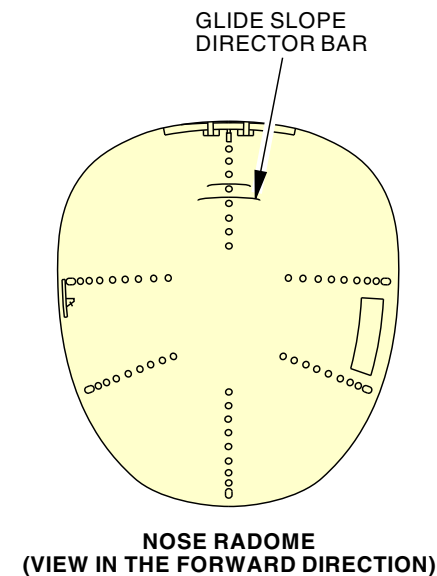
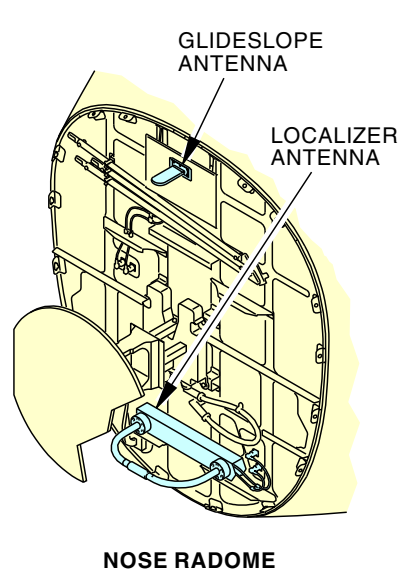
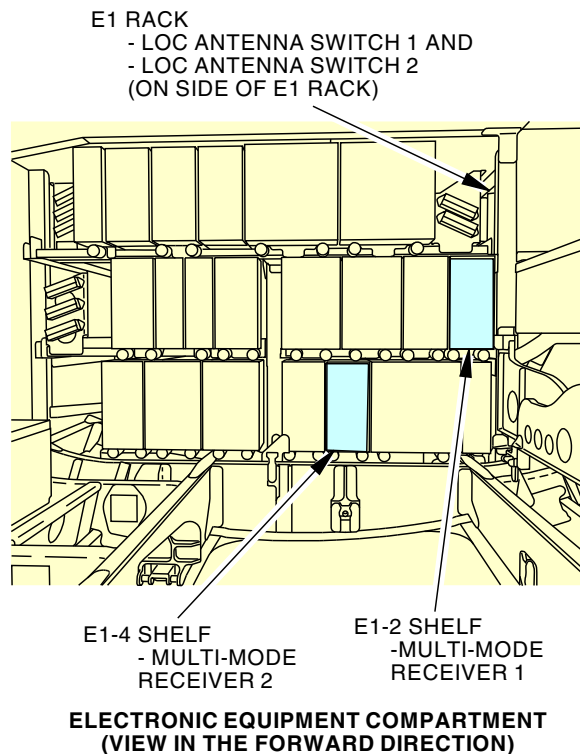
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ILS - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT - COMPONENT LOCATION

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ILS - POWER INTERFACES

Power Inputs**SIA 001-005**

The P18-1 circuit breaker panel contains the multi-mode receiver (MMR) 1 and NAV CONT PNL 1 circuit breakers. The circuit breakers receive 115v ac from the 115v ac standby bus section 1. The circuit breakers supply power to the MMR 1 and the captain's navigation control panel (NCP).

SIA 006-999

The P18-1 circuit breaker panel contains the integrated multi-mode receiver (IMMR) 1 and NAV CONT PNL 1 circuit breakers. The circuit breakers receive 115v ac from the 115v ac standby bus section 1. The circuit breakers supply power to the IMMR 1 and the captain's navigation control panel (NCP).

SIA ALL

The P18-1 circuit breaker panel also contains the NAV SENSOR DC 1 circuit breaker. The circuit breaker receives 28v dc from the 28v dc standby bus. The circuit breaker sends 28v dc to the captain's NCP and to the integrated flight system accessory unit (IFSAU).

SIA 001-005

The P6-1 circuit breaker panel contains the NAV CONT PNL 2 and the MMR 2 circuit breakers. The circuit breakers receive 115v ac from the 115v ac transfer bus section 2. The circuit breakers supply power to the MMR 2 and the first officer's NCP.

SIA 006-999

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SIA ALL

The P6-1 circuit breaker panel also contains the NAV SENSOR DC 2 circuit breaker. The circuit breaker receives 28v dc from the 28v dc standby bus. The circuit breaker sends 28v dc to the first officer's NCP and to the IFSAU.

SIA 001-005

The IFSAU contains circuits that supply a discrete signal to the LOC antenna switches for operation. The IFSAU uses the 28v dc from the NCP and a discrete signal from the FCC to set the logic for the ground discrete signal to operate the LOC antenna switches.

SIA 006-999

The IFSAU uses the 28v dc from the NAV SENSOR DC 1 and 2 circuit breakers and a ground discrete signal from the FCC to set the logic for the ground discrete signal to operate the localizer antenna switch function inside the IMMR.

When you tune an ILS frequency on the NCP, 28v dc goes to IMMRs 1 and 2 and to FCC A and B. The FCCs and IMMRs use the 28v dc as an indication of mode selection.

SIA 001-005

When you tune an ILS frequency on the NCP, 28v dc goes to the FCCs and the LOC antenna switch. The FCC's use the 28v dc for mode selection. The LOC antenna switches use the 28v dc for operation.

SIA ALL

When you select a GNSS landing system (GLS) channel on the NCP, 28v dc goes to FCC A and B. The FCCs use the 28v dc as an indication of mode selection.

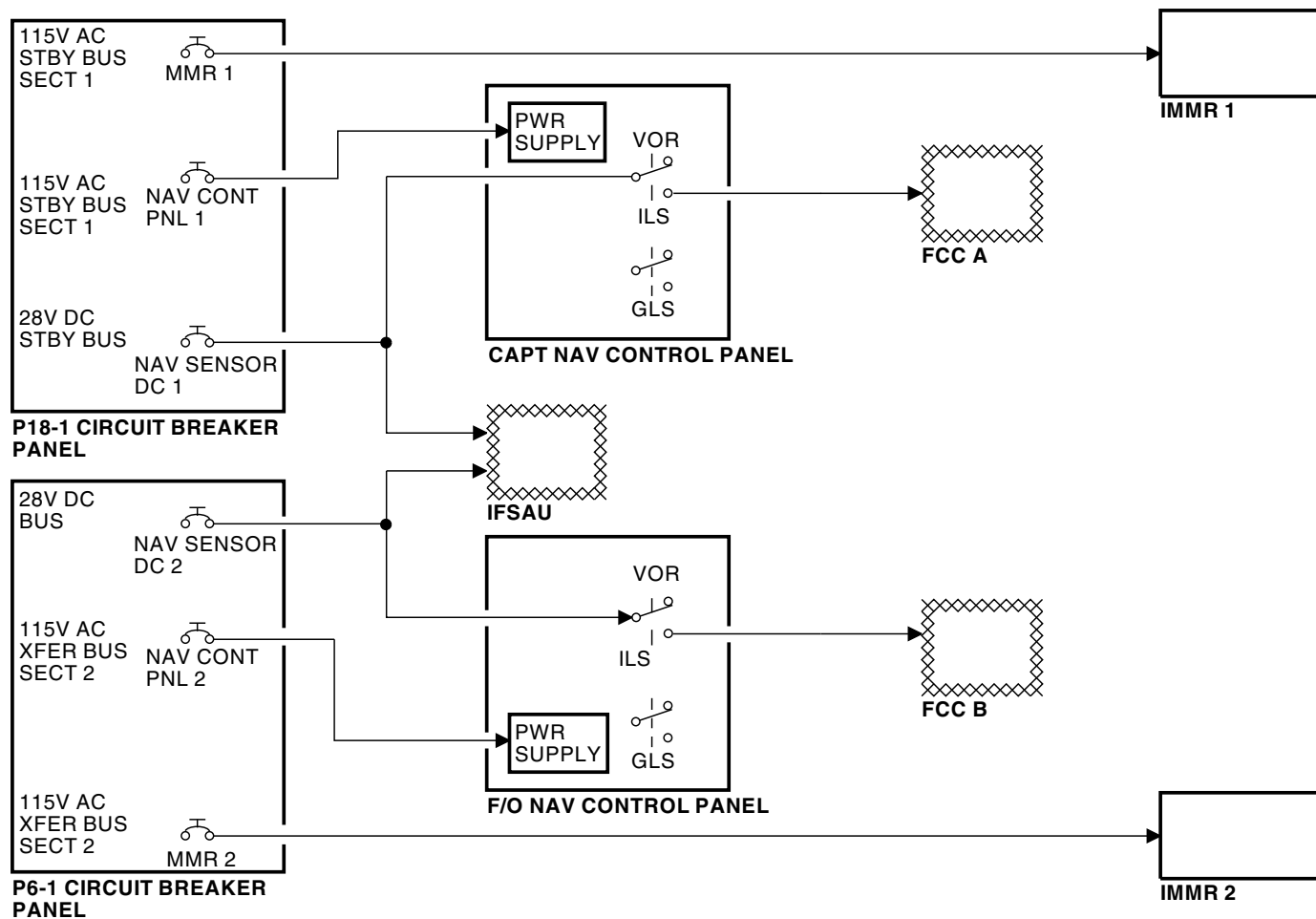
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ILS - POWER INTERFACES



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ILS - POWER INTERFACES

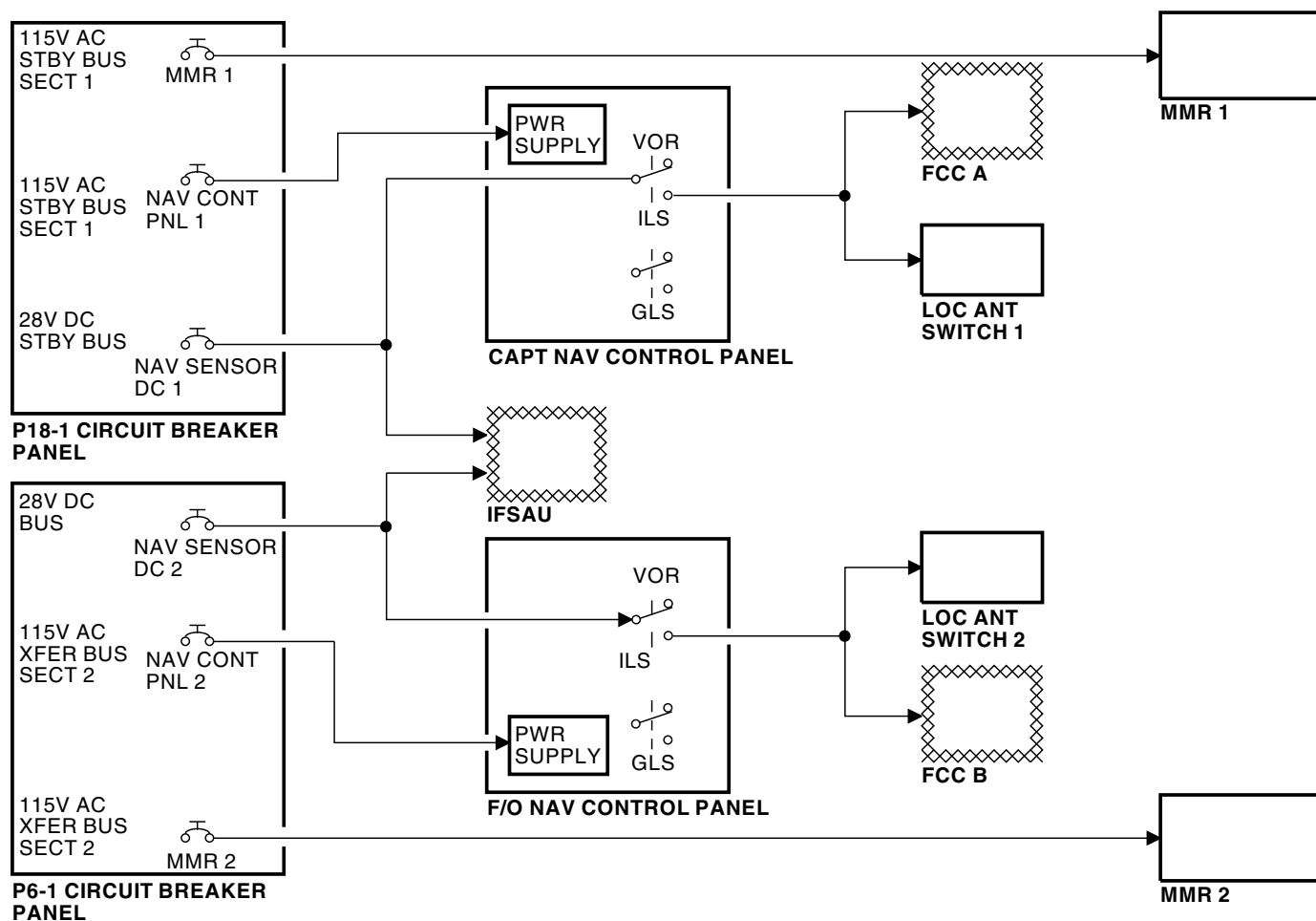
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ILS - POWER INTERFACES



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ILS - POWER INTERFACES

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ILS - DIGITAL INTERFACE

General**SIA 001-005**

These are the components that have a digital interface with the multi-mode receivers (MMRs):

SIA 006-999

These are the components that have a digital interface with the integrated multi-mode receivers (IMMRs):

SIA ALL

- Captain and first officer NAV control panels
- Digital flight data acquisition unit (DFDAU)
- Integrated standby flight display (ISFD)
- Enhanced ground proximity warning computer (EGPWC)
- Flight management computer (FMC) 1 and 2
- Master Caution Unit (MCU)
- Display processor computer (DPC) 1 and 2
- Flight control computer (FCC) A and B.

Digital Inputs**SIA 001-005**

The NAV control panels supply frequency tune inputs to the MMRs. The NAV control panels also send tune inputs to the VOR and DME systems on a separate data bus.

SIA 006-999

The NAV control panels supply frequency tune inputs to the IMMRs. The NAV control panels also send tune inputs to the VOR and DME systems on a separate data bus.

SIA 001-005Digital Outputs

Each MMR has two output data buses. Output data bus 1 goes to the FCCs. Output data bus 2 goes to many components.

The DFDAU receives ILS data and status of the MMR receivers. The DFDAU processes the data for the flight data recorder.

The MCU monitors for MMR receivers and mode(s) failures. If one occurs, the MCU send signals to the MSU to annunciate the failures.

The ISFD uses localizer and glideslope deviations for the ILS deviation bar operation. Only MMR 1 sends ILS data to the ISFD.

The EGPWC receives glideslope data from both ILS receivers for mode 5 (below glideslope) warnings.

FMC 1 and FMC 2 receive ILS data and receiver status from the two MMRs. The FMCS uses the ILS data for position update calculations.

The FCCs use ILS data to calculate airplane steering commands for the digital flight control system (DFCS) autopilot and flight director modes.

The DPC 1 receives two inputs from MMR 1 and two inputs from MMR 2. DPC 2 also receives two inputs from MMR 1 and two inputs from MMR 2. The MAX display system (MDS) uses the ILS data to calculate the localizer deviation and glideslope deviation displays.

SIA 006-999Digital Outputs

Each IMMR has two output data buses. Output data bus 1 goes to the FCCs. Output data bus 2 goes to many components.

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ILS - DIGITAL INTERFACE

SIA 006-999 (Continued)

The ISFD uses localizer and glideslope deviations for the ILS deviation bar operation. Only IMMR 1 sends ILS data to the ISFD.

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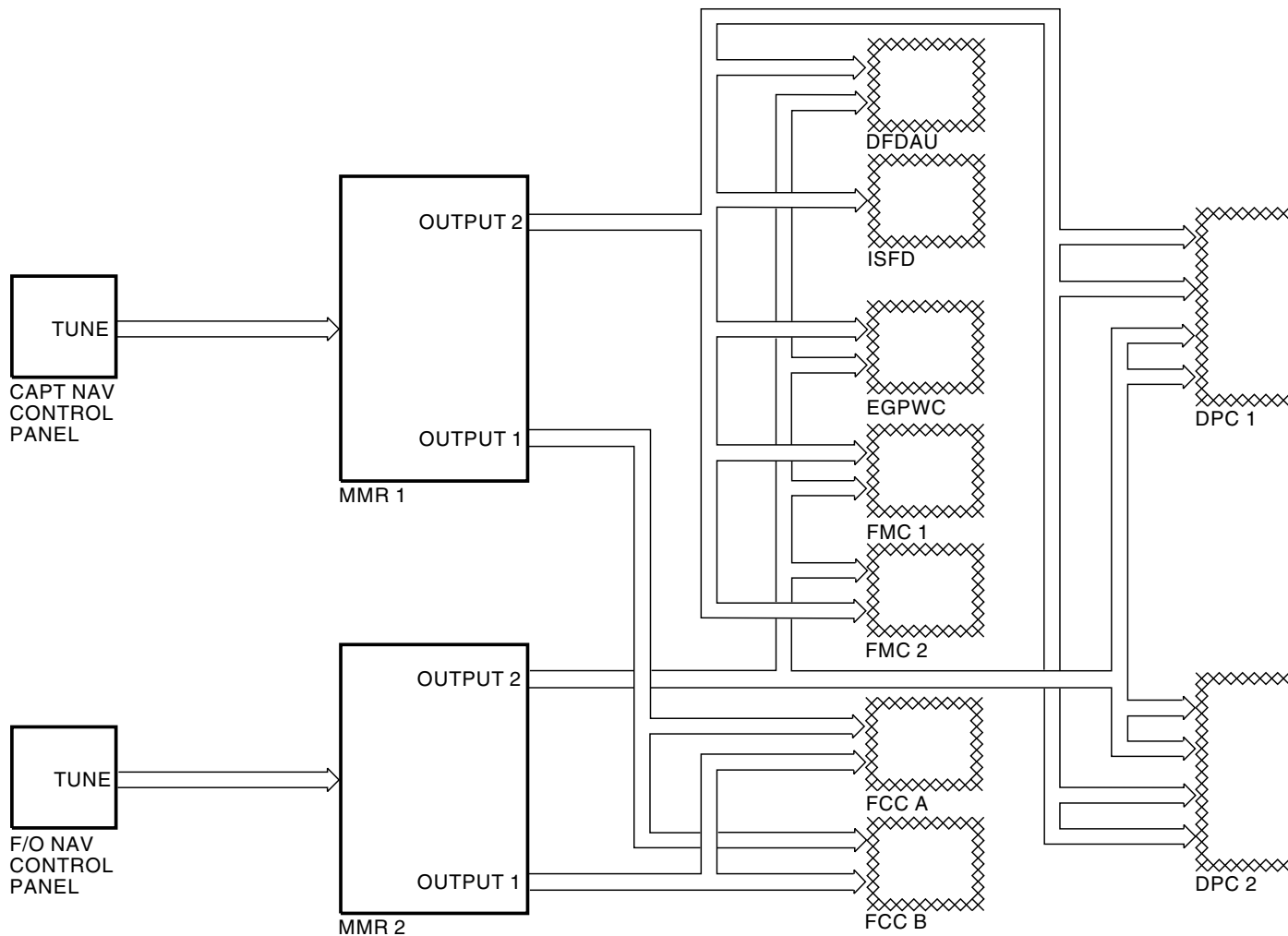
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ILS - DIGITAL INTERFACE

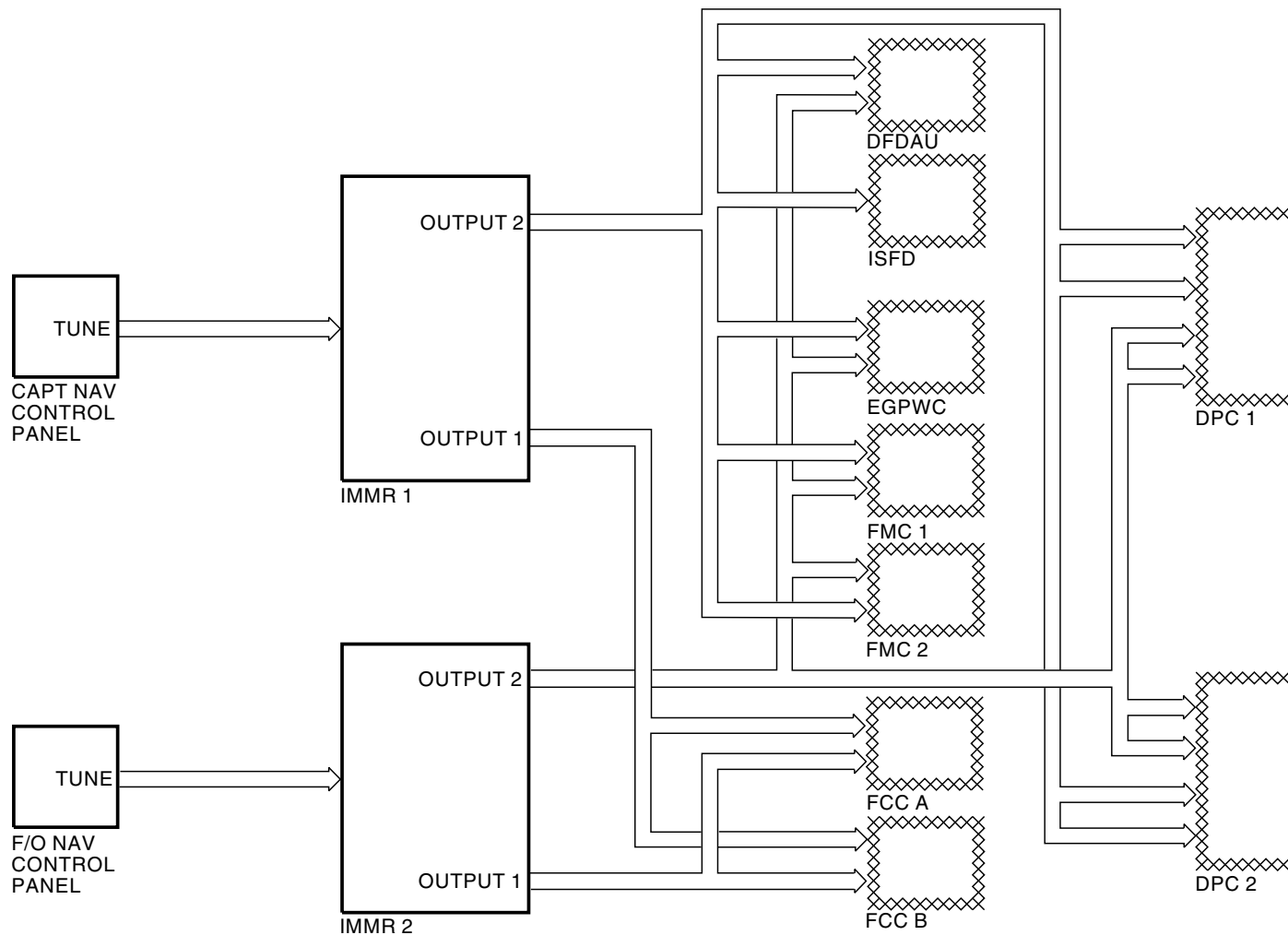


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ILS - DIGITAL INTERFACE



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ILS - DIGITAL INTERFACE

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**ILS - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING****General**

The navigation control panel (NCP) and the VHF NAV transfer switch on the P5 instrument switching module have interfaces with the flight control computers (FCCs) and display processor computers (DPCs).

ACT/STBY Transfer Switch

The ACT/STBY transfer switch on the NCP permits the crew to transfer the selected ILS frequency from the standby display window on the NCP to the active display window. The transfer switch is a momentary action switch. When you push the switch, it changes the discrete level to the FCCs. The discrete gives the FCCs an indication that there is an ILS frequency change.

If the autopilot is engaged in the VOR/LOC mode, the FCC causes a reset of the mode. If the autopilot is engaged in the APP mode, it disengages when you push the transfer switch.

Frequency Logic Switch

The frequency logic switches in the NCPs connect a ground discrete to the two DPCs as an indication that you selected an ILS frequency. The EFIS MODE/NAV FREQ DISAGREE message logic uses this discrete.

Navigation/Displays Source Select Panel

The VHF NAV switch on the navigation/displays source select panel is a three position switch. The positions are: BOTH ON 1, NORMAL, and BOTH ON 2. This switch changes the source of the data that the DPCs use for the ILS displays.

SIA 001-005

In the NORMAL position, MMR 1 supplies data for the captain displays and MMR 2 supplies data for the first officer displays. When you select BOTH ON 1, the DPCs use MMR 1 as the source for the captains displays and first officers displays. When you select BOTH ON 2, MMR 2 is the source for the captains displays and first officers displays.

SIA 006-999

In the NORMAL position, IMMR 1 supplies data for the captain displays and IMMR 2 supplies data for the first officer displays. When you select BOTH ON 1, the DPCs use IMMR 1 as the source for the captains displays and first officers displays. When you select BOTH ON 2, IMMR 2 is the source for the captains displays and first officers displays.

SIA ALL

Discrete signals also go to the flight control computers (FCCs) to signal that the switch is not in the normal position.

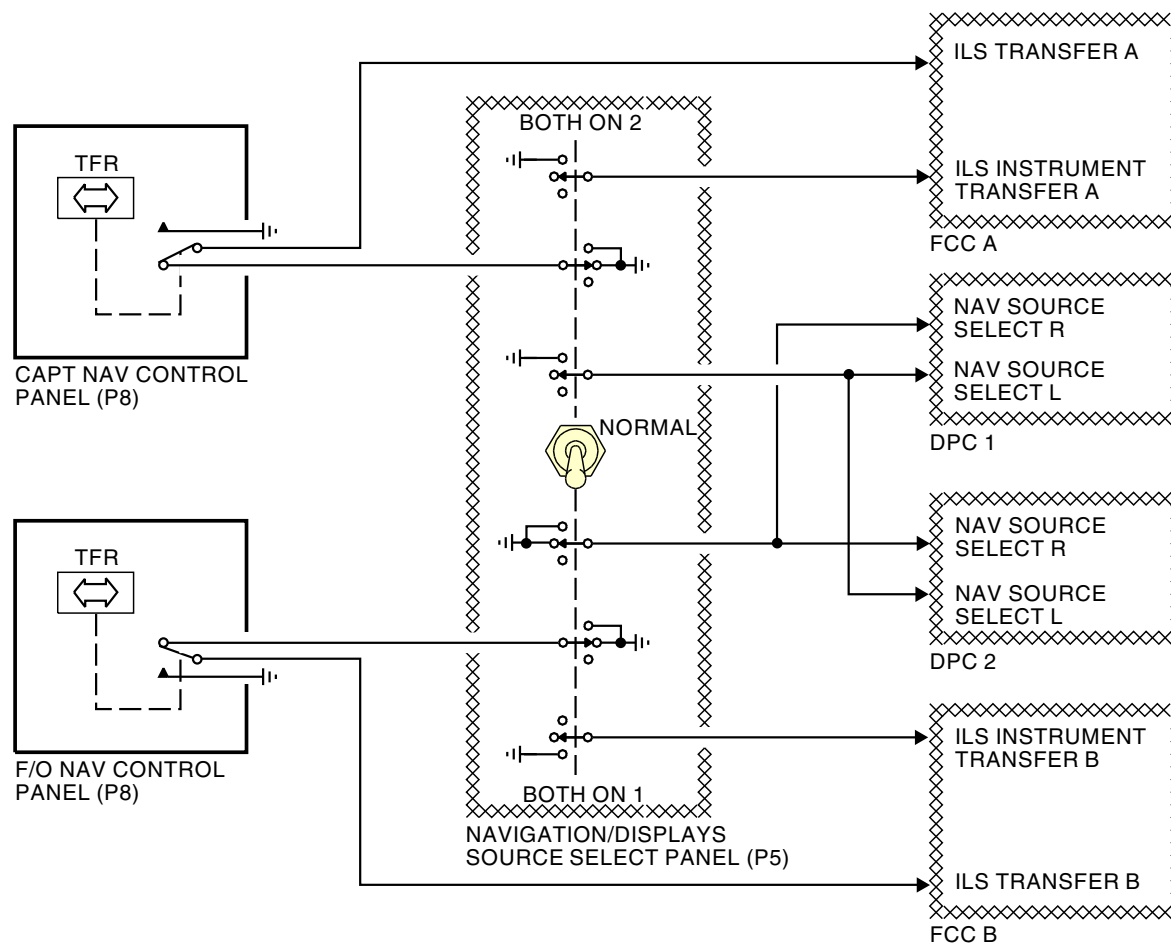
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ILS - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING



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ILS - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

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ILS - ANTENNA INTERFACE

SIA 006-999

General

The integrated multi-mode receivers (IMMRs) get RF inputs from these antennas:

- Dual VOR/LOC antenna on the vertical stabilizer
- Dual Localizer antenna in the nose radome
- Dual Glideslope antenna in the nose radome.

The dual VOR/LOC antenna, the dual localizer antenna and the dual glideslope antenna all have RF inputs that go directly to the IMMRs.

When an ILS frequency is tuned on the navigation control panels (NCP), 28v dc is connected with the integrated flight systems accessory unit (IFSAU).

The IFSAU will use the 28v dc from the NCPs and a discrete signal from the flight control computers (FCCs) or the heads-up guidance system (HGS) computer, to send a ground discrete to the IMMRs. The IMMRs will use this ground discrete to switch from the VOR/LOC antenna to the dual localizer antenna as the source of the RF input.

The FCCs send the discrete to the IMMRs when you select the approach (APP) or localizer (LOC) mode on the DFCS mode control panel.

The HGS computer sends the discrete to the IFSAU if the autopilot is not engaged on approach or when the takeoff/go around (TO/GA) mode is active for low visibility takeoffs.

SIA 001-005

General

The multi-mode receivers (MMRs) get RF inputs from these antennas:

- Dual VOR/LOC antenna on the vertical stabilizer
- Dual Localizer antenna in the nose radome
- Dual Glideslope antenna in the nose radome.

The dual VOR/LOC antenna RF inputs go through the power dividers then to the localizer (LOC) antenna (ANT) switches.

The dual localizer antenna RF inputs go directly to the LOC ANT switches. The antenna switches connect the VOR/LOC antenna or localizer antenna to the MMRs.

The glideslope antenna inputs do not go through the antenna switches. Glideslope antenna RF inputs go directly to the MMRs.

When an ILS frequency is tuned on the navigation control panels (NCPs), 28v dc is connected to the LOC antenna switches. The LOC ANT switches use 28v dc from the NCPs and a ground discrete signal from the integrated flight system accessory unit (IFSAU) for operation.

The IFSAU will send the ground signal when it receives a discrete from the flight control computers (FCCs) or the heads-up guidance system (HGS) computer.

The FCCs send the discrete to the IFSAU when you select the approach (APP) or localizer (LOC) mode on the DFCS mode control panel.

The HGS computer sends the discrete to the IFSAU if the autopilot is not engaged on approach or when the takeoff/go around (TO/GA) mode is active for low visibility takeoffs.

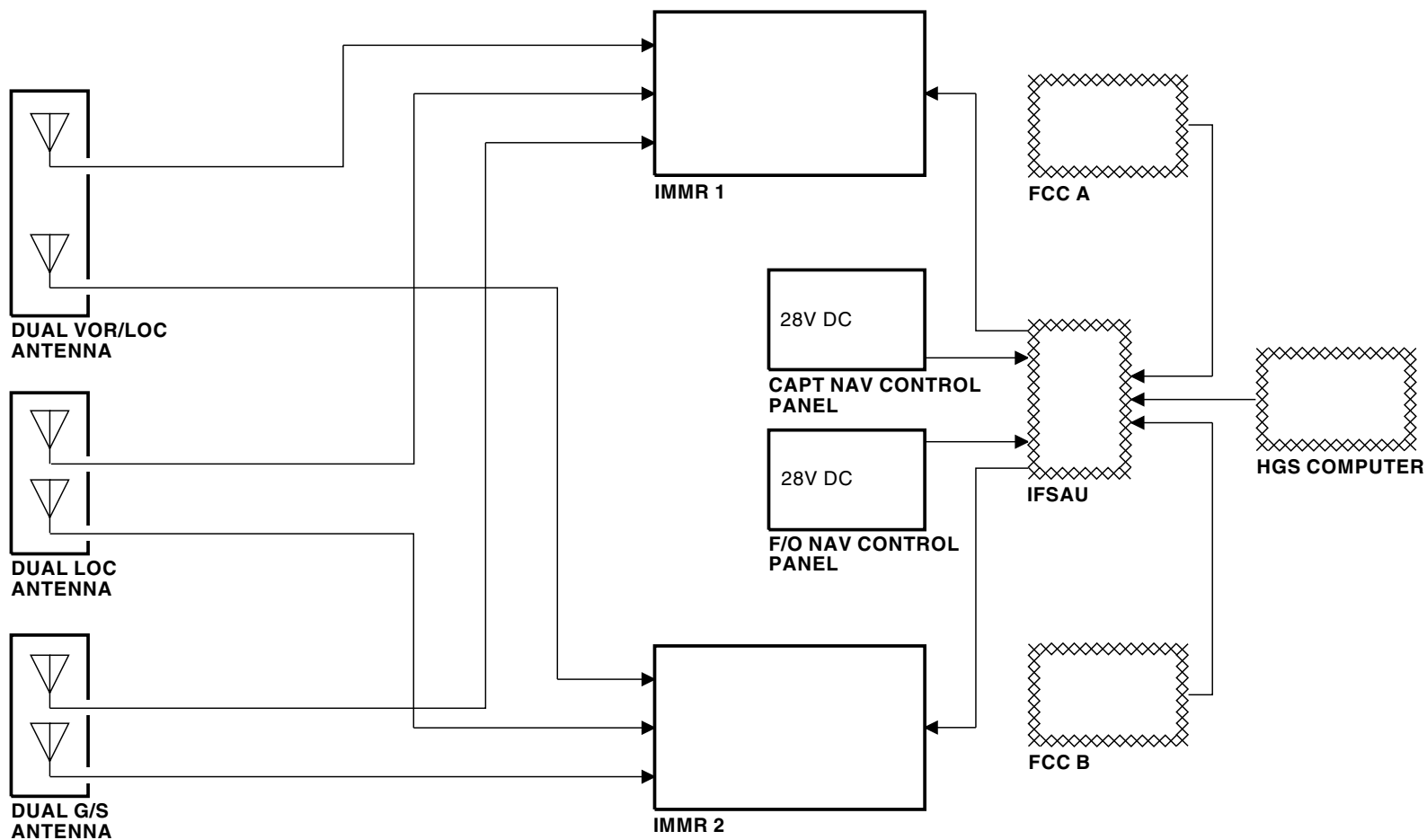
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ILS - ANTENNA INTERFACE

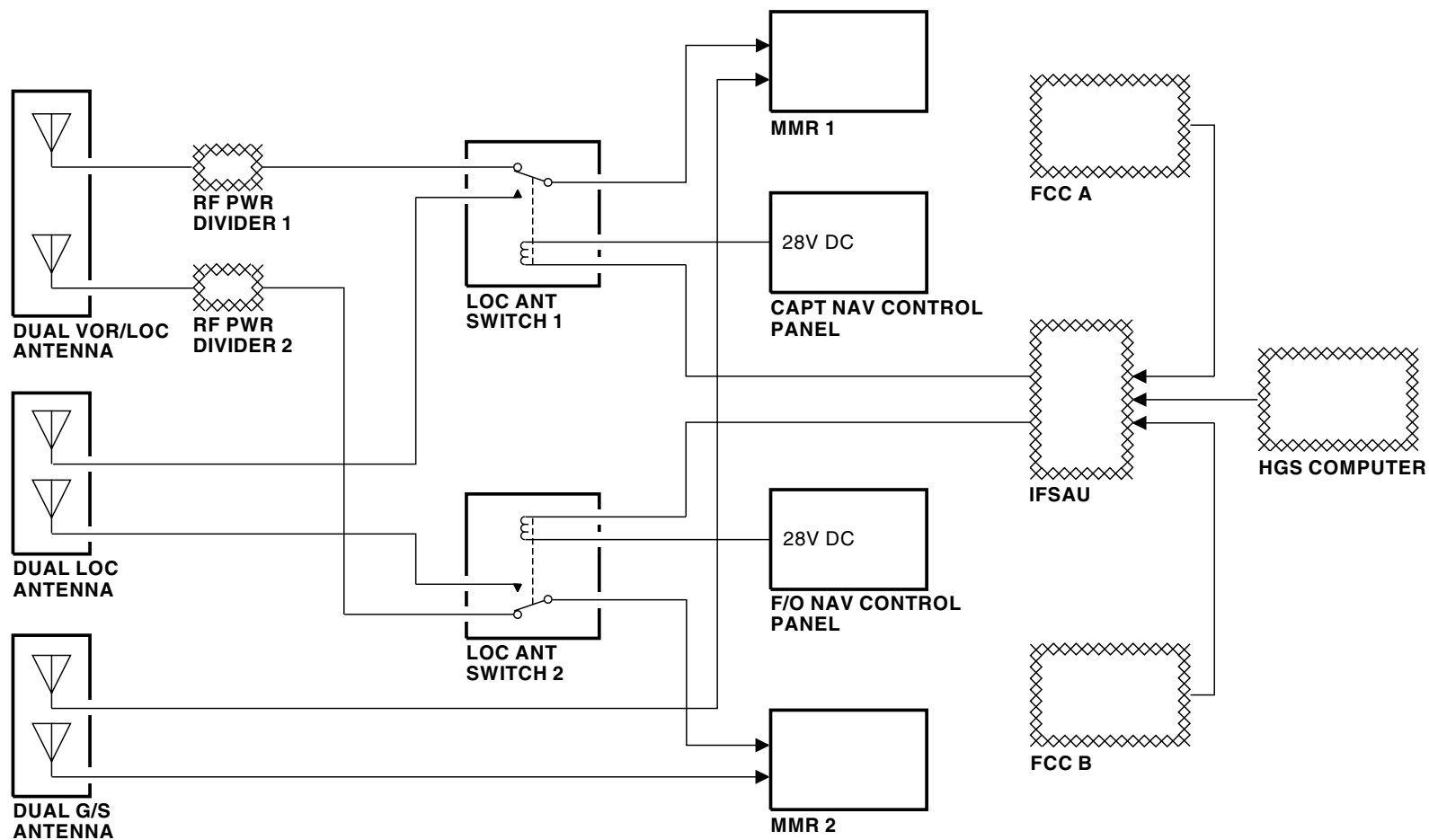


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ILS - ANTENNA INTERFACE

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ILS - ANTENNA INTERFACE



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ILS - ANALOG INTERFACES

SIA 001-005

General

When you tune an ILS frequency on the NAV control panels (NCPs), discrete signals go to the DPCs to tell if the frequency is an ILS or VOR frequency. Each NCP sends the discrete signal to the DPC 1 and DPC 2.

The FCCs send an ILS tune inhibit to the ILS function of the MMRs during the approach (APP) mode of operation. The ILS receiver will not accept another tune frequency during this mode.

The PSEU sends air/ground discrete signals to the MMRs to set the flight leg count in the internal memory, and also inhibit test in the air.

The MMRs send ILS ground station audio to the REU. The REU sends the audio to the flight compartment.

SIA 006-999

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When you tune an ILS frequency on the NAV control panels (NCPs), discrete signals go to the DPCs to tell if the frequency is an ILS or VOR frequency. Each NCP sends the discrete signal to the DPC 1 and DPC 2.

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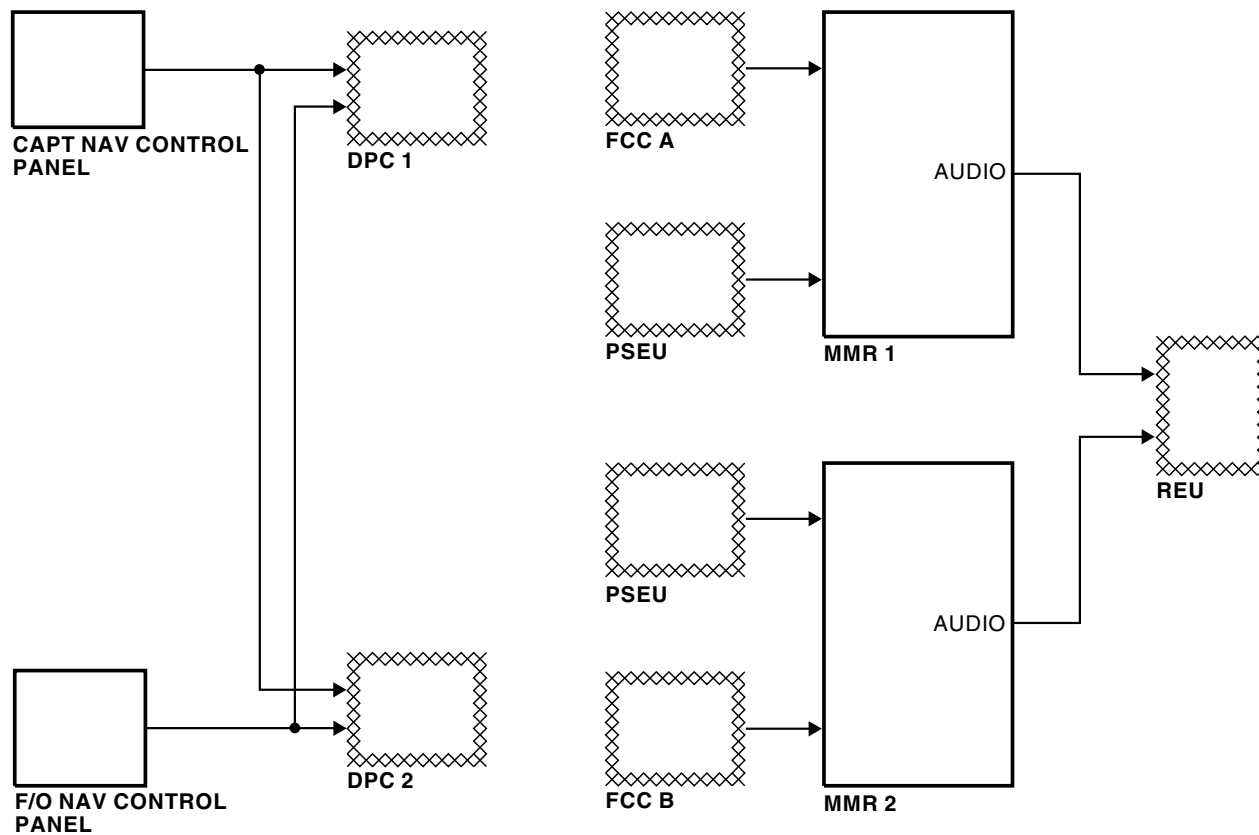
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ILS - ANALOG INTERFACES

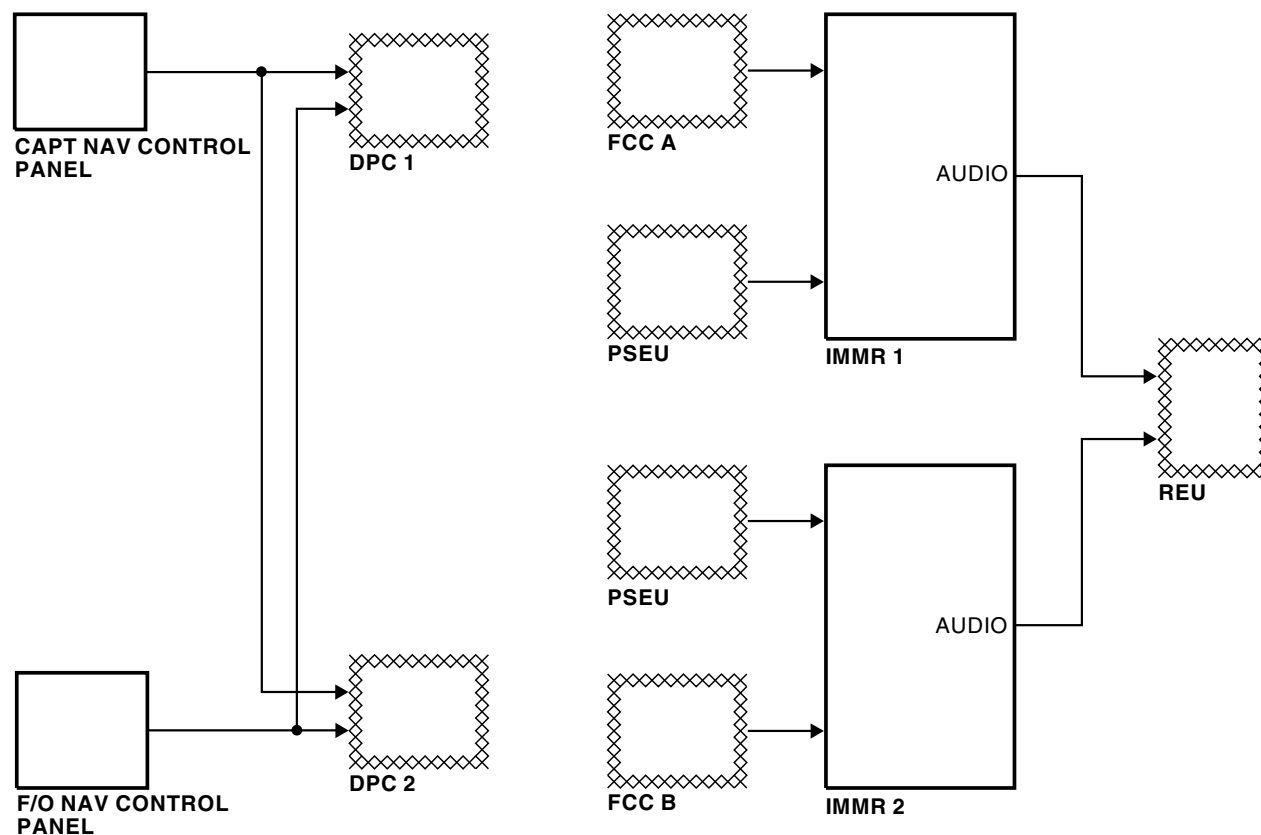


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ILS - ANALOG INTERFACES



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ILS - ANALOG INTERFACES

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ILS - RECEIVER

SIA 006-999

Purpose

The integrated multi-mode receiver (IMMR) contains these functions:

- An instrument landing system (ILS) receiver function
- A global positioning system (GPS) receiver function
- A VHF omnidirectional ranging / marker beacon (VOR/MB) function
- An optional GNSS landing system (GLS) function.

The ILS receiver function supplies ILS frequency/identifier, localizer, and glideslope deviation to different airplane systems.

SIA 001-005

Purpose

The multi-mode receiver (MMR) contains these functions:

- An instrument landing system (ILS) receiver function
- A global positioning system (GPS) receiver function
- An optional GNSS landing system (GLS) function.

The ILS receiver function supplies ILS frequency/identifier, localizer, and glideslope deviation to different airplane systems.

SIA ALL

Description

SIA 006-999

The IMMR is a standard ARINC 600 3 MCU unit with dimensions approximately 3.74 x 7.87 x 14.72 inches. The receiver weighs approximately 9 pounds and uses 115v ac, 400Hz power for operation.

SIA 001-005

The MMR is a standard ARINC 600 3 MCU unit with dimensions approximately 3.74 x 7.87 x 14.72 inches. The receiver weighs approximately 9 pounds and uses 115v ac, 400Hz power for operation.

SIA ALL

Test and Indication

SIA 006-999

There are status LED indicators and a test switch on the front of the IMMR. The test switch starts a functional test of the receiver. The LED status indicators show test results.

SIA 001-005

There are status LED indicators and a test switch on the front of the MMR. The test switch starts a functional test of the receiver. The LED status indicators show test results.

SIA 006-999

The IMMR has nonvolatile flight fault memory. The faults are stored for later use by shop personnel.

SIA 001-005

The MMR has nonvolatile flight fault memory. The faults are stored for later use by shop personnel.

Line personnel will use the onboard network system (ONS) to load software onto the MMR.

SIA 006-999

Line personnel will use the onboard network system (ONS) to load software onto the IMMR.

SIA ALL

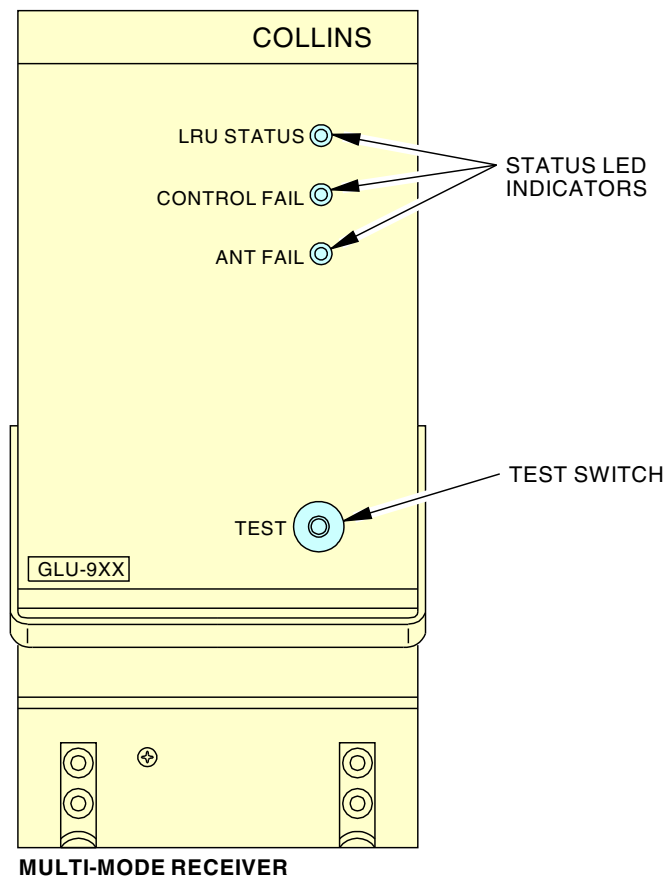
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ILS - RECEIVER

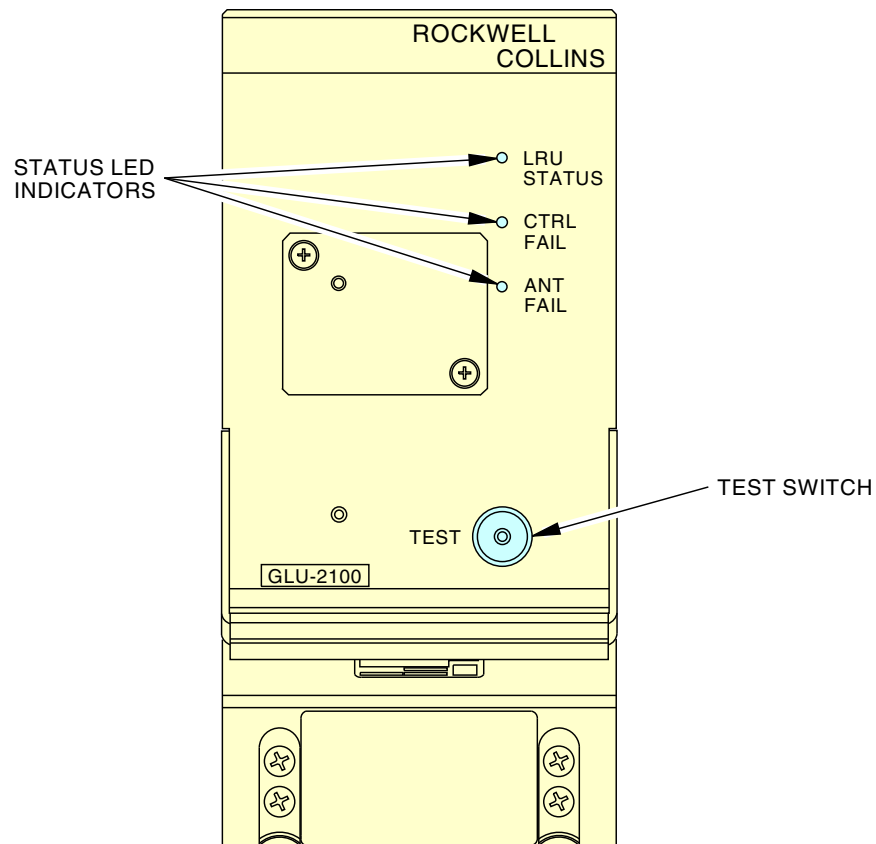


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ILS - RECEIVER

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ILS - RECEIVER



INTEGRATED MULTI-MODE RECEIVER

ILS - RECEIVER

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**ILS - ANTENNAS****Localizer Antenna**

The localizer antenna has two elements. One element supplies RF inputs to ILS receiver 1 and one element supplies RF inputs to ILS receiver 2. The localizer antenna receives frequencies from 108.1 MHz to 111.95 MHz at odd tenth intervals.

Glideslope Antenna**SIA 001-005**

The glideslope antenna also has two elements. One element supplies RF signal inputs to MMR 1 and one element supplies RF signal inputs to MMR 2. The glideslope antenna receives frequencies from 328.6 MHz to 335.4 MHz.

SIA 006-999

The glideslope antenna also has two elements. One element supplies RF signal inputs to IMMR 1 and one element supplies RF signal inputs to IMMR 2. The glideslope antenna receives frequencies from 328.6 MHz to 335.4 MHz.

SIA ALL**34-31-00**

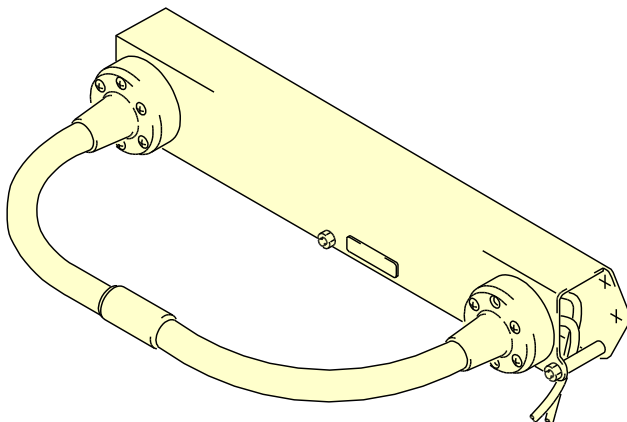
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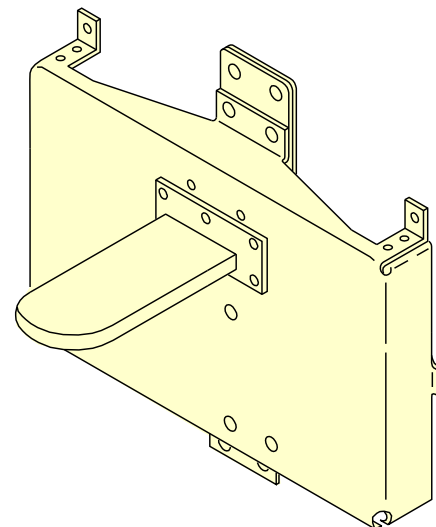
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ILS - ANTENNAS



LOCALIZER ANTENNA



GLIDESLOPE ANTENNA

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ILS - ANTENNAS

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ILS - NAVIGATION CONTROL PANEL

General

The navigation control panels (NCPs) supply frequency control and test signals to the instrument landing system (ILS) and distance measuring equipment (DME) navigation radios.

Operation

The NCPs have an active mode frequency/channel indicator and a standby mode frequency/channel indicator. The mode frequency/channel that shows in the active frequency/channel indicator is the mode frequency/channel the navigation radios use for operation. The standby mode frequency/channel indicator shows the next frequency/channel you will use.

The mode frequency/channel transfer button is a momentary action button. It transfers the mode frequency/channel in the standby frequency/channel indicator to the active frequency/channel indicator. When you push the button, the frequency/channel in the active frequency/channel indicator transfers to the standby frequency/channel indicator.

The MODE Select buttons are used to select one of the modes available (ILS, VOR, MLS, or GLS).

The numeric key pad (keys 0 thru 9) is used to set the frequency/channel in the standby frequency/channel indicator.

The CLR button is used to erase one, several, or all digits of a frequency or channel value shown in the STBY display. If the CLR button is pushed for less than one second, only one digit is erased. If the CLR button is pushed for more than 1 second, the whole value shown in the STBY display is erased and replaced with underscores (_ _ _ _ _).

At power up, the frequency displays show the last frequency entry before power down.

The NCP continuous BITE function monitors the operation. The NCP shows PNL FAIL in the active and the standby frequency indicators when there is a control panel failure.

An internal monitor in the NCP monitors the 28v dc input. If the monitor does not see the 28v dc, it shows the message BLANK in the active and the standby frequency indicators.

Test**SIA 001-005**

When you push the NCP test button, a test command goes out on the data bus. If a VOR frequency is active, the VOR receiver starts a self test. If an ILS frequency or a GLS channel is active, the MMR receiver starts a self test. If a DME frequency is paired with the VOR or ILS frequency, the DME interrogator starts a self test at the same time.

SIA 006-999

When you push the NCP test button, a test command goes out on the data bus. If a VOR frequency is active, the VOR receiver starts a self test. If an ILS frequency or a GLS channel is active, the IMMR receiver starts a self test. If a DME frequency is paired with the VOR or ILS frequency, the DME interrogator starts a self test at the same time.

SIA ALL

When you do a test of the master dim and test system, the NCP shows 888.88. The display shows for two seconds on, then one second off until the test is complete.

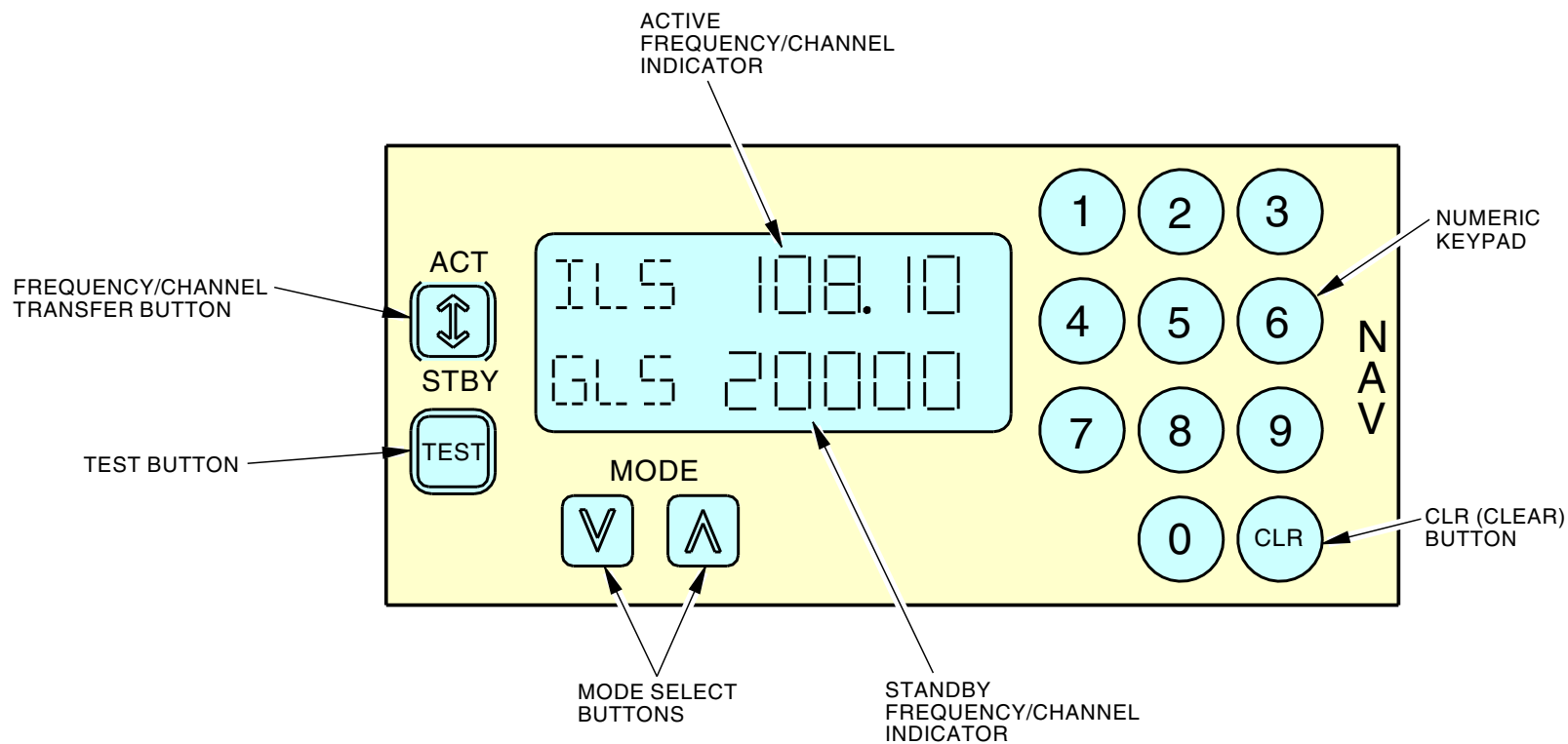
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ILS - NAVIGATION CONTROL PANEL



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ILS - NAVIGATION CONTROL PANEL

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ILS - FUNCTIONAL DESCRIPTION

Power Interface

The NAV control panel uses 115v ac power for operation. It also uses 28v dc for an internal monitor. The navigation control panel (NCP) uses 5v ac from the master dim and test for panel lights.

ARINC 429 Interfaces

SIA 001-005

Frequency tune inputs and test commands from the NCP go to the MMR on an ARINC 429 bus.

SIA 006-999

Frequency tune inputs and test commands from the NCP go to the IMMR on an ARINC 429 bus.

SIA ALL

When you tune an ILS frequency, the frequency tune circuits operate switches in the NCP that send these discrete signals:

- Open discrete to the REU
- Ground discrete to the DPCs

SIA 001-005

- 28v dc to the LOC antenna switches

SIA ALL

- 28v dc to the FCCs.

Discrete Interfaces

The REU uses the open discrete to select ILS audio. The DPCs use the ground discrete to set the ILS displays. The NCP sends the 28v dc to the FCCs when an ILS frequency is active.

SIA 001-005

The NCP also sends 28v dc to the LOC antenna switches when an ILS frequency is active for switch operation.

The on-side FCC supplies a discrete during an AFDS approach mode. The discrete causes the MMR to not accept any frequency changes. The discrete also goes to the NCP. When the discrete is set, It prevents any frequency change to the output data word that goes to the MMR. The MMR uses the air/ground discrete for flight leg count.

SIA 006-999

The on-side FCC supplies a discrete during an AFDS approach mode. The discrete causes the IMMR to not accept any frequency changes. The discrete also goes to the NCP. When the discrete is set, It prevents any frequency change to the output data word that goes to the IMMR. The IMMR uses the air/ground discrete for flight leg count.

SIA ALL

RF Interfaces

SIA 001-005

RF signals from the VOR/LOC antenna or localizer antenna in the nose radome, go to the localizer receiver circuits in the MMR. RF signals from the glideslope antenna in the nose radome go to the glideslope receiver circuits in the MMR.

SIA 006-999

RF signals from the VOR/LOC antenna or localizer antenna in the nose radome, go to the localizer receiver circuits in the IMMR. RF signals from the glideslope antenna in the nose radome go to the glideslope receiver circuits in the IMMR.

SIA ALL

Receiver Functional Description

All inputs to the receiver go through a high intensity radiated frequency (HIRF) filter. This filter provides protection to internal circuits.

Tune inputs from the NCP go to the main processor. The processor sends the tune frequency to the frequency synthesizer circuits. The frequency synthesizer circuits tune the localizer receiver and glideslope receiver.

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ILS - FUNCTIONAL DESCRIPTION

The receiver circuits send the RF signal inputs from the antennas to the main processor. The processor computes localizer deviation and glideslope deviation.

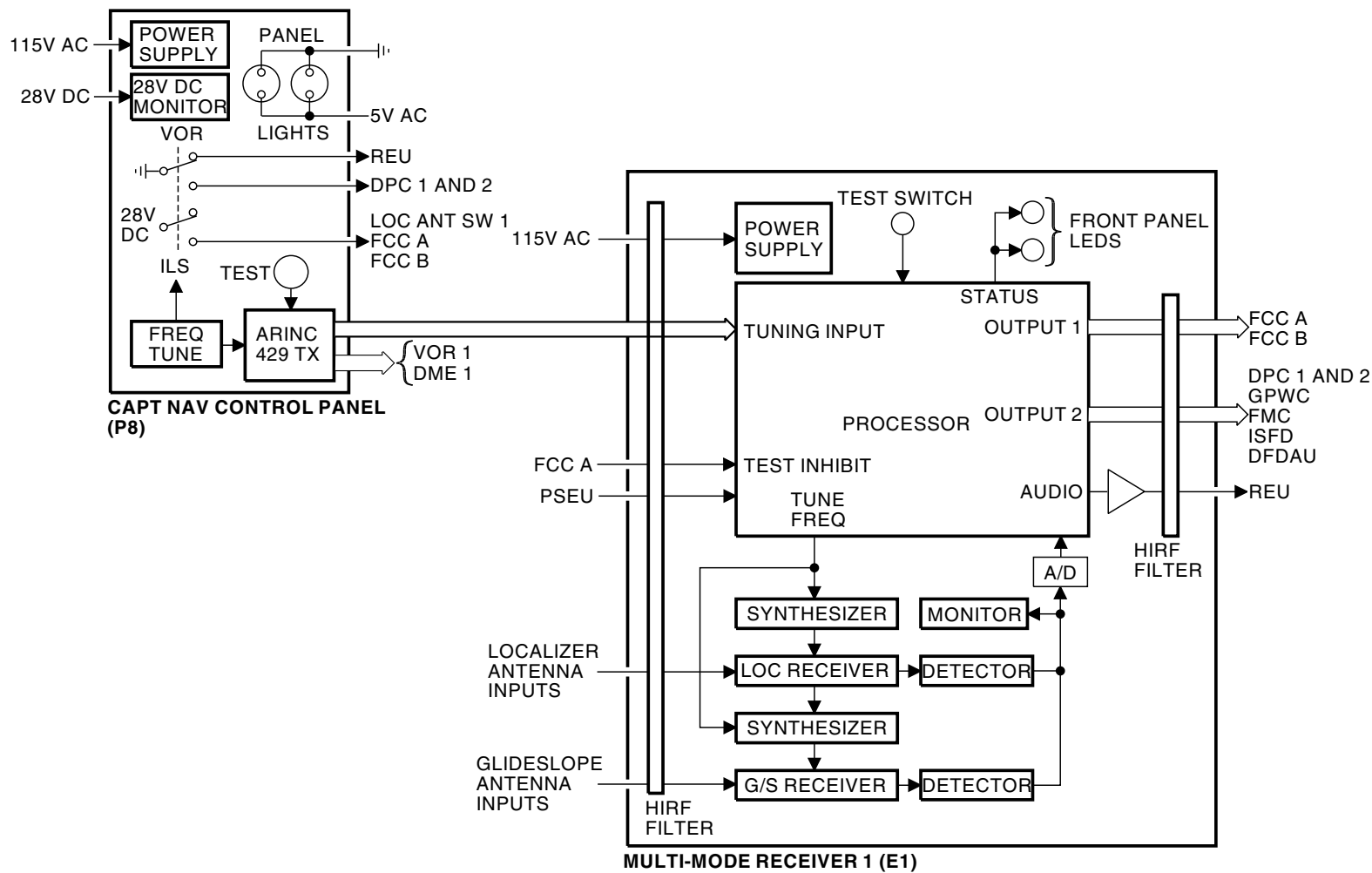
ILS data goes out on two ARINC 429 buses. Output 1 goes to FCC A and FCC B. Output 2 goes to these LRUs:

- DFDAU
- ISFD
- EGPWC
- MCU
- FMCs
- DPCs.

The localizer receiver sends audio from the localizer ground station to the audio processor. The audio processor sends ILS audio to the REU. Audio also goes through a detector that decodes the ground stations Morse code station identifier. If there is a station identifier with the station audio, the detector sends it through the ARINC transmitter on the output data bus. When there is an identifier on the data bus, the DPC replaces the frequency display with the four letter station identifier.

SIA ALL	EFFECTIVITY
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ILS - FUNCTIONAL DESCRIPTION

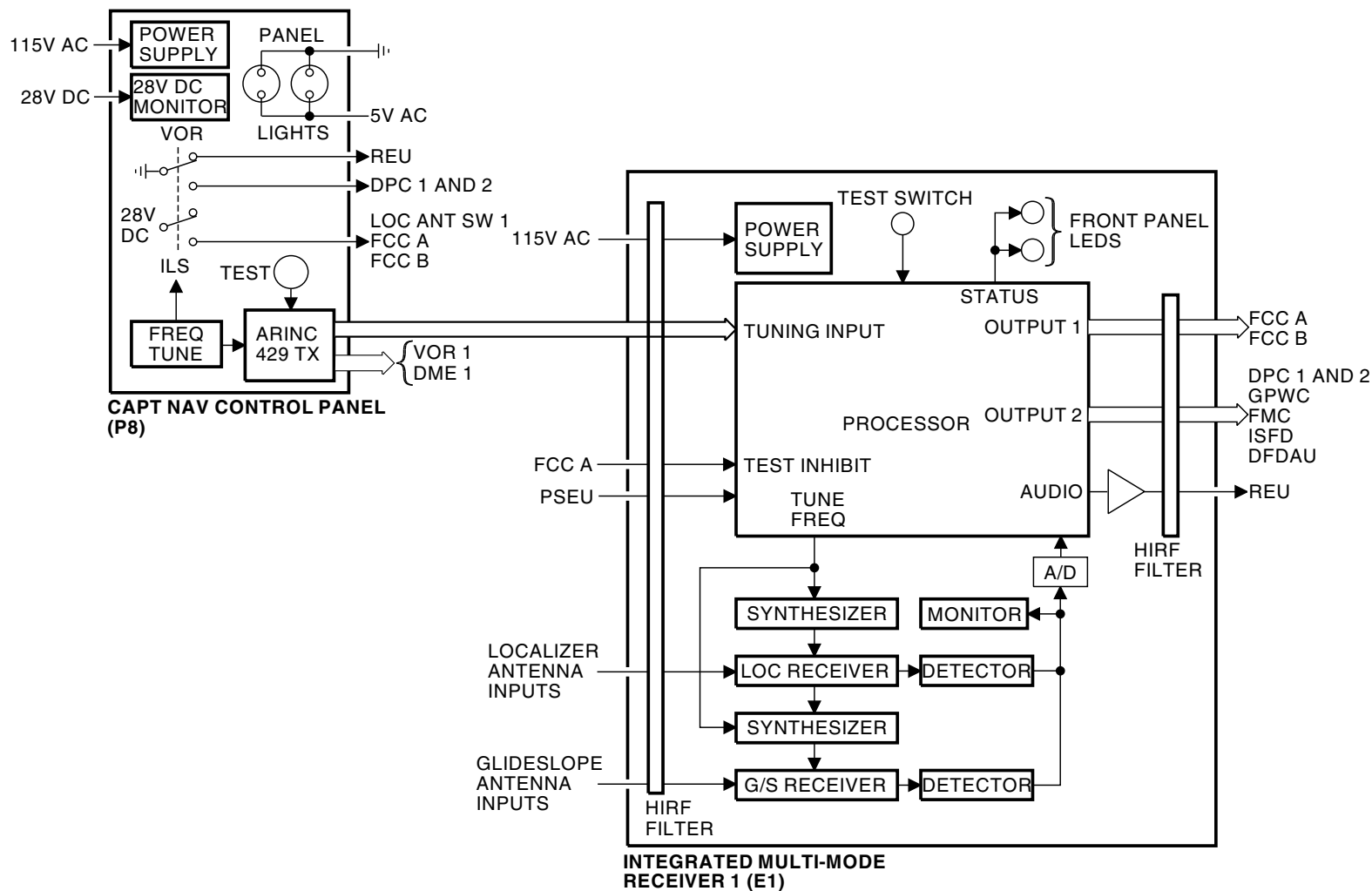


2532079 S0000599622_V2

ILS - FUNCTIONAL DESCRIPTION

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ILS - FUNCTIONAL DESCRIPTION



2802663 S0000642338_V1

ILS - FUNCTIONAL DESCRIPTION

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ILS - CONTROLS

EFIS Controls

ILS data is shown on the captain and first officer navigation displays (ND) by setting the mode selector on the EFIS control panel to the APP position.

DFCS Controls

The digital flight control system (DFCS) mode control panel (MCP) supplies runway heading data to the display processing computer (DPC) for ILS displays. You use the DFCS MCP course selector to set the course for approach.

The DPC uses the course input and ILS deviation to calculate the airplane's deviation from the runway centerline. The DPCs compare the course input to the airplane's track to calculate if this is a back course approach. If the course input and airplane track are different by more than 90 degrees, the DPCs show back course ILS displays.

Audio Control Panel Controls

The audio control panels (ACPs) lets the crew listen to ILS station audio or the morse code station identifier.

SIA 001-005

You use the ACP receiver switches to select the ILS audio you want to listen to. The NAV 1 receiver switch selects the MMR 1 audio and the NAV 2 receiver switch selects the MMR 2 audio.

SIA 006-999

You use the ACP receiver switches to select the ILS audio you want to listen to. The NAV 1 receiver switch selects the IMMR 1 audio and the NAV 2 receiver switch selects the IMMR 2 audio.

SIA ALL

The filter switch lets you listen to only voice audio in the voice (V) position. The range (R) position lets you listen to the station morse code identifier. With selector in the both (B) position you can listen to both the voice audio and the morse code station identifier.

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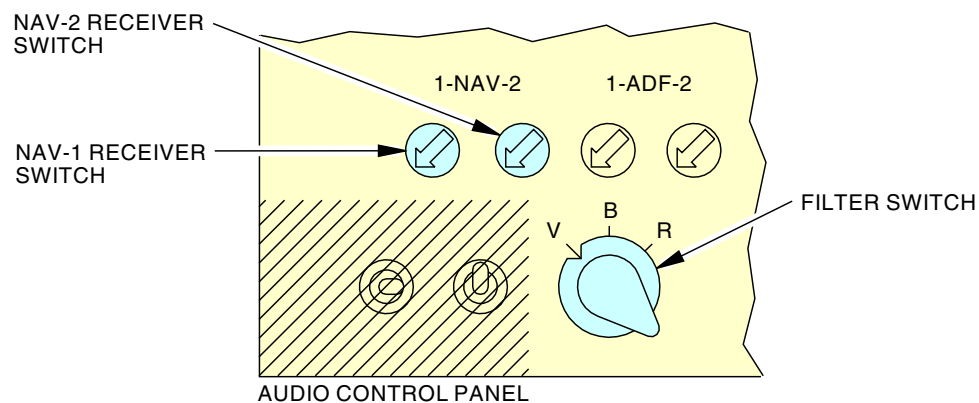
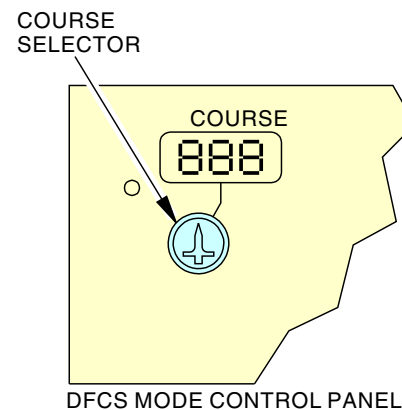
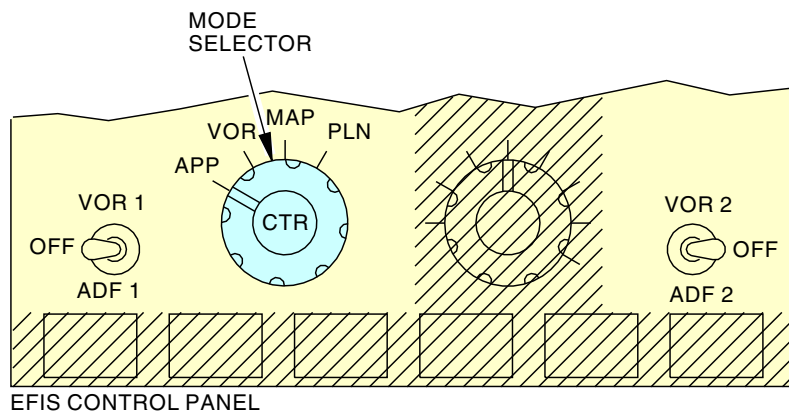
EFFECTIVITY

SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ILS - CONTROLS



ILS - CONTROLS

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SIA ALL	EFFECTIVITY

D633AM102-SIA

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ILS - INTEGRATED STANDBY FLIGHT DISPLAY

General

The integrated standby flight display (ISFD) has these parameters:

- Pitch and roll attitude
- Indicated airspeed
- Altitude
- Heading
- Instrument landing system (ILS) localizer and glideslope deviation
- GNSS landing system (GLS) lateral and vertical deviation.

When the ISFD receives no computed ILS data, the related pointers go out of view, but the scales stay in view.

SIA 001-005

The ISFD receives deviation data from multi-mode receiver (MMR) 1.

SIA 006-999

The ISFD receives deviation data from integrated multi-mode receiver (IMMR) 1.

SIA ALL

Approach Mode Switch (APP)

The APP mode switch controls the display of the lateral and vertical deviation scales.

When the ISFD gets power, the ISFD does not show the lateral and vertical scales. The scales show when you push the APP mode switch.

You push the APP mode switch a second time to select the back course mode.

You push the APP mode switch a third time to make the lateral and vertical scales and pointers go away.

Indications

When the ISFD receives invalid ILS data, the deviation pointers and the scales go away. The LOC and G/S flags show.

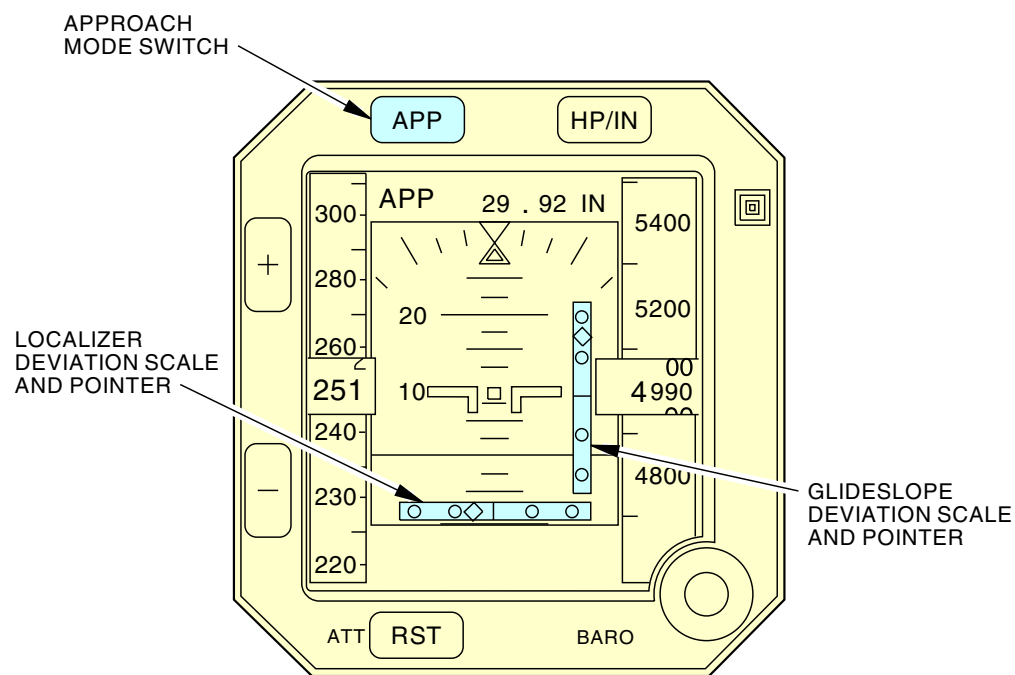
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ILS - INTEGRATED STANDBY FLIGHT DISPLAY



INTEGRATED STANDBY FLIGHT DISPLAY
(EXAMPLE)

2369877 S00061520525_V3

ILS - INTERGRATED STANDBY FLIGHT DISPLAY

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SIA ALL	EFFECTIVITY
	D633AM102-SIA



ILS - ADI DISPLAYS

General

To show ILS displays on the ADI you must tune a valid ILS frequency on the NCP and select it to the active display window.

It also sends 28v dc to the LOC antenna switches when an ILS frequency is active for switch operation.

- Localizer and glideslope indications
- Scale identifier annunciation
- Rising runway indications
- Approach reference data.

Normal Display

The localizer deviation pointer and scale show at the bottom and to the right of the attitude display. The scale is a standard four dot scale. One dot equals 1 degree of deviation. The deviation indication shows deviation to the left or right of the runway centerline. The localizer scale shows in white and the localizer pointer shows in magenta.

The localizer scale can show the standard display or the expanded scale. A two-dot expanded scale can replace the four-dot scale. For the expanded scale, each dot equals 0.5 degrees of deviation. The white expanded scale goes to amber and flashes when the autopilot sends an ILS deviation warning. The expanded scale shows for these conditions:

- LOC deviation is less than 5/8 dot
- LOC or APP mode is engaged
- ILS course and the airplane track are within 5 degrees of each other
- An autopilot is in CMD, or flight director is on.

The glideslope deviation pointer and scale show to the right of the attitude display. The scale is a standard four-dot scale. One dot equals 0.35 degrees of deviation. The pointer gives fly-to commands to intercept the glideslope beam. The glideslope scale shows in white and the glideslope pointer shows in magenta. There is no expanded scale for glideslope deviation.

The ILS station frequency and course show above and to the right of the ADI. If the ILS ground station transmits a morse coded station identifier, the stations letter identifier replaces the numeric frequency display when the receiver captures the signal.

Rising Runway

The rising runway shows when there is a LOC signal capture and the radio altitude is below 2500 feet. The symbol goes out of view above 2500 feet. The rising runway symbol is green with a magenta stem.

The rising runway symbol represents the radio altitude above the runway. It moves laterally with the localizer deviation pointer to show localizer deviation. The symbol starts to move when the radio altitude is 200 feet. It touches the airplane symbol when the radio altitude is 0 or at touchdown.

NCD Display

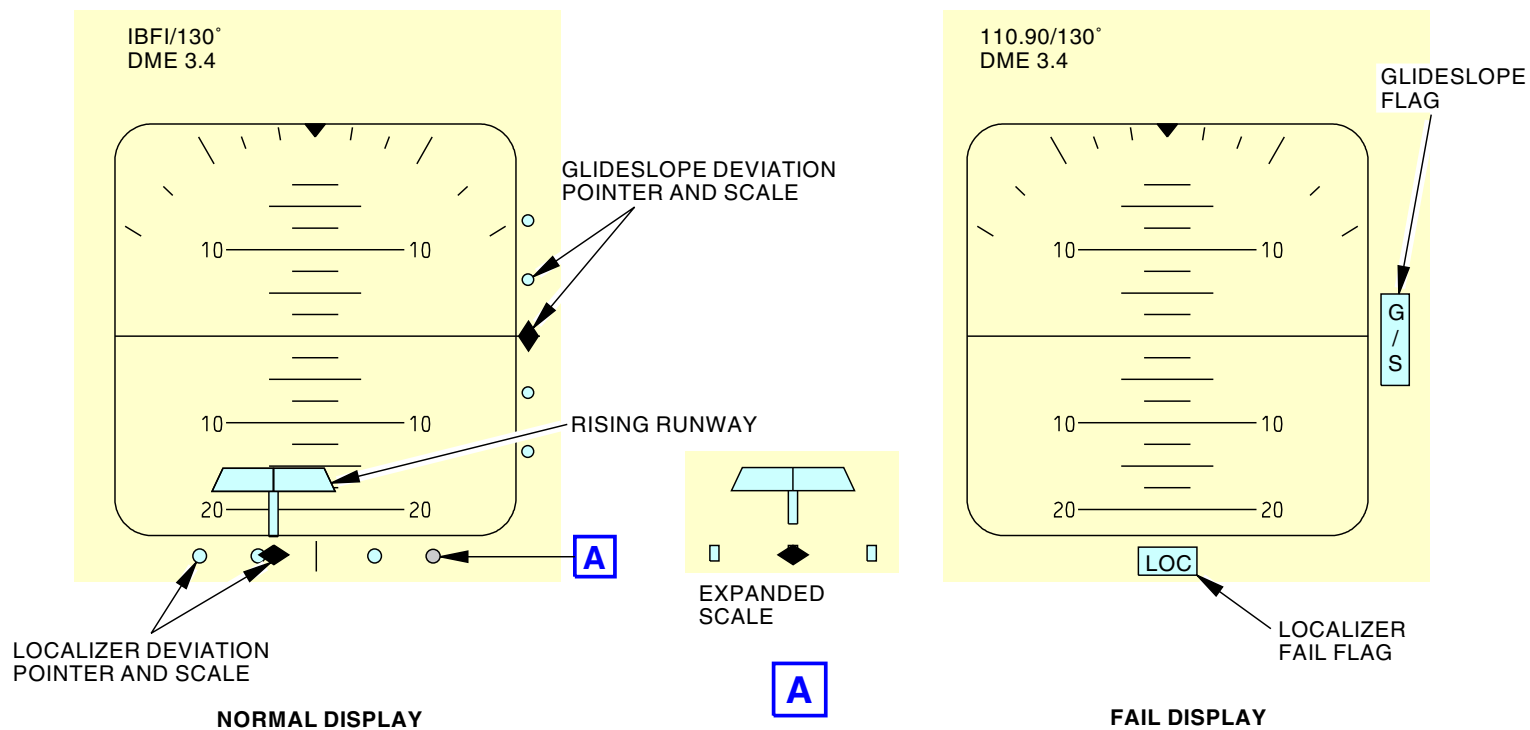
When the ILS data goes to an NCD condition, the MDS shows the localizer and glideslope scales and removes the pointers.

Fail Display

The amber LOC flag replaces the localizer deviation pointer and scale when the localizer receiver function has a failure. The amber G/S flag replaces the glideslope deviation pointer and scale when the glideslope receiver function has a failure.

EFFECTIVITY	
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ILS - ADI DISPLAYS



ILS - ADI DISPLAYS

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SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ILS - EXPANDED ILS DISPLAY

General

To show ILS displays on the MAX display system (MDS), set the EFIS control panel mode selector to the APP position. You must also tune a valid ILS frequency on the navigation control panel (NCP).

Normal Display

The glideslope deviation pointer and scale show at the right of the navigation display (ND). The glideslope deviation pointer is magenta and the scale is white.

The glideslope scale is the standard four dot scale where each dot equals 0.35 degrees of deviation. The glideslope deviation pointer gives fly-to signals to intercept the glideslope beam.

The course pointer points to the number that you set on the DFCS MCP.

The localizer deviation indicator and scale shows at the bottom of the ND. The localizer scale is white and the localizer deviation indicator is magenta.

The localizer deviation scale is the standard four dot scale. One dot is equal to 1 degree of deviation. The localizer deviation indicator shows the deviation to the left or right of the runway centerline.

The NAV data source shows in white at the upper right corner of the display. It shows the source of the data for the ILS displays. To the right of the NAV data source is the active ILS frequency display.

The ILS frequency display shows the active ILS frequency and the selected course. If the ILS ground station transmits a Morse coded station identifier, the letter identifier replaces the numeric frequency when the receiver captures the ground station signal.

NCD Display

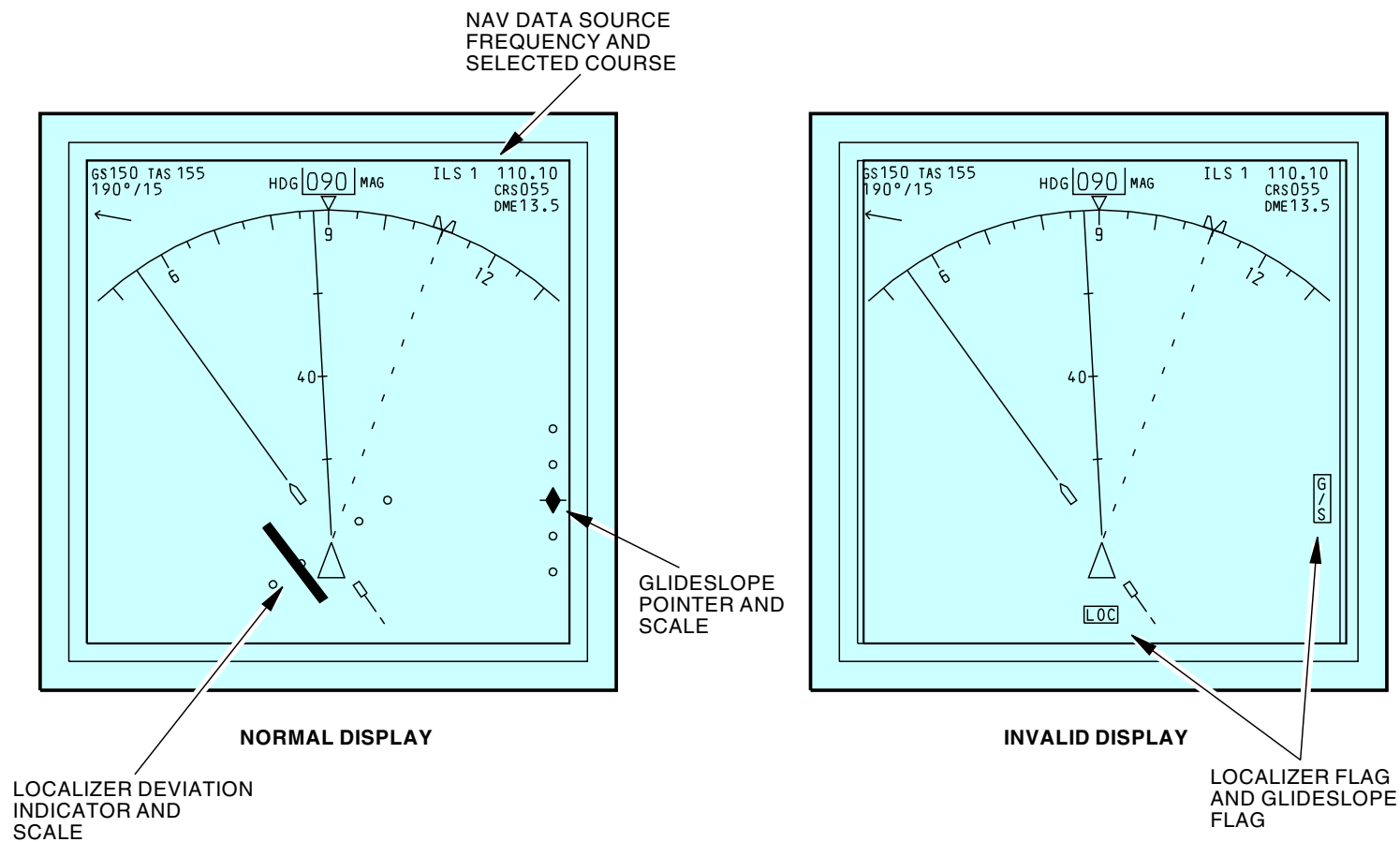
When the ILS data goes to an NCD condition, the MDS shows the localizer and glideslope scales and removes the pointers. The ILS frequency changes to dashes.

Fail Display

For invalid ILS/GLS data, the MDS replaces the localizer deviation scale and indicator with the amber LOC flag when the localizer receiver fails. The amber G/S flag replaces the glideslope deviation scale and pointer when the glideslope receiver fails.

EFFECTIVITY	
SIA ALL	

ILS - EXPANDED ILS DISPLAY



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ILS - EXPANDED ILS DISPLAY

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SIA ALL	EFFECTIVITY
	D633AM102-SIA



ILS - CENTERED ILS DISPLAY

General

To show the centered ILS navigation display (ND), push the CTR switch on the EFIS control panel mode selector switch.

Normal Displays

The glideslope deviation pointer and scale show to the right of the HSI display. The glideslope pointer is magenta and the scale is white.

The glideslope scale is the standard four dot scale. Each dot equals 0.35 degrees of deviation. The pointer gives fly-to commands to intercept the glideslope beam.

The course pointer points to the number that you set on the DFCS MCP.

The localizer deviation indicator and scale show in the center of the HSI compass card. The localizer deviation indicator is magenta and the scale is white.

The localizer scale is the standard four dot scale. Each dot is equal to 1 degree of deviation. The deviation indicator shows the deviation to the left or the right of the runway centerline.

The NAV data source shows in white in the upper right corner of the display. It shows the source of data for the ILS display. The active ILS frequency shows to the right of the NAV data source.

The ILS frequency display shows the active ILS frequency and the selected course. If the ILS ground station transmits a Morse coded station identifier, then the letter identifier replaces the numeric frequency when the receiver captures the ground station signal.

NCD Display

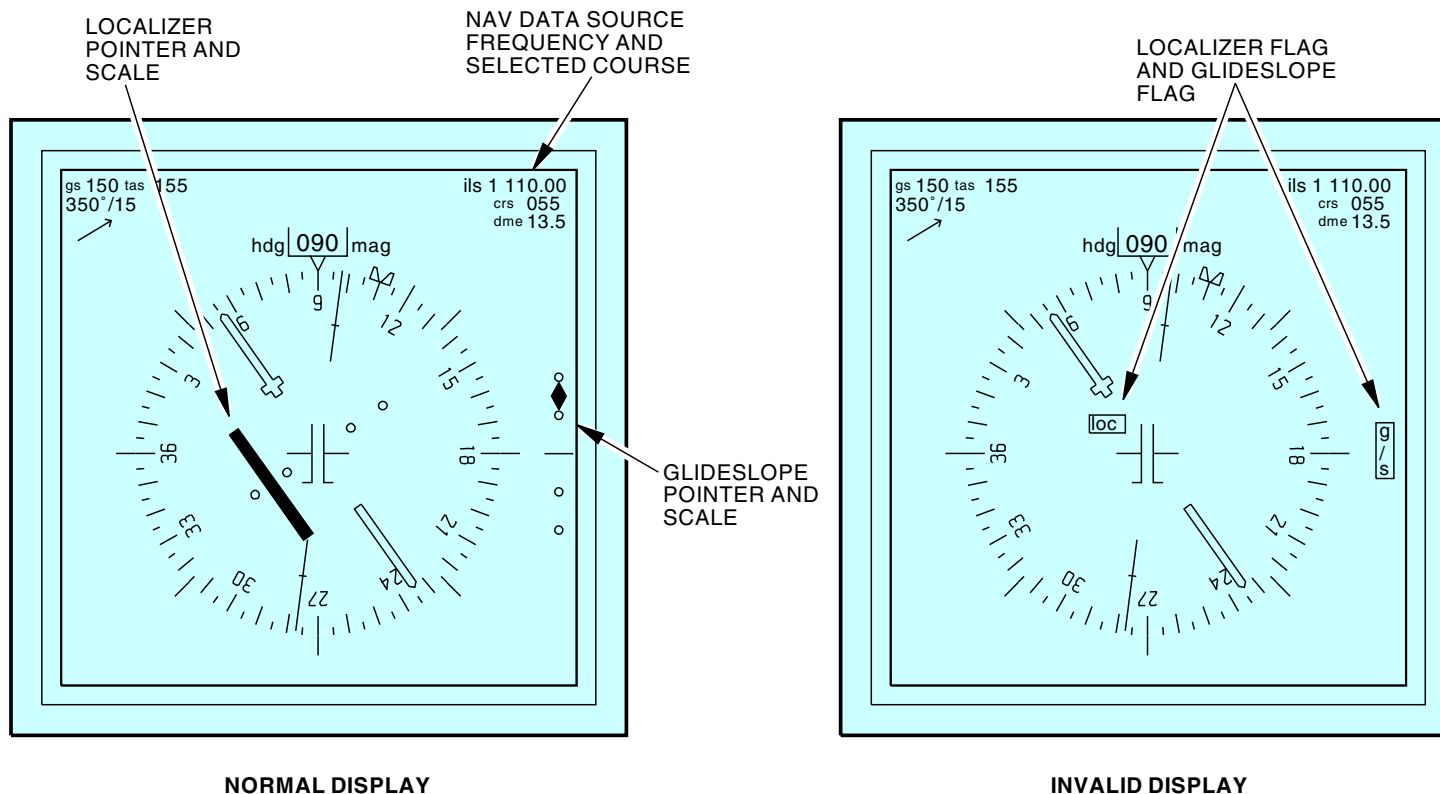
For an ILS NCD condition, the MDS displays the localizer and glideslope scales and removes the deviation bar and glideslope pointer.

Fail Display

For invalid ILS/GLS data, the MDS replaces the localizer scale and deviation indicator with the amber LOC flag when the localizer receiver fails. The amber G/S flag replaces the glideslope scale and pointer when the glideslope receiver fails.

EFFECTIVITY	
SIA ALL	

ILS - CENTERED ILS DISPLAY



ILS - CENTERED ILS DISPLAY

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

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ILS - FRONT PANEL BITE

SIA 001-005

Test

When you push the test switch, the MMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 44 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on red
- 2 to 4 seconds - the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 16 seconds - all LEDs go off
- 16 to 44 seconds - test status shows.

The LRU STATUS segment shows red when there is an internal failure in the MMR. Green shows that the MMR is operating normally.

The CONTROL FAIL segment shows red when an interface to the MMR has a failure. Green shows that all the interfaces to the MMR are normal.

SIA 006-999

Test

When you push the test switch, the IMMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 44 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on red
- 2 to 4 seconds - the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 16 seconds - all LEDs go off
- 16 to 44 seconds - test status shows.

The LRU STATUS segment shows red when there is an internal failure in the IMMR. Green shows that the IMMR is operating normally.

The CONTROL FAIL segment shows red when an interface to the IMMR has a failure. Green shows that all the interfaces to the IMMR are normal.

SIA ALL

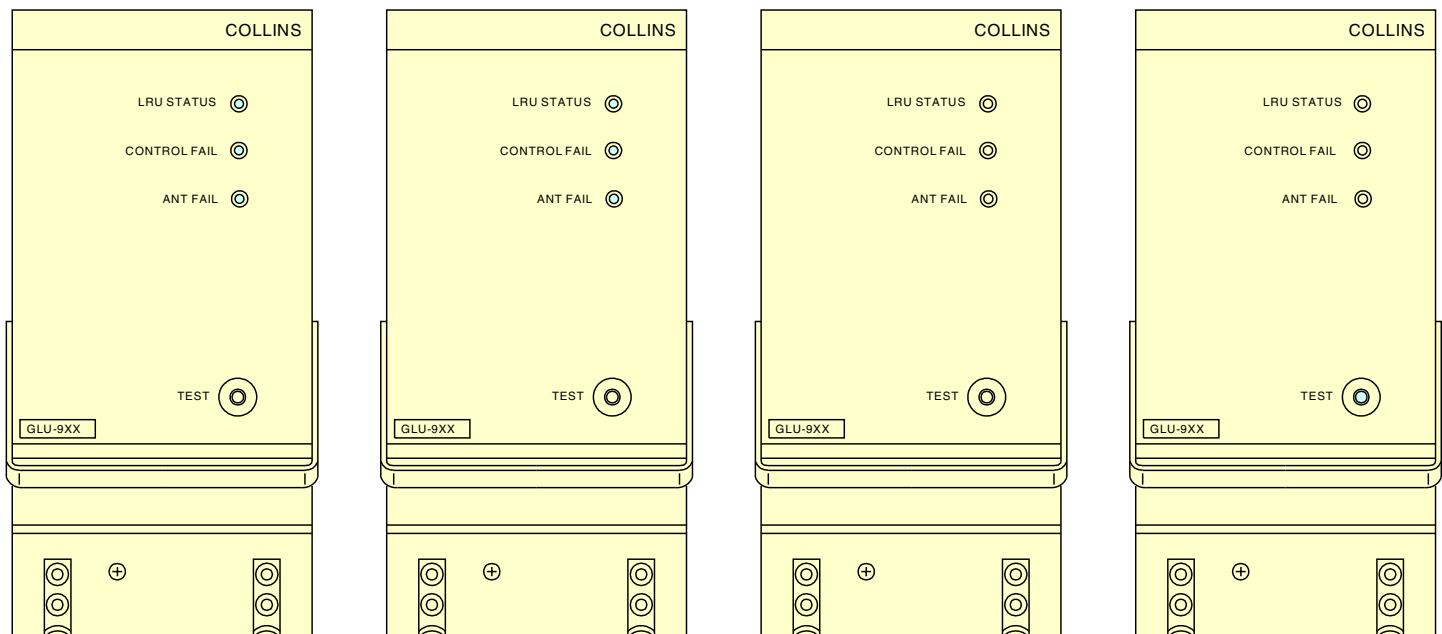
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ILS - FRONT PANEL BITE



0-2 SECONDS

THE LRU STATUS, CONTROL FAIL AND ANT FAIL LEDS ON RED.

2-4 SECONDS

THE LRU STATUS IS GREEN, CONTROL FAIL AND ANT FAIL ARE RED.

4-16 SECONDS

ALL LEDS OFF.

16-44 SECONDS

THE TEST STATUS SHOWS.

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ILS - FRONT PANEL BITE

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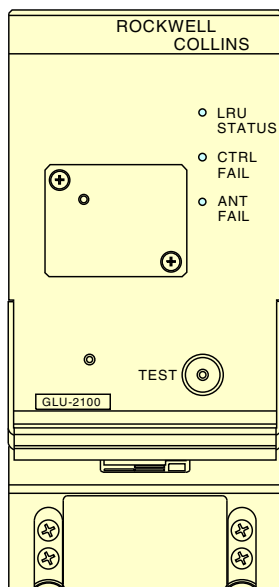
EFFECTIVITY

SIA 001-005

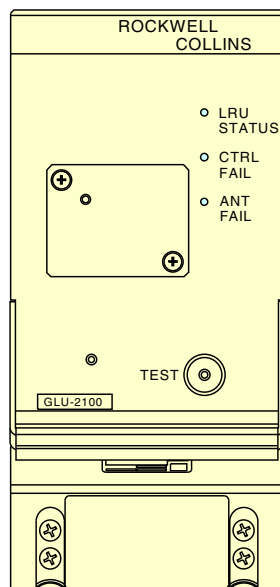
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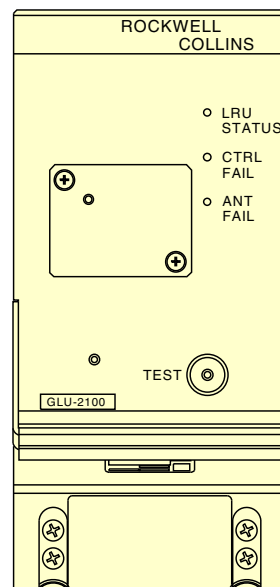
ILS - FRONT PANEL BITE



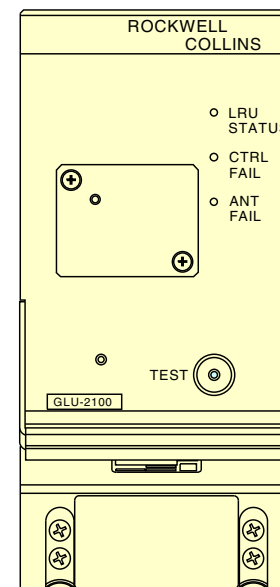
0-2 SECONDS
THE LRU STATUS, CONTROL FAIL AND ANT FAIL LEDS ON RED.



2-4 SECONDS
THE LRU STATUS IS GREEN, CONTROL FAIL AND ANT FAIL ARE RED.



4-16 SECONDS
ALL LEDS OFF.



16-44 SECONDS
THE TEST STATUS SHOWS.

2801320 S0000641918_V1

ILS - FRONT PANEL BITE

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EFFECTIVITY

SIA 006-999

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ILS - SELF-TEST****Test****SIA 001-005**

You use the navigation control panels (NCPs) to do an ILS test from the flight compartment. The captain NCP does a test of MMR 1 and the first officer NCP does a test of MMR 2.

SIA 006-999

You use the navigation control panels (NCPs) to do an ILS test from the flight compartment. The captain NCP does a test of IMMR 1 and the first officer NCP does a test of IMMR 2.

SIA ALL

You need to set these controls to do an ILS test:

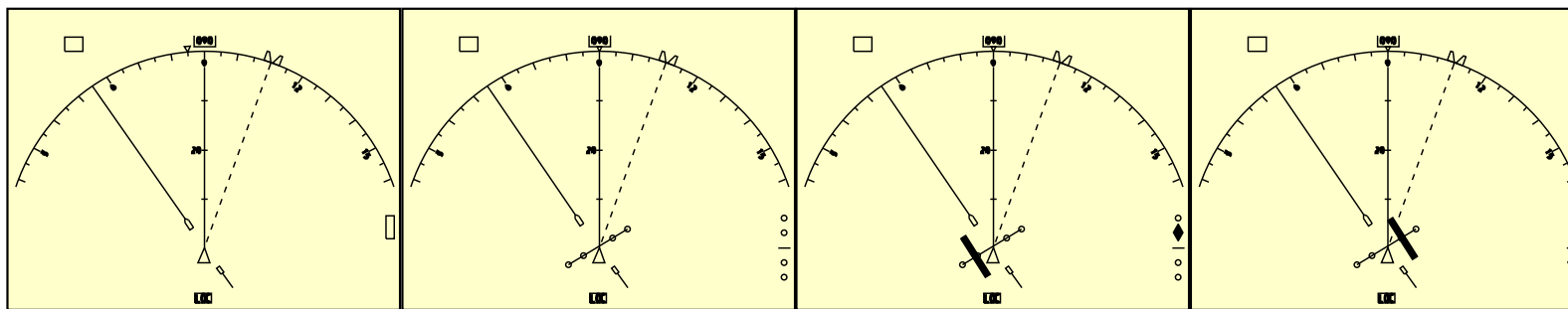
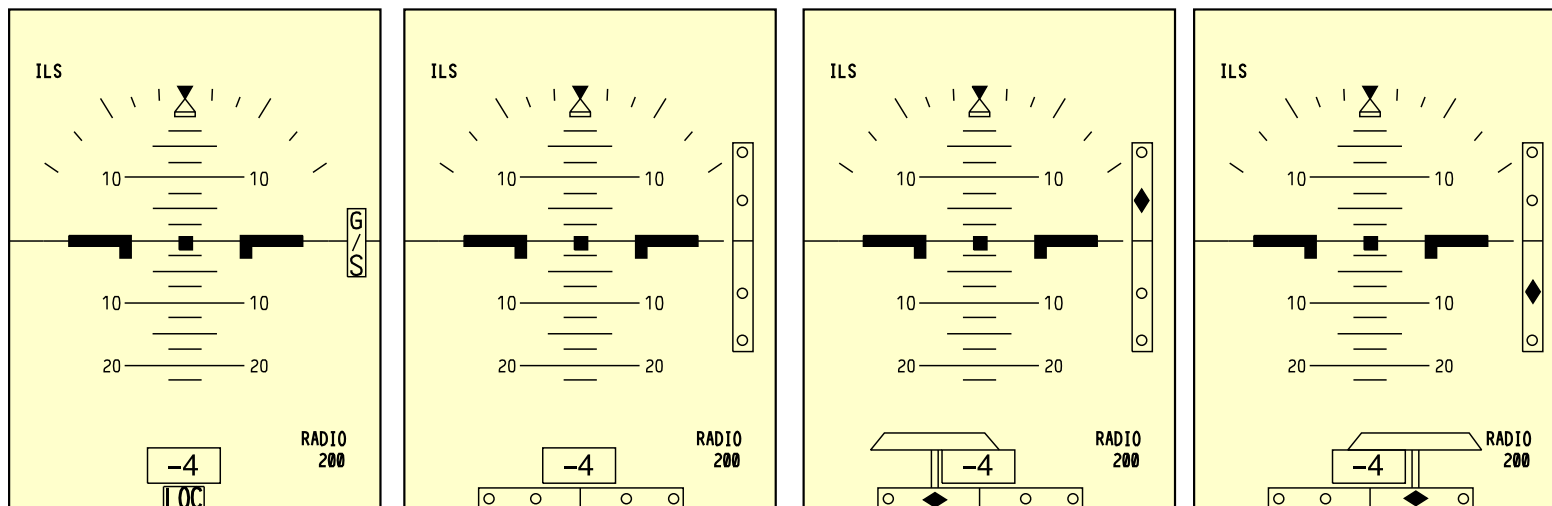
- Enter a valid ILS frequency into the active frequency display window on the NCP
- Set a course on the DFCS mode control panel that is within 90 degrees of the airplane heading
- Select the APP mode on the EFIS control panel
- Push the test switch on the NAV control panel.

This is the display sequence that shows on the outside primary flight display (PFD) and navigation display (ND) during the ILS test:

- LOC and G/S fail indications for 2 seconds
- LOC and G/S no computed data (NCD) indications for 2 seconds
- One dot left of localizer deviation and one dot up of glideslope deviation for 3 seconds
- One dot right of localizer deviation and one dot down of glideslope deviation for 3 seconds
- Displays return to normal indications.

EFFECTIVITY	
SIA ALL	

ILS - SELF-TEST



FAIL DISPLAY FOR 2 SECONDS

NCD DISPLAY FOR 2 SECONDS

UP/LEFT DISPLAY FOR 3 SECONDS

DOWN/RIGHT DISPLAY FOR 3 SECONDS

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ILS - SELF-TEST

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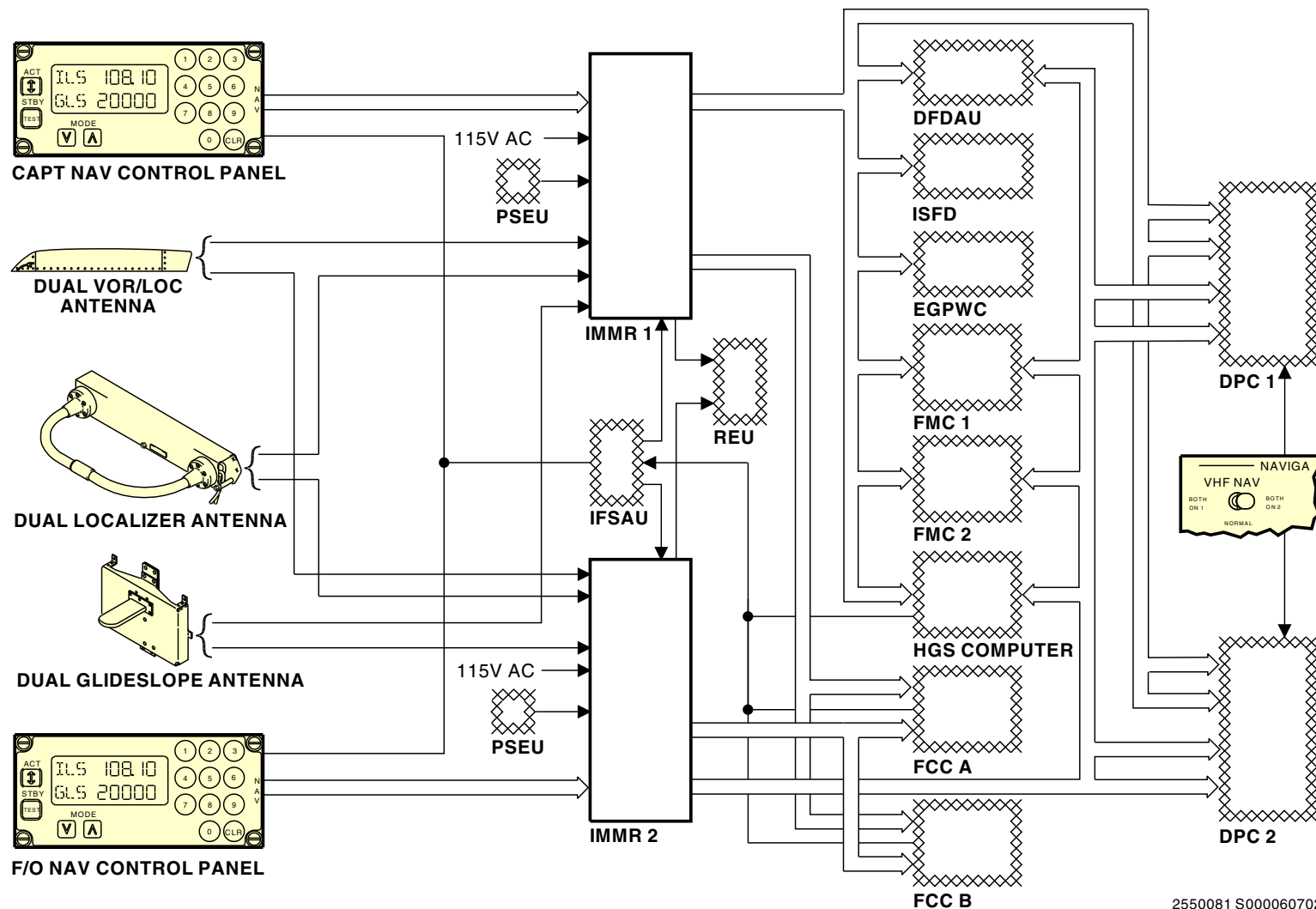
ILS - SYSTEM SUMMARY

General

This page is for reference.

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	D633AM102-SIA

ILS - SYSTEM SUMMARY

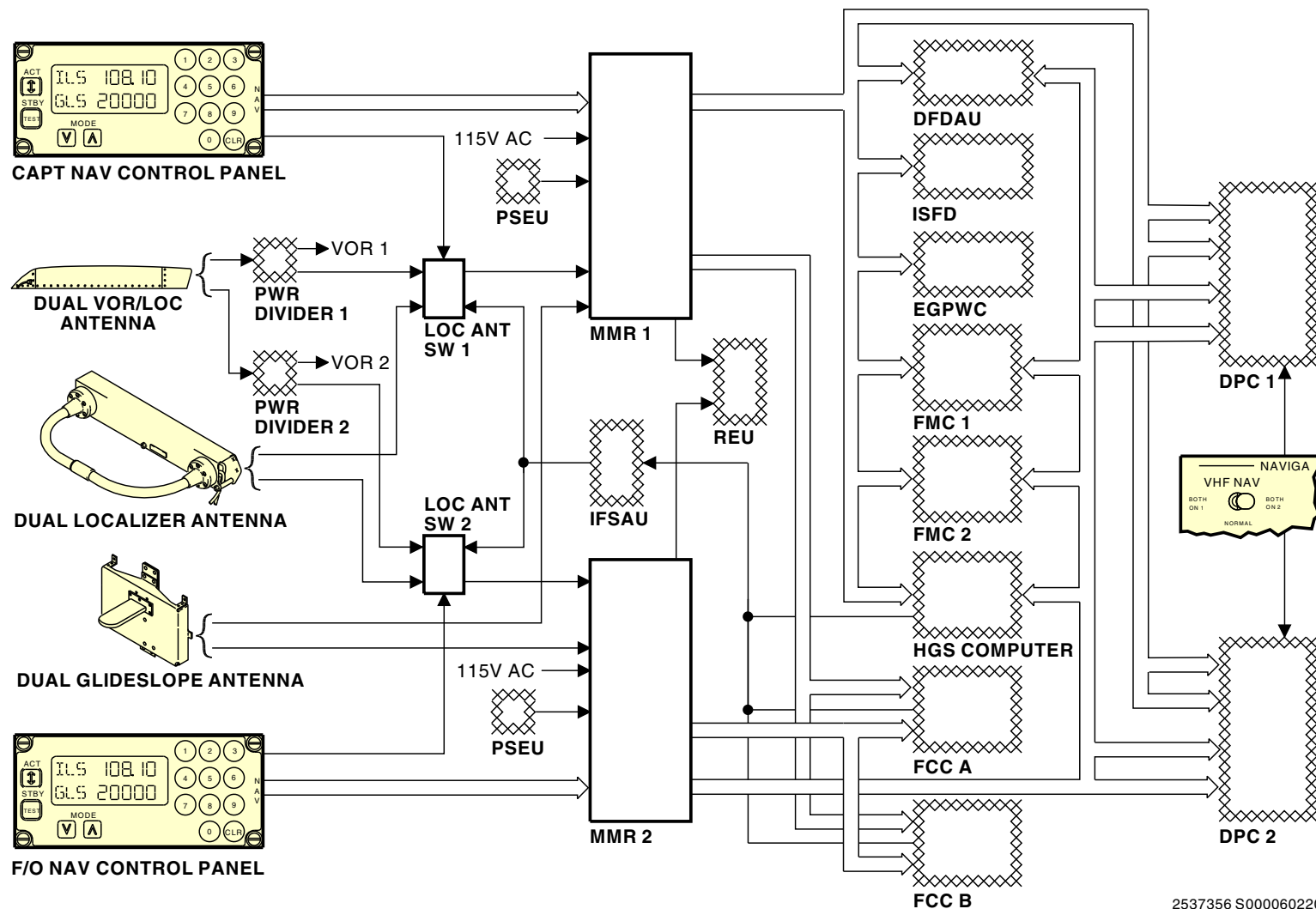


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ILS - SYSTEM SUMMARY

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ILS - SYSTEM SUMMARY



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ILS - SYSTEM SUMMARY

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**MARKER BEACON SYSTEM - INTRODUCTION****General**

The marker beacon system supplies visual and aural indications when the airplane flies over airport runway marker beacon transmitters.

Abbreviations and Acronyms

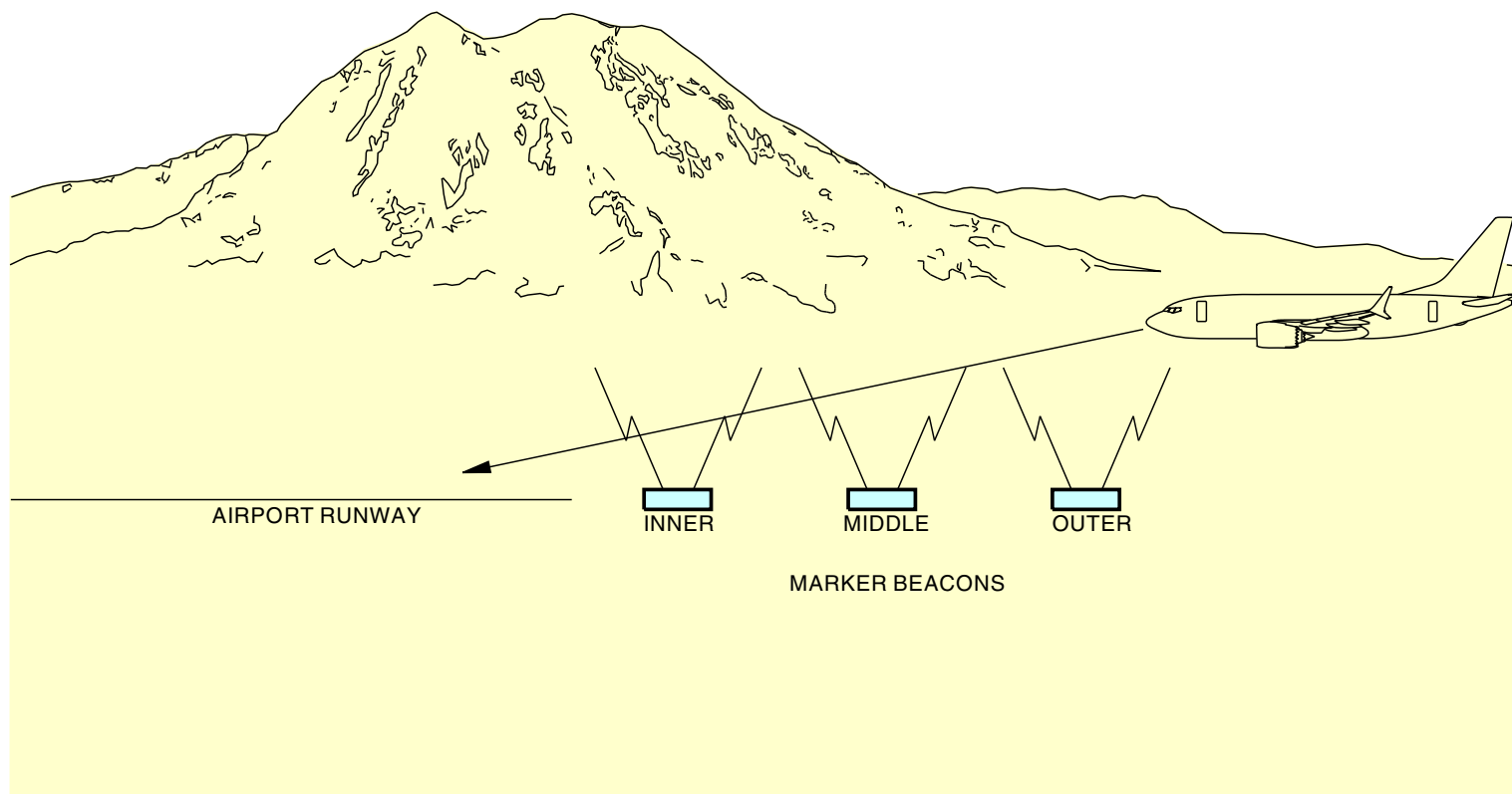
- A/P - autopilot
- AC - alternating current
- ACP - audio control panel
- AMP - amplifier
- BITE - built-in test equipment
- DFDAU - digital flight data acquisition unit
- DME - distance measuring equipment
- DPC - display processing computer
- DU - display unit
- EFIS - electronic flight instrument system
- GND - ground
- Hz - hertz
- ILS - instrument landing system
- IM - inner marker
- I/O - input/output
- LED - light emitting diode
- LRU - line replaceable unit
- MAINT - maintenance
- MB - marker beacon
- MDS - MAX display system
- MHz - mega hertz
- MM - middle marker
- MMR - multi mode receiver
- NAV - navigation
- ND - navigation display
- NORM - normal
- NVM - non-volatile memory
- OM - outer marker
- PFD - primary flight display
- R - range
- REU - remote electronics unit
- RF - radio frequency
- R/T - receive/transmit
- RCVR - receiver
- STA - station
- TFR - transfer
- V - volt
- VHF - very high frequency
- VOR - vhf omnidirectional ranging

34-32-00**SIA ALL EFFECTIVITY**

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MARKER BEACON SYSTEM - INTRODUCTION



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MARKER BEACON SYSTEM - INTRODUCTION

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

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**MARKER BEACON SYSTEM - GENERAL DESCRIPTION****General**

The marker beacon (MB) system has an antenna and a receiver.

SIA 006-999

The MB system uses an integrated multi-mode receiver (IMMR) which has the marker beacon function. The marker beacon function only operates in the IMMR 1 position.

SIA 001-005

The MB system uses a VHF omnidirectional ranging/marker beacon (VOR/MB) receiver. The marker beacon function only operates in the VOR/MB receiver 1 position.

SIA ALL**Operation**

The MB antenna receives the MB signals. The signals go to the MB receiver. The receiver supplies this data:

- Marker beacon audio to the remote electronics unit (REU)
- Marker beacon data to the MAX display system (MDS) display processing computer (DPC)
- Marker beacon data to the digital flight data acquisition unit (DFDAU).

The displays show marker beacon data.

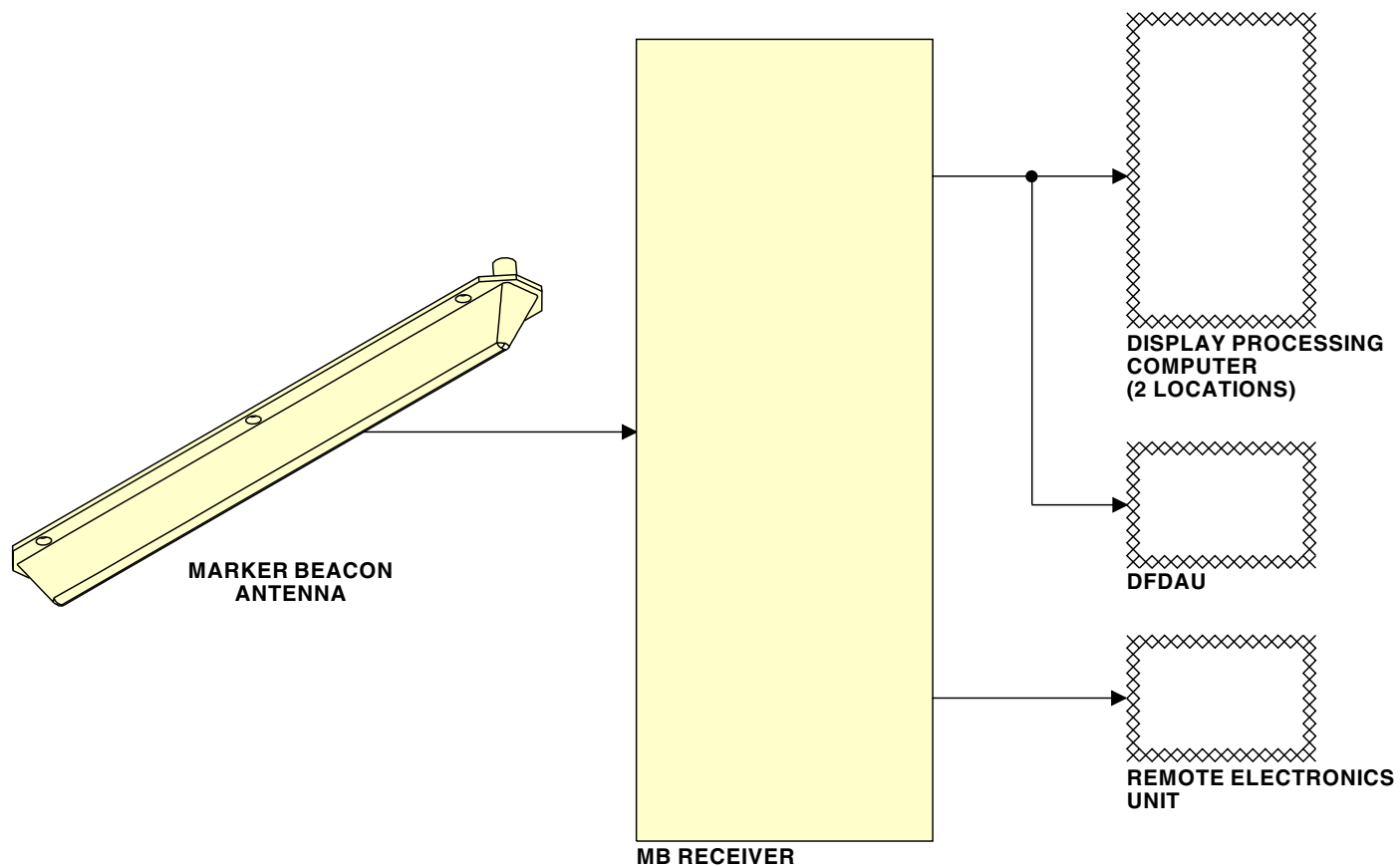
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SIA ALL **EFFECTIVITY**

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

MARKER BEACON SYSTEM - GENERAL DESCRIPTION



2369885 S00061520543_V2

MARKER BEACON SYSTEM - GENERAL DESCRIPTION

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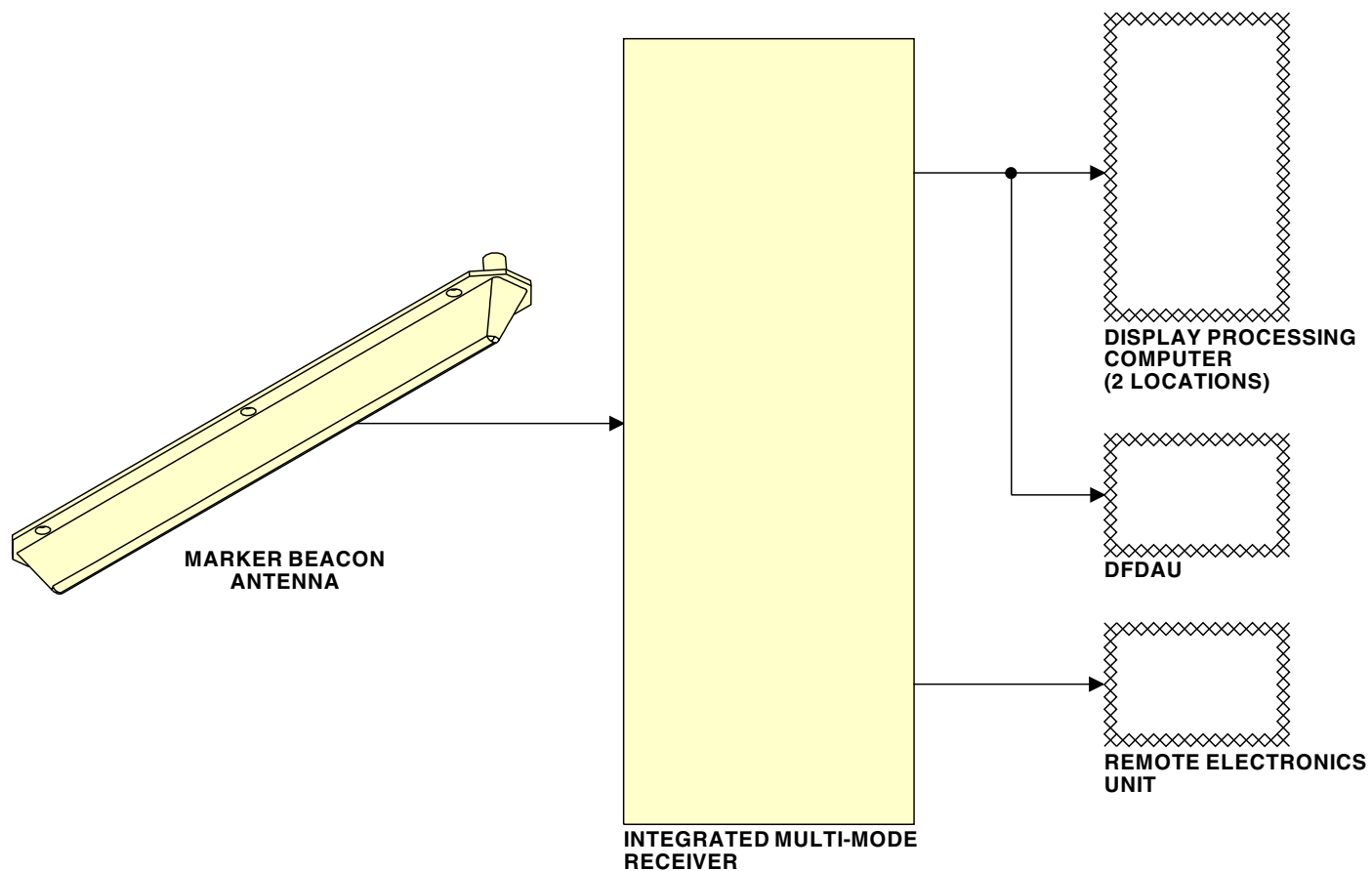
EFFECTIVITY
SIA 001-005

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

MARKER BEACON SYSTEM - GENERAL DESCRIPTION



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MARKER BEACON SYSTEM - GENERAL DESCRIPTION

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EFFECTIVITY
SIA 006-999

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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**MARKER BEACON SYSTEM - COMPONENT LOCATIONS****General**

The marker beacon antenna is on the bottom of the fuselage.

SIA 006-999

The IMMR 1 is on the E1-2 shelf in the forward electronic equipment compartment.

SIA 001-005

The VOR/MB receiver 1 is on the E3-2 shelf in the forward electronic equipment compartment.

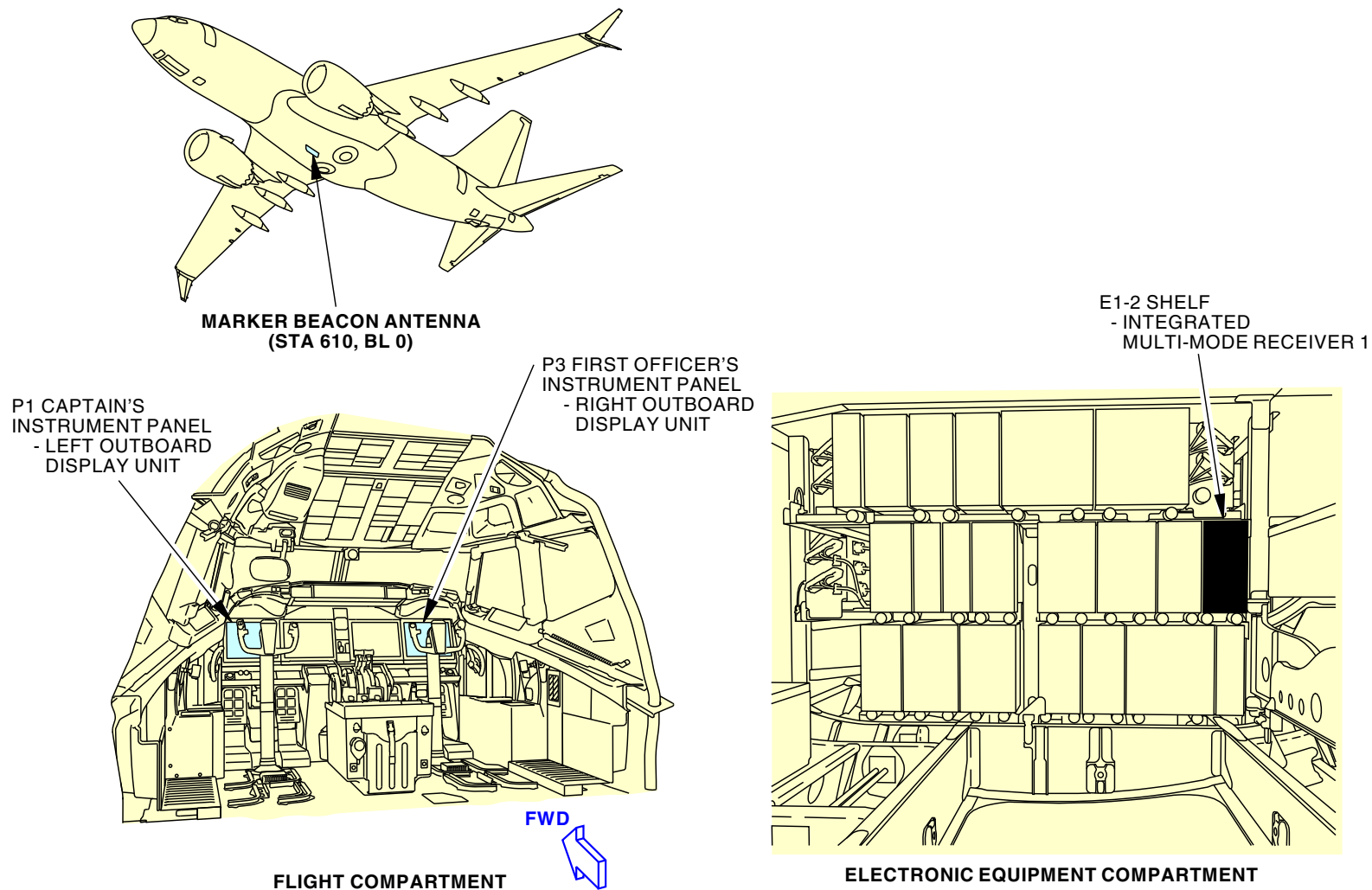
SIA ALL

The marker beacon data shows on these display units:

- Left outboard display unit
- Right outboard display unit.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

MARKER BEACON SYSTEM - COMPONENT LOCATIONS



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MARKER BEACON SYSTEM - COMPONENT LOCATIONS

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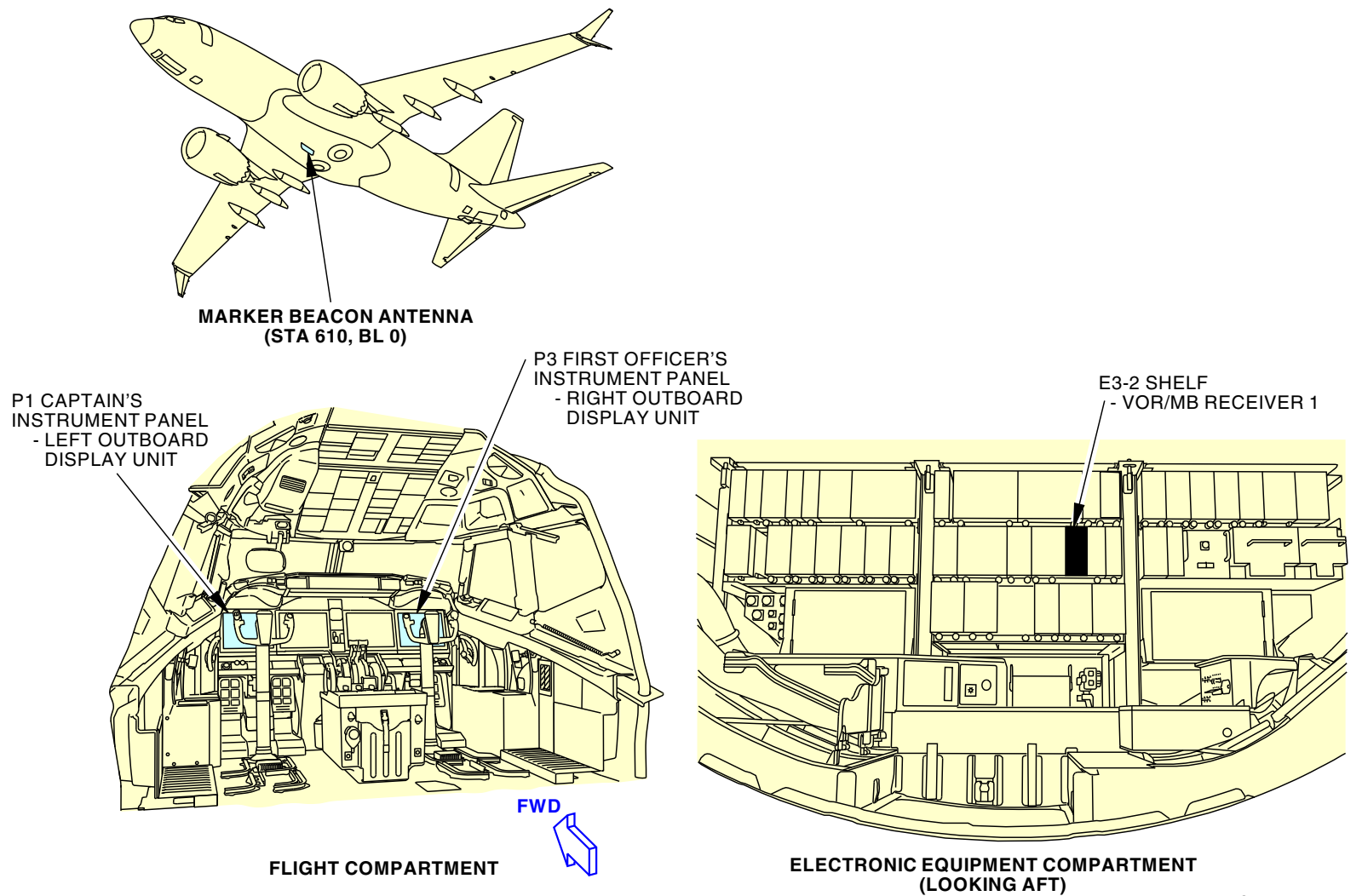
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SIA 006-999

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MARKER BEACON SYSTEM - COMPONENT LOCATIONS



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MARKER BEACON SYSTEM - COMPONENT LOCATIONS

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EFFECTIVITY
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MARKER BEACON SYSTEM - INTERFACES

Power

SIA 006-999

The integrated multi mode receiver (IMMR) 1 uses 115v ac power from the standby bus.

SIA 001-005

The VOR/marker beacon (VOR/MB) receiver 1 uses 115v ac power from the standby bus.

SIA ALL

Antenna Interface

SIA 006-999

The marker beacon (MB) antenna sends radio frequency (RF) signals to the integrated multi mode receiver.

SIA 001-005

The marker beacon (MB) antenna sends radio frequency (RF) signals to the MB receiver.

SIA ALL

PSEU

SIA 006-999

The proximity switch electronics unit (PSEU) supplies an air/ground discrete signal to the IMMR. The IMMR uses this signal for these functions:

SIA 001-005

The proximity switch electronics unit (PSEU) supplies an air/ground discrete signal to the MB receiver. The MB receiver uses this signal for these functions:

SIA ALL

- Prevent a test in the air

- Count flight legs.

Audio Interface

SIA 006-999

The IMMR sends marker beacon audio to the remote electronics unit (REU). The REU supplies marker beacon audio to the flight compartment.

SIA 001-005

The MB receiver sends marker beacon audio to the remote electronics unit (REU). The REU supplies marker beacon audio to the flight compartment.

SIA ALL

Marker Beacon Data

SIA 006-999

The IMMR supplies marker beacon data to the 1 and 2 MAX display system (MDS) display processing computers (DPC). The receiver also supplies marker beacon data to the digital flight data acquisition unit (DFDAU).

SIA 001-005

The MB receiver supplies marker beacon data to the 1 and 2 MAX display system (MDS) display processing computers (DPC). The receiver also supplies marker beacon data to the digital flight data acquisition unit (DFDAU).

SIA ALL

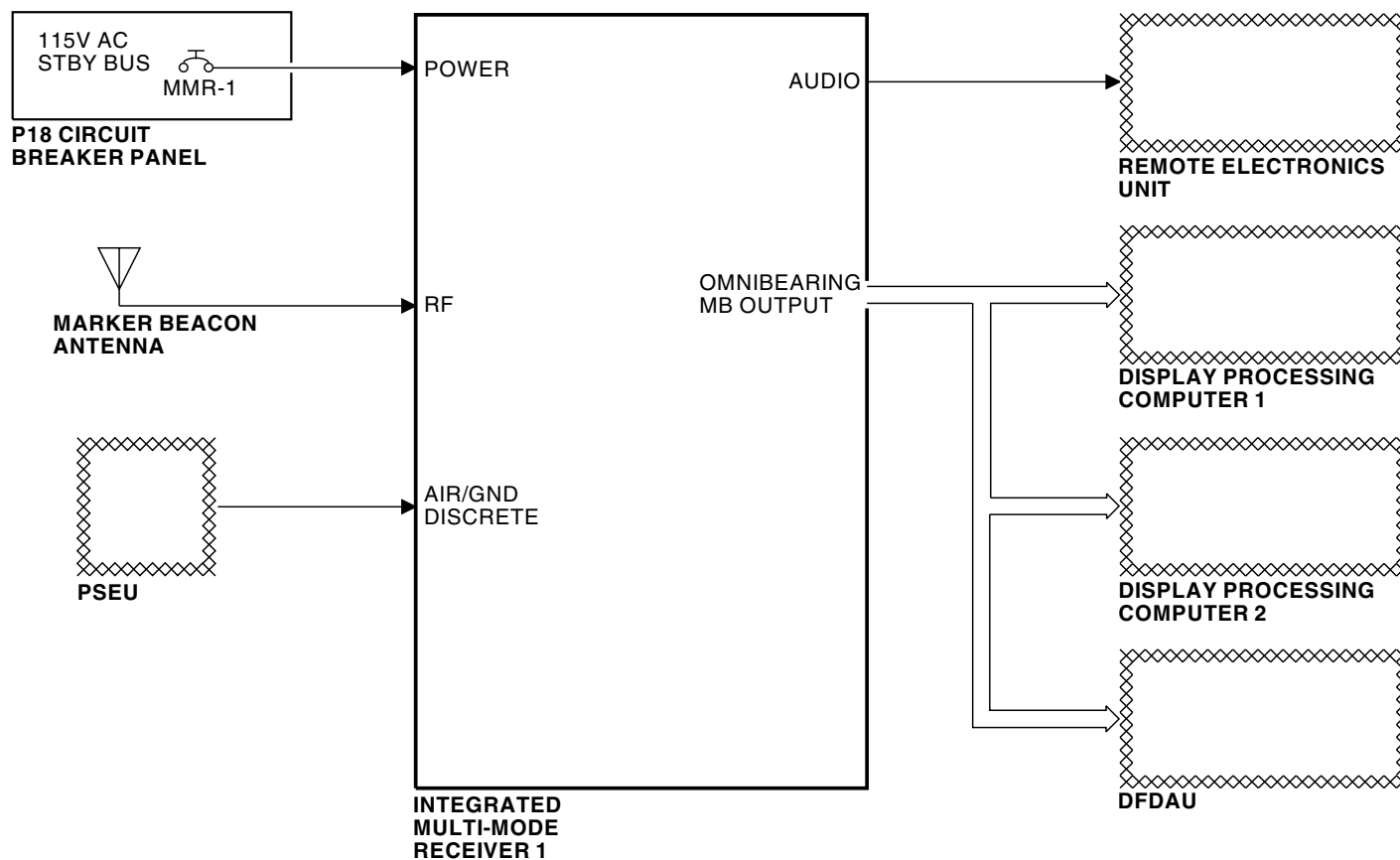
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SIA ALL	

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MARKER BEACON SYSTEM - INTERFACES



2551060 S0000606661_V2

MARKER BEACON SYSTEM - INTERFACES

34-32-00-004

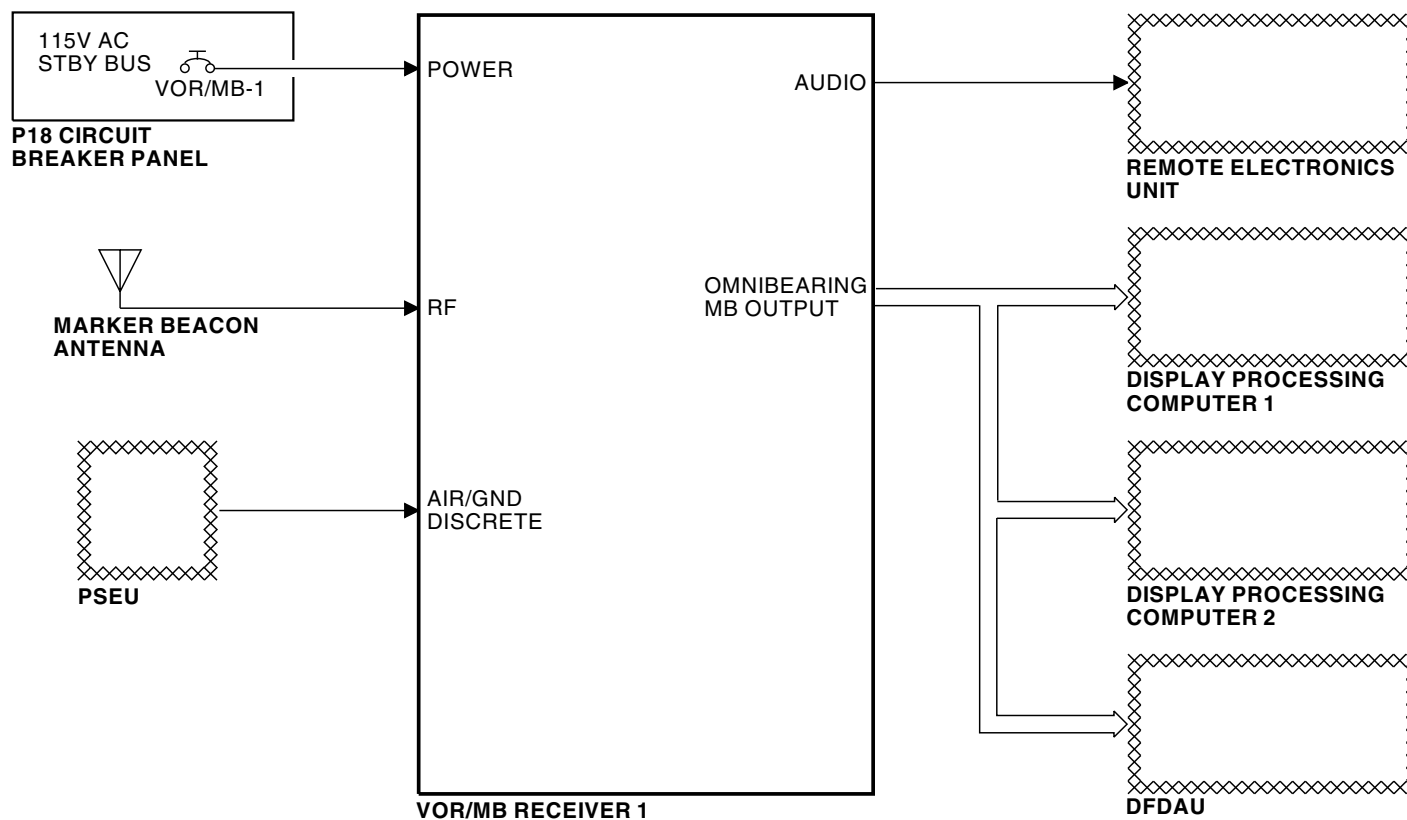
EFFECTIVITY
SIA 006-999

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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MARKER BEACON SYSTEM - INTERFACES



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MARKER BEACON SYSTEM - INTERFACES

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MARKER BEACON SYSTEM - MARKER BEACON RECEIVER

SIA 006-999

General

The marker beacon (MB) is a function of the integrated multi-mode receiver (IMMR).

The marker beacon system operates in the IMMR 1 position.

The marker beacon receiver receives 75 MHz signals.

SIA 001-005

General

The VOR/marker beacon (VOR/MB) receiver has these two parts:

- VOR receiver
- Marker beacon receiver.

The marker beacon system operates in the VOR/MB receiver 1 position.

The marker beacon receiver receives 75 MHz signals.

SIA ALL

Test and Indications

You do a test of the these MB receiver functions at the same time:

- VOR function
- MB function.

SIA 006-999

There is a test switch and three light emitting diodes (LEDs) on the front panel of the IMMR.

SIA 001-005

There is a test switch and two light emitting diodes (LEDs) on the front panel of the VOR/MB receiver.

SIA ALL

Software Loading

SIA 006-999

Shop personnel use the USB or Ethernet ports on the front panel to load software to the line replaceable unit (LRU). These features are not for use by line maintenance personnel.

SIA 001-005

Shop personnel use the RS 232 connector to connect shop test equipment to the LRU. This feature is not for use by line maintenance personnel.

SIA ALL

Flight Fault Memory

SIA 006-999

The IMMR has a nonvolatile flight fault memory. The faults are sent to the onboard network system (ONS) for use by line personnel.

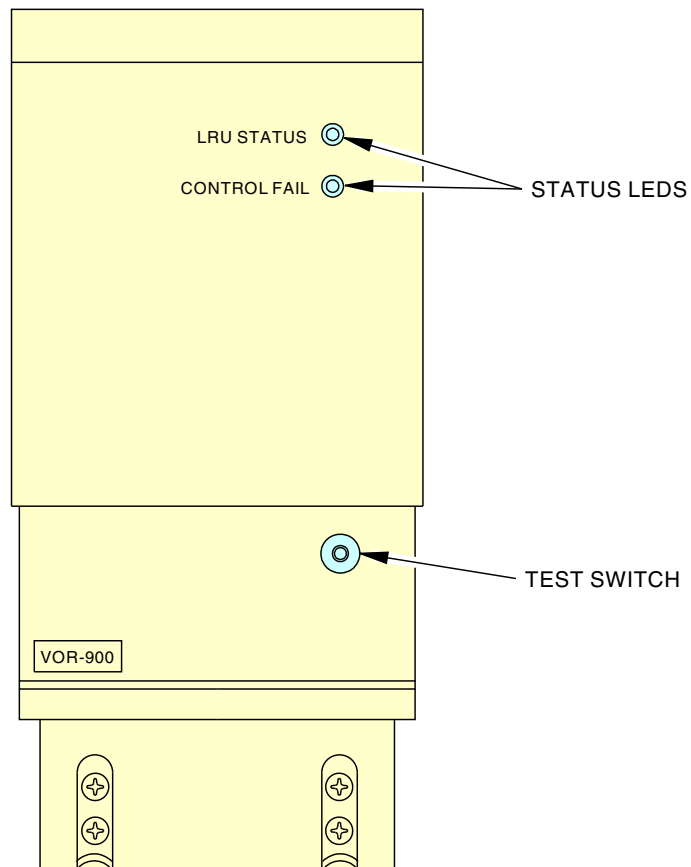
SIA 001-005

The VOR/MB receiver has a nonvolatile flight fault memory. Maintenance personnel can read the memory.

SIA ALL

EFFECTIVITY	
SIA ALL	

MARKER BEACON SYSTEM - MARKER BEACON RECEIVER



2551164 S0000607373_V1

MARKER BEACON SYSTEM - MARKER BEACON RECEIVER

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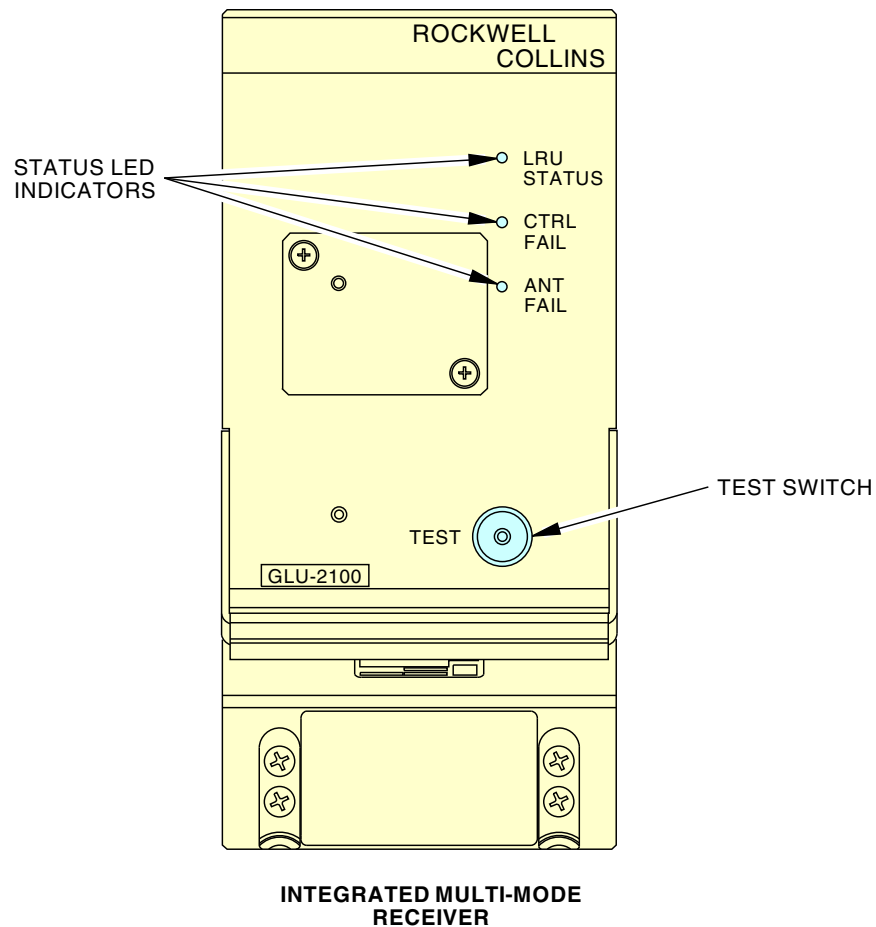
SIA 001-005 EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

MARKER BEACON SYSTEM - MARKER BEACON RECEIVER



MARKER BEACON SYSTEM - MARKER BEACON RECEIVER

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MARKER BEACON SYSTEM - MARKER BEACON ANTENNA

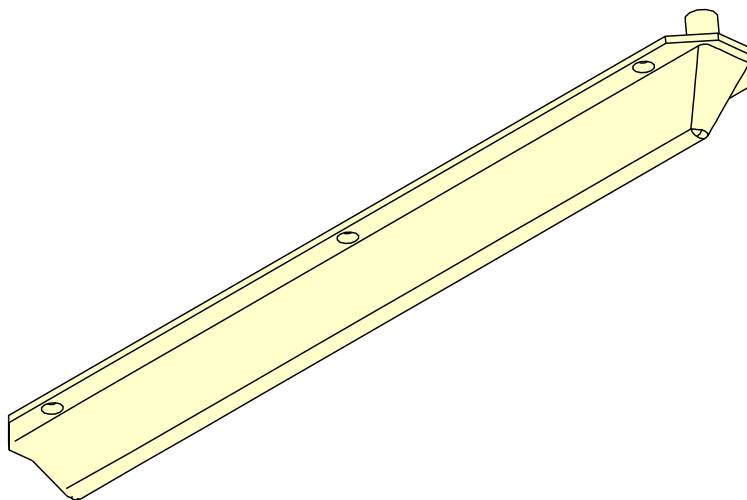
General

The marker beacon antenna receives signals from marker beacon ground stations.

Six screws hold the antenna to the fuselage.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

MARKER BEACON SYSTEM - MARKER BEACON ANTENNA



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MARKER BEACON SYSTEM - MARKER BEACON ANTENNA

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**MARKER BEACON SYSTEM - DISPLAYS AND AUDIO OUTPUTS****General**

When the airplane goes above a marker beacon transmitter, marker beacon data shows on the primary flight display (PFD).

If you want to hear marker beacon audio, you select the marker beacon audio on the audio control panel (ACP).

Display Types

OM shows when the airplane goes above the outer marker. The OM letters are cyan.

MM shows when the airplane goes above the middle marker. The MM letters are yellow.

IM shows when the airplane goes above the inner marker, backcourse marker, or an airways marker. The letters IM are white.

NCD/Fail Display

If marker beacon data fails or is no computed data (NCD), the display does not show.

Audio General

The ACP supplies control signals to the remote electronics unit (REU). The REU uses the control signals to select the audio that goes to the flight interphone speakers and headsets.

Use the ACP to listen to marker beacon audio.

Audio Operation

You make these ACP selections to listen to marker beacon audio:

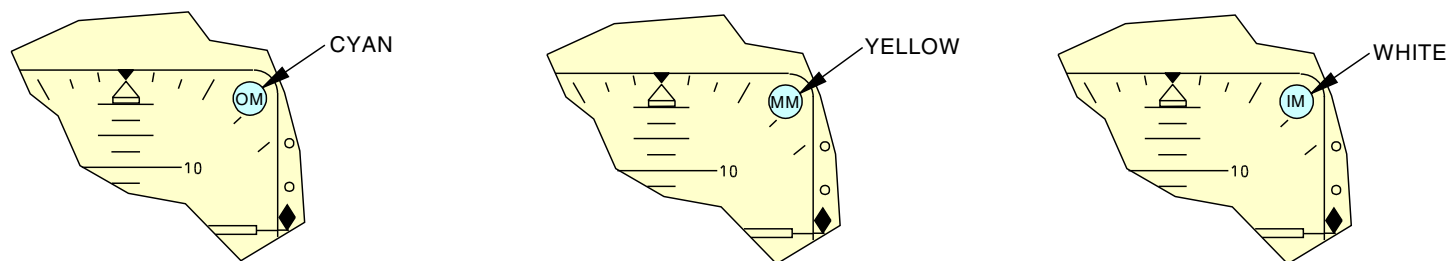
- Push the marker beacon volume control to make the marker beacon audio come on
- Turn the marker beacon volume control to change the volume level.

Audio Outputs

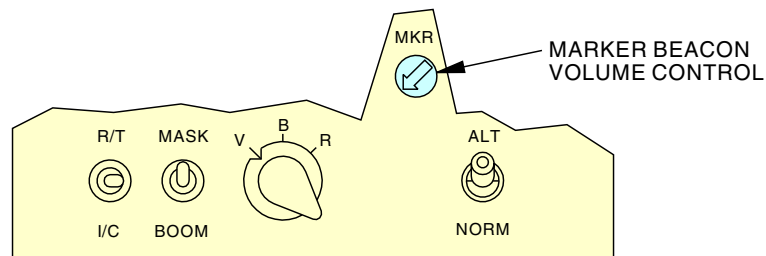
These are the marker beacon audio outputs:

- Outer marker (OM) is 400 Hz, continuous dashes (- - - -)
- Middle marker (MM) is 1300 Hz, alternate dots and dashes (-.-.-.-)
- Inner marker (IM) is 3000 Hz, continuous dots (.....)
- Backcourse marker is 3000 Hz, continuous paired dots (.. ..)
- Airways marker is 3000 Hz with the morse code identifier for that station.

MARKER BEACON SYSTEM - DISPLAYS AND AUDIO OUTPUTS



MARKER BEACON
DISPLAYS (PFD)



AUDIO CONTROL PANEL



MARKER BEACON AUDIO OUTPUTS

MARKER BEACON SYSTEM - DISPLAYS AND AUDIO OUTPUTS

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MARKER BEACON SYSTEM - FUNCTIONAL DESCRIPTION

Marker Beacon Signal**SIA 006-999**

The marker beacon antenna receives the 75 MHz signal and sends it to a 75 MHz filter in the integrated multi-mode receiver (IMMR). This filter tunes and rejects unwanted signals. The output goes to a radio frequency (RF) amplifier. A detector receives the amplifier output and sends the demodulated signal to three bandpass filters.

SIA 001-005

The marker beacon antenna receives the 75 MHz signal and sends it to a 75 MHz filter in the marker beacon (MB) receiver. This filter tunes and rejects unwanted signals. The output goes to a radio frequency (RF) amplifier. A detector receives the amplifier output and sends the demodulated signal to three bandpass filters.

SIA ALL

The bandpass filters are at 400 Hz, 1300 Hz, and 3000 Hz. The filters send the signals to an audio amplifier and to an input/output (I/O) card. The audio amplifier sends audio tones to the remote electronics unit (REU). The I/O card sends data to the display processing computer (DPC) and the digital flight data acquisition unit (DFDAU).

The DPC shows marker beacon data on the primary flight displays (PFDs).

Monitor and Test**SIA 006-999**

The test switch on the IMMR starts a test of the receiver. The BITE circuits do a test of the IMMR. The results of the test show on the PFD, receiver LEDs, and through the flight interphone speakers and headsets.

SIA 001-005

The test switch on the MB receiver starts a test of the receiver. The BITE circuits do a test of the MB receiver. The results of the test show on the PFD, receiver LEDs, and through the flight interphone speakers and headsets.

SIA ALL

During the test, a self-test frequency generator gives a 75 MHz RF signal that has 400 Hz, 1300 Hz, and 3000 Hz audio signals. The bandpass filters find the audio signals and send them to the audio amplifier. The audio amplifier sends the audio signals to the REU. The REU sends the audio signals to the flight interphone speakers and headsets in the flight deck.

SIA 006-999

The BITE circuits monitor the condition of the output data of the integrated multi-mode receiver.

SIA 001-005

The BITE circuits monitor the condition of the output data of the MB receiver.

SIA ALLPSEU**SIA 006-999**

The IMMR gets an air/ground discrete signal from the proximity switch electronics unit (PSEU). The IMMR uses this signal to prevent a test in the air.

34-32-00**EFFECTIVITY**
SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



MARKER BEACON SYSTEM - FUNCTIONAL DESCRIPTION

SIA 001-005

The MB receiver gets an air/ground discrete signal from the proximity switch electronics unit (PSEU). The MB receiver uses this signal to prevent a test in the air.

SIA ALL

An internal nonvolatile fault memory (NVM) in the BITE circuits use the air/ground discrete signal. The NVM uses this signal to calculate flight legs.

SIA ALL	EFFECTIVITY
	D633AM102-SIA



The diagram illustrates the internal architecture of the Integrated Multi-Mode Receiver 1 (E1) and its interface with the CAPT NAV CONTROL PANEL (P8).

CAPT NAV CONTROL PANEL (P8) Components and Connections:

- POWER SUPPLY:** Receives 115V AC and 28V DC. It provides 5V AC to the PANEL LIGHTS.
- 28V DC MONITOR:** Monitors the 28V DC supply.
- PANEL LIGHTS:** Two indicator lights for 5V AC.
- VOR:** Variable Frequency Oscillator, connected to the REU.
- DPC 1 AND 2:** Data Processing Channels, connected to the REU.
- FCC A FCC B:** Frequency Control Channels, connected to the REU.
- ILS:** Instrument Landing System, connected to the ARINC 429 TX.
- TEST:** Test input, connected to the ARINC 429 TX.
- FREQ TUNE:** Frequency tuning control, connected to the ARINC 429 TX.
- ARINC 429 TX:** Transceiver, connected to the TUNING INPUT of the receiver.

Integrated Multi-Mode Receiver 1 (E1) Internal Components and Connections:

- POWER SUPPLY:** Receives 115V AC and provides power to the internal components.
- TEST SWITCH:** A switch for testing the receiver.
- FRONT PANEL LEDS:** Two indicator lights for the STATUS output.
- PROCESSOR:** The central processing unit, receiving TUNING INPUT, TEST INHIBIT, and TUNE FREQ signals. It outputs STATUS, OUTPUT 1, OUTPUT 2, and AUDIO.
- OUTPUT 1:** Provides FCC A and FCC B signals to the REU.
- OUTPUT 2:** Provides DPC 1 AND 2, GPWC, FMC, ISFD, and DFDAU signals to the REU.
- AUDIO:** Provides an audio signal to the REU.
- HIRF FILTER:** High Interference Rejection Filter, used to filter the audio signal.
- ANTENNA INPUTS:**
 - VOR/LOC ANTENNA OR LOCALIZER ANTENNA INPUTS:** Connected to the LOC RECEIVER and DETECTOR.
 - GLIDESLOPE ANTENNA INPUTS:** Connected to the G/S RECEIVER and DETECTOR.
 - MB ANTENNA INPUTS:** Connected to the MB RECEIVER and DETECTOR.
- Internal Signal Flow:**
 - The LOC RECEIVER and G/S RECEIVER are connected to their respective DETECTORS.
 - The MB RECEIVER is connected to its DETECTOR.
 - The DETECTORS are connected to the A/D (Analog-to-Digital) converter.
 - The A/D converter outputs to the MONITOR.
 - The MONITOR is connected to the STATUS output.

Legend:

- 115V AC
- 28V DC
- 5V AC
- REU
- DPC 1 AND 2
- FCC A
- FCC B
- GPWC
- FMC
- ISFD
- DFDAU
- TEST INHIBIT
- TUNE FREQ
- STATUS
- OUTPUT 1
- OUTPUT 2
- AUDIO
- HIRF FILTER
- MONITOR
- DETECTOR
- LOC RECEIVER
- G/S RECEIVER
- MB RECEIVER
- SYNTHESIZER
- LOC ANTENNA
- GLIDESLOPE ANTENNA
- MB ANTENNA
- TEST SWITCH
- FRONT PANEL LEDS
- POWER SUPPLY
- 28V DC MONITOR
- PANEL LIGHTS
- VOR
- ILS
- TEST
- FREQ TUNE
- ARINC 429 TX

2551168 S0000607391 V3

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The diagram illustrates the internal architecture of the VOR/LOC Receiver (E3-2). It is divided into two main sections: the VOR/LOC Receiver (E3-2) and the VOR/LOC Transmitter (E3-1).

VOR/LOC Receiver (E3-2) Components and Signal Flow:

- Inputs:** 115V AC, 28V DC, and 5V AC are provided to the POWER SUPPLY.
- Control Panel (P8):** Includes VOR, ILS, and TEST controls. The VOR control is connected to REU, DPC 1, and DPC 2. The ILS control is connected to the FREQ TUNE block. The TEST control is connected to the PROCESSOR.
- Transmitter Section (E3-1):**
 - FREQ TUNE:** Receives input from the ILS control and outputs to the ARINC 429 TX.
 - ARINC 429 TX:** Outputs to DME 1 and MMR 1.
 - ARINC 429 RCVR:** Receives input from MMR 1 and outputs to the PROCESSOR.
 - PROCESSOR:** Receives input from the ARINC 429 RCVR and outputs to the MEMORY CARD and the FREQUENCY SYNTHESIZER.
 - FREQUENCY SYNTHESIZER:** Outputs to the RECEIVER CIRCUITS.
 - RECEIVER CIRCUITS:** Outputs to the AUDIO PROCESSOR CIRCUITS and the BEARING PROCESSOR.
 - AUDIO PROCESSOR CIRCUITS:** Outputs to the MORSE DECODER and the AUDIO OUTPUTS.
 - MORSE DECODER:** Outputs to the OUTPUT 1 ARINC 429 XMTR.
 - BEARING PROCESSOR:** Outputs to the OUTPUT 2 ARINC 429 XMTR.
 - OUTPUT 1 ARINC 429 XMTR:** Outputs to FCC A.
 - OUTPUT 2 ARINC 429 XMTR:** Outputs to DFDAU, FMC 1, DPC 1, and DPC 2.
- Other Components:**
 - POWER SUPPLY:** Provides power to the MEMORY CARD, ARINC 429 RCVR, FREQUENCY SYNTHESIZER, RECEIVER CIRCUITS, AUDIO PROCESSOR CIRCUITS, MORSE DECODER, and AUDIO OUTPUTS.
 - MEMORY CARD:** Receives input from the PROCESSOR.
 - LRU STATUS and CONTROL FAIL:** Indicators connected to the PROCESSOR.
 - TEST:** Indicator connected to the PROCESSOR.
 - HIRF FILTER:** Filters the receiver input and output signals.
 - PSEU:** Pseudo Random Sequence Unit, connected to the receiver input.

VOR/LOC Transmitter (E3-1) Components and Signal Flow:

- Inputs:** 115V AC, 28V DC, and 5V AC are provided to the POWER SUPPLY.
- Control Panel (P8):** Includes VOR, ILS, and TEST controls. The VOR control is connected to REU, DPC 1, and DPC 2. The ILS control is connected to the FREQ TUNE block. The TEST control is connected to the PROCESSOR.
- Transmitter Section (E3-1):**
 - FREQ TUNE:** Receives input from the ILS control and outputs to the ARINC 429 TX.
 - ARINC 429 TX:** Outputs to DME 1 and MMR 1.
 - ARINC 429 RCVR:** Receives input from MMR 1 and outputs to the PROCESSOR.
 - PROCESSOR:** Receives input from the ARINC 429 RCVR and outputs to the MEMORY CARD and the FREQUENCY SYNTHESIZER.
 - FREQUENCY SYNTHESIZER:** Outputs to the RECEIVER CIRCUITS.
 - RECEIVER CIRCUITS:** Outputs to the AUDIO PROCESSOR CIRCUITS and the BEARING PROCESSOR.
 - AUDIO PROCESSOR CIRCUITS:** Outputs to the MORSE DECODER and the AUDIO OUTPUTS.
 - MORSE DECODER:** Outputs to the OUTPUT 1 ARINC 429 XMTR.
 - BEARING PROCESSOR:** Outputs to the OUTPUT 2 ARINC 429 XMTR.
 - OUTPUT 1 ARINC 429 XMTR:** Outputs to FCC A.
 - OUTPUT 2 ARINC 429 XMTR:** Outputs to DFDAU, FMC 1, DPC 1, and DPC 2.
- Other Components:**
 - POWER SUPPLY:** Provides power to the MEMORY CARD, ARINC 429 RCVR, FREQUENCY SYNTHESIZER, RECEIVER CIRCUITS, AUDIO PROCESSOR CIRCUITS, MORSE DECODER, and AUDIO OUTPUTS.
 - MEMORY CARD:** Receives input from the PROCESSOR.
 - LRU STATUS and CONTROL FAIL:** Indicators connected to the PROCESSOR.
 - TEST:** Indicator connected to the PROCESSOR.
 - HIRF FILTER:** Filters the receiver input and output signals.
 - PSEU:** Pseudo Random Sequence Unit, connected to the receiver input.

2551170 S0000607392 V1

MARKER BEACON SYSTEM - FUNCTIONAL DESCRIPTION

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MARKER BEACON SYSTEM - FRONT PANEL BITE

General

When you do a test of the marker beacon (MB) system, you test the VOR system 1 at the same time.

Enter a VOR frequency in the captain's navigation control panel (NCP) before testing the MB system.

SIA 001-005**Operation**

Push the test switch on the front of the receiver to start a test of the VOR/MB receiver 1. The receiver then does a check of the internal receiver operation and of the interfaces. The LEDs show the test results.

This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the line replaceable unit (LRU) status and the control fail LEDs are red
- 2 to 4 seconds - the LRU status LED is green and the control fail LED is red
- 4 to 12 seconds - the LRU status and the control fail LEDs go off
- 12 to 42 seconds - the test status shows.

The LRU status LED indicator shows green for an LRU test pass condition. It shows red for an LRU test fail condition.

These conditions cause the control fail LED to show red:

- no input from the NAV control panel
- invalid input from the NAV control panel.

SIA 006-999**Test**

When you push the test switch, the IMMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 44 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on red
- 2 to 4 seconds - the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 16 seconds - all LEDs go off
- 16 to 44 seconds - test status shows.

The LRU STATUS segment shows red when there is an internal failure in the IMMR. Green shows that the IMMR is operating normally.

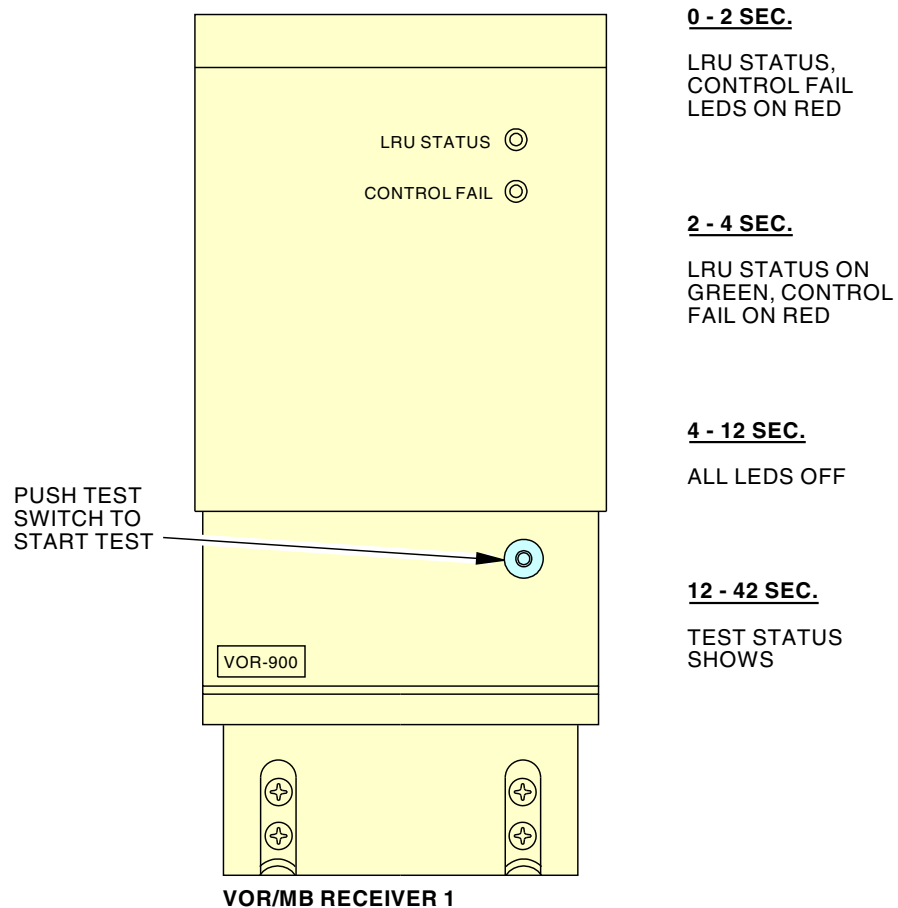
The CONTROL FAIL segment shows red when an interface to the IMMR has a failure. Green shows that all the interfaces to the IMMR are normal.

SIA ALL**34-32-00****SIA ALL** EFFECTIVITY

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MARKER BEACON SYSTEM - FRONT PANEL BITE



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MARKER BEACON SYSTEM - FRONT PANEL BITE

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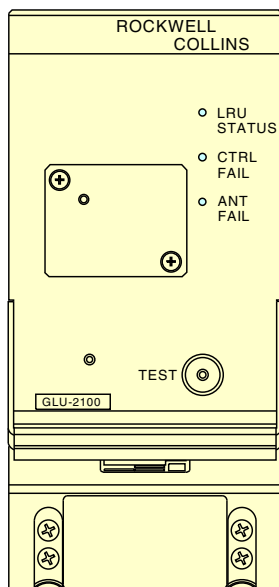
34-32-00

EFFECTIVITY
SIA 001-005

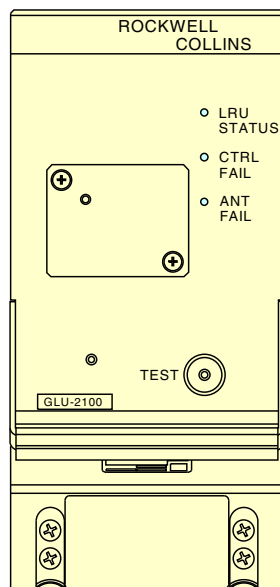
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

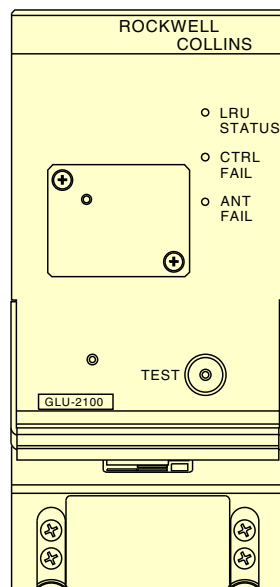
MARKER BEACON SYSTEM - FRONT PANEL BITE



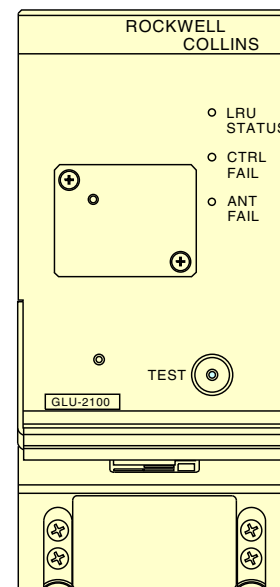
0-2 SECONDS
THE LRU STATUS, CONTROL FAIL AND ANT FAIL LEDS ON RED.



2-4 SECONDS
THE LRU STATUS IS GREEN, CONTROL FAIL AND ANT FAIL ARE RED.



4-16 SECONDS
ALL LEDS OFF.



16-44 SECONDS
THE TEST STATUS SHOWS.

ILS - FRONT PANEL BITE

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EFFECTIVITY

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**MARKER BEACON SYSTEM - SELF-TEST****General****SIA 006-999**

You do a remote test of the Integrated Multi-Mode Receiver (IMMR) with the Navigation Control Panel (NCP).

SIA 001-005

You do a remote test of the Marker Beacon (MB) receiver with the NCP.

SIA 006-999

When you do a test of the MB system, you do a test of the IMMR 1 at the same time.

SIA 001-005

When you do a test of the MB system, you do a test of the VHF Omnidirectional Range/Marker Beacon (VOR/MB) receiver 1 at the same time.

SIA ALL**Operation**

To do a test of the MB system, do these steps:

- Select a VHF Omnidirectional Range (VOR) frequency on the captain NCP
- If within a MB range, select MB audio on at least one of the audio control panels to hear the audio tones
- Push the test switch on the front panel of the captain NCP
- The FT indication appears in the upper, right corner of the captain and first officer primary flight displays.

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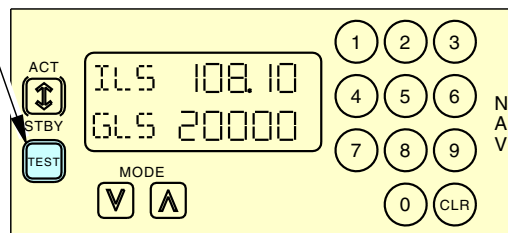
EFFECTIVITY	
SIA ALL	

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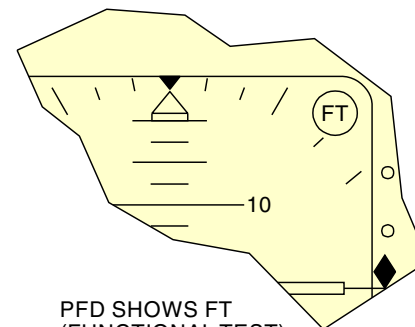
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MARKER BEACON SYSTEM - SELF-TEST

PUSH TEST BUTTON WITH
VOR FREQUENCY SELECTED
TO START A TEST



CAPTAIN NAVIGATION CONTROL PANEL



PFD SHOWS FT
(FUNCTIONAL TEST)
WHEN THE IMMR 1
IS IN TEST

3012514 S0000786124_V1

MARKER BEACON SYSTEM - SELF-TEST

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SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



RADIO ALTIMETER SYSTEM - INTRODUCTION

General

The radio altimeter (RA) system measures the vertical distance from the airplane to the ground. The radio altitude shows in the flight compartment on the captain's and first officer's primary flight displays (PFDs). The radio altitude is computed with the receiver transmitter unit by comparing the transmitted signal to the received signal. The R/T unit transmits a radio signal then receives the reflected RF signal back from the ground to determine the altitude of the aircraft. The R/T sends computed altitude data out on two ARINC 429 data buses to user systems on the aircraft.

The flight crew and other airplane systems use the altitude data during low altitude flight, approach, and landing.

The system has a range of -12 to 2500 feet.

An adjustable radio minimums alert operates with the radio altitude system and is independently selectable from 0 to 999 feet on the captain's and first officer's EFIS control panels. The radio minimums altitude selection is compared and processed in the display processing computers (DPCs) with the existing radio altitude value output from the radio altitude R/T. When the airplane descends to the selected radio minimums altitude a flashing radio minimums alert is displayed on the PFDs.

Abbreviations and Acronyms

- ADI - attitude direction indication
- AID - aircraft installed delay
- altm - altimeter
- ant - antenna
- approx - approximately
- ARINC - Aeronautical Radio, Inc.
- BITE - built-in test equipment
- CAPT - captain
- conn - connector
- CP - control panel
- CW - continuous wave

- DH - decision height
- DME - distance measuring equipment
- DFDAU - digital flight data acquisition unit
- DPC - Display Processing Computer
- DU - display unit
- EFIS - electronic flight instrument system
- FCC - flight control computer
- FM - frequency modulation
- F/O - first officer
- freq - frequency
- fwd - forward
- gnd - ground
- GPWC - ground proximity warning computer
- ILS - instrument landing system
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- maint - maintenance
- MDA - minimum descent altitude
- MDS - MAX Display System
- mins - minimums
- PFD - primary flight display
- P/N - part number
- RA - radio altimeter
- RA - radio altitude
- rec - receiver
- RF - radio frequency
- rst - reset
- R/T - receiver transmitter
- S/W - software

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SIA ALL EFFECTIVITY

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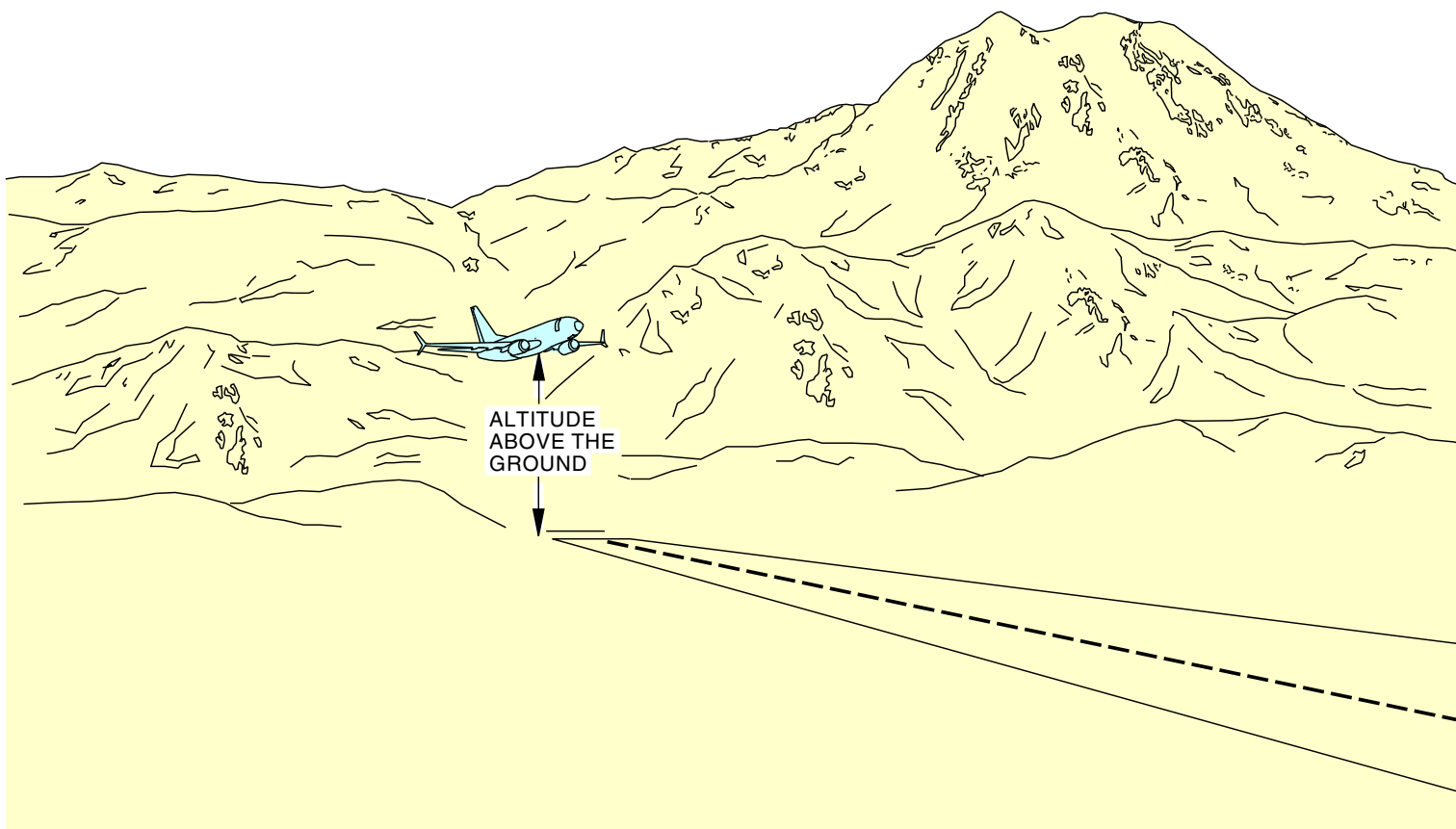
ECCN 9E991 BOEING PROPRIETARY - See title page for details



RADIO ALTIMETER SYSTEM - INTRODUCTION

- sys - system
- T - time
- TCAS - traffic alert and collision avoidance system
- VCO - voltage controlled oscillator
- WXR - weather radar
- xmit - transmit

RADIO ALTIMETER SYSTEM - INTRODUCTION



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RADIO ALTIMETER SYSTEM - INTRODUCTION

34-33-00

SIA ALL	EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**RA SYSTEM - GENERAL DESCRIPTION****General**

The radio altimeter system has two receiver/transmitters (R/Ts). Each R/T has a transmit and a receive antenna. The radio altimeter R/T makes a frequency modulated continuous wave RF signal that is sent to the ground and reflected back to the airplane. The time that it takes for the signal to travel from the transmit circuit of the R/T to the receive circuit of the R/T is changed into absolute altitude. The number one system altitude shows on the captain display and the number two system shows on the first officer display.

The altitude data and signal validity is sent on two ARINC 429 data buses.

ARINC 429 data bus 1 sends data to these components:

- Flight Control Computer (FCC)
- Autothrottle computer.

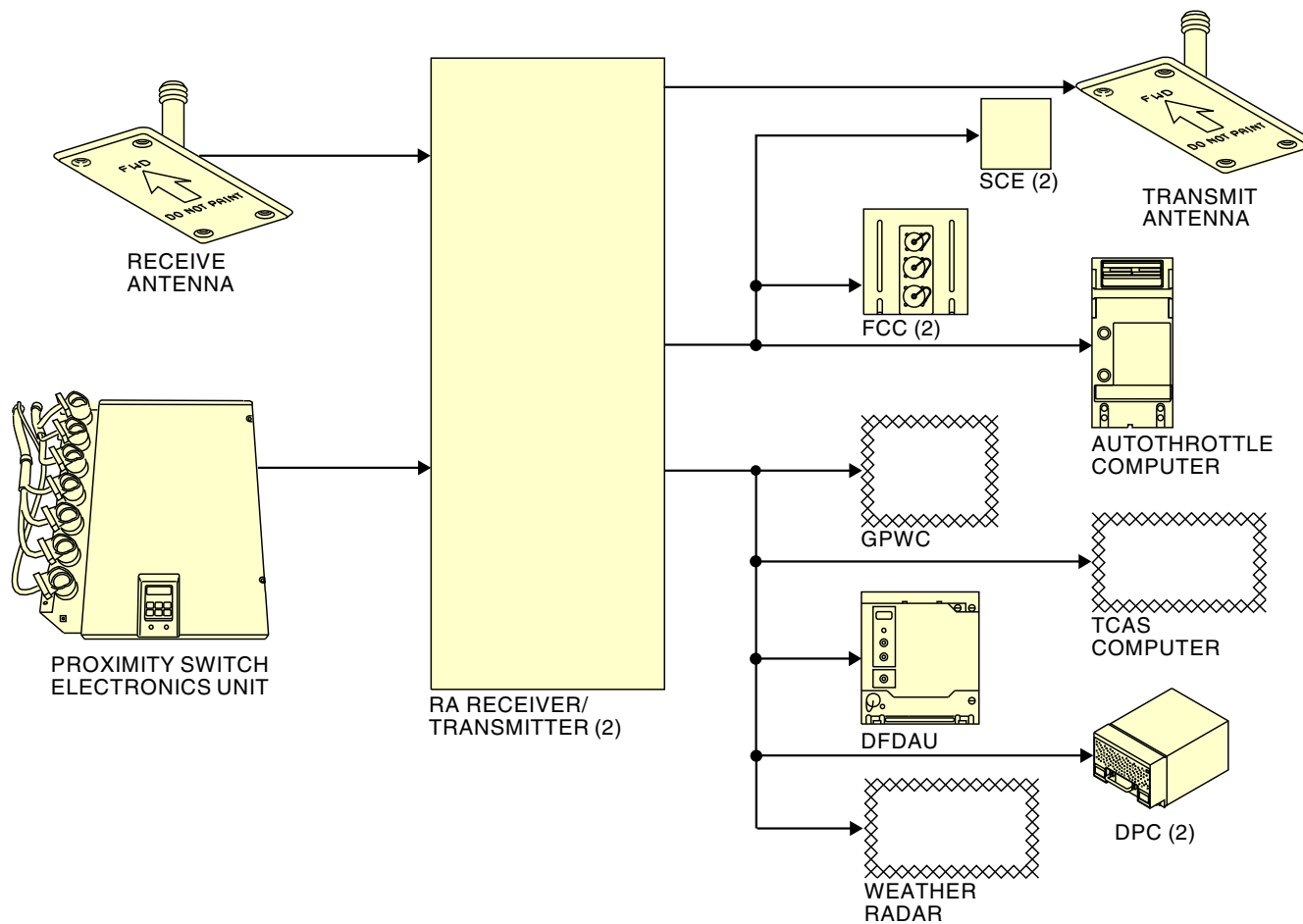
ARINC 429 data bus 2 sends data to these components:

- Ground Proximity Warning Computer (GPWC)
- Traffic Alert and Collision Avoidance System (TCAS) computer
- Digital Flight Data Acquisition Unit (DFDAU)
- Weather Radar (WXR)
- MAX Display System (MDS)
- Display Processing Computer (DPC)

The receiver/transmitters get discrete inputs from the Proximity Switch Electronic Unit (PSEU) used to count flight legs for fault recording.

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RA SYSTEM - GENERAL DESCRIPTION



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RA SYSTEM - GENERAL DESCRIPTION

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RA SYSTEM - COMPONENT LOCATION - 1

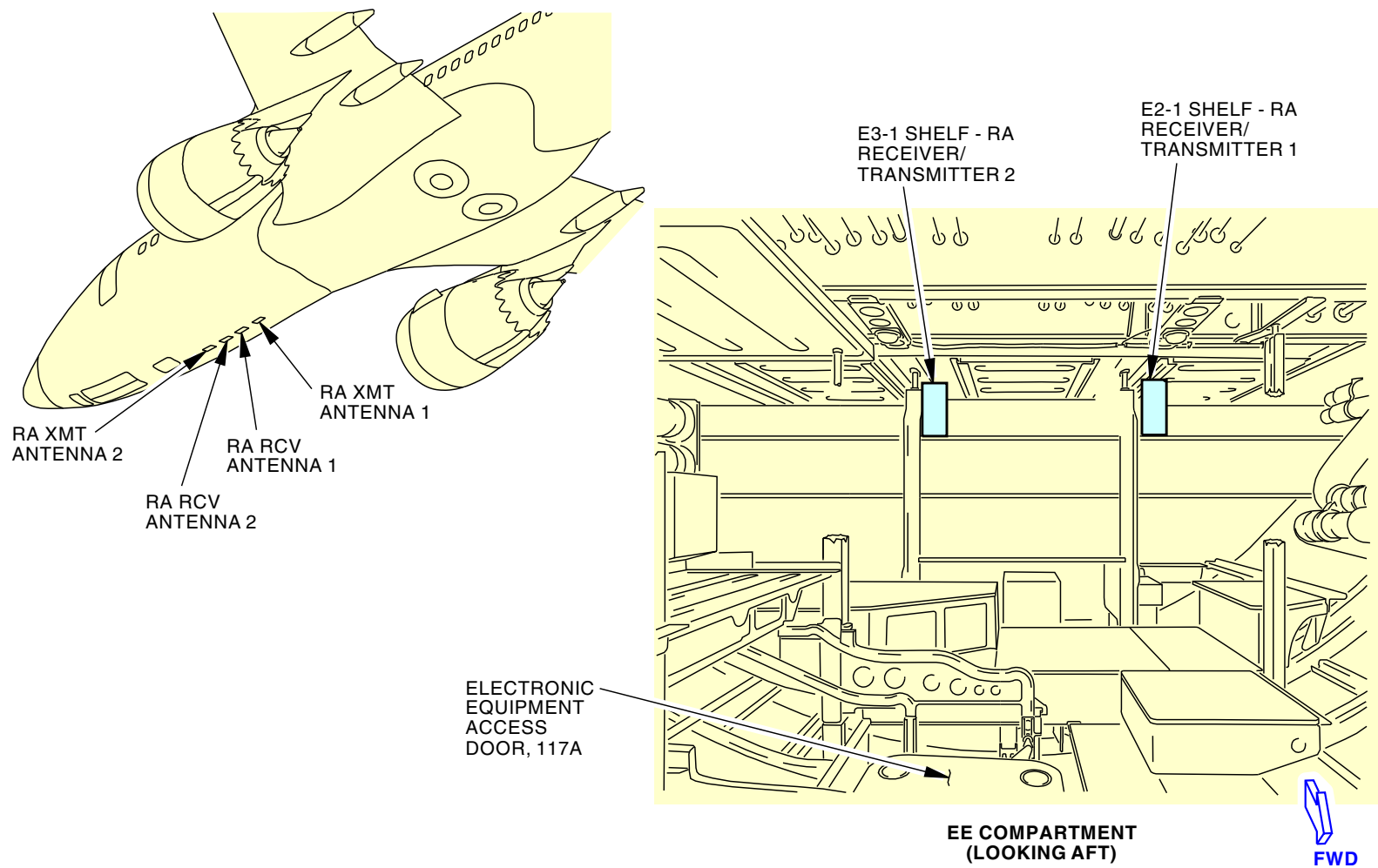
General

The RA receiver/transmitters are on the E2 and E3 rack in the electronic equipment (EE) compartment.

The RA antennas are on the bottom of the fuselage.

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RA SYSTEM - COMPONENT LOCATION - 1



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RA SYSTEM - COMPONENT LOCATION - 1

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RA SYSTEM - COMPONENT LOCATION - 2

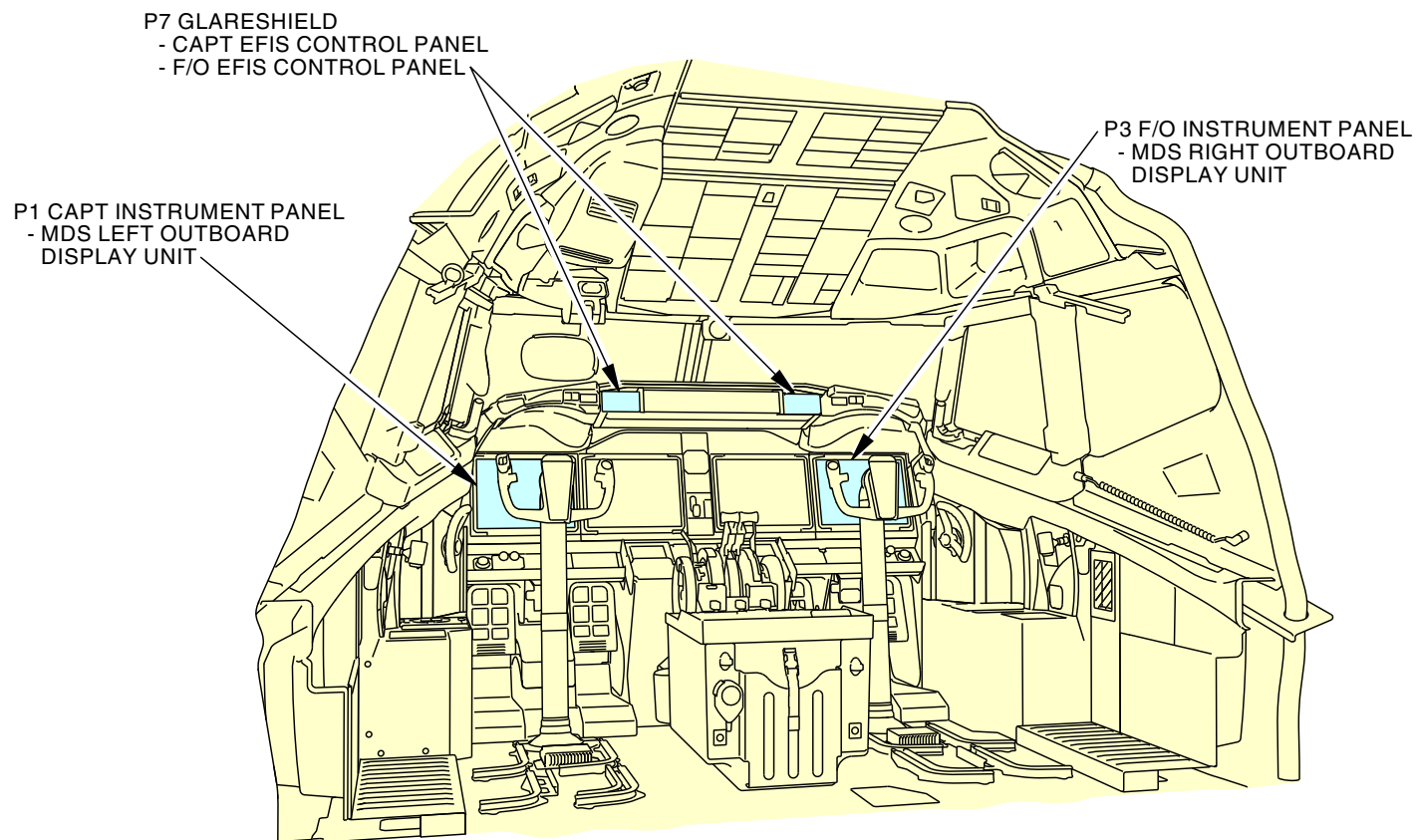
General

These are the components in the flight compartment that interface with the RA system:

- Left and right EFIS control panels
- MAX Display System (MDS) display units (DU).

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RA SYSTEM - COMPONENT LOCATION - 2



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RA SYSTEM - COMPONENT LOCATION - 2

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EFFECTIVITY

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**RA SYSTEM - POWER, ANTENNA, AND DISCRETE INPUTS****Power**

Power for the RA receiver/transmitter 1 is 115v ac from xfer bus 1. RA receiver/transmitter 2 receives 115v ac from xfer bus 2.

Antenna Interfaces

The transmit antenna sends radio frequency (RF) signals to the ground. The receive antenna sends reflected RF signals to the receiver circuits of the RA receiver/transmitter.

Flight Control Computer Discrete

The flight control computers (FCC) supply a test inhibit signal to the RA receiver/transmitter. This signal prevents an RA test when ILS mode is selected.

PSEU

The RA receiver/transmitter keeps internal and external faults in a nonvolatile fault memory. The RA receiver/transmitter keeps these faults by flight segments. The RA identifies the faults as airborne faults or ground faults. The proximity switch electronics unit (PSEU) gives the air/ground condition.

Input Program Pins

These are the radio altimeter program pins:

- Continuous data. When grounded, lets continuous altitude data be transmitted to user systems
- Aircraft installed delay (AID) of 57 feet. This lets the RA system compensate the altitude calculation for antenna cable length and distance of the RA system antennas from the ground at touchdown
- System select. Used to identify which system.

Indicator Discrete

The indicator discrete supplies the status of flight compartment radio altitude indicators. This system does not use radio altitude indicators.

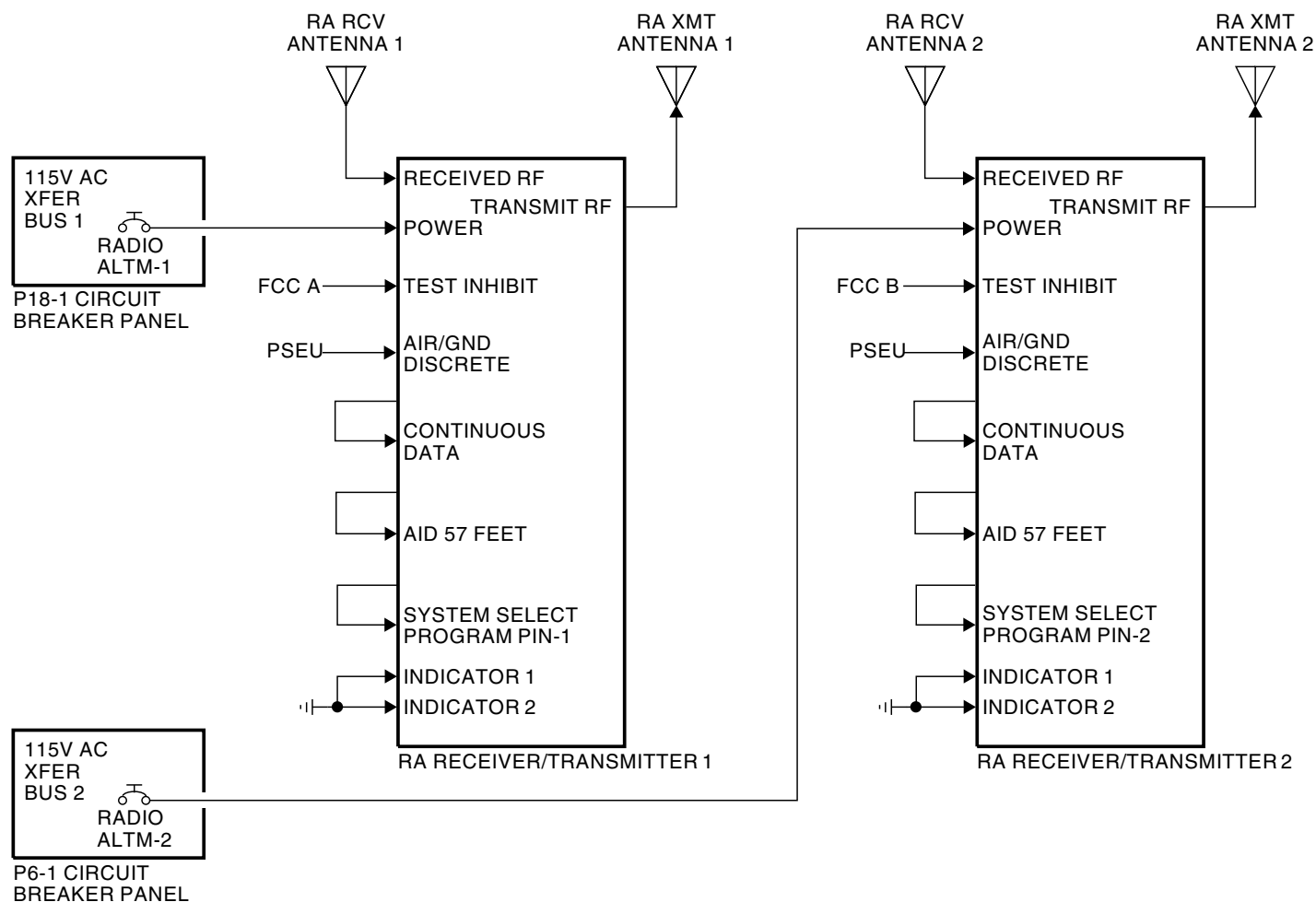
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RA SYSTEM - POWER, ANTENNA, AND DISCRETE INPUTS



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RA SYSTEM - POWER, ANTENNA, AND DISCRETE INPUTS

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SIA ALL EFFECTIVITY

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**RA SYSTEM - DATA BUS OUTPUTS, DECISION HEIGHT INTERFACE****General**

The RA system supplies radio altitude (RA) data to these components:

- Flight Control Computer (FCC) A and the FCC B
- Autothrottle computer
- Display Processing Computer (DPC) 1
- DPC 2
- Weather radar R/T
- Ground Proximity Warning Computer (GPWC)
- Digital Flight Data Acquisition Unit (DFDAU)
- Traffic Alert and Collision Avoidance System (TCAS) computer.

RA Receiver/Transmitter Outputs

Each FCC uses radio altitude from its on-side RA receiver/transmitter. The FCCs use radio altitude in the approach control and low altitude flight calculations.

The autothrottle uses radio altitude in the TO/GA calculations and autothrottle flare calculations.

The DPCs use radio altitude data to calculate the type of radio altitude display and the radio altitude value to show on the display units.

The weather radar R/T uses radio altitude to turn on or off the predictive windshear function and to enable/disable display and alert functions.

The GPWC uses radio altitude in its ground proximity alert and warning logic calculations.

The DFDAU records radio altitude values.

The TCAS computer uses radio altitude to set the sensitivity levels for intruder advisory calculations and to find if an intruder aircraft is on the ground.

EFIS Control Panel Interface

The EFIS control panels supply radio minimums values to the DPCs. The DPCs use radio minimums and radio altitude to calculate radio minimums alerts that show on the display units.

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RA SYSTEM - DATA BUS OUTPUTS, DECISION HEIGHT INTERFACE

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D633AM102-SIA

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**RA SYSTEM - RA RECEIVER/TRANSMITTER****Purpose**

The Radio Altimeter (RA) receiver/transmitter calculates radio altitude.

The RA receiver/transmitter has a non-volatile memory which stores fault information from the last 63 flights. It can store up to 13 faults per flight. Only shop personnel read the non-volatile memory information.

Description

These are the operation limits of the receiver/transmitter:

- Frequency = 4235 MHz to 4365 MHz
- Transmit power = 600 mW nominal
- Operating range = -15 to 5500 feet

A test connector on the front panel connects test equipment for shop tests.

Operation

These are the three Light Emitting Diode (LED) status indicators on the front panel:

- Red or green LRU STATUS LED shows the receiver/transmitter operational status. It comes on green when the receiver/transmitter is OK. It comes on red when the receiver/transmitter has a fault
- Red XMIT ANT FAIL LED shows a transmission antenna or coax cable fault
- Red REC ANT FAIL LED shows a receive antenna or coax cable fault.

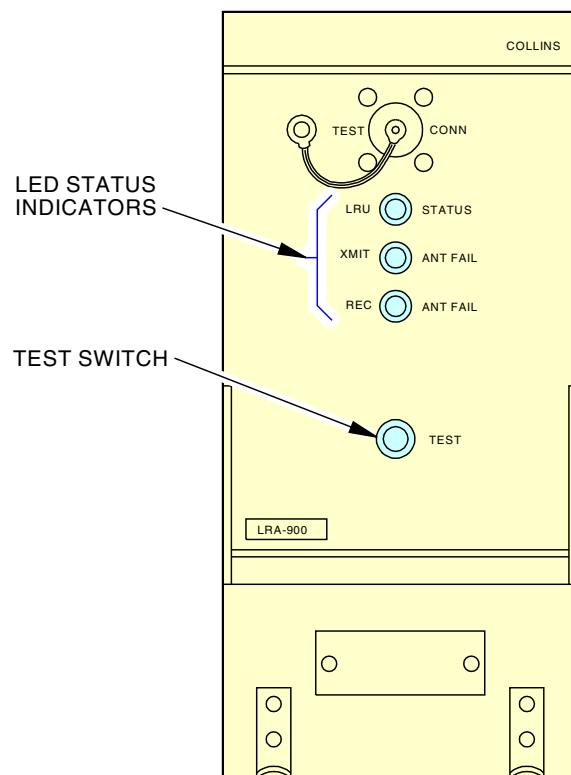
You push the test switch to start a self-test.

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RA SYSTEM - RA RECEIVER/TRANSMITTER



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RA SYSTEM - RA RECEIVER/TRANSMITTER

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**RA SYSTEM - RA ANTENNA****Purpose**

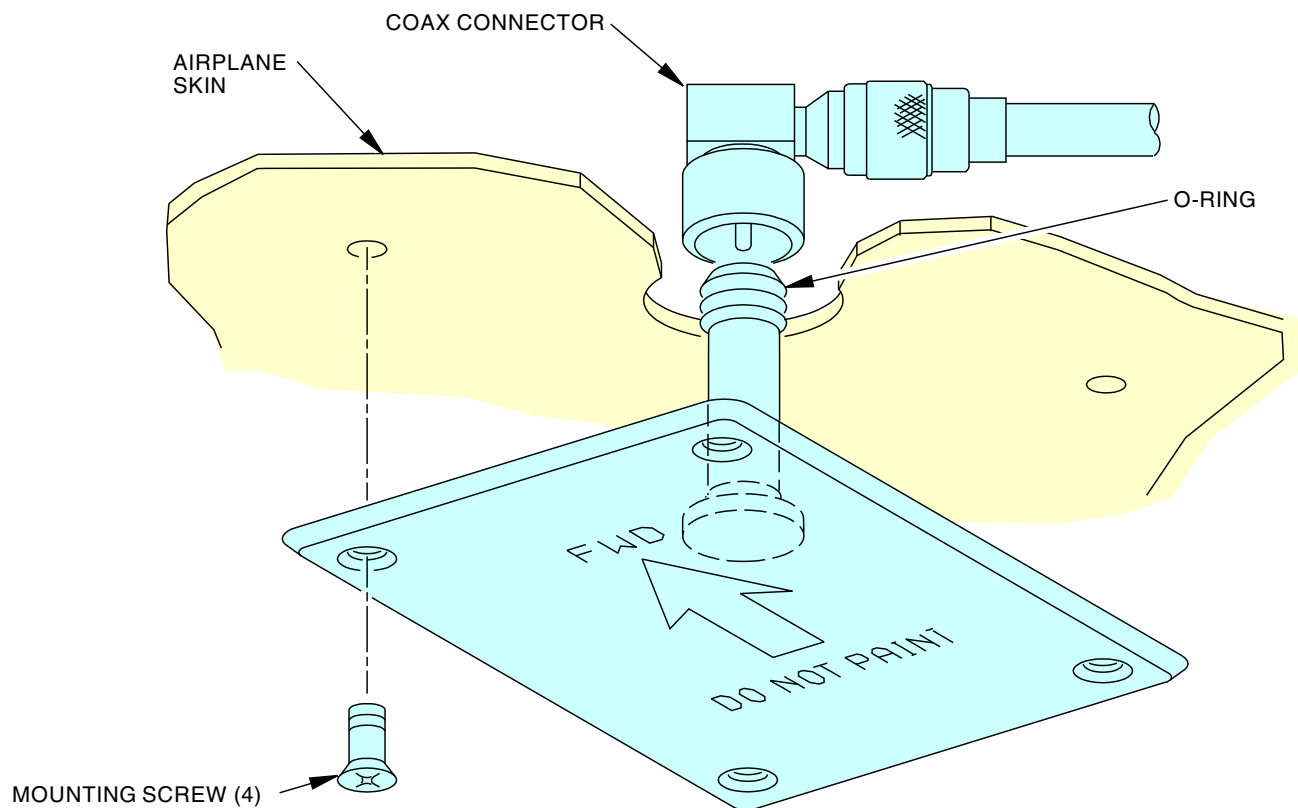
The RA system uses four antennas that transmit and receive RF signals. Each RA receiver/transmitter has a transmit and receive antenna. The transmit and receive antennas are the same and interchangeable.

Physical Description

Four screws attach each antenna to the bottom of the fuselage. There is an O-ring seal in a groove around the coax connector. The O-ring seal gives moisture protection. The radiation side of the antenna has red markings "FWD" and "DO NOT PAINT".

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RA SYSTEM - RA ANTENNA



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RA SYSTEM - RA ANTENNA

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RA SYSTEM - OPERATION - 1

EFIS Control Panel

The EFIS control panel controls the radio minimums value and resets the radio minimums alert display to a normal display. The radio minimums shows on the captain (CAPT) and first officer (F/O) primary flight displays (PFDs). The left EFIS control panel controls the CAPT PFD. The right EFIS control panel controls the F/O PFD.

The minimums controls have these three controls:

- A two-position rotary switch (minimums reference selector)
- A spring loaded rotary switch (minimums altitude selector)
- A radio minimums reset (RST) switch.

You use the radio position on the minimums reference selector to set the radio minimums.

To set a radio minimums value, use the rotary switch to adjust the value between -1 feet and +999 feet.

Push the radio minimums reset (RST) switch to set the radio minimums alert display back to normal.

Primary Flight Display

The PFD shows radio altitude and radio minimums values. The flight crew uses this data during an approach and a landing.

Radio altitude shows in white for airplane altitude between -12 and 2500 feet. This is when the radio altitude values update:

- Two foot increments from -12 to 100 feet
- Ten foot increments from 100 to 500 feet
- Twenty foot increments from 500 to 2500 feet.

The radio altitude does not show above 2500 feet.

The white radio altitude shows as a digital display on the PFD for altitudes between -12 and 2500 feet. For altitudes between 0 and 1000 feet, a round dial shows around the digital display. The dial has increments of 100 feet. As the radio altitude increases or decreases, the display adds or removes the perimeter of the dial. A green radio minimums bug moves around the dial and shows the value selected from the EFIS control panel radio mins altitude selector.

The green radio minimums display shows above the digital radio altitude display. The radio minimums display does not show for these reasons:

- Baro minimums is selected on the EFIS control panel
- Radio minimums reset switch is pushed
- Radio minimums value is less than zero.

The green radio minimums display shows above the digital radio altitude display when the airplane is on the ground or when radio altitude is more than 1000 feet. If the radio minimums value is selected to a value less than zero feet, the display is removed.

Radio Minimums Alert

A radio minimums alert occurs when the radio altitude of the aircraft is the same as the selected radio mins altitude value from the EFIS control panel. The radio minimums alerts occur separately between the captain and first officer displays.

Also, the radio altitude dial changes from white to amber and goes on and off for three seconds and the decision height bug changes from green to amber and goes on and off for three seconds.

After three seconds, the display continues to show amber until it is set back to normal.

Each of these procedures sets the radio minimums alert back to normal:

- Push the reset (RST) switch on the EFIS control panel
- The airplane climbs to 75 feet above the radio minimums value
- The airplane lands.

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**RA SYSTEM - OPERATION - 1**

When radio minimums is set to normal, the radio altitude goes back to white, and the radio minimums display goes back to green.

Rising Runway

The rising runway shows in two colors, a magenta stem with a green trapezoid box on the top. The rising runway shows at the bottom of the ADI when these conditions occur:

- Radio altitude is less than 2500 feet
- ILS localizer deviation shows on the ADI.

The rising runway symbol moves toward the airplane symbol on the ADI as the airplane altitude decreases from 200 feet to 0 feet. At 0 feet, the rising runway shows at the bottom of the airplane symbol. The rising runway symbol also moves left and right to stay aligned with the ILS localizer deviation pointer.

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The diagram illustrates the Left EFIS Control Panel and the Radio Altimeter Display. The control panel, located in the top left, features a circular interface with 'RST' in the center and 'MINS', 'RADIO', and 'BARO' around the perimeter. An arrow points to the 'RST' button, labeled 'MINIMUMS CONTROLS'. The main display area shows the Radio Altimeter (RA) scale, ranging from 0 to 200 feet. The RA scale is highlighted in green, indicating the radio minimums. The RA scale is labeled 'RADIO 300' at the bottom. The RA scale is also labeled 'RADIO ALTITUDE HIGHLIGHT BOX' and 'RADIO MINIMUMS (GREEN)'. The RA scale is also labeled 'RADIO ALTITUDE FOR RADIO MINIMUMS ALERT, DISPLAY GOES TO AMBER'.

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RA SYSTEM - OPERATION - 1

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**RA SYSTEM - OPERATION - 2****RA Data NCD**

RA data NCD causes the RA display and rising runway symbol to be removed. The NCD occurs when the return RA signals are too weak or the radio altitude is more than 2500 feet. Also, the rising runway will not show when the ILS is not captured.

RA Data Invalid

Invalid RA data causes an amber RA flag to show in the radio altitude position. Invalid RA also causes the rising runway symbol to be removed. The invalid data occurs when the RA receiver/transmitter finds a failure in the RA system.

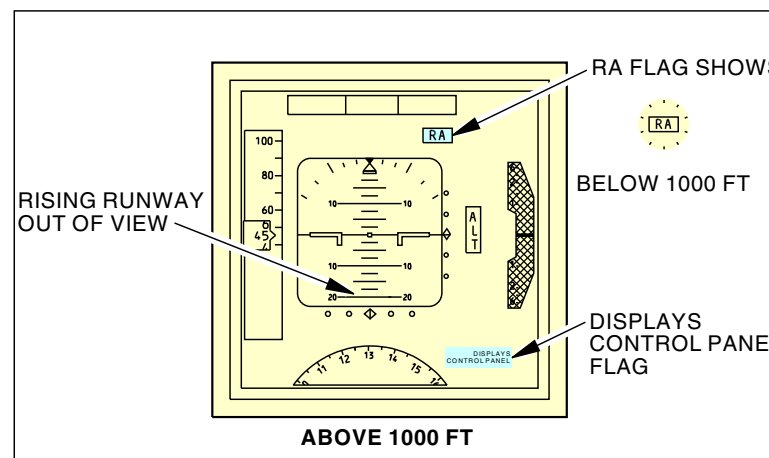
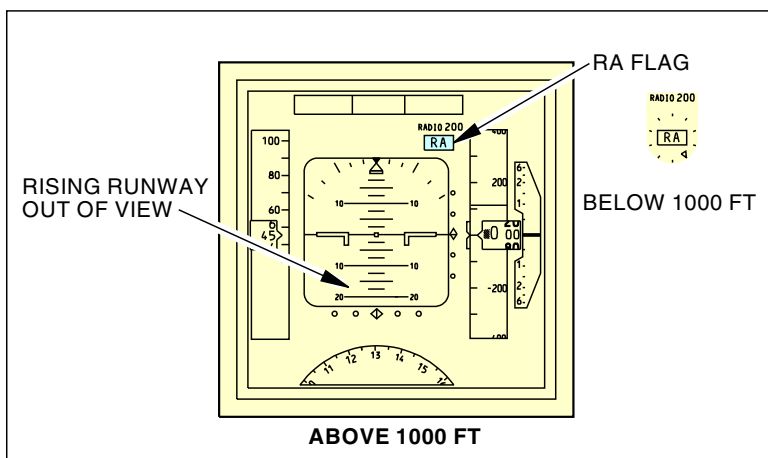
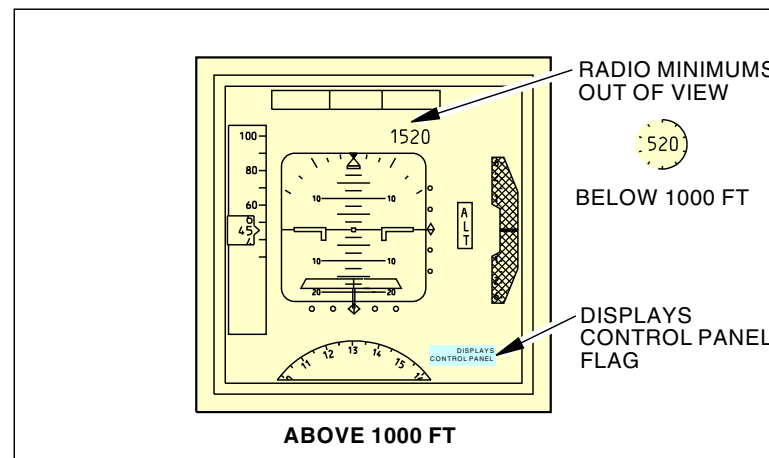
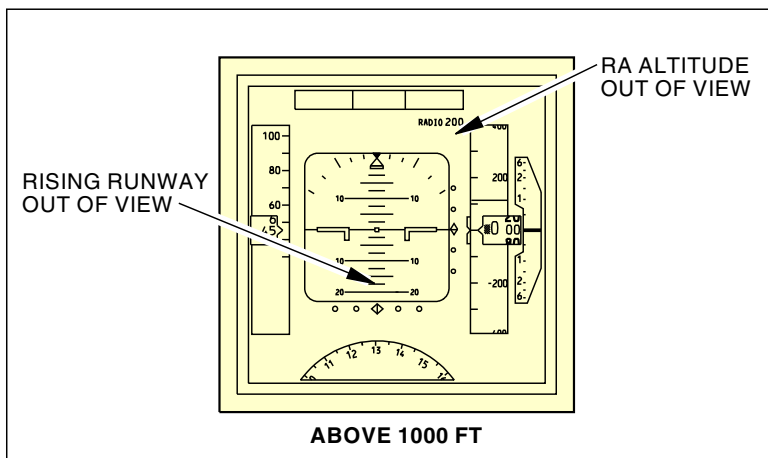
Radio Minimums Data Invalid

Invalid EFIS control panel data on the ground or above 1000 feet causes the amber displays control panel flag to show and the letters RADIO and the radio minimums value to go out of view. Between 0 and 1000 feet, the amber controls display panel flag shows and the radio minimums bug is removed.

Also, the vertical speed indication (VSI) is grey. There is no VSI fail flag for this condition.

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RA SYSTEM - OPERATION - 2



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RA SYSTEM - OPERATION - 2

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**RA SYSTEM - RF PROCESSING****General**

The radio altimeter transmits a frequency modulated/continuous wave (FM/CW) signal through the transmit antenna. This signal is a CW carrier that scans linearly from 4,235 to 4,365 MHz 145 times a second.

Transmit and Receive

The ground causes a reflection of the transmit signal. The receive antenna receives the signal.

The RF processor mixes the transmit and receive signals to make a difference frequency. The difference frequency is in proportion to the time it takes the signal to go to the ground and come back. The main processor changes the difference frequency to radio altitude. The radio altitude goes out on two ARINC 429 data buses. The two buses supply radio altitude and status information to these components:

- Flight Control Computer (FCC) A or FCC B
- Autothrottle computer
- Display Processing Computer (DPC) 1
- DPC 2
- Ground Proximity Warning Computer (GPWC)
- Traffic Alert and Collision Avoidance System (TCAS) computer
- Digital Flight Data Acquisition Unit (DFDAU).

Input Program Pins

The system select program pin input sets the system modulation rate and system identification. The modulation rate for the RA 1 system is 145Hz, the RA 2 system is 155Hz.

The aircraft installation delay (AID) program pin is grounded to the 57 feet selection. This calibrates the system so that the radio altitude is 0 feet at touchdown. It makes an allowance for these conditions:

- Length of the antenna cables
- Fuselage to ground distance
- Flare angle.

When grounded, the continuous data program pin selects non-interrupted RA data output at all times.

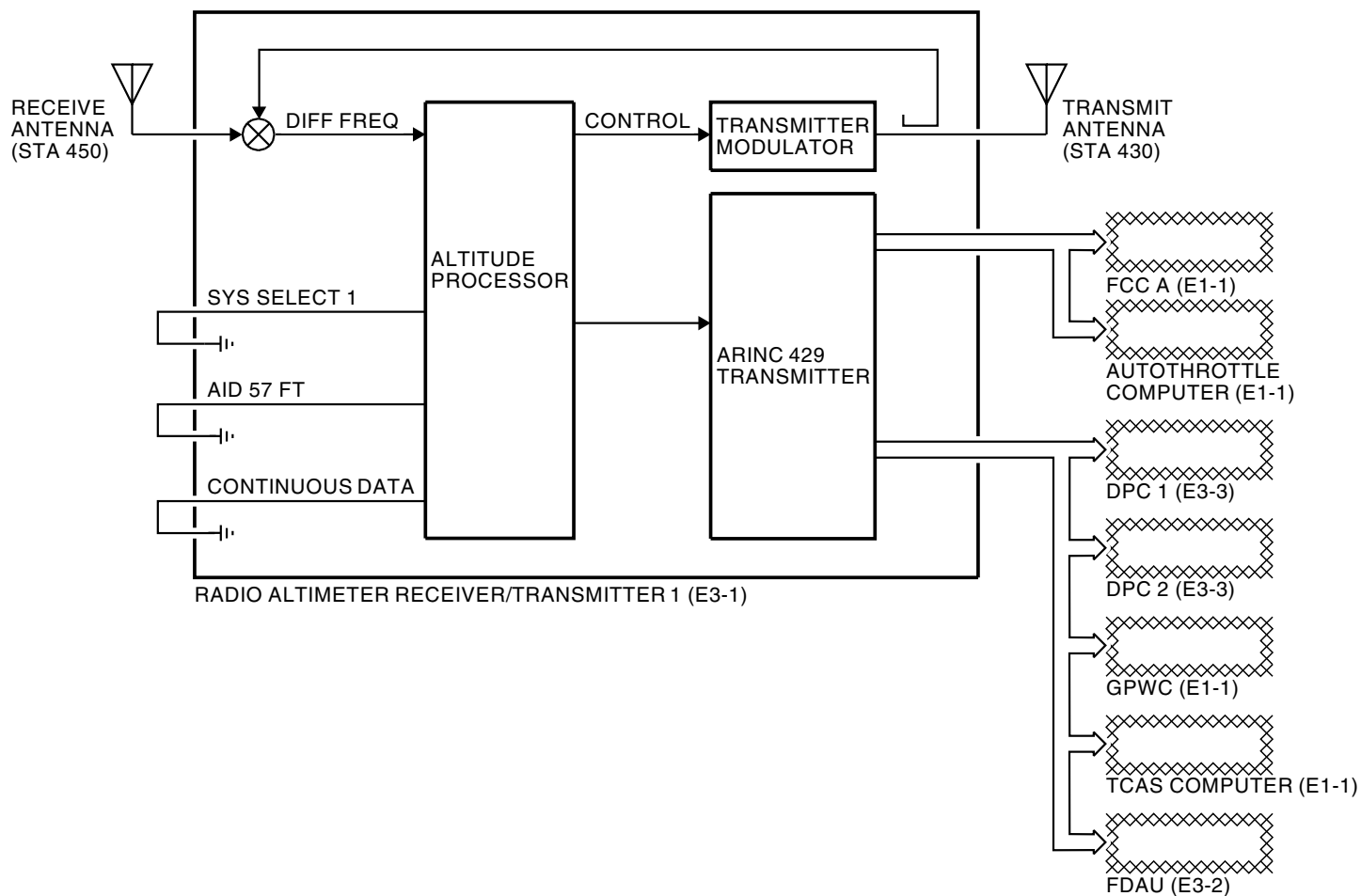
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RA SYSTEM - RF PROCESSING



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RA SYSTEM - RF PROCESSING

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**RA SYSTEM - FAULT DETECTION****BITE Module**

The built-in test equipment (BITE) module monitors the circuits in the RA receiver/transmitter for faults. The flight fault memory stores the number of faults for each flight leg. Shop personnel use the automatic test equipment (ATE) connector to read the fault memory contents.

Test

A test switch on the front of the RA receiver/transmitter starts an RA self-test. LEDs show the results of the self-test.

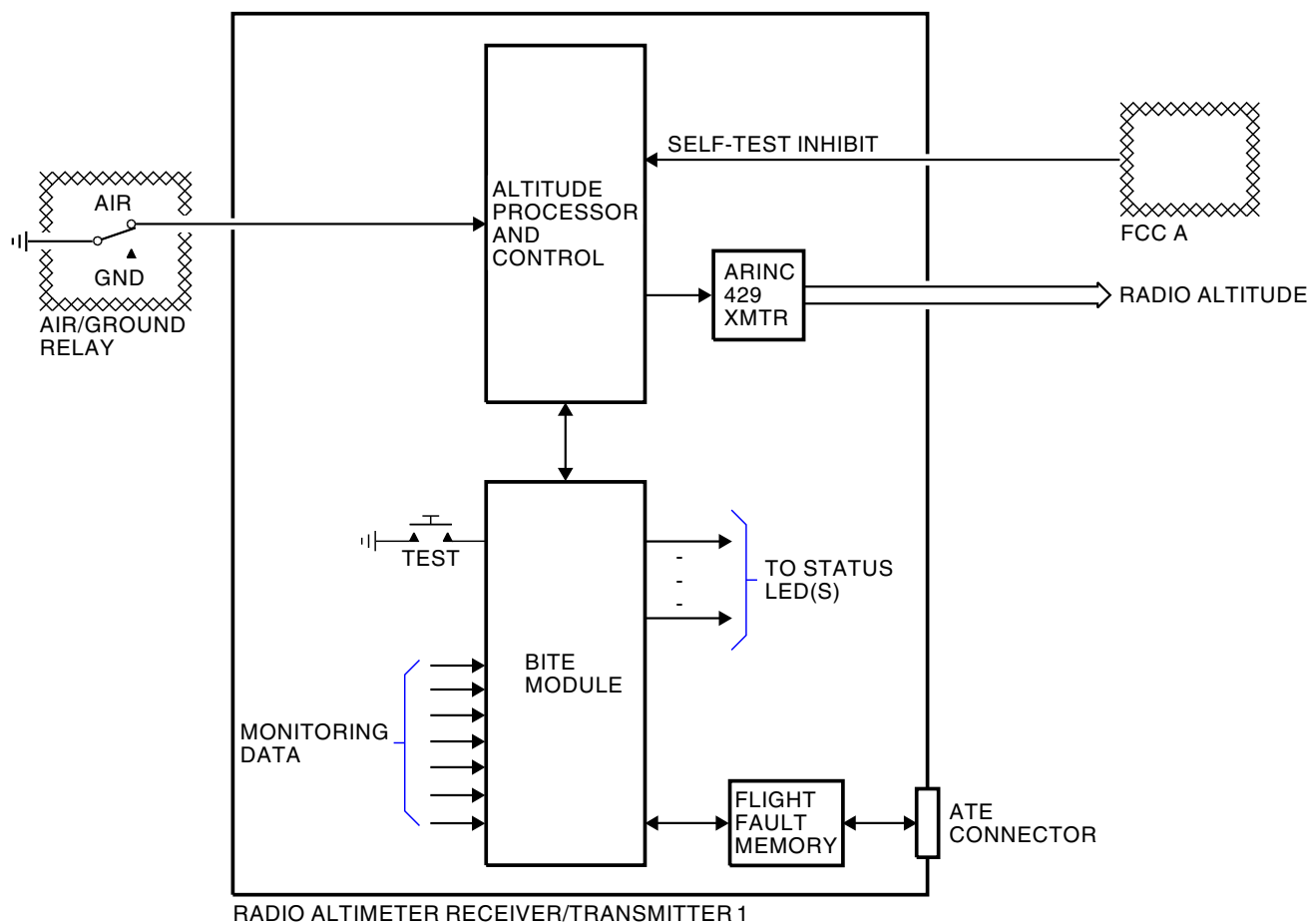
The self-tests do a check of these:

- Receiver/transmitter internal status
- ARINC 429 output transmitters status
- Antennas and coaxial cables.

The flight control computers (FCCs) supply a test inhibit signal to the receiver/transmitters. This prevents an RA test when the FCC is in the approach mode.

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RA SYSTEM - FAULT DETECTION



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RA SYSTEM - FAULT DETECTION

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**RA SYSTEM - FRONT PANEL BITE****Test**

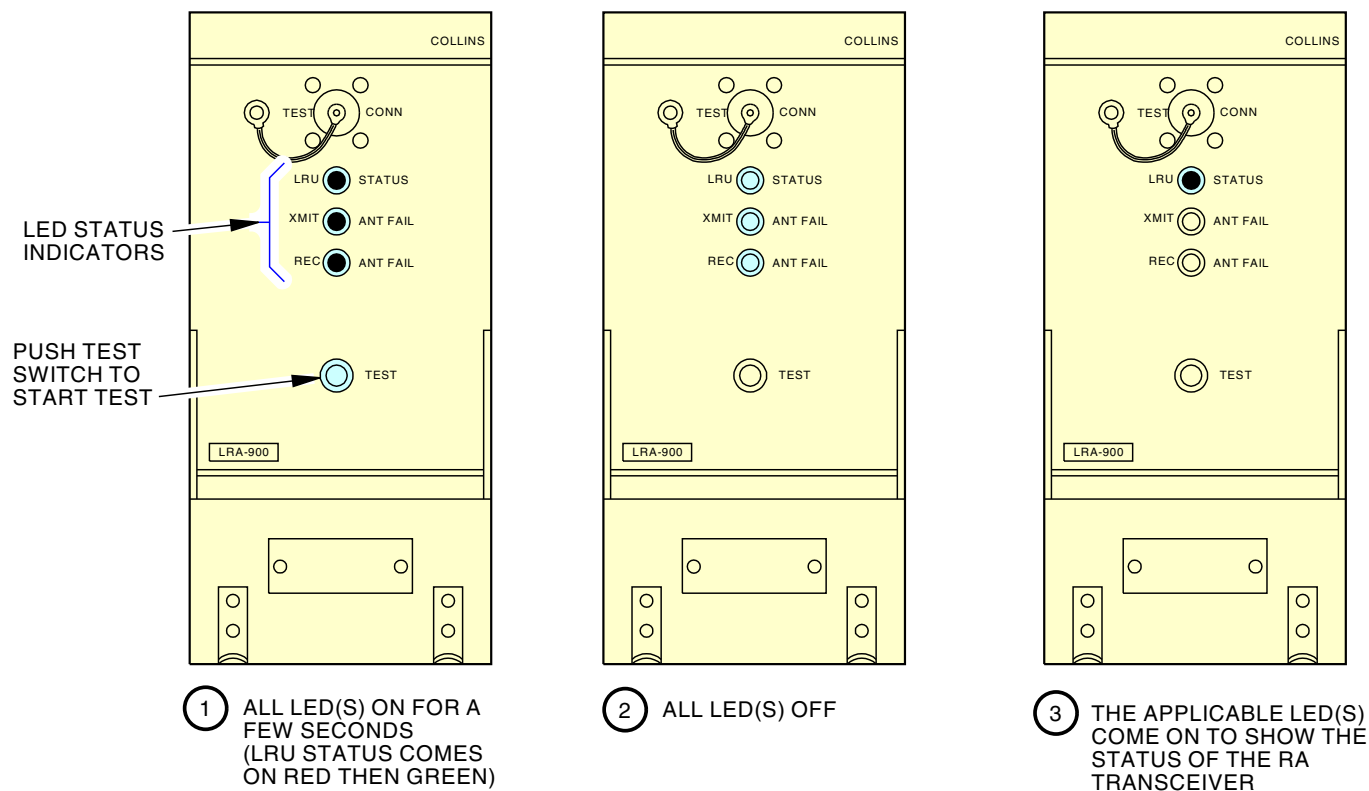
The front panel BITE test only operates when the airplane is on the ground.

Momentarily push the test switch on the front of the RA receiver/transmitter to start a self test. Monitor the front panel for these results:

- Time = 0 seconds - all front panel LEDs come on red
- Time = 2 seconds - LRU STATUS LED changes to green
- Time = 4 seconds - all front panel LEDs go off
- Time = 6 seconds - applicable LEDs come on to show a normal (green) or fault (red) condition
- Time = 36 seconds - Front panel LEDs go off.

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RA SYSTEM - FRONT PANEL BITE



RA SYSTEM - FRONT PANEL BITE

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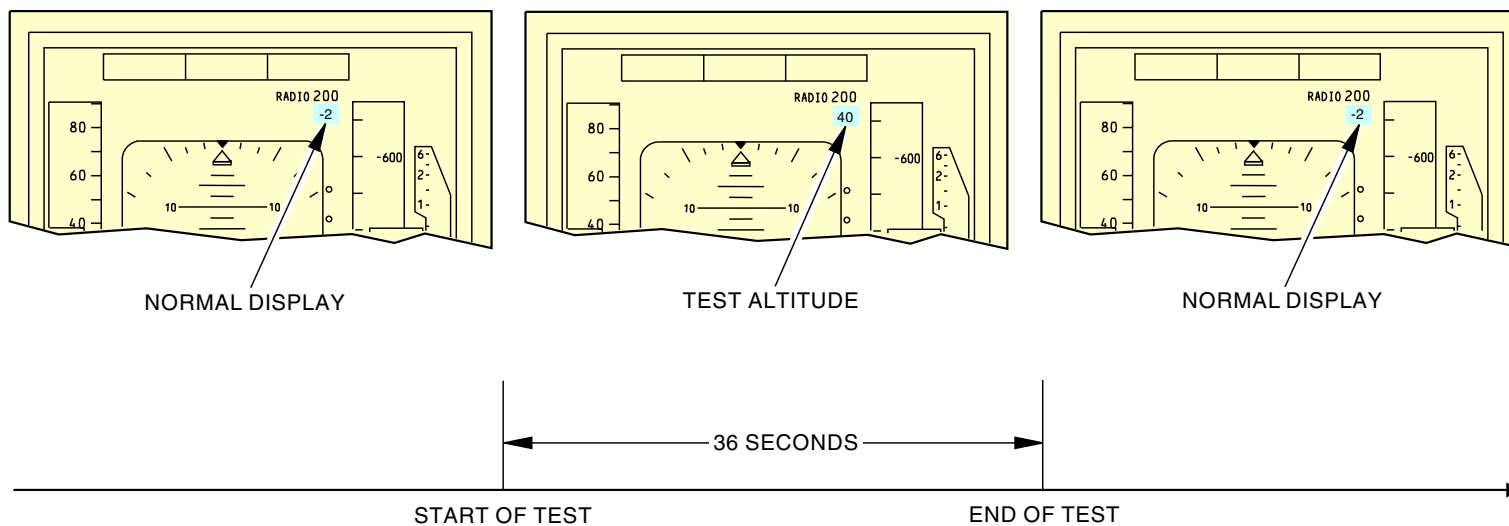
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**RA SYSTEM - FLIGHT COMPARTMENT BITE DISPLAY****General**

The front panel BITE test causes the RA receiver/transmitter (R/T) to make a test altitude signal. This test altitude signal is sent to the display processing computers (DPCs) to be displayed on the captain and first officer primary flight displays (PFDs). The test altitude is 40 feet. The test altitude shows during the full test. The altitude display goes back to normal when the test is complete.

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RA SYSTEM - FLIGHT COMPARTMENT BITE DISPLAY



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RA SYSTEM - FLIGHT COMPARTMENT BITE DISPLAY

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RA SYSTEM - SYSTEM SUMMARY

General

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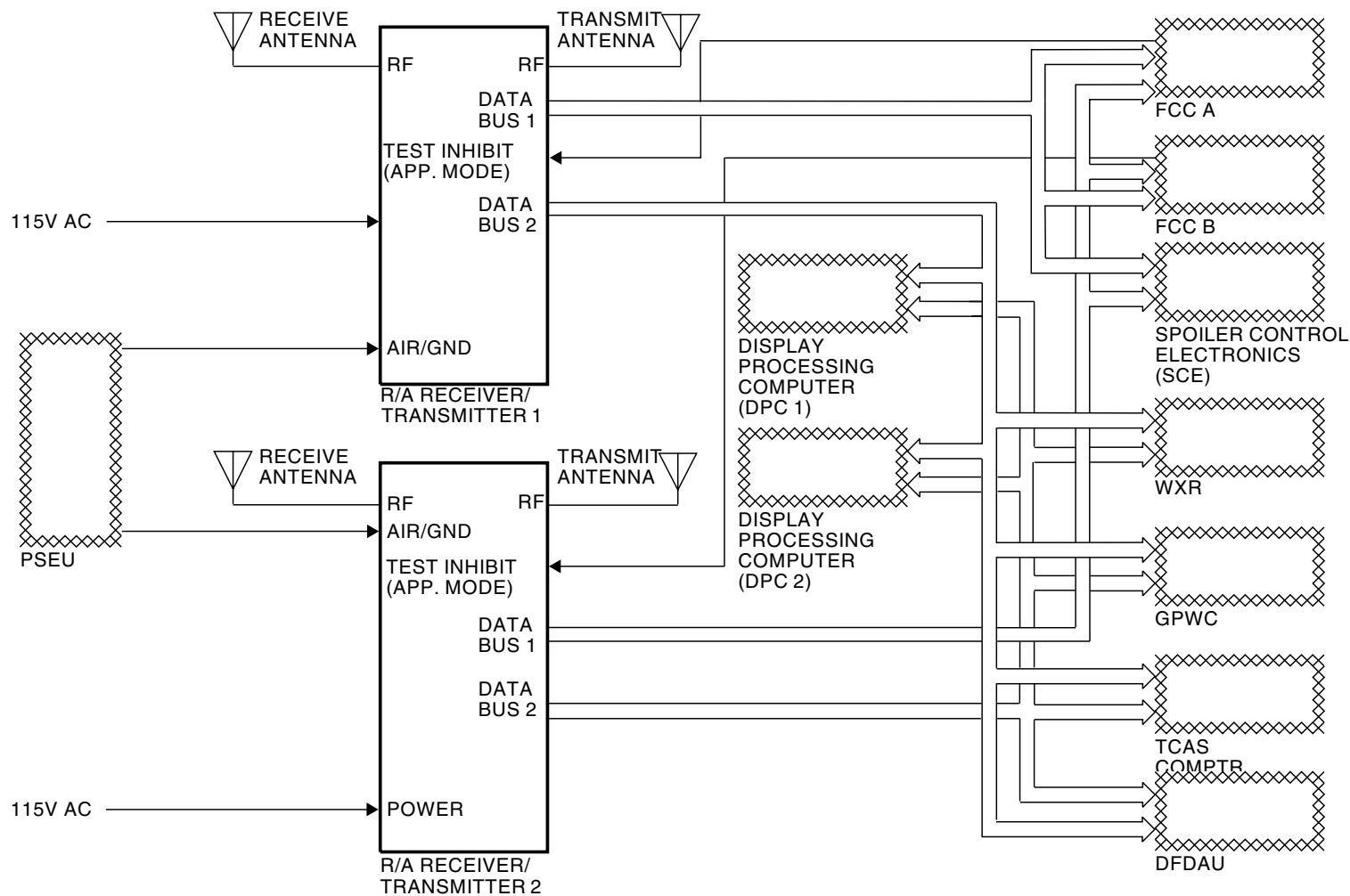
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RA SYSTEM - SYSTEM SUMMARY



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RA SYSTEM - SYSTEM SUMMARY

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WEATHER RADAR SYSTEM - INTRODUCTION

Purpose

The weather radar (WXR) system supplies these visual indications:

- Weather conditions
- Windshear events
- Two-level turbulence detection
- Land contours.

Description

WXR operates on the same principle as an echo. The WXR system transmits radio frequency (RF) pulses in a 180 degree area forward of the airplane. Objects reflect the pulses back to the receiver. The receiver processes the return signal to show weather, terrain, and windshear events.

The receiver also processes the return signal to determine the two-level turbulence data.

Display

The WXR returns show in four different colors on the navigation displays (ND). Colors of the indications give the crew information about the intensity of the returns.

The predictive wind shear (PWS) cautions and warnings show in amber and red on the ND and PFD displays. Also, there are aural alerts for PWS cautions and warnings.

The two-level turbulence data for ride quality and minimum operational performance is shown as speckled and solid magenta on the ND.

Abbreviations and Acronyms

- ac - alternating current
- ADF - automatic direction finder
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- alt - altitude

- ant - antenna
- app - approach
- ARINC - Aeronautical Radio, Inc.
- arpt - airport
- AZ - azimuth
- baro - barometric
- BITE - built-in test equipment
- BL - buttock line
- CAL - calibrate
- capt - captain
- CDU - control display unit
- con - control
- CP - control panel
- CPU - central processing unit
- dc - direct current
- DPC - display processing computer
- DH - decision height
- dn - down
- EFIS - electronic flight instrument system
- EGPWS - enhanced ground proximity warning system
- EL - elevation
- elex - electric
- F/O - first officer
- FMC - flight management computer
- FMCS - flight management computing system
- FPV - flight path vector
- fwd - forward
- gnd - ground
- GS - ground speed
- hPa - hectopascals

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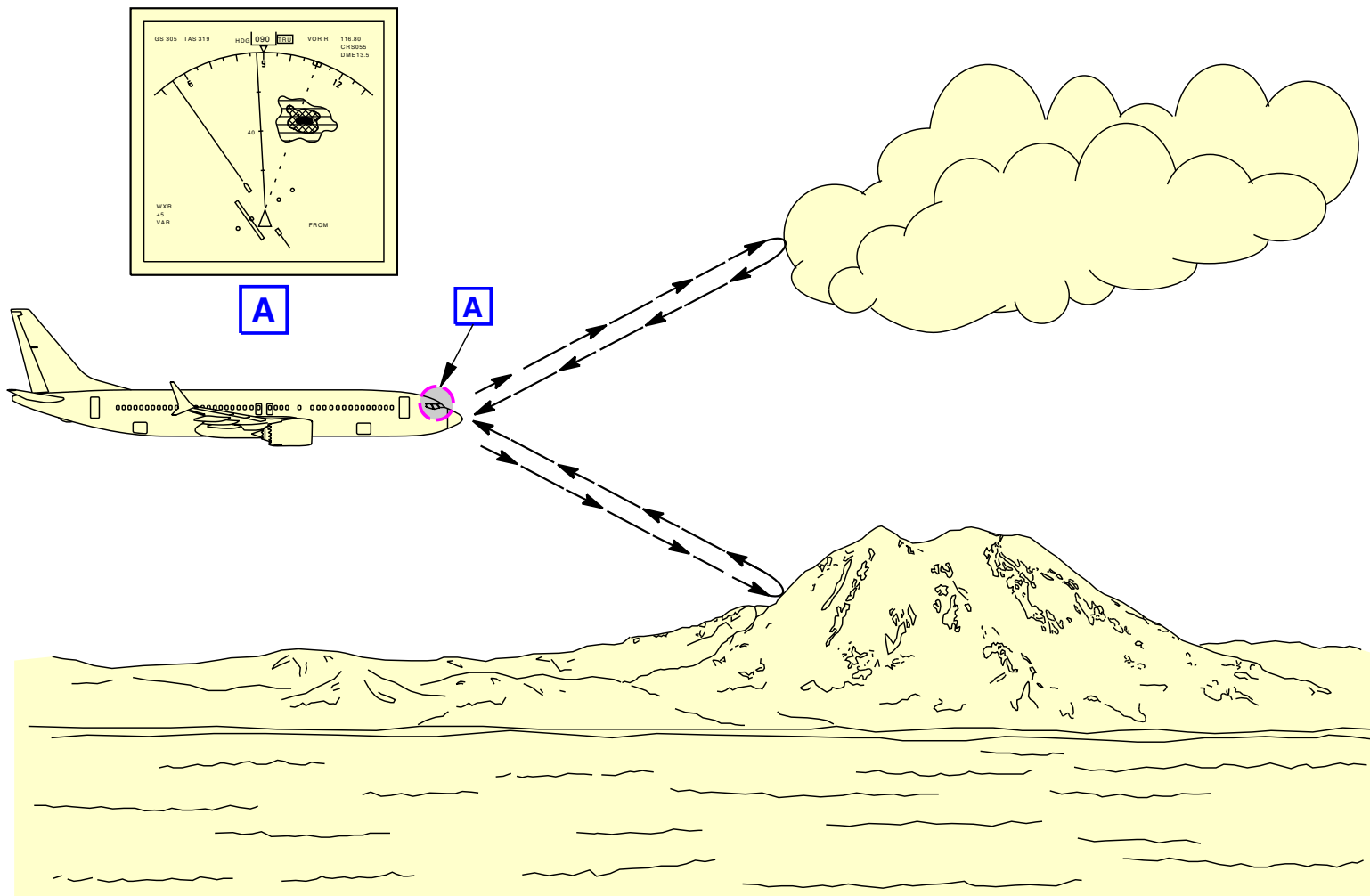
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WEATHER RADAR SYSTEM - INTRODUCTION

- in - inch
- intlk - interlock
- IRS - inertial reference system
- kg - kilograms
- L - left
- lb - pounds
- LED - light emitting diode
- mag - magnetic
- max - maximum
- MDA - minimum descent altitude
- MHz - megahertz
- MINS - minimums
- MTRS - meters
- nav - navigation
- NCD - no computed data
- ND - navigation display
- NM - nautical miles
- OK - good or pass
- PFD - primary flight display
- pos - position
- PRF - pulse repetition frequency
- PWS - predictive windshear
- R - right
- rad - radio
- RF - radio frequency
- R/T - receiver/transmitter
- sta - station
- stab - stabilization
- stb - stabilization
- std - standard
- TAS - true air speed
- TCAS - traffic alert and collision avoidance
- trk - track
- TRU - true
- V - volts
- VOR - very high frequency omnidirectional range
- wpt - waypoint
- WX - weather
- WX/TURB - weather/turbulence
- WX+TURB - weather+turbulence
- WXR - weather radar
- Z - zulu (universal coordinated time)

WEATHER RADAR SYSTEM - INTRODUCTION



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WEATHER RADAR SYSTEM - INTRODUCTION

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WXR SYSTEM - GENERAL DESCRIPTION

Control

These components supply weather radar (WXR) system control:

- Left and right EFIS control panels
- Weather radar control panel.

System Inputs

These components supply signals to the WXR transceivers for predictive windshear:

- Air data inertial reference system sends air data for the PWS function
- Radio altimeters send altitude to enable or disable PWS during takeoff and approach
- Autothrottle switch packs enable PWS during takeoff
- Landing gear lever switch sends a landing gear down discrete to enable PWS during approach
- An air/ground relay sends an air/ground discrete for flight leg counting.

System Outputs

The weather radar transceiver sends these signals out for predictive windshear:

- PWS video to the DPCs
- PWS warnings or cautions to the GPWS to prioritize any callouts
- Audio inhibit to TCAS when there is a PWS warning
- Audio to the REU for PWS.

The weather radar transceiver sends two-level turbulence data video to the DPCs.

Display

WXR data shows on the navigation displays (NDs). The weather data from the WXR receiver/transmitters (R/T) goes to the DPCs.

If TERR is selected on the EFIS control panel or there is a Terrain Awareness/Terrain Clearance Floor warning from the GPWC, then the EGPWS terrain data shows on the navigation display (ND). If TERR is not selected and there are no EGPWS warnings, WXR data shows on the ND.

Antenna

The WXR antenna sends the RF pulses and receives the RF returns. The R/T's gets air data inertial reference unit (ADIRU) pitch and roll data for antenna stabilization.

Receiver/Transmitter (R/T)

The primary component of the WXR system is the weather radar R/T. The system has Dual R/Ts. The WXR R/T does these functions:

- Transmits RF pulses
- Processes the RF returns
- Detects windshear events and sends warnings and cautions to the flight crew
- Supplies the WXR display data.

Selection of the Left or Right R/T is done on the WXR Control Panel with the "L/R" switch. This document refers to the selected Receiver/Transceiver.

Receiver/Transmitter (R/T) and Radar Processor (RP)

The primary components of the WXR system are the weather radar receiver/transmitter (R/T) and the radar processor (RP). The system has dual R/T's and RP's. The WXR R/T does these functions:

- Produces RF pulses
- Transmits RF pulses
- Receives RF pulses

The WXR RP does these functions:

- Processes the RF returns

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WXR SYSTEM - GENERAL DESCRIPTION

- Detects windshear events and sends warnings and cautions to the flight crew
- Supplies the WXR display data

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The diagram illustrates the architecture of the Weather Radar System, showing the flow of data and control signals between various components. The system is divided into two main channels, No. 1 and No. 2.

Channel No. 1 Components:

- Control Panels:** CAPTAIN'S EFIS CONTROL PANEL, WEATHER RADAR CONTROL PANEL, and FIRST OFFICER'S EFIS CONTROL PANEL.
- Processing:** WEATHER RADAR PROCESSOR (RP) NO. 1.
- Input/Output:** REU TCAS (Receiving/Transmitting Unit - Traffic Collision Avoidance System), ADIRS (Air Data Inertial Reference System), RADIO ALTIMETERS, AUTO THROTTLE SWITCH PACKS, LANDING GEAR LEVER SWITCH, PROXIMITY SWITCH, ELECTRONICS UNIT, and DFDAU (Digital Flight Data Acquisition Unit).
- Antenna Drive:** WEATHER RADAR RECEIVER/TRANSMITTER NO. 1, WEATHER RADAR ANTENNA DRIVE UNIT AND ANTENNA FLAT PLATE.

Channel No. 2 Components:

- Control Panels:** CAPTAIN'S EFIS CONTROL PANEL, WEATHER RADAR CONTROL PANEL, and FIRST OFFICER'S EFIS CONTROL PANEL.
- Processing:** WEATHER RADAR PROCESSOR (RP) NO. 2.
- Input/Output:** REU TCAS, ADIRS, RADIO ALTIMETERS, AUTO THROTTLE SWITCH PACKS, LANDING GEAR LEVER SWITCH, PROXIMITY SWITCH, ELECTRONICS UNIT, and DFDAU.
- Antenna Drive:** WEATHER RADAR RECEIVER/TRANSMITTER NO. 2, WEATHER RADAR ANTENNA DRIVE UNIT AND ANTENNA FLAT PLATE.

System Interconnections:

- The CAPTAIN'S EFIS CONTROL PANEL and FIRST OFFICER'S EFIS CONTROL PANEL are connected to both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2.
- The WEATHER RADAR CONTROL PANEL is connected to both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2.
- Both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2 are connected to the ADIRS, RADIO ALTIMETERS, AUTO THROTTLE SWITCH PACKS, LANDING GEAR LEVER SWITCH, PROXIMITY SWITCH, ELECTRONICS UNIT, and DFDAU.
- Both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2 are connected to the REU TCAS.
- Both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2 are connected to the WEATHER RADAR RECEIVER/TRANSMITTER NO. 1 and WEATHER RADAR RECEIVER/TRANSMITTER NO. 2.
- Both WEATHER RADAR PROCESSOR (RP) NO. 1 and WEATHER RADAR PROCESSOR (RP) NO. 2 are connected to the WEATHER RADAR ANTENNA DRIVE UNIT AND ANTENNA FLAT PLATE.
- The WEATHER RADAR ANTENNA DRIVE UNIT AND ANTENNA FLAT PLATE is connected to the WEATHER RADAR RECEIVER/TRANSMITTER NO. 1 and WEATHER RADAR RECEIVER/TRANSMITTER NO. 2.
- The WEATHER RADAR RECEIVER/TRANSMITTER NO. 1 and WEATHER RADAR RECEIVER/TRANSMITTER NO. 2 are connected to the DPCS (Data Processing Control System).

WXR SYSTEM - GENERAL DESCRIPTION

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**WXR SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT****WXR System Components**

The weather radar control panel is on the P8 aft electronic panel in the flight compartment.

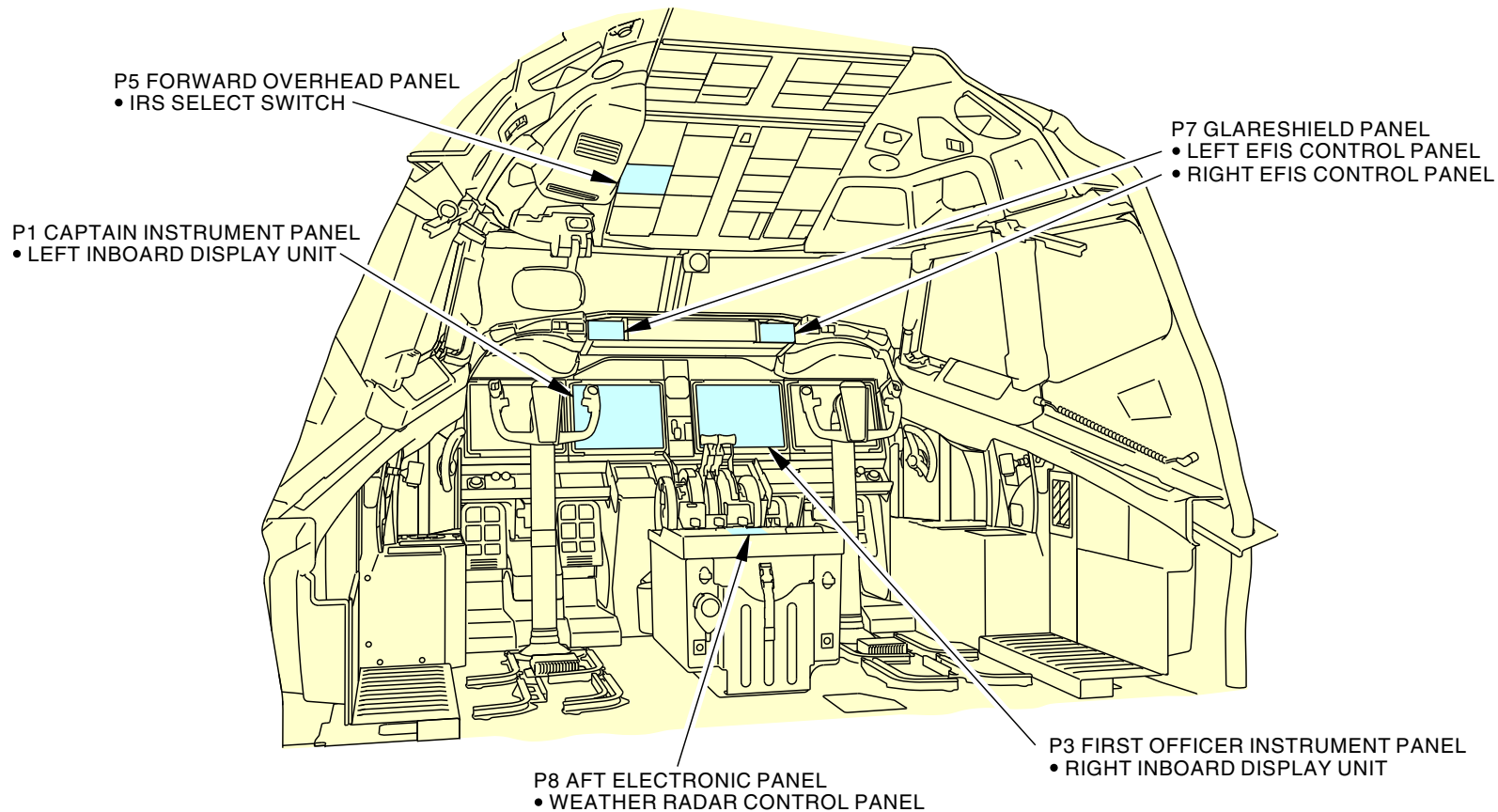
WXR System Interface Components

These are the flight compartment components that have an interface with the WXR system:

- Left EFIS control panel (P7)
- Right EFIS control panel (P7)
- Left inboard display unit (P1)
- Right inboard display unit (P3)
- IRS select switch on the navigation/displays source select panel (P5).

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WXR SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT



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WXR SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT

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WXR SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND NOSE RADOME

General

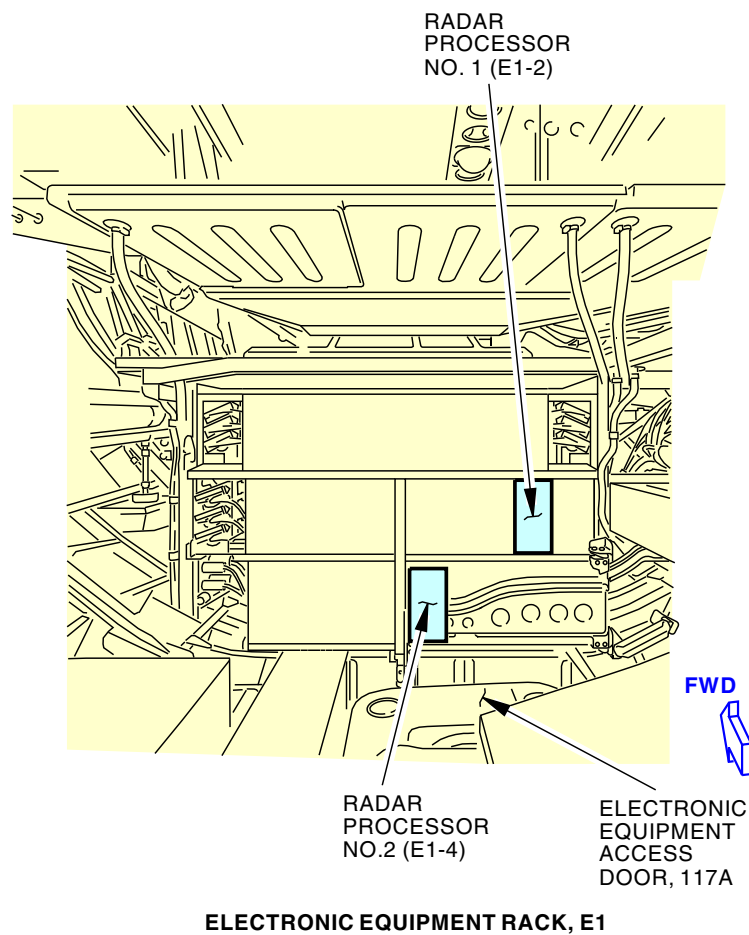
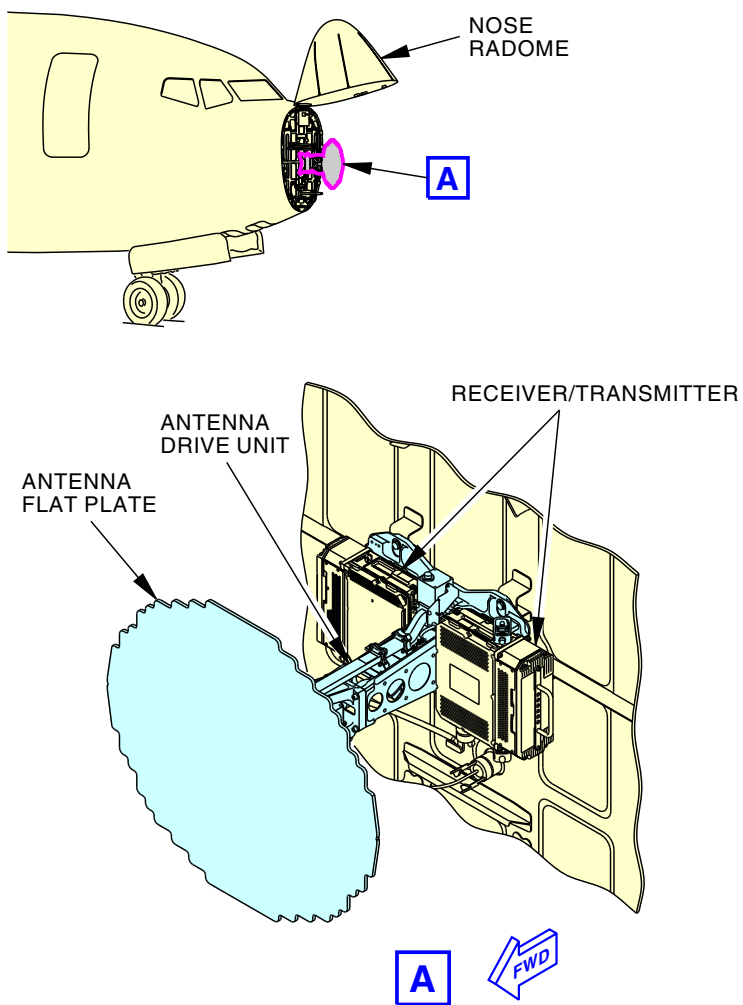
These WXR system components are on the forward bulkhead behind the nose radome.

- Antenna flat plate
- Antenna drive unit
- Left and Right Receiver/Transmitters.

The left and right WXR radar processors are on the electronic equipment rack, E1.

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WXR SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND NOSE RADOME



ELECTRONIC EQUIPMENT RACK, E1

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WXR SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND NOSE RADOME

**WXR SYSTEM - POWER AND ANALOG INTERFACES****System Power and ON/OFF**

The Left WXR processor gets 115v ac through the WXR Radar R/T circuit breaker from the 115v AC XFR BUS 2 (P6 circuit breaker panel). The Right WXR processor gets 115v ac through the WXR Radar R/T circuit breaker from the 115v AC XFR BUS 1 (P18 circuit breaker panel).

The Display Processing Computer (DPC)s make sure that the navigation display is in a mode that can show WXR data. If the navigation display is in a correct mode, the DPCs send an ON/OFF discrete to the WXR control panel.

The ON/OFF discrete goes through the WXR control panel to the WXR R/Ts. This discrete lets the WXR R/T operate.

When the WXR R/Ts gets the ON signal, it sends 28v dc to the power supply in the WXR control panel and 115v ac to the WXR R/T power supply.

The WXR R/Ts sends a 28v dc power interlock to the WXR control panel. The control panel sends the 28v dc interlock back to the WXR R/T as R/T ENABLE.

The WXR antenna gets 28v ac from the WXR antenna drive unit.

Discretes

The GPWS sends an inhibit discrete to the PWS. The discrete inhibits PWS aural alerts if the GPWS alerts are a higher priority.

The PWS aural alert will stop when a higher GPWS alert is received.

The landing gear lever sends a landing gear down discrete to enable PWS during an approach.

The left and right auto throttle switch packs send discretes (QFR A) to enable the PWS function. When the throttles move through 53 degrees and the aircraft is below 2300 feet RA, the radar turns on.

The audio inhibit discrete goes to the TCAS. The TCAS uses this discrete to downgrade all RAs to TAs and inhibit all aural alerts.

RF Transmission and Reception

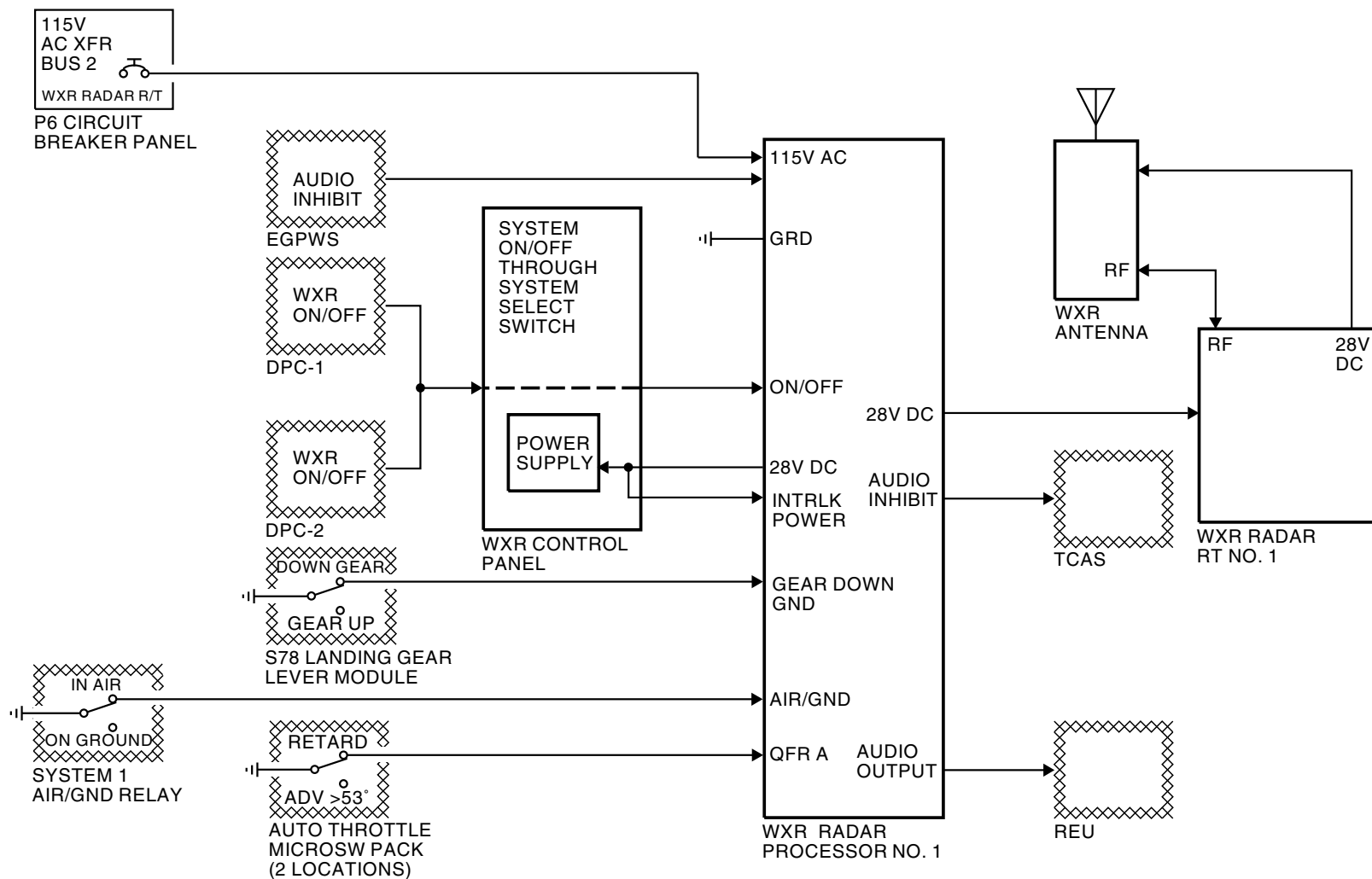
Transmit radio frequency (RF) goes from the R/T through the waveguide to the weather radar antenna. The receive RF goes from the antenna through the waveguide to the R/T.

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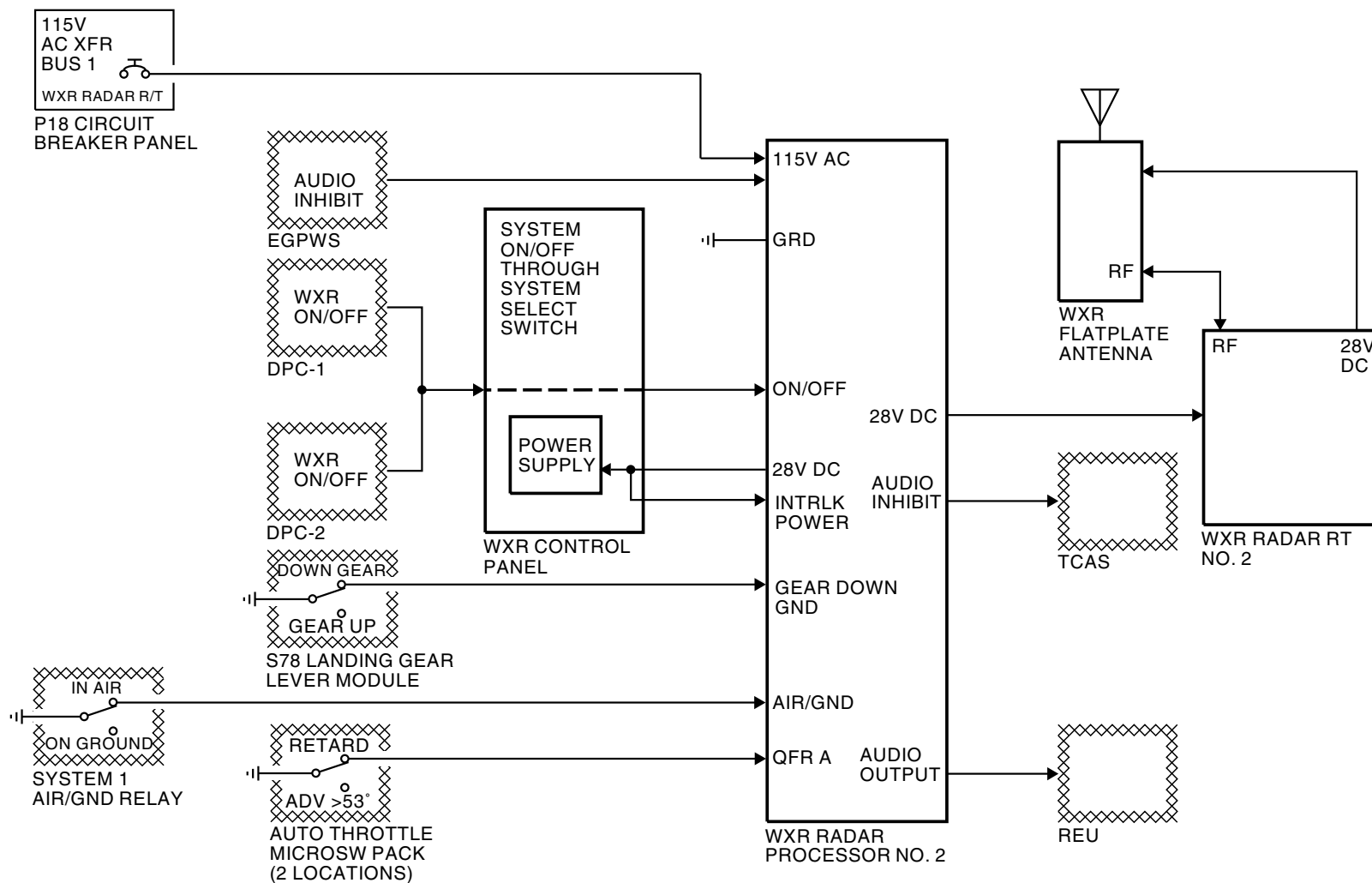
WXR SYSTEM - POWER AND ANALOG INTERFACES



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WXR SYSTEM - NO.1 POWER AND ANALOG INTERFACES

WXR SYSTEM - POWER AND ANALOG INTERFACES



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WXR SYSTEM - NO. 2 POWER AND ANALOG INTERFACES

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**WXR SYSTEM - CONTROL AND DISPLAY INTERFACE****Digital Inputs**

The WXR R/T receives data from these systems:

- Air data inertial reference system (ADIRS)
- Radio altimeter (RA) system
- MAX Display System (MDS).

Air Data Inertial Reference System

The ADIRS sends this inertial reference (IR) data to the dual WXR R/Ts on a high-speed ARINC 429 data bus:

- Pitch angle
- Roll angle
- Groundspeed
- True heading
- Magnetic heading
- Drift angle
- Discretes.

The ADIRS sends this air data (AD) to the WXR R/T on a low-speed ARINC 429 data bus:

- Uncorrected baro altitude
- Corrected baro altitude
- True airspeed
- Computed airspeed.

The WXR RP uses altitude and airspeed data for windshear calculation. The WXR RP also uses altitude data for sensitivity time control calculations.

Radio Altimeter System

The radio altimeters send radio altitude on a low-speed ARINC 429 data bus to the dual WXR R/Ts for the predictive windshear (PWS) function. The PWS uses this data to do these functions:

- Turn PWS on and off
- Enable/disable display and alert functions.

MAX Display System

The EFIS control panels send range data and the WXR on/off discrete to the Display Processing Computer (DPC)s on an ARINC 429 data bus.

The DPCs send range data from the EFIS control panel to the WXR R/T on ARINC 429 data buses. The DPCs send the WXR on/off discrete to the WXR control panel on a discrete wire.

Control Inputs

The WXR control panel supplies this data to the both WXR R/Ts:

- Transmit mode
- Tilt
- Gain control
- On/off discrete.



The diagram illustrates the WXR Processor (Weather Radar Processor) and its associated components. The processor is a central block with various inputs and outputs.

Inputs to the WXR Processor:

- MODE, TILT, AND GAIN CONTROL (from a top input)
- ON/OFF (from a top input)
- WXR CONTROL PANEL (with a blue box 'A' indicating a specific input)
- EFIS CP RANGE (with a blue box 'A' indicating a specific input)
- EFIS CP MRANGE (with a blue box 'B' indicating a specific input)
- ADC BUS 1 (from ADIRU 1)
- ADR-L-4 BUS (from ADIRU 1)
- ADIRU 1
- ADC BUS 1 (from ADIRU 2)
- ADR-L-4 BUS (from ADIRU 2)
- ADIRU 2
- RA 2 BUS (from RA 1)
- RADIO ALTIMETER-1
- RA 2 BUS (from RA 2)
- RADIO ALTIMETER-2

Outputs from the WXR Processor:

- BUS 1 DISPLAY DATA (ARINC 453)
- BUS 2 DISPLAY DATA (ARINC 453)
- HAZARD BUS (WINDSHEAR DATA) (to EGPWS)

Internal Data Flow:

- The WXR Processor outputs data to two display units: DPC-1 and DPC-2.
- DPC-1 receives data from the WXR Processor and outputs to CAPT INBD DU.
- DPC-2 receives data from the WXR Processor and outputs to F/O INBD DU.

Legend:

- Blue box 'A' indicates a specific input to the WXR Processor.
- Blue box 'B' indicates a specific input to the WXR Processor.

WXR SYSTEM - CONTROL AND DISPLAY INTERFACE

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WXR SYSTEM - PWS INTERFACES

General Description

The predictive windshear (PWS) part of the weather radar (WXR) system interfaces with other airplane systems and components.

Air Data Inertial Reference System

The air data inertial reference system (ADIRS) sends this data to PWS:

- Attitude Data
- Heading data
- Air data.

Ground Proximity Warning Computer

PWS sends windshear alert data to the ground proximity warning computer (GPWC) on the ARINC 708A hazard bus. The GPWC uses this data to prioritize alerts. If there is a higher priority alert, the GPWC sends an inhibit discrete to the WXR. This discrete inhibits the PWS alert output.

Landing Gear Control Lever Module

The landing gear control lever module sends an analog discrete to PWS. PWS uses this discrete in its takeoff/approach alert logic.

Radio Altimeter

The radio altimeter (RA) provides radio altitude data to PWS. PWS uses radio altitude data to do these functions:

- Turn PWS on and off
- Enable/disable display and alert functions.

Remote Electronic Unit

The WXR sends the PWS aural alerts to the remote electronic unit (REU).

Autothrottle Microswitch Pack

The left and right autothrottle microswitch packs send a discrete to the PWS. The PWS uses this discrete to determine the throttle lever position for the automatic turn on.

Display Processing Computers

The WXR sends the following discretes to the display processing computers:

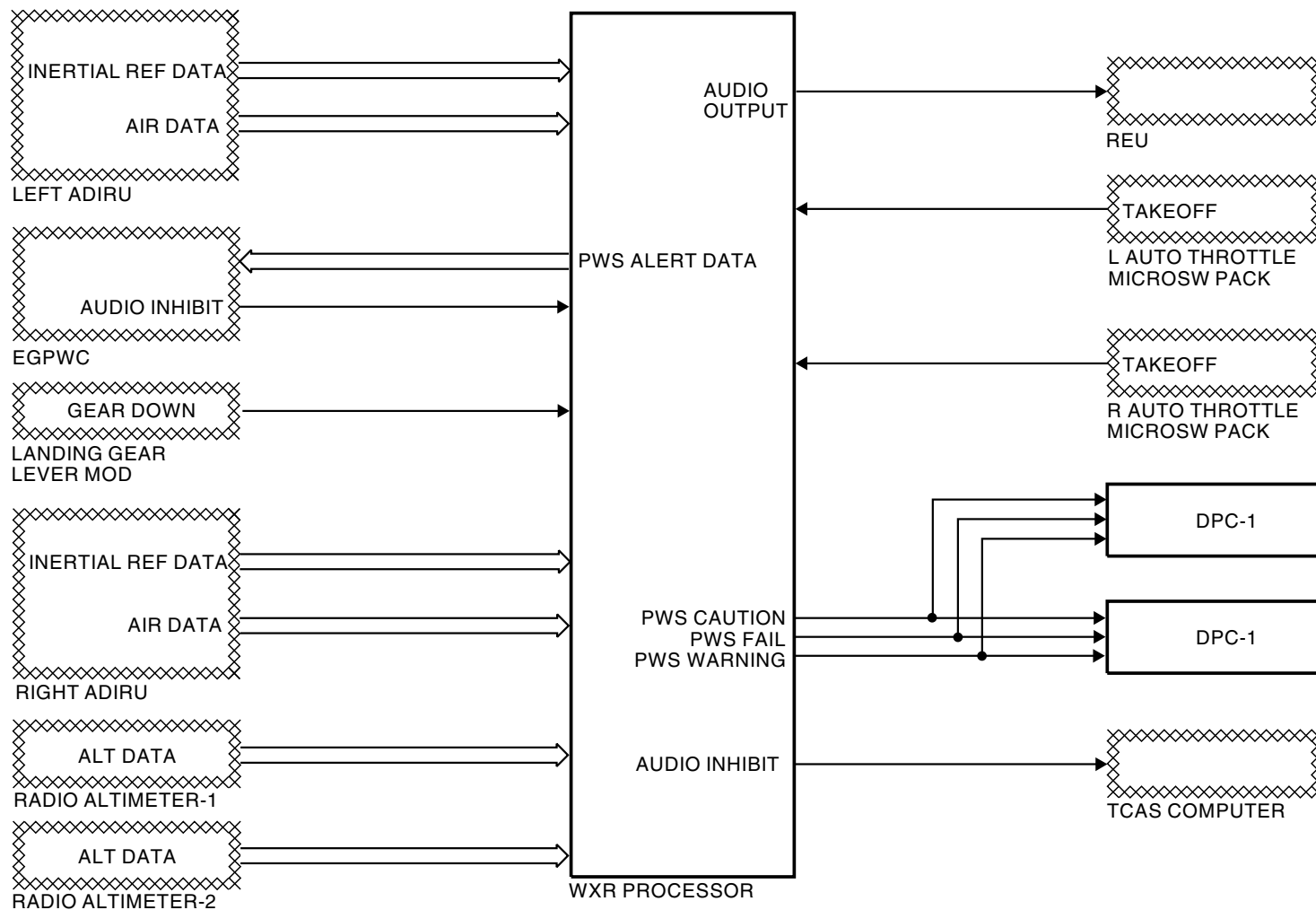
- PWS warning
- PWS caudogington
- PWS fail.

Traffic Alert and Collision Avoidance System

WXR sends an inhibit discrete to the traffic alert and collision avoidance system (TCAS) computer when there is a PWS alert. This discrete does these functions:

- Changes resolution advisories (RAs) to traffic advisories (TAs)
- Inhibits all TCAS audio alerts.

WXR SYSTEM - PWS INTERFACES



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WXR SYSTEM - PWS INTERFACES

**WXR SYSTEM - ANTENNA CONTROL INTERFACE****Antenna Tilt**

The WXR panel supplies antenna tilt control signals to the WXR R/Ts.

Attitude Sources

The WXR R/T uses ADIRU attitude data to stabilize the antenna.

Attitude Source Select Discrete

Use the IRS select switch to choose the ADIRU source to both WXR R/Ts. Set the switch to NORMAL or BOTH ON L to use the left ADIRU input. Set the switch to BOTH ON R to use the right ADIRU input.

WXR R/T Antenna Control

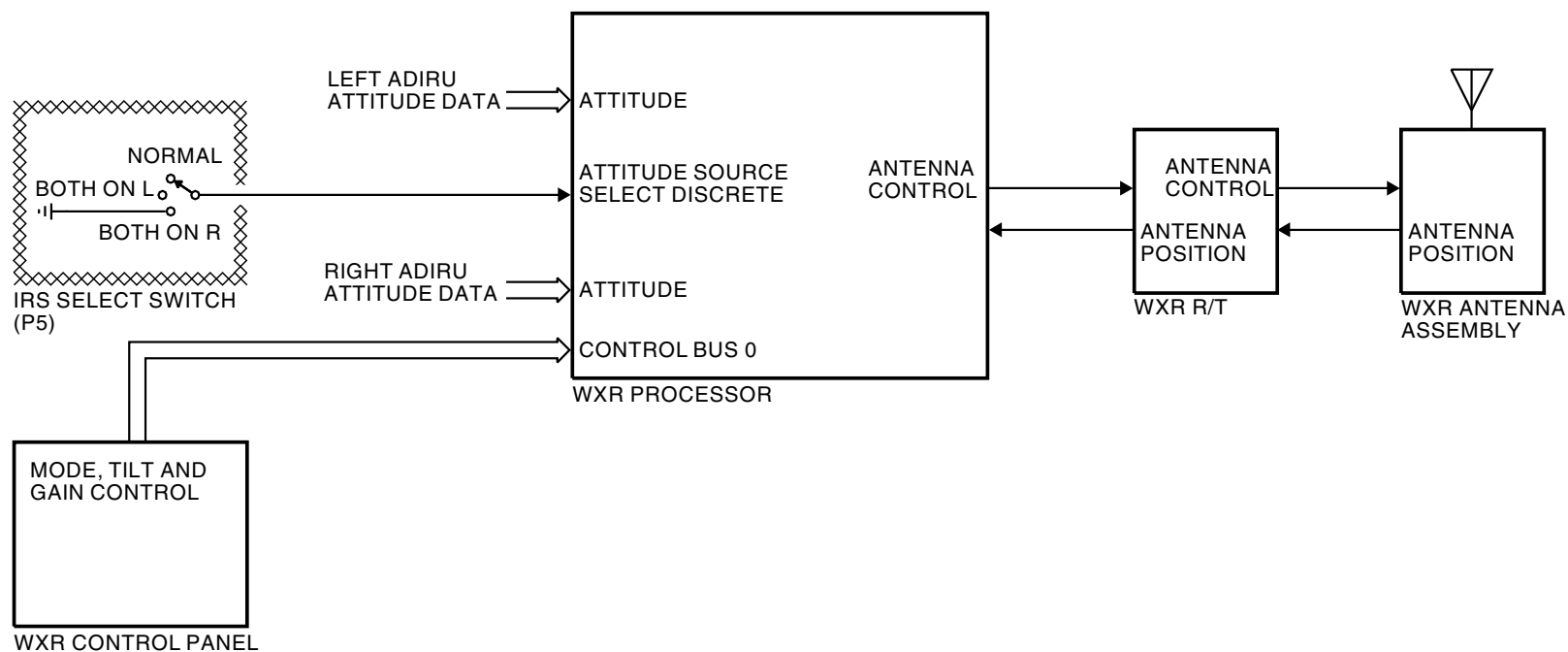
Both WXR R/Ts sends signals to the WXR antenna assembly to control it and make it stable.

Antenna Position Monitoring

The WXR antenna sends antenna position data to both WXR R/Ts for scan and elevation feedback.

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WXR SYSTEM - ANTENNA CONTROL INTERFACE



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WXR SYSTEM - ANTENNA CONTROL INTERFACE

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**WXR SYSTEM - CONTROL PANEL****General**

The weather radar (WXR) control panel has these functions:

- System selection
- Mode selection
- Tilt control
- Gain control.

System Controls

These are the system control switches:

- AUTO - when pushed in sets the multiscan (automatic) mode
- TEST - activates the self test mode and displays the results on the NDs
- L/R - when pushed in (out) selects the system right (left) receiver-transmitter.

Mode Select Switches

There are five mode select switches:

- TFR - shows the opposite display's mode, tilt and gain.
- WX - displays weather without turbulence
- WX+T - dual weather plus turbulence
- MAP - shows terrain and weather features on the NDs
- GC - temporarily adds ground clutter back into the display

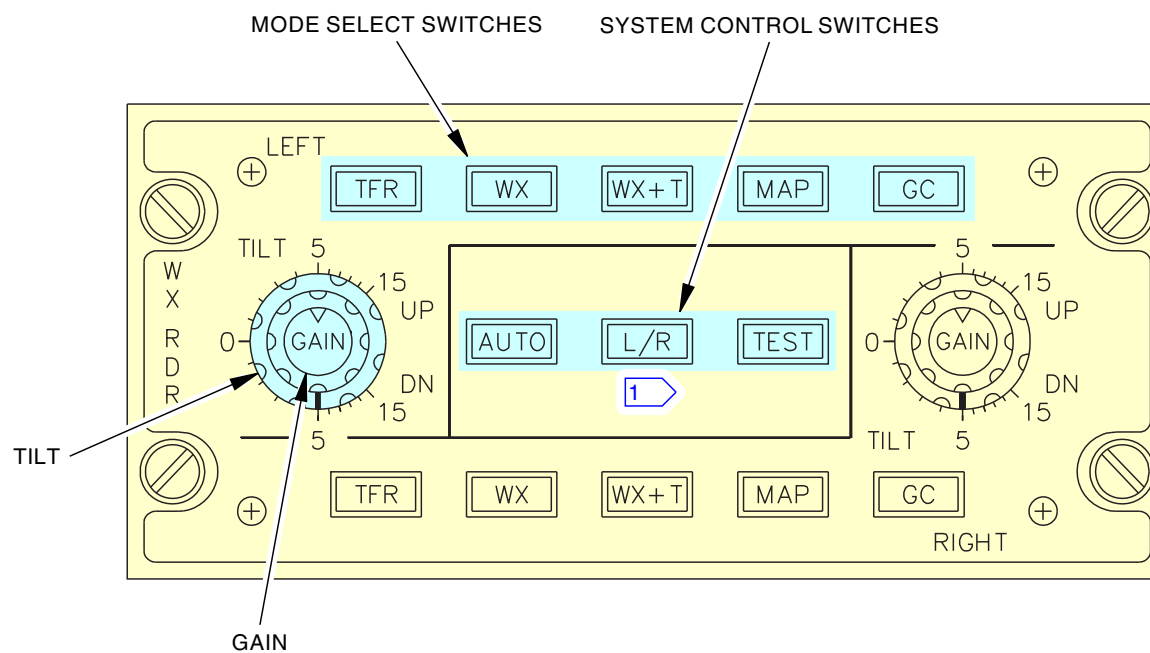
Tilt Control

The tilt control (TILT) is the outer rotary knob and the gain control (GAIN) is the inner rotary knob. The TILT knob lets you adjust the antenna tilt position for the best display. Each left and right side may be independently adjusted. The tilt range is from 15 degrees down to 15 degrees up.

Gain Control

The gain control adjusts the gain for the WXR RP signal returns. In the CAL position, the gain is set to a calibrated level by the RP. When you rotate the gain adjust out of the CAL position, you can manually adjust the gain.

WXR SYSTEM - CONTROL PANEL



1 L/R SWITCH ONLY APPLICABLE TO DUAL WXR SYSTEM.

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WXR SYSTEM - CONTROL PANEL

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**WXR SYSTEM - RECEIVER/TRANSMITTER****Purpose**

These are the functions of the WXR receiver/transmitters (R/Ts):

- Make and transmit RF pulses
- Process RF return signals
- Make display data
- Send display data to the DPCs
- Supply antenna stabilization
- Monitor and do system operation test
- Send fault status and test data to the DPCs
- Make WXR display test patterns show on the display units.

The WXR R/Ts provides these displays to the DPCs:

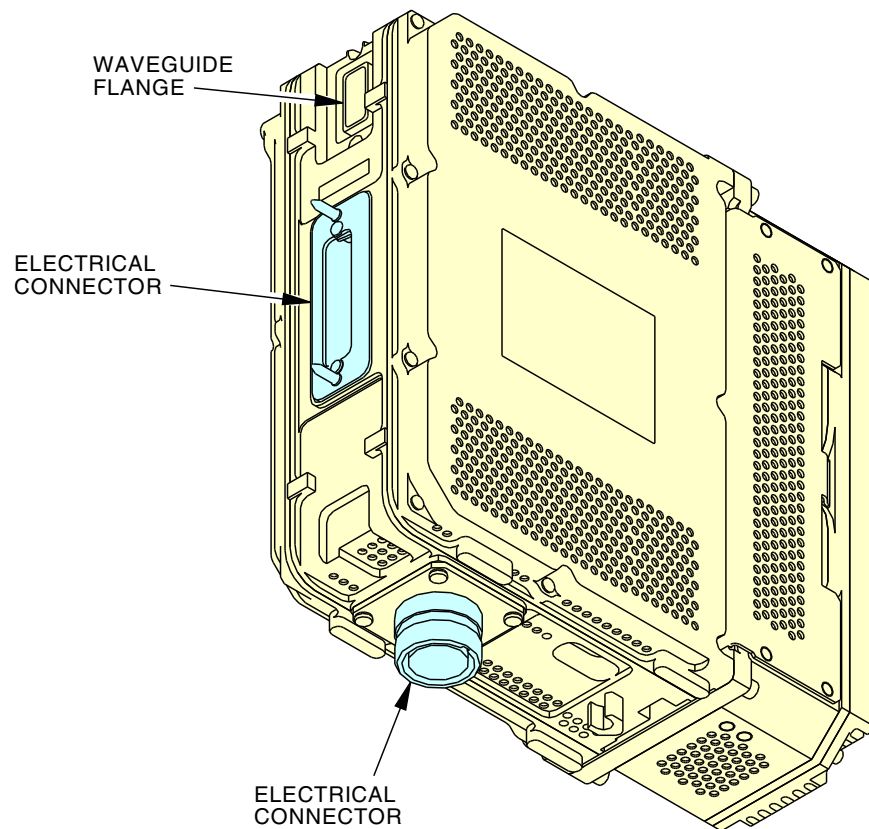
- Test
- Weather
- Map (ground mapping).

Physical Description

Each of the Dual WXR R/T weighs 8.22 lb (3.73 kg) and they are installed on to the antenna drive assembly. Each RT has these interface connectors:

- The antenna control connector is on the bottom of the R/T. Its interface is with the RP.
- The motor drive connector is on the rear panel of the R/T. Its interface is with the gimbal drive module (GDM) in the antenna drive assembly.
- The waveguide connector is on the rear panel of the R/T. It interfaces with the antenna flat plate through a short waveguide that is installed on the antenna drive assembly.

WXR SYSTEM - RECEIVER/TRANSMITTER



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WXR SYSTEM - RECEIVER/TRANSMITTER

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**WXR SYSTEM - RADAR PROCESSOR****Purpose**

This is the purpose of the WXR radar processor (RP):

- Process RF return signals
- Make display data
- Supply mode control to the R/T
- Supply antenna commands and stabilization
- Monitor and test system operation
- Send and record fault status and test results
- Make WXR display test patterns to show on the display units.

Physical Description

The WXR RP weighs 8.6 lb (3.90 kg). Forced air from the RP mount fan cools the WXR RP. The front panel of the RP has these items:

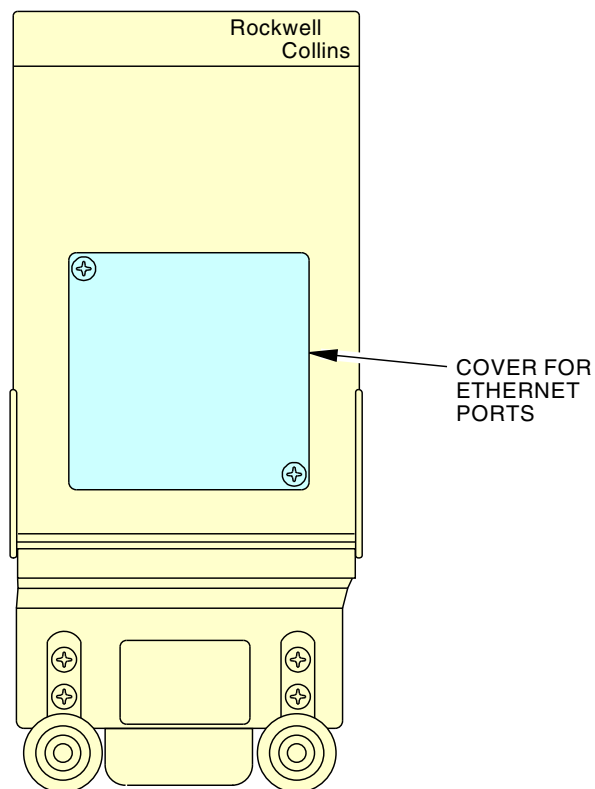
- Two ethernet ports.

Front Panel

There are the two ethernet ports. The upper ENG port needs to be connected when using the IOP Data Dump tab from the Health Monitor (HM) software. Data from the IOP card can be downloaded for engineering debugging and diagnostic. The lower HM port connects the RP to the user supplied computer.

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WXR SYSTEM - RADAR PROCESSOR



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WXR SYSTEM - RADAR PROCESSOR

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**WXR SYSTEM - ANTENNA****Antenna Assembly**

These are the parts of the antenna:

- Flat plate antenna
- Antenna pedestal.

Flat Plate Antenna

The flat plate antenna transmits and receives RF pulses.

The flat plate antenna is an array of radiation slots. The RF pulses radiate from each of the slots and combine to make a pencil beam 3.0 degrees high and 3.0 degrees wide. The antenna weighs 5.6 lb (2.55 kg) and is 30 inches wide.

Antenna Pedestal

The antenna pedestal contains these items:

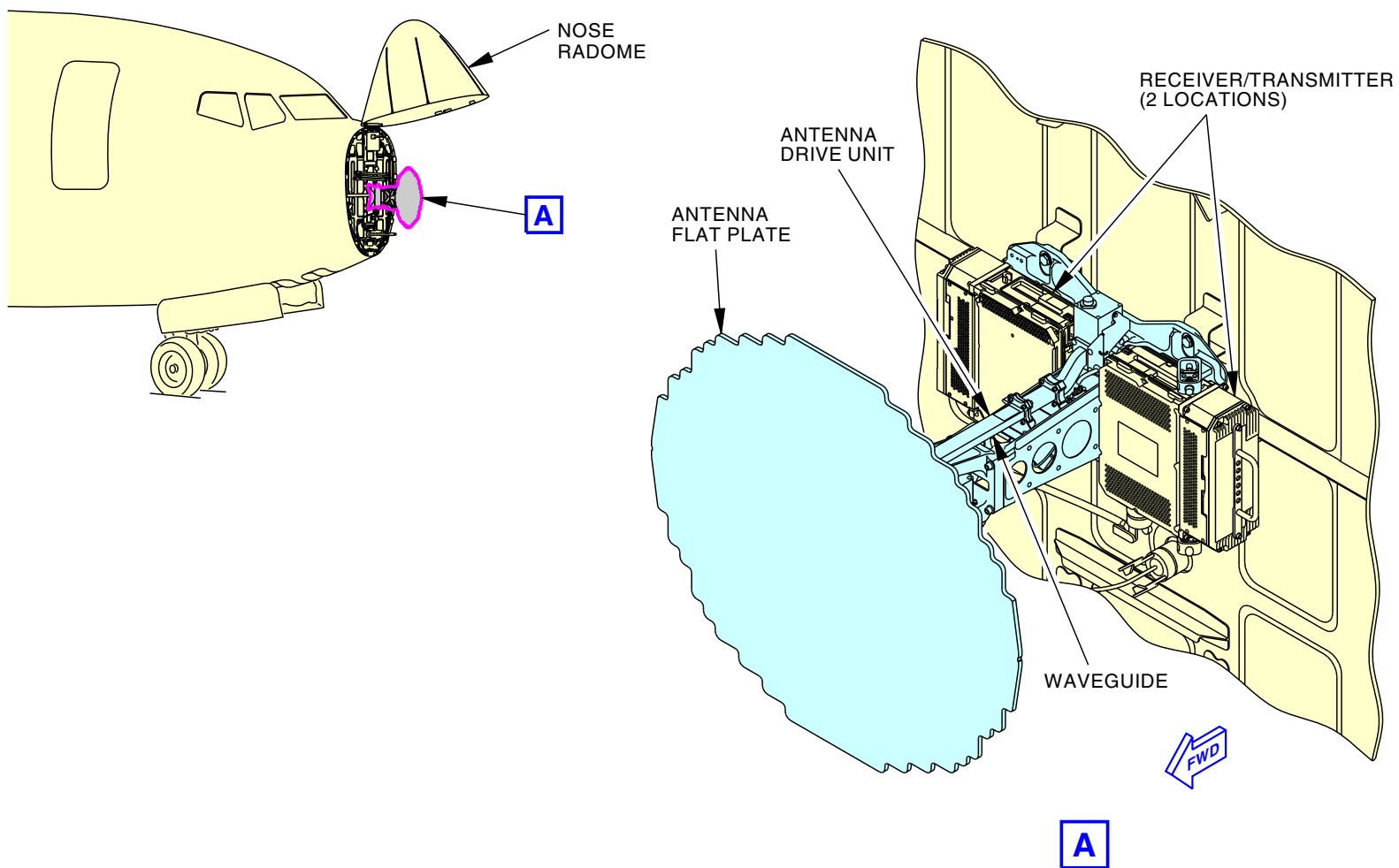
- Scan motors
- Antenna position monitors
- Elevation and scan disable switches.

There is a horizontal scan motor to move the antenna +/- 90 degrees from the airplane centerline. There is also an elevation scan motor to move the antenna +/- 40 degrees up or down. This value includes manual tilt selection from the WXR control panel.

There is a zero position monitor and an incremental monitor for each motor. These monitors send antenna horizontal scan and elevation scan position data to the WXR R/T. There are elevation and azimuth scales that permit a visual measurement of the tilt and scan angles.

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WXR SYSTEM - ANTENNA



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WXR SYSTEM - ANTENNA

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**WXR SYSTEM - EFIS CONTROL PANEL - OPERATION****EFIS Control Panel**

These are the functions of the EFIS control panel (CP) for WXR control:

- Supplies the on and off control of the WXR RP.
- Enables the navigation displays (ND) to show WXR data
- Supplies the selection of different ND modes
- Supplies the selection of different ranges for WXR data to show on the NDs.

The weather/turbulence mode shows turbulence data up to a maximum range of 40 nautical miles (NM). If a range more than 40 NM is set on the EFIS control panel, the NDs show weather and turbulence data up to a range of 40 NM and weather data only beyond 40 NM.

WXR Map Switch

These are the things that occur when you push the WXR map switch:

- The WXR RP and R/T start to operate
- The WXR data shows on the on-side ND.

To stop the operation of the WXR RP and R/T, the WXR map switches on both EFIS control panels must be off.

Mode Selector

Use the mode selector switch to select an ND mode. A WXR display can show in these ND modes:

- Expanded APP (approach) mode
- Expanded VOR mode
- Expanded MAP mode
- Centered MAP mode.

Range Selector

The EFIS control panel range selector has eight positions. The range selections are 5, 10, 20, 40, 80, 160, 320, and 640 nautical miles (NM). With the 640 NM range selection, the 640 NM range shows on the ND. But the WXR R/T only shows weather displays out to a maximum range of 320 NM.

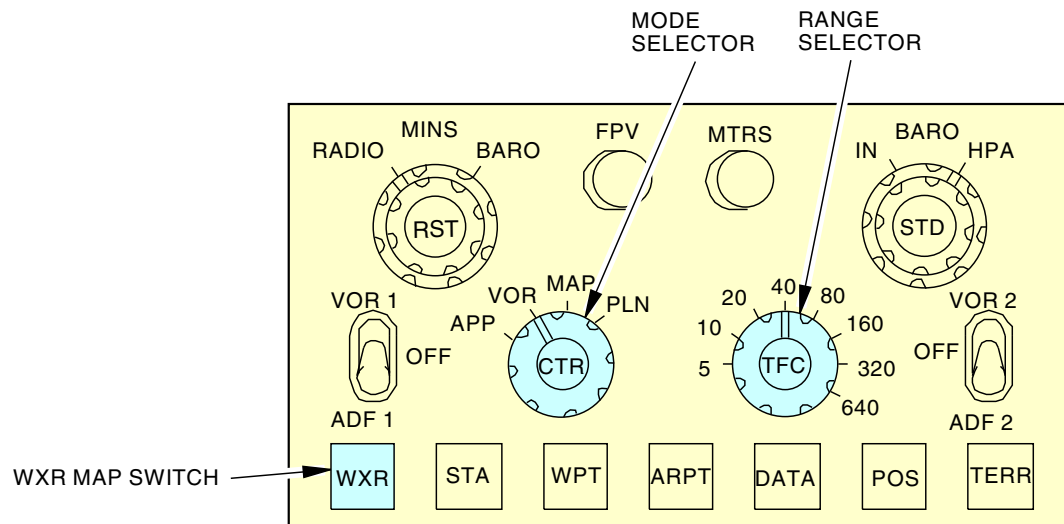
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WXR SYSTEM - EFIS CONTROL PANEL - OPERATION



WXR SYSTEM - EFIS CONTROL PANEL - OPERATION

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**WXR SYSTEM - SYSTEM SELECT AND SYSTEM ON/OFF****System Select**

The left receiver transmitter (R/T) gets 115v ac from XFR bus 2 and the right R/T gets 115v ac from XFR bus 1. The keep alive power supply makes unregulated and regulated 28v dc. The unregulated 28v dc power goes to the power relay in the R/T and also provides the interlock (INTRLK) signal through the WXR control panel to switch S1. S1 is held closed.

System On

To make the WXR system operate, push the WXR switch on one of the EFIS control panels.

When you push the WXR switch, the on-side Display Processing Computer (DPC) supplies a ground through the WXR control panel. The ground then goes through switch S1 of the R/T. This ground lets the unregulated 28v dc power from the power supply energize the relay to close switches S2 and S3. The keep-alive power supply sends regulated 28v dc power through switch S2 to energize the WXR CP power supply. The 115v ac goes through switch S3 to energize these things:

- R/T low voltage power supply
- Elapsed time counter
- WXR antenna drive
- WXR cooling fan.

Certain conditions cause the predictive windshear (PWS) function to turn the WXR system on automatically. When this happens, the ground signal comes from the PWS card in the R/T instead of the DPCs.

System Off

To make the WXR system go OFF, push the WXR switch on the EFIS control panel to OFF. This removes the ON discrete from the DPC. If more than one WXR switch is on, push all of the switches to OFF.

NOTE: You can also push the TERR switch on the EFIS control panel to make the WXR system go off.

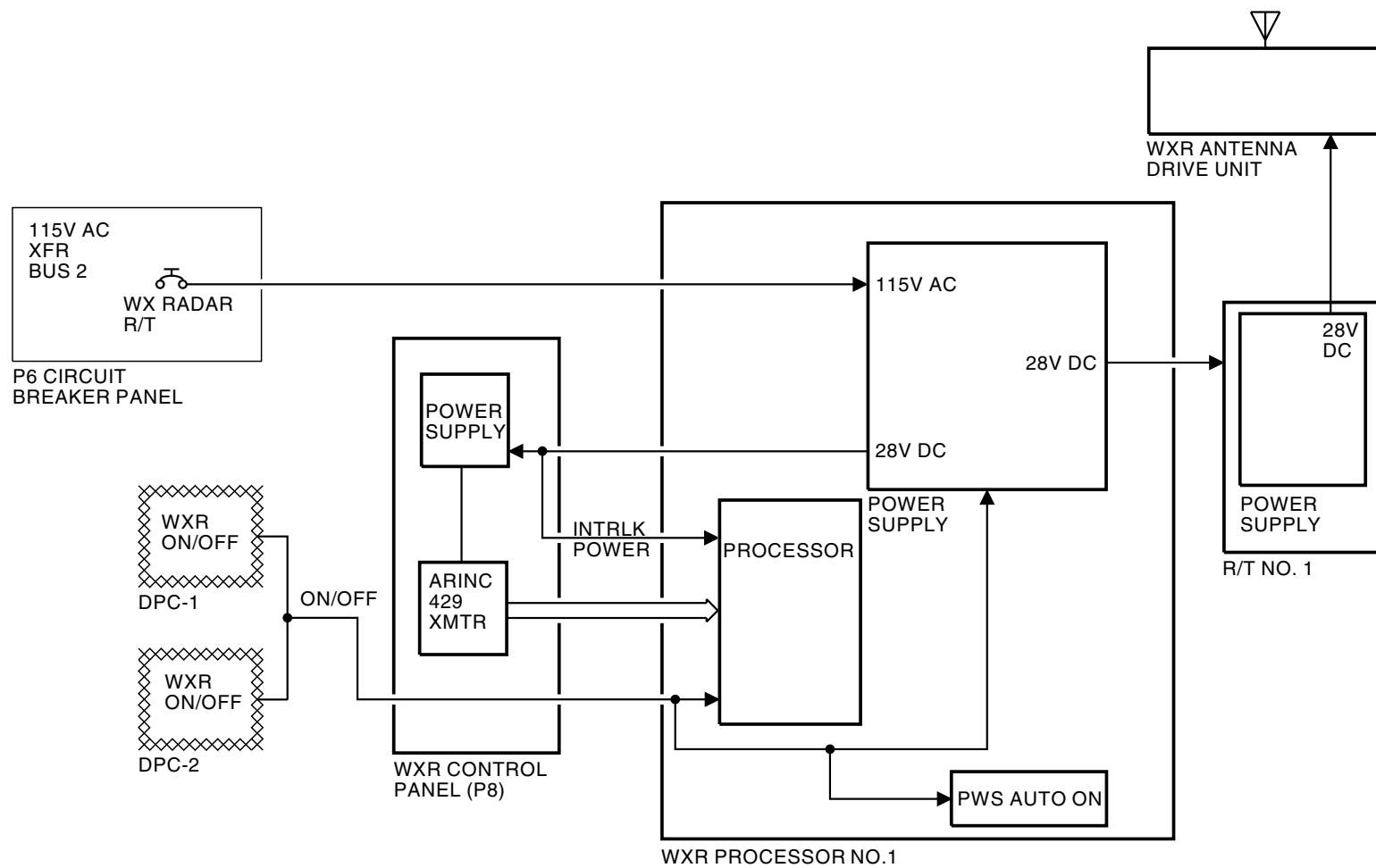
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WXR SYSTEM - SYSTEM SELECT AND SYSTEM ON/OFF

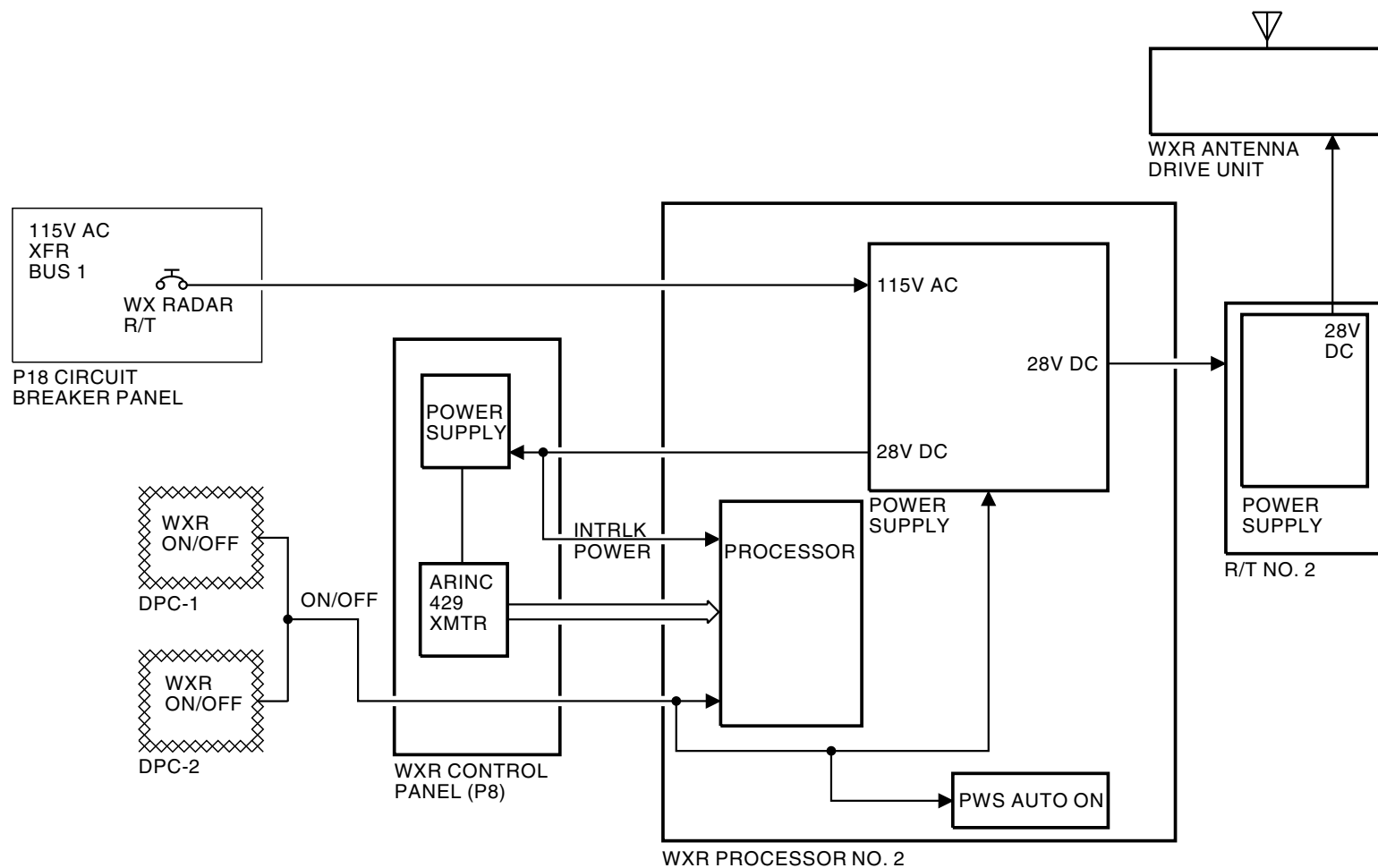


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WXR SYSTEM - SYSTEM NO. 1 SELECT AND SYSTEM ON/OFF

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WXR SYSTEM - SYSTEM SELECT AND SYSTEM ON/OFF



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WXR SYSTEM - SYSTEM NO. 2 SELECT AND SYSTEM ON/OFF

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WXR SYSTEM - NORMAL DISPLAYS

Display Modes

The navigation display (ND) shows WXR system data in these modes:

- Expanded approach
- Expanded VOR
- Center MAP
- Expanded MAP.

WXR System Display Data

The ND shows these displays:

- WXR data
- WXR system messages
- WXR alert messages.

WXR Displays

The WXR data on the ND shows the weather or the terrain in front of the airplane. Colors show the strength of the RF return signals from the weather or the terrain. These are the four colors for the WXR displays:

- Green - light weather
- Yellow - medium weather
- Red - heavy weather
- Magenta - turbulence.

The WXR system calculates and shows turbulence only to 40 NM.

WXR System Messages

This weather radar data shows on three lines in the bottom left of the navigation display:

- Mode
- Antenna tilt
- Gain.

Line 1 shows mode. Mode shows this data:

- WXR
- MAP
- WX+T
- TEST.

Line 2 shows the antenna tilt value set on the WXR panel. Antenna tilt shows 0.0 to + 15 or - 15 degrees.

Line 3 shows gain. Gain shows this data:

- VAR - R/T has gain set by gain switch
- Blank - normal operation (gain switch in AUTO).

All WXR system messages show cyan. There is no annunciation for the standby mode.

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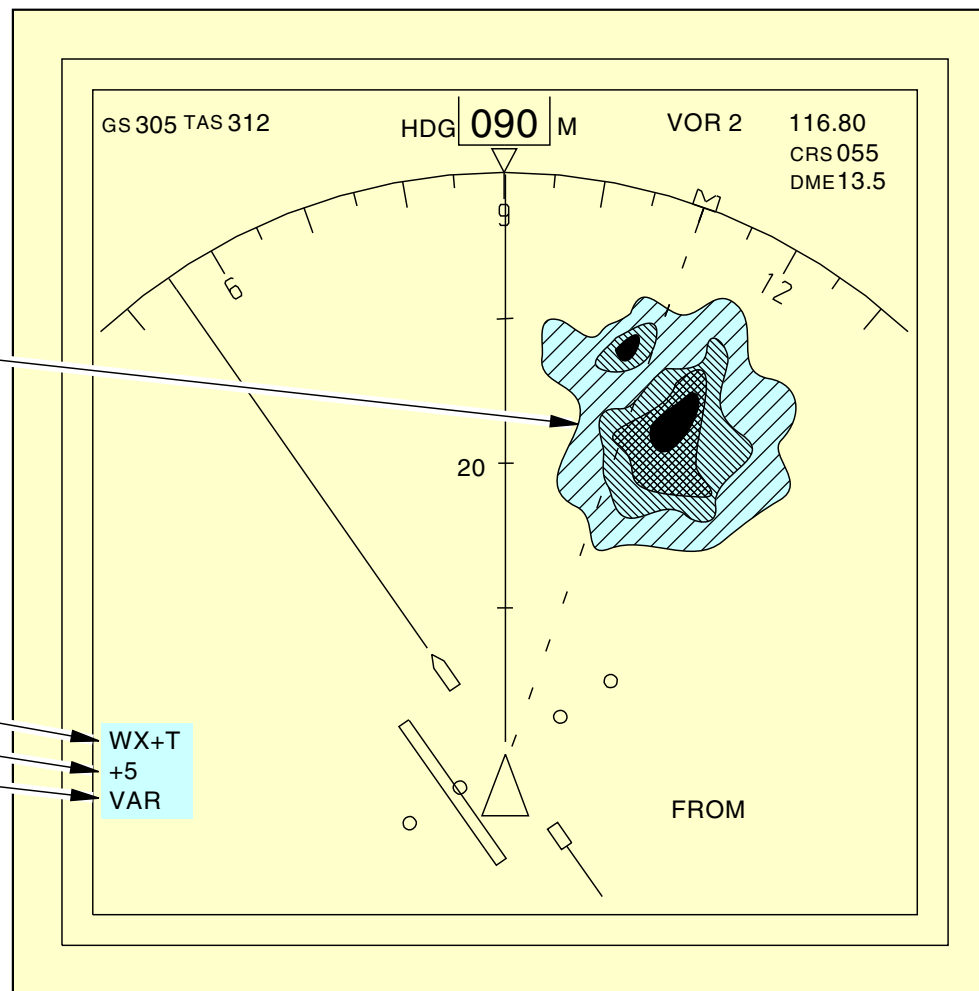
WXR SYSTEM - NORMAL DISPLAYS

WEATHER DATA:

- GREEN = LIGHT WEATHER
- YELLOW = MEDIUM WEATHER
- RED = HEAVY WEATHER
- MAGENTA = TURBULENCE

WEATHER SYSTEM MESSAGES:

- WEATHER MODE
- ANTENNA TILT
- GAIN VALUE



(EXAMPLE)

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WXR SYSTEM - NORMAL DISPLAYS

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**WXR SYSTEM - PWS OPERATION****General Description**

If the PWS detects a windshear threat, it makes an alert. The alert may be a warning or a caution. The alert the crew receives depends upon these conditions:

- Position of the windshear relative to airplane heading
- Distance to the windshear
- Airplane flight phase - takeoff or approach.

PWS Warning Area

During takeoff, PWS gives a warning if it detects a windshear threat in this area:

- Less than 0.25 NM on either side of the airplane projected magnetic heading
- More than 0.5 NM but less than 3 nm ahead of the airplane.

During approach, PWS gives a warning if it detects a windshear threat in this area:

- Less than 0.25 NM on either side of the airplane projected magnetic heading
- More than 0.5 NM but less than 1.5 nm ahead of the airplane.

PWS inhibits new windshear warnings during takeoff and approach if both of these conditions exist:

- Airspeed more than 100 knots
- Less than 50 feet radio altitude.

PWS Caution Area

PWS gives a caution if it detects a windshear threat in this area:

- Within 25 degrees on either side of the airplane projected magnetic heading
- More than 0.5 nm but less than 3 nm ahead of the airplane

- Not in the PWS warning area.

PWS inhibits new windshear cautions during takeoff and approach if both of these conditions exist:

- Airspeed more than 80 knots
- Less than 400 feet radio altitude

All PWS alerts are inhibited above 1200 feet radio altitude.

PWS Warning - Flight Deck Effects

A PWS warning has these visual and aural annunciations:

- Red WINDSHEAR message on the PFD
- Red WINDSHEAR message on the ND
- Aural annunciation - WINDSHEAR AHEAD, WINDSHEAR AHEAD (takeoff)
- Aural annunciation - GO AROUND, WINDSHEAR AHEAD (approach).

PWS Caution - Flight Deck Effects

A PWS caution has these visual and aural annunciations:

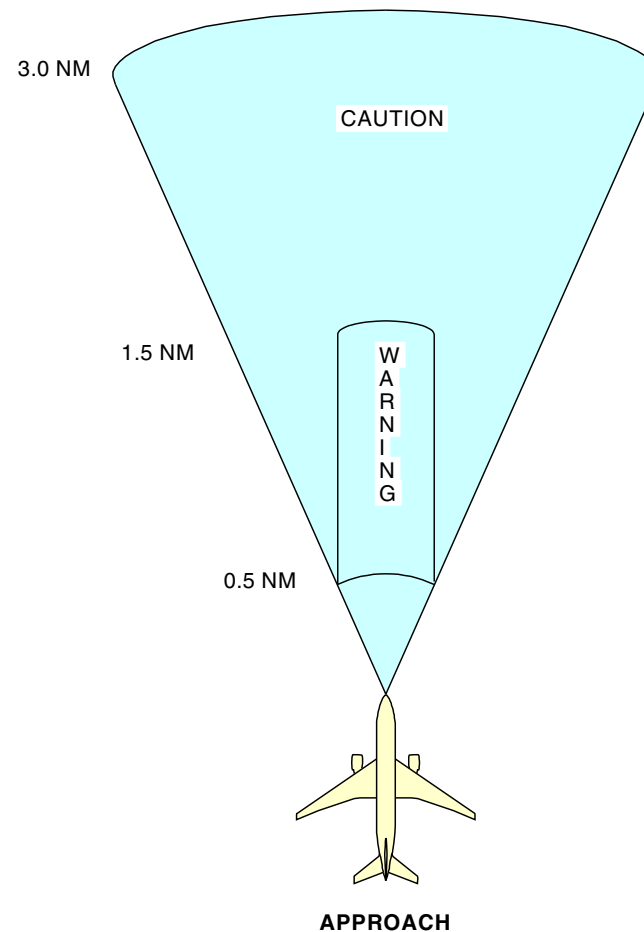
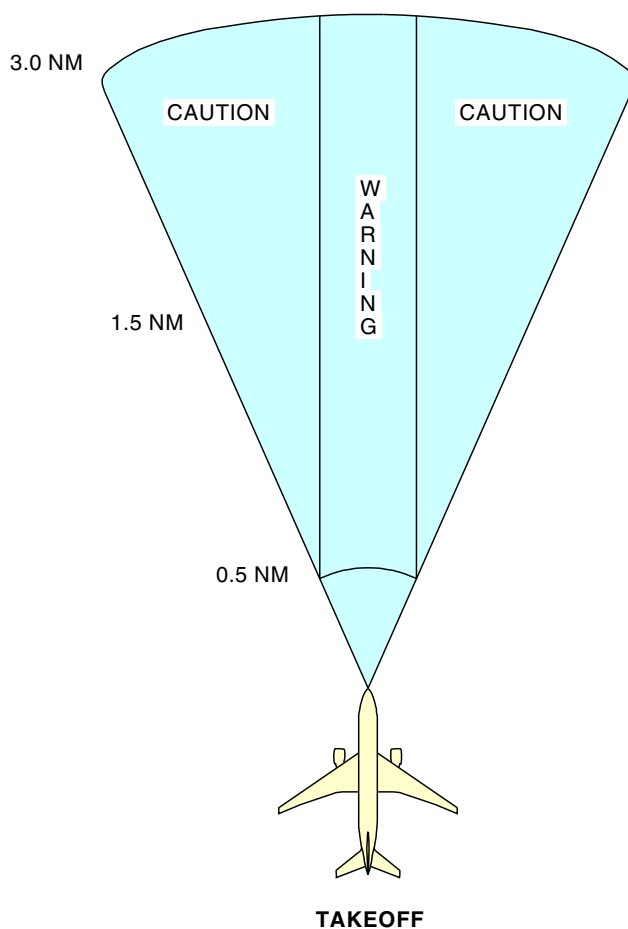
- Amber WINDSHEAR message on the ND
- Windshear symbol on the ND
- Aural annunciation - MONITOR RADAR DISPLAY.

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WXR SYSTEM - PWS OPERATION



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WXR SYSTEM - PWS OPERATION

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**WXR SYSTEM - PWS DISPLAYS****General Description**

Weather radar with predictive windshear (PWS) detects windshear ahead of the airplane. PWS uses this data to detect windshear:

- Doppler radar returns
- Inertial data
- Air data.

If PWS detects a windshear condition, it alerts the flight crew with visual and aural annunciations.

System On/Off - Takeoff

PWS turns on when the airplane is on the ground and has one of these conditions:

- Throttles move through 53 degrees
- Flight crew pushes the WXR button on an EFIS control panel.

The WXR button on the EFIS CP does not turn off the PWS if the throttle levers are above 53 degrees. PWS turns off automatically when the airplane climbs above 2300 feet radio altitude.

System On/Off - Approach

PWS turns on automatically when the airplane descends below 2300 feet radio altitude. PWS turns off when one of these conditions occur:

- Airplane lands
- Airplane climbs above 2300 feet radio altitude

If PWS is on and WXR is not selected on the EFIS CP, all antenna sweeps search for windshear. If WXR is selected, the antenna uses one sweep to search for windshear and the other sweep to search for normal weather returns. PWS operation does not affect the WXR mode or range selected by the flight crew.

PWS Display

If PWS detects windshear, it makes a windshear symbol on the ND. The symbol is red and black bars. Yellow bars go from the edges of the symbol to the compass rose. The yellow bars help the crew to see the PWS symbol.

The ND mode selector must be in a correct mode for the windshear data to show. These are the ND modes that show windshear data:

- Expanded APP
- Expanded VOR
- Expanded MAP
- Centered MAP.

PWS cautions or warnings are inhibited above 1200 feet radio altitude.

New PWS cautions are inhibited between 80 knots computed airspeed on the ground and 400 feet radio altitude.

New PWS warnings are inhibited between 100 knots computed airspeed and 50 feet radio altitude.

These inhibits apply to both takeoff and approach modes.

NOTE: These inhibits do not remove a PWS caution or warning that already exists.

Sweep Patterns

The antenna sweep is the same for takeoff and approach PWS modes. The PWS changes the sweep when PWS is active. Both WXR and PWS sweeps decrease to -60 to +60 degrees.

PWS and WXR Sweep Pattern					
Position	Dir	Radar Sweep	Paint Sweep	Angle (Degrees)	Time
Sweep 1	L-R	Capt WXR data updated	Capt WXR + icon painted	-60 to +60	3

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WXR SYSTEM - PWS DISPLAYS

(Continued)

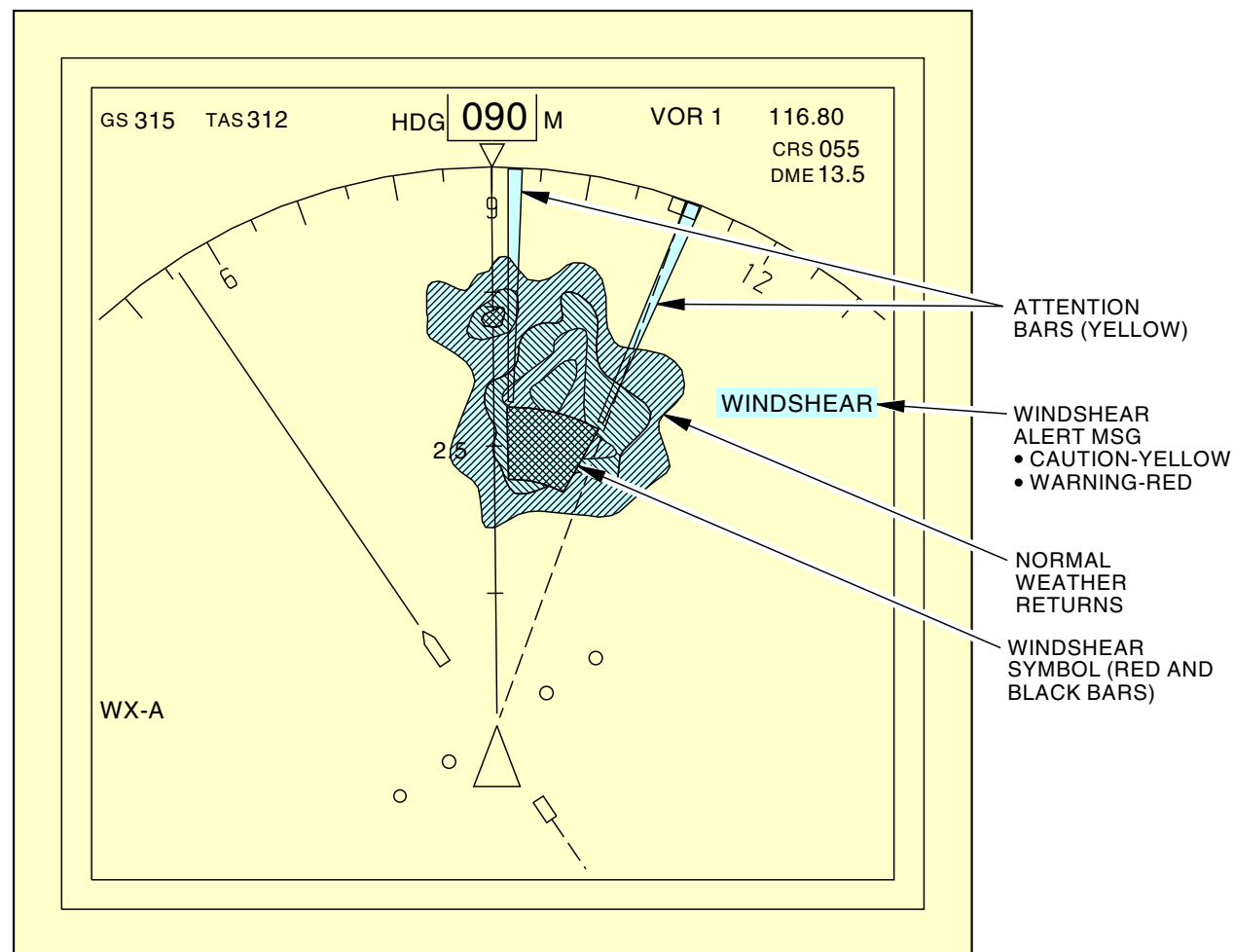
PWS and WXR Sweep Pattern					
Sweep 2	R-L	Both PWS data updated	None	+60 to -60	3
Sweep 3	L-R	F/O WXR data updated	F/O WXR + icon painted	-60 to +60	3
Sweep 4	R-L	Both PWS data updated	None	+60 to -60	3

The sweep pattern may go to a PWS only mode during takeoff and approach when WXR is not selected and PWS is automatically activated. The scan is -60 to +60 degrees.

PWS Sweep Pattern					
Position	Dir	Radar Sweep	Paint Sweep	Angle (Degrees)	Time
Sweep 1	L-R	None	None	N/A	3
Sweep 2	R-L	Both PWS data updated	None	+60 to -60	3
Sweep 3	L-R	None	None	N/A	3
Sweep 4	R-L	Both PWS data updated	None	+60 to -60	3

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WXR SYSTEM - PWS DISPLAYS



(EXAMPLE)

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WXR SYSTEM - PWS DISPLAYS

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**WXR SYSTEM - OPERATION - FAILURE DISPLAYS****WXR System Alert Messages and Display**

- WXR ATT shows when the selected attitude input fails

The alert messages show on these alert lines:

- Line 1 shows Weather Radar (WXR) in amber
- Line 2 shows ATT in amber.

WXR System Fail Messages and Display

A failure of these components causes a WXR failure:

- R/T
- WXR control panel
- WXR antenna.

A WXR failure causes these conditions:

- WXR FAIL message shows on Navigation Display (ND)
- Mode, altitude and gain messages go out of view

The fail message shows on these alert lines:

- Line 1 shows WXR in amber
- Line 2 shows FAIL in amber.

A failure of these components will cause a Proximity Warning System (PWS) failure:

- The two Radio Altimeter (RA)'s
- Scan and elevation antenna faults
- Internal WXR faults.

A failure of the predictive windshear causes an amber PWS FAIL message on the ND.

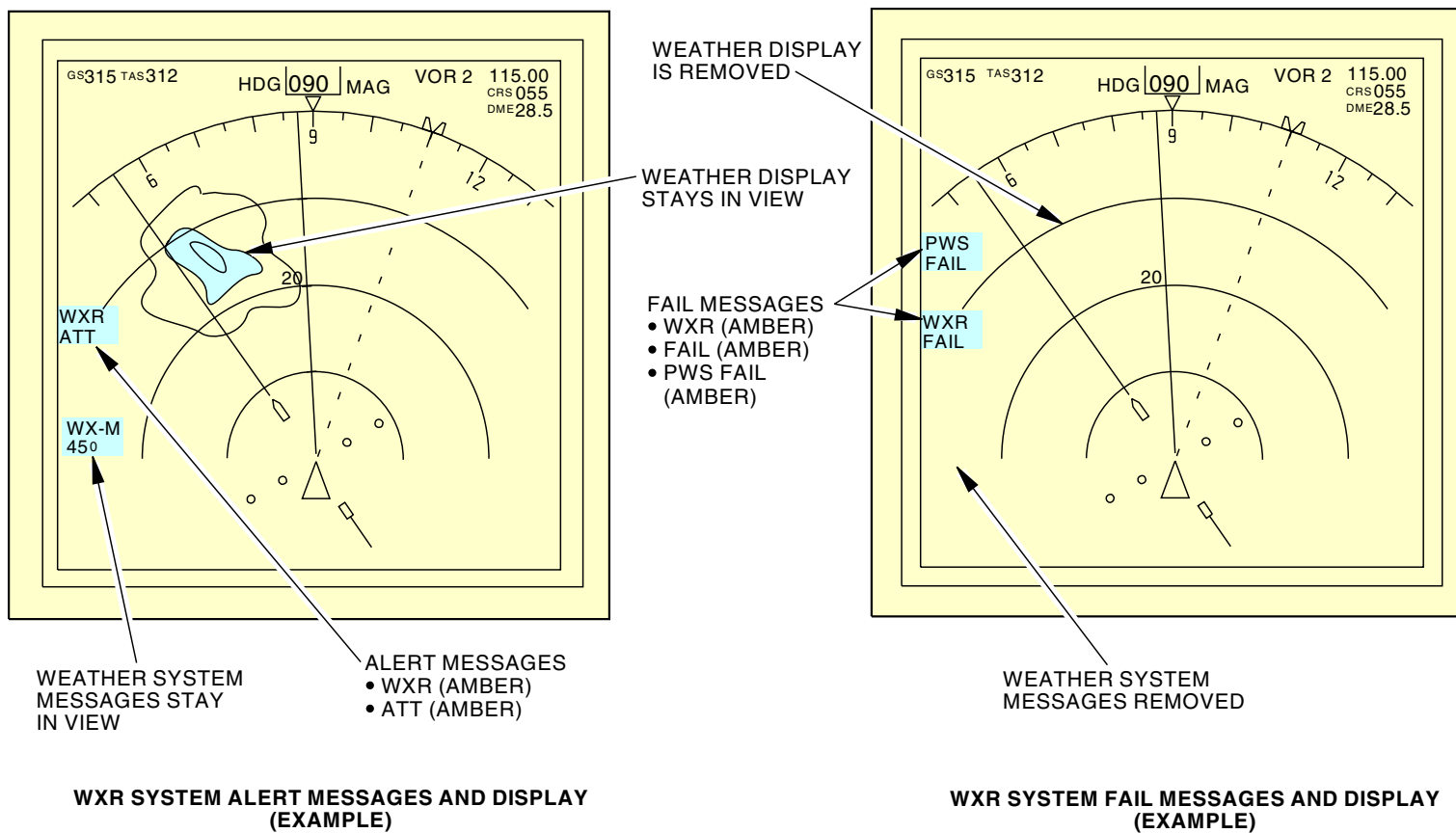
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WXR SYSTEM - OPERATION - FAILURE DISPLAYS



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WXR SYSTEM - OPERATION - FAILURE DISPLAYS

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**WXR SYSTEM - ND RANGE DISAGREEMENT****General**

The DPCs compare the ND ranges from these components:

- EFIS CP
- WXR R/Ts
- Flight management computer (FMC).

A difference between any of these ranges causes an amber range disagreement message on alert line 3.

These WXR range disagreement messages are possible:

- WXR RANGE DISAGREE; shows when there is a difference between the EFIS CP range and the WXR R/T range
- MAP/WXR RANGE DISAGREE; shows when there is a difference between the EFIS CP range, the WXR R/T range, and the FMC range.

WXR RANGE DISAGREE will show in these modes:

- Expanded approach
- Expanded VOR
- Expanded map
- Centered map.

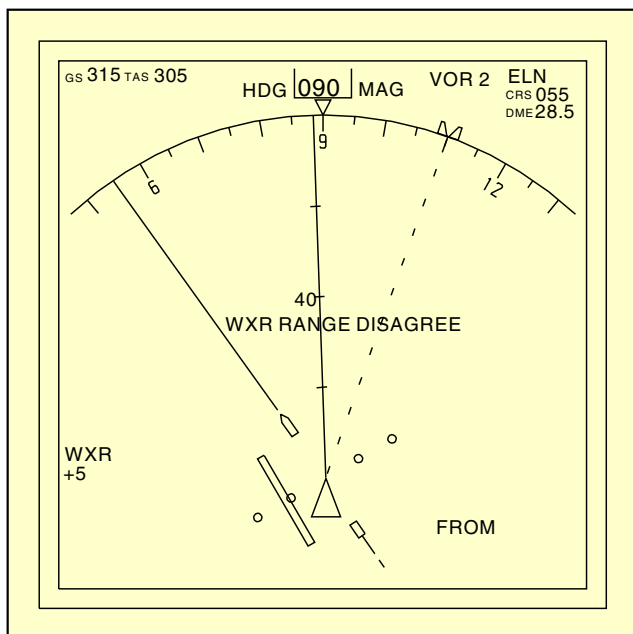
MAP/WXR RANGE DISAGREE will show in these modes:

- Expanded map
- Centered map.

This happens during a range disagreement:

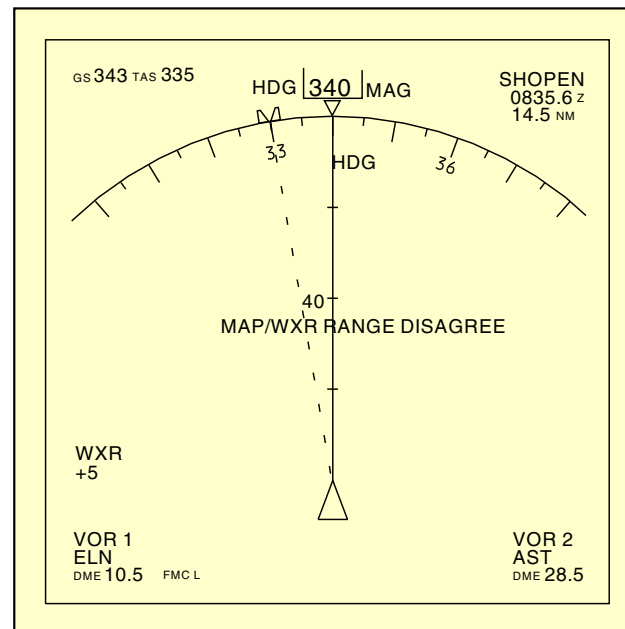
- WXR display goes out of view
- mode, tilt, and gain messages show
- FMC range shows.

WXR SYSTEM - ND RANGE DISAGREEMENT



(EXAMPLE)

MODES:
 - EXPANDED APPROACH
 - EXPANDED VOR
 - EXPANDED MAP
 - CENTERED MAP



(EXAMPLE)

MODES:
 - EXPANDED MAP
 - CENTERED MAP

WXR SYSTEM - ND RANGE DISAGREEMENT

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WXR SYSTEM - WXR RP AND R/T FUNCTIONAL DESCRIPTION

General

The WXR R/T makes RF pulses and sends them to the antenna. The antenna transmits pulses and receives the return signals and sends them to the WXR R/T. The R/T then sends the signals to the RP to process for display data that shows on the NDs. The WXR data on the ND shows the weather patterns in front of the airplane.

The WXR RP and R/T also comes on automatically during take off and approach to detect windshear events in front of the airplane. If a windshear event is detected, the WXR sends cautions or warnings to the flight compartment.

Control Inputs

The EFIS control panel (EFIS CP) sends the WXR system ON/OFF discrete on a digital bus to the Display Processing Computer (DPC). The DPC sends a discrete to the WXR control panel to enable the weather radar. The WXR control panel then sends mode information to the RP. The RP and R/T start to operate when it gets the digital mode information. The DPCs only send the ON discrete if the navigation display is in the correct mode. The EFIS CP sends range data to the WXR RP.

The WXR control panel sends control data on a bus to the WXR RP. The WXR CP sends these signals:

- Gain
- Altitude
- Mode of operation.

Predictive Windshear Inputs

These are the inputs to the WXR RP for predictive windshear (PWS):

- Ground proximity warning system inhibit discrete
- Auto throttle 1 switch pack throttle position discrete
- Auto throttle 2 switch pack throttle position discrete
- Radio altimeter 1 and 2.

The GPWS determines the priority for the aural warnings and cautions to the flight compartment. If the PWS CPU finds there is a windshear condition, the WXR RP sends the warning or caution to the GPWS.

The auto throttle packs determine the position of the throttles. When the airplane is on the ground and either throttle is moved more than 53 degrees, the PWS comes on automatically.

The PWS CPU uses the radio altimeter input to turn the PWS on or off. When the airplane goes below 1800 feet radio altitude on approach, the PWS is turned on. When the altitude goes above 1800 feet during takeoff, the PWS is turned off.

Antenna Control

The WXR RP gets attitude data for antenna stabilization from the ADIRUs. When the IRS select switch on the navigation/displays source select panel is in NORMAL or BOTH ON L, the RP uses the left ADIRU for stabilization. You put the IRS select switch to BOTH ON R to change to the right ADIRU stabilization data. The IRS select switch sends a ground discrete to the WXR RP.

WXR Central Processor Unit

The RP has a WXR central processor unit (CPU) uses the control data to control the operation of the RP, R/T and the antenna drive. The CPU sends these control signals to the transmitter circuits:

- Range
- Gain
- Mode.

Also, the WXR CPU makes the scan and elevation signals from the ADIRU attitude data. It sends these signals to the antenna for antenna stabilization. The WXR CPU also gets antenna position signals from the antenna assembly.

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**WXR SYSTEM - WXR RP AND R/T FUNCTIONAL DESCRIPTION****Predictive Windshear Central Processor Unit**

The PWS CPU uses inputs from these systems to turn on the WXR PWS function:

- Auto throttle switch packs
- Radio altimeters.

The PWS CPU controls the antenna scan and pulse repetition frequency of the transmitter to detect windshear events directly in front of the airplane. The area is limited to a very small range because of the high pulse repetition frequency.

When the PWS CPU detects a windshear, it sends the warning or caution to the GPWS. The GPWS has the priority logic for warnings and cautions. If there is no higher priority warning or caution, the PWS CPU sends the windshear display to the DPCs and sends the aural signal to the REU. Also, the PWS CPU sends an aural inhibit to the TCAS computer to inhibit any aural signals from TCAS.

Signal Generator/Transmitter Circuits

The signal generator/transmitter circuit makes RF pulse patterns and sends them out through the WXR antenna.

RF Transmit

The RF pulses go from the transmitter circuits through the duplexer. The duplexer connects the antenna to the transmitter during RF transmission. It also connects the antenna to the receiver circuits to get the return RF pulses.

RF Receive

The antenna receives the RF return signals. Then the RF return signal goes through the duplexer to the receiver circuits. The receiver circuits send the return signals to the RP CPU to process. The CPU uses the strength of the RF return signals to calculate the intensity of the precipitation and to make the WXR display data.

When the PWS is on, the return signals may also contain windshear information. The PWS CPU processes the windshear returns and makes the aural signals and display signals.

WXR Display Data

The CPU puts this data into the ARINC 453 format:

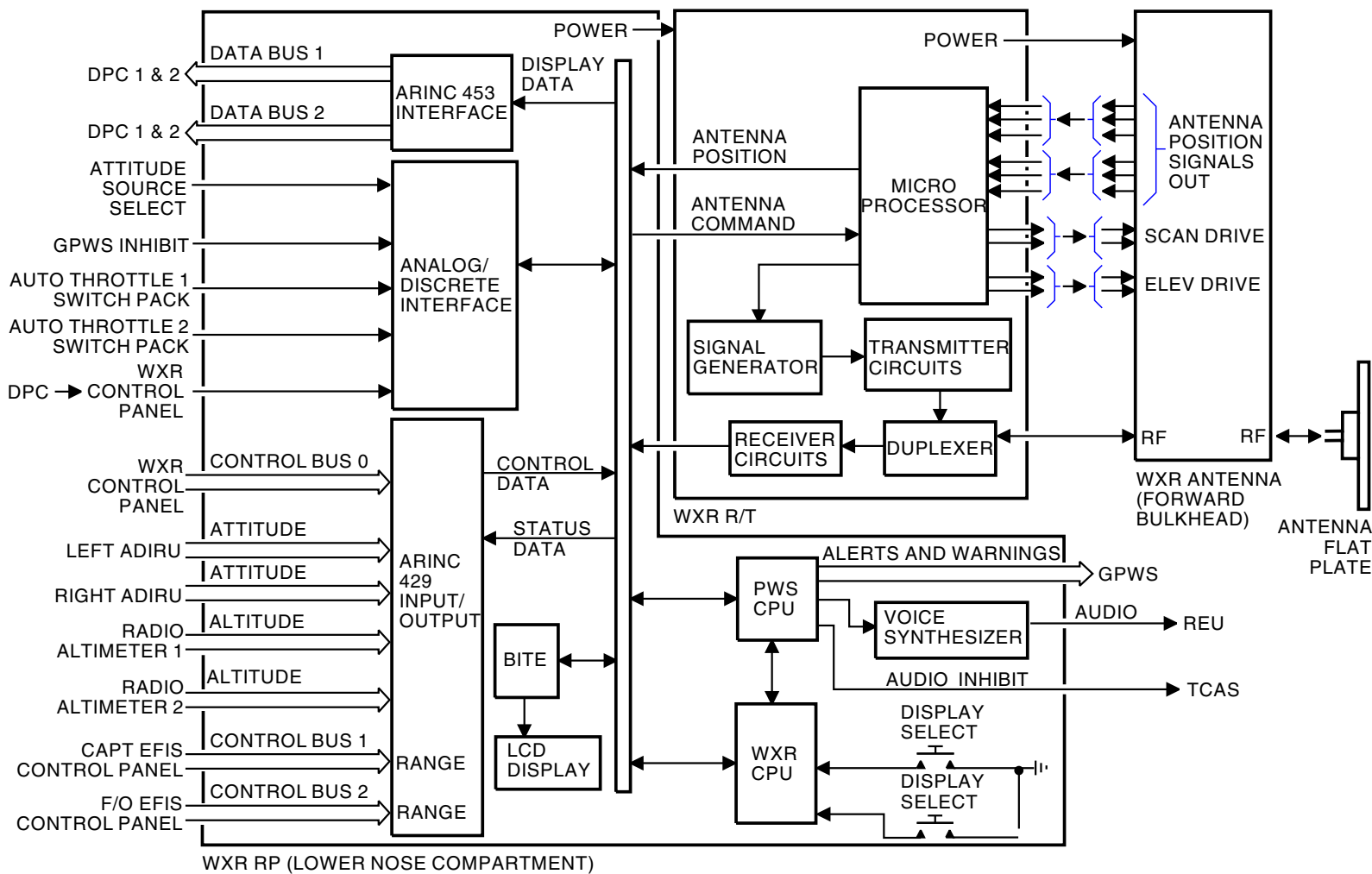
- WXR display data
- Range processed
- System mode
- Status data.

The CPU sends the output data to the ARINC 453 transmitters. The 453 transmitters send the data on the high speed ARINC 453 DATA BUS 1 and DATA BUS 2 to the DPCs.

System Status Data

The BITE module continuously gets system status data. The BITE module stores the faults in memory. The system status and the faults show on the ND alert lines. The LCD on the front of the RP shows system failures and fault history.

WXR SYSTEM - WXR RP AND R/T FUNCTIONAL DESCRIPTION



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WXR SYSTEM - WXR RP AND R/T FUNCTIONAL DESCRIPTION



WXR SYSTEM - ANTENNA FUNCTIONAL DESCRIPTION

Antenna Control

The CPU in the WXR R/Ts controls and monitors the antenna operation.

Antenna Stabilization

The WXR R/Ts uses attitude inputs from the ADIRU for antenna stabilization. The CPU uses the attitude inputs to calculate and control the scan and elevation movements. It sends the scan and elevation drive signals to the antenna.

Antenna Operation

The antenna power supply gets 115v ac from the WXR R/Ts. The antenna power supply sends 26v dc power to the antenna motor driver. The motor driver sends 26v dc power to the scan and elevation stepper motors. The motor driver also sends power to the antenna position monitors.

Antenna Drive

The antenna has one scan motor and one elevation motor. The scan motor drives a geartrain which moves the antenna horizontally. It moves the antenna |90 degrees from the centerline of the airplane. The elevation motor drives a gear train which moves the antenna vertically. It moves the antenna up and down |40 degrees. This elevation range includes |15 degrees for the manual tilt.

Antenna Position Feedback

There are two zero and two incremental monitors in the antenna assembly. Each stepper motor has one zero monitor and one incremental monitor. The zero monitors read the zero or center position of the stepper motor. The incremental monitors count the number of steps the motor moves from the center position. The monitors send antenna position data to the WXR R/Ts.

Antenna Position Compare

The WXR R/Ts CPU uses the position information from the monitors to compare the actual antenna position with the desired antenna position. When the two are not the same, the WXR R/T sets the antenna fault.

Disable Switches

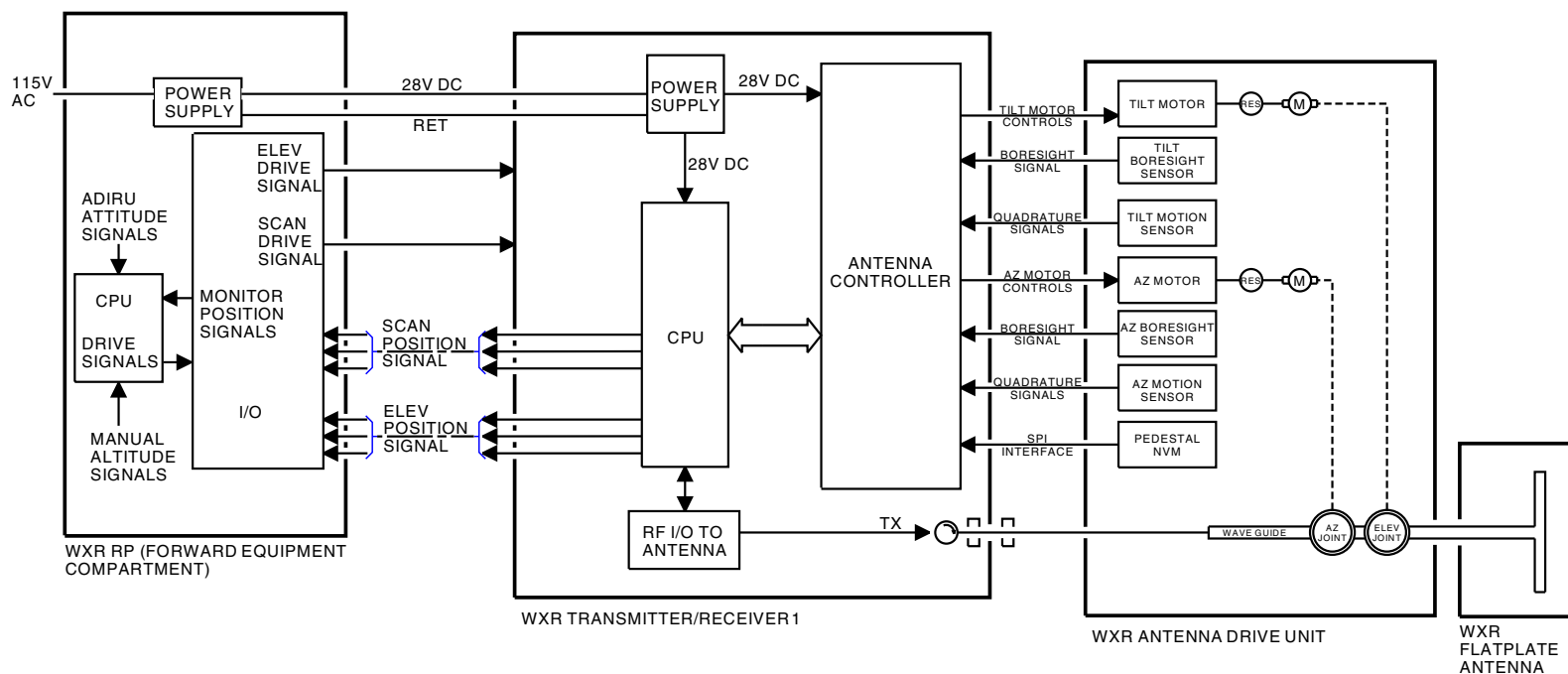
The disable switches are on the antenna pedestal. The scan disable switch disconnects the scan motor from the motor drive. The elevation disable switch disconnects the elevation motor from the motor drive. Because the motors disconnect from the motor drives, the antenna does not move.

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WXR SYSTEM - ANTENNA FUNCTIONAL DESCRIPTION



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WXR SYSTEM - ANTENNA FUNCTIONAL DESCRIPTION

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**WXR SYSTEM - WXR RP BITE - FUNCTIONAL DESCRIPTION****General**

The CPU in the WXR RP controls the operation of the BITE module. These are the functions of the BITE module:

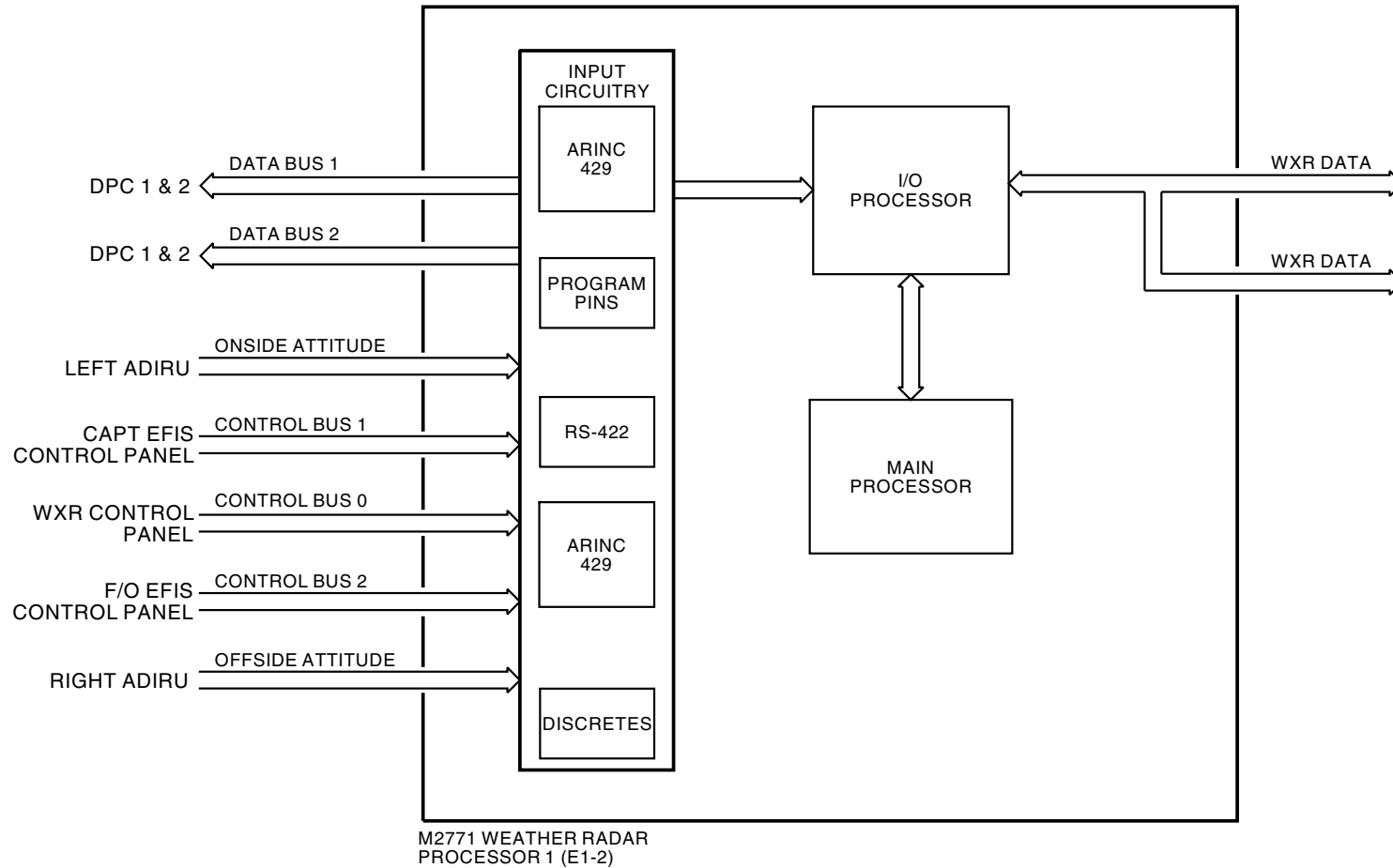
- Gets status information from the interface components
- Gets internally monitored data
- Does a self-test when it gets a command from the WXR CP
- Sends a test pattern to the Display Processing Computer (DPC)s to show on the ND
- Shows faults and fault history on LCD display
- Stores faults in nonvolatile fault memory
- Sends system status data to the DPCs to show on the ND.

Internal Input Monitoring

The BITE monitors these things:

- Over temperature from the power supply
- Control and range from the WXR panel on control bus 0
- Range inputs from the EFIS control panels on control bus 1 and 2
- Antenna scan and elevation position from the CPU.

WXR SYSTEM - WXR RP BITE - FUNCTIONAL DESCRIPTION



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WXR SYSTEM - WXR RP BITE - FUNCTIONAL DESCRIPTION

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**WXR SYSTEM - SELF-TEST****Test Preparation**

On the WXR control panel, select these functions:

- Set the tilt control to 0 degrees
- Set the gain control to the AUTO position.

On the EFIS control panel, select these functions:

- Set the range selector to 40 NM
- Set the mode selector to the correct ND mode (expanded APP, expanded VOR, expanded MAP or centered MAP).

Also, adjust the inner ND brightness control to the middle position.

Test Start

Push the WXR switch on the EFIS control panel to apply power to the WXR RP and R/T. On the WXR control panel, push the TEST switch in to start the test.

NOTE: If the TEST switch is selected (pushed in) before you apply power to the WXR RP and R/T, you must push the switch to unlatch it and then push it back in to start the test.

Test Operation

During the test, these things happen:

- R/T transmits a few pulses to let the BITE monitor for correct operation
- R/T makes a test pattern and sends it to the Display Processing Computer (DPC) to show on the NDs
- R/T sends test messages and mode, gain, and tilt information to the DPCs to show on the NDs
- WXR test pattern shows on ND.

The PWS symbol does not show in the TEST pattern. If PWS finds a windshear threat while in TEST mode, the test stops. The WXR Radar Processor then switches to the WXR mode and shows actual display data and alert annunciations. If the mode switch on the WXR control panel is still in the TEST position, the WXR will go back to the test pattern on the display when the PWS alert stops.

The test of the PWS indicators can be less than 10 seconds. The system completes a full self-test in approximately 50 seconds.

The test pattern shows until you select another mode on the WXR panel or EFIS control panel.

Test Pass

For a valid WXR self-test, MDS shows these displays:

- WXR test pattern
- Amber WINDSHEAR message on ND
- Aural message - MONITOR RADAR DISPLAY
- Red WINDSHEAR message on ND and PFD
- Aural message - GO AROUND, WINDSHEAR AHEAD, (pause) WINDSHEAR AHEAD, WINDSHEAR AHEAD
- WXR on alert message line one
- TEST on alert message line two.

Test Fail

For a test that fails, these are the indications on the ND:

- WXR test pattern does not show
- WXR shows on alert message on line one
- FAIL shows on alert message on line two
- Line three shows all of the failures.

These are the messages that can show on line three:

- R/T - receiver/transmitter fault

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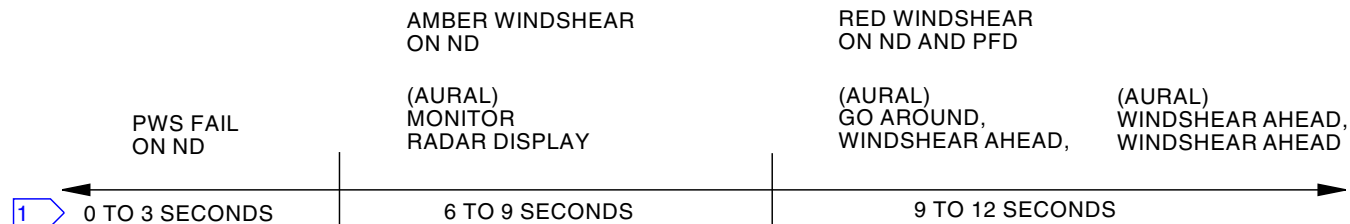
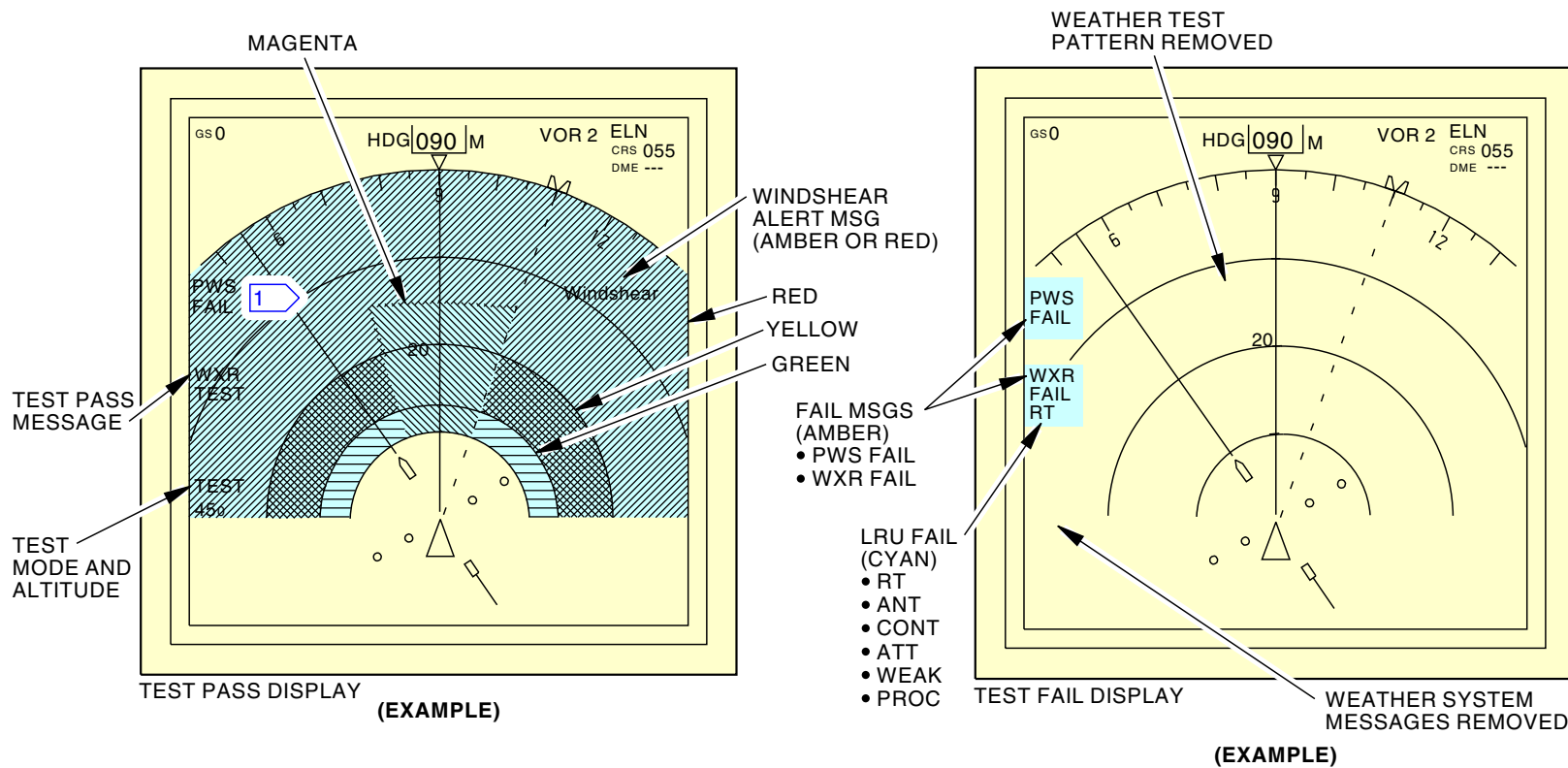
WXR SYSTEM - SELF-TEST

- ANT - antenna fault
- CONT - control panel fault
- ATT - attitude input fault
- WEAK - calibration fault.
- PROC - processor fault

There is no Aural output from WXR if the test fails.

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WXR SYSTEM - SELF-TEST



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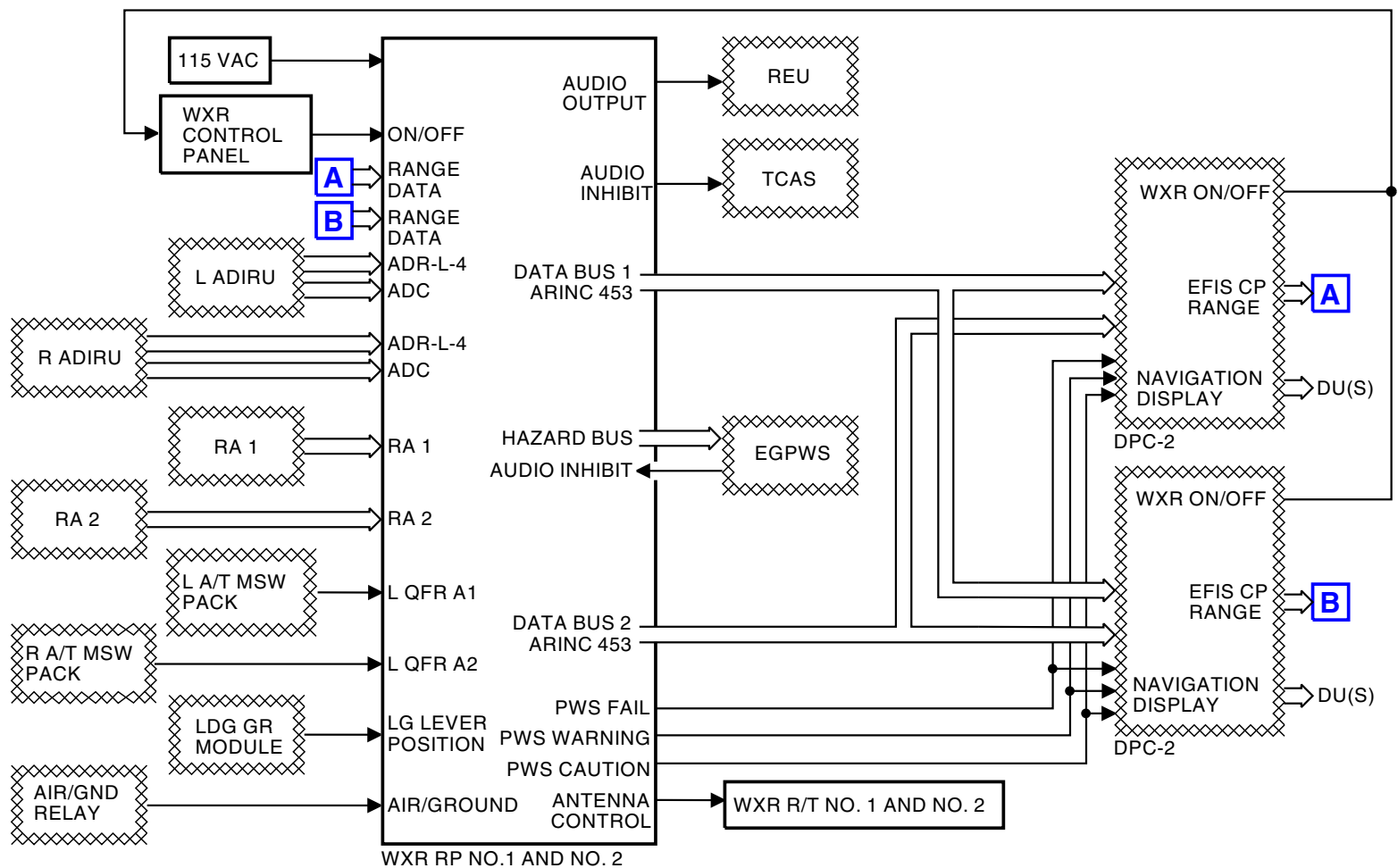
WXR SYSTEM - SYSTEM SUMMARY

General

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WXR SYSTEM - SYSTEM SUMMARY



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WXR SYSTEM - SYSTEM SUMMARY

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TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRODUCTION

General

The traffic alert and collision avoidance system (TCAS) helps the flight crew maintain safe air traffic separation from other ATC transponder equipped airplanes. TCAS is an airborne system and operates independently of the ground-based ATC system.

TCAS sends interrogation signals to nearby airplanes. These airplanes which are equipped with an air traffic control radar beacon system (ATCRBS) transponder or an air traffic control (ATC) mode S transponder respond to these interrogations. TCAS uses these response signals to calculate the range, relative bearing, and altitude of the responding airplane. If a responding airplane does not report altitude, TCAS cannot calculate the altitude of that airplane. Airplanes tracked by TCAS are called targets.

Using the information from the response signals and altitude of own airplane, TCAS calculates the relative movement between own airplane and the target. TCAS then calculates how close the target will be to own airplane at the closest point of approach (CPA).

Targets are classified as one of these four types depending on the separation at CPA and the time it will take until CPA occurs:

- Other traffic
- Proximate traffic
- Intruders
- Threats.

Each type of target has a different symbol on the display.

If the separation at CPA is within certain limits, TCAS provides advisory messages to the flight crew. TCAS provides two levels of advisories to the flight crew, traffic advisory (TA) and resolution advisory (RA). The type of advisory is determined by a combination of altitude, the time to CPA, and the separation at CPA. The TA shows for relatively longer times to CPA and relatively larger separation at CPA and is for intruder targets. The RA shows for relatively shorter times to CPA and relatively smaller separation at CPA and is for threat targets.

The TA shows the range, bearing, and relative altitude (if relative altitude is known) of the intruder target. The RA also gives visual and aural commands to the flight crew to make sure there is safe vertical separation from the threat target.

TCAS also communicates with other airplanes that have TCAS to coordinate the flight movement to prevent a collision.

Abbreviations and Acronyms

- abs - absolute
- abv - above
- ADIRU - air data inertial reference unit
- AGL - above ground level
- AI - attitude indicator
- ant - antenna
- arpt - airport
- ATC - air traffic control
- ATCRBS - air traffic control radar beacon system
- BITE - built-in-test equipment
- blw - below
- CPA - closest point of approach
- CPU - central processing unit
- CTR - center
- DME - distance measuring equipment
- DPC - display processing computer
- EFIS - electronic flight instrument system
- exp - expanded
- FDAU - flight data acquisition unit
- FL - flight level
- FPM - feet per minute
- fwd - forward
- gnd - ground

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TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRODUCTION

- GPWC - ground proximity warning computer
- grd - ground
- ident - identification
- IF - intermediate frequency
- INT - interrogator
- I/O - input/output
- L - left
- LED - light emitting diode
- max - maximum
- MDU - MAX display unit
- MHz - megahertz
- NCD - no computed data
- NM - nautical miles
- norm - normal
- R - right
- RA - resolution advisory
- rel - relative
- REU - remote electronic unit
- RF - radio frequency
- R/T - receiver/transmitter
- stby - standby
- sw - switch
- TA - traffic advisory
- TAS - true airspeed
- TAU - time to closest point of approach
- TCAS - traffic alert and collision avoidance system
- tfc - traffic
- trk - track
- VOR - very high frequency omnidirectional range
- VSI - vertical speed indicator
- wpt - waypoint
- xfr - transfer
- xpndr - transponder

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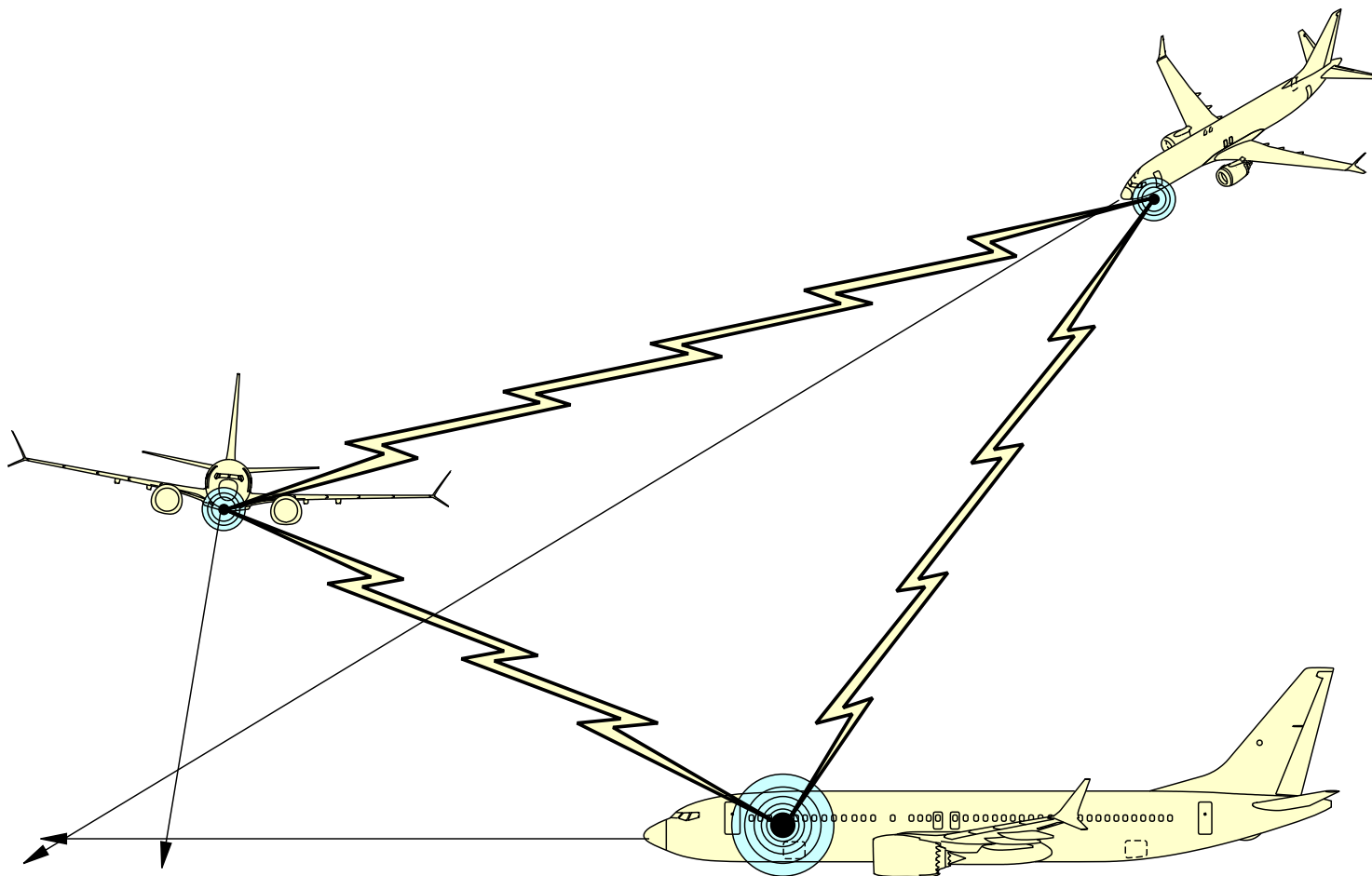
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TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRODUCTION



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TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRODUCTION

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TCAS - GENERAL DESCRIPTION

General

The TCAS transmits to and receives signals from other airplanes to get altitude, range, and bearing data. The other airplanes report their own altitudes. The range of the other airplanes is calculated by measurement of the time between the transmission of an interrogation and the reception of a response from the other airplanes. Bearing is calculated by the use of directional antennas. TCAS uses these data and inputs from other onboard airplane systems to provide visual indications of the position of other airplanes and to provide visual and aural traffic avoidance alerts.

General Description

These are the TCAS components:

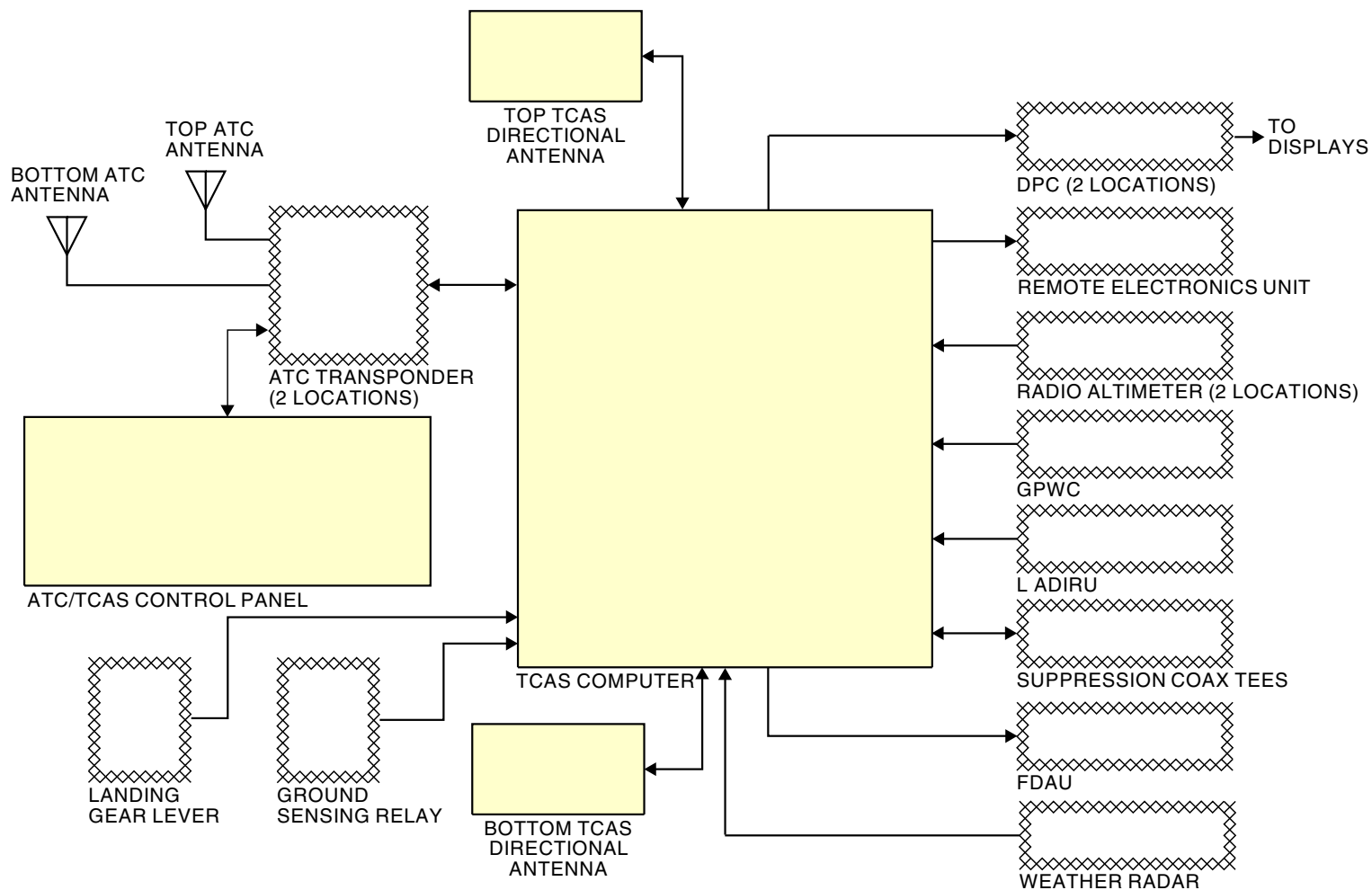
- TCAS directional antennas (2)
- TCAS computer
- ATC/TCAS control panel.

TCAS interfaces with these other system components:

- ATC transponders (2)
- Landing gear lever
- PSEU
- MAX display unit (MDU) display processing computer (DPCs) (2)
- Remote electronics unit (REU)
- Radio altimeters (2)
- Ground proximity warning computer (GPWC)
- Weather radar
- Left air data inertial reference unit (ADIRU)
- Suppression coax tees
- Flight data acquisition unit (FDAU).

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TCAS - GENERAL DESCRIPTION



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TCAS - GENERAL DESCRIPTION

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**TCAS - COMPONENT LOCATION****Electronic Equipment Compartment**

The TCAS computer is in the electronic equipment compartment.

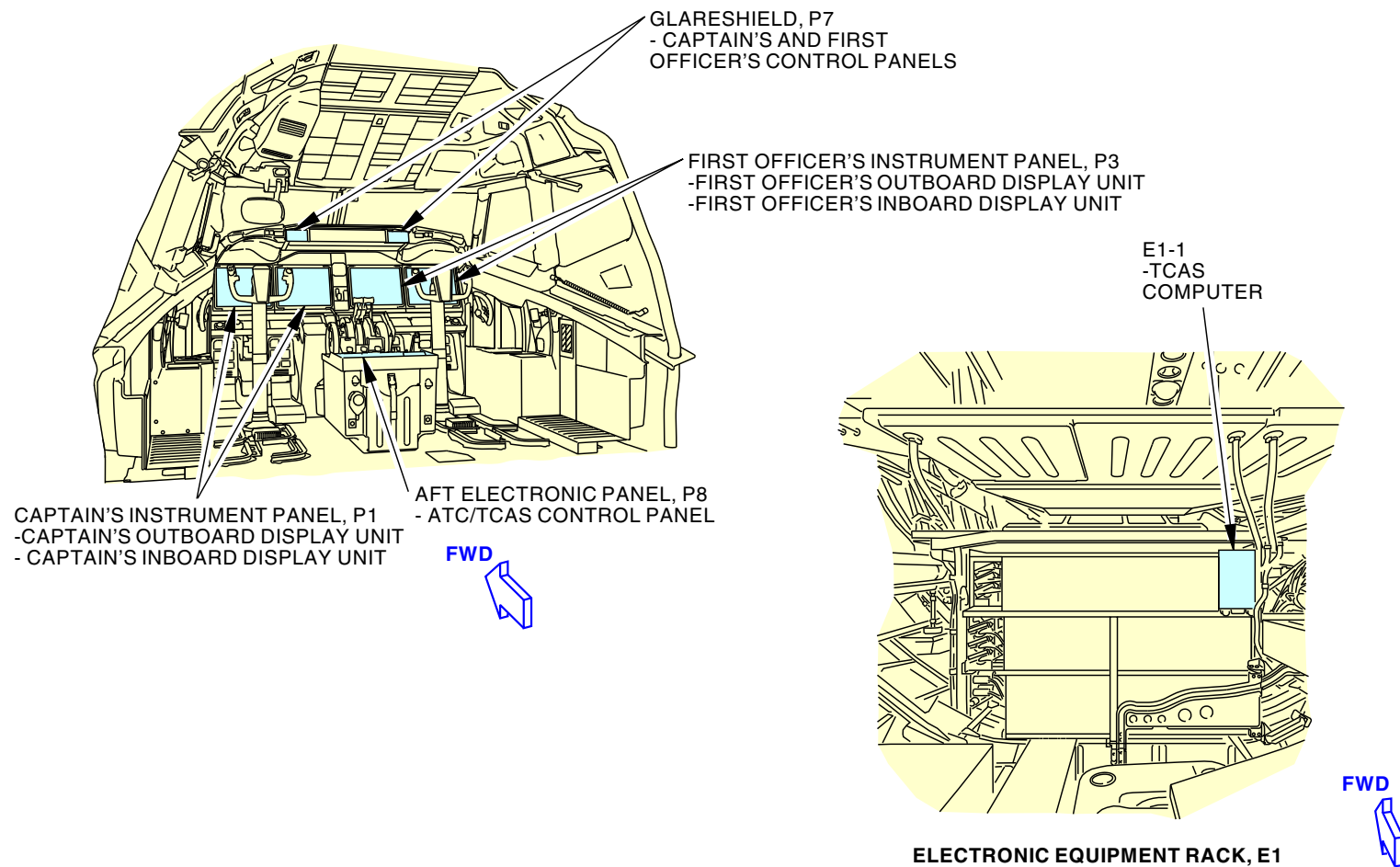
Flight Compartment

These are the components in the flight compartment that interface with TCAS:

- Captain and first officer's electronic flight instrument system (EFIS) control panel
- Captain's inboard display unit
- Captain's outboard display unit
- First officer's inboard display unit
- First officer's outboard display unit
- ATC/TCAS control panel.

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TCAS - COMPONENT LOCATION



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TCAS - COMPONENT LOCATION



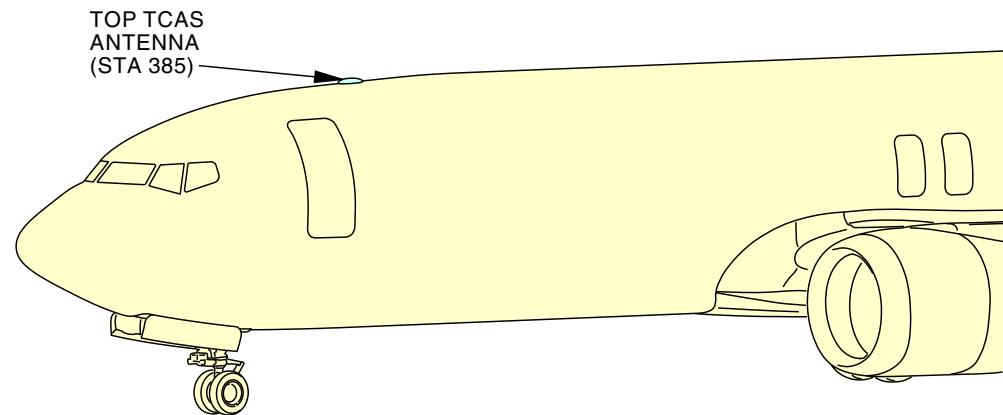
TCAS - ANTENNA LOCATION

General

The top TCAS directional antenna is at station 385 on top of the fuselage.
The bottom TCAS directional antenna is at station 305 on the bottom of the fuselage.

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TCAS - ANTENNA LOCATION



TCAS - ANTENNA LOCATION

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**TCAS - POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS****General**

The TCAS computer has analog and discrete interfaces with these components:

- Top and bottom TCAS directional antennas
- Landing gear lever switch
- Proximity Switch Electronics Unit (PSEU)
- Ground proximity warning computer (GPWC)
- Weather radar
- DME/ATC/TCAS suppression coax tees
- Display processing computer (DPC) 1 and 2
- Remote electronics unit (REU).

Program pins control the configuration of the TCAS computer.

Power

The TCAS computer gets 115v ac from AC transfer bus-1 through the TCAS circuit breaker on the P18 circuit breaker panel.

Antennas

There are two TCAS directional antennas. The TCAS directional antennas receive traffic airplane reply signals. They also transmit the TCAS interrogation signals.

Landing Gear Lever Switch

The discrete from the landing gear lever switch tells the TCAS computer that the landing gear is down. When the TCAS computer gets this discrete, the TCAS computer makes the bottom directional antenna become an omnidirectional antenna.

PSEU

The discrete from the PSEU supplies in-air or on-ground status to the TCAS computer. The air/ground discrete inhibits TCAS operation on the ground and inhibits tests when in the air. The air/ground discrete also controls flight leg increments in the TCAS nonvolatile memory.

GPWC - Advisory Inhibit Discretes

The GPWC sends one discrete to the TCAS computer. This discrete inhibits TCAS aural and visual warnings when the GPWC makes any voice message.

Weather Radar

The TCAS computer gets one discrete from the weather radar. This discrete inhibits all TCAS aural warnings and changes RAs to TAs when the weather radar makes a predictive windshear warning.

Suppression Input/Output

The TCAS computer gets a suppression pulse when an ATC transponder or DME interrogator transmits. When the TCAS computer transmits, it sends a suppression pulse to the ATC transponders and the DME interrogators.

DPC - Display Status

A discrete from either DPC goes to the TCAS computer when the DPC loses the ability to show TCAS displays. When the TCAS computer gets this discrete, the TCAS computer does not do these functions:

- Send TCAS display outputs to the DPC
- Send TCAS aural to the REU
- Transmit coordination data to traffic airplanes with TCAS.

REU - TCAS Aural - Voice Outputs

The TCAS computer sends resolution advisory (RA) and traffic advisory (TA) aural signals to the remote electronic unit (REU). The REU amplifies the RA and TA aural. Then it sends them to the flight interphone speakers and headsets to alert the flight crew.

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TCAS - POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS

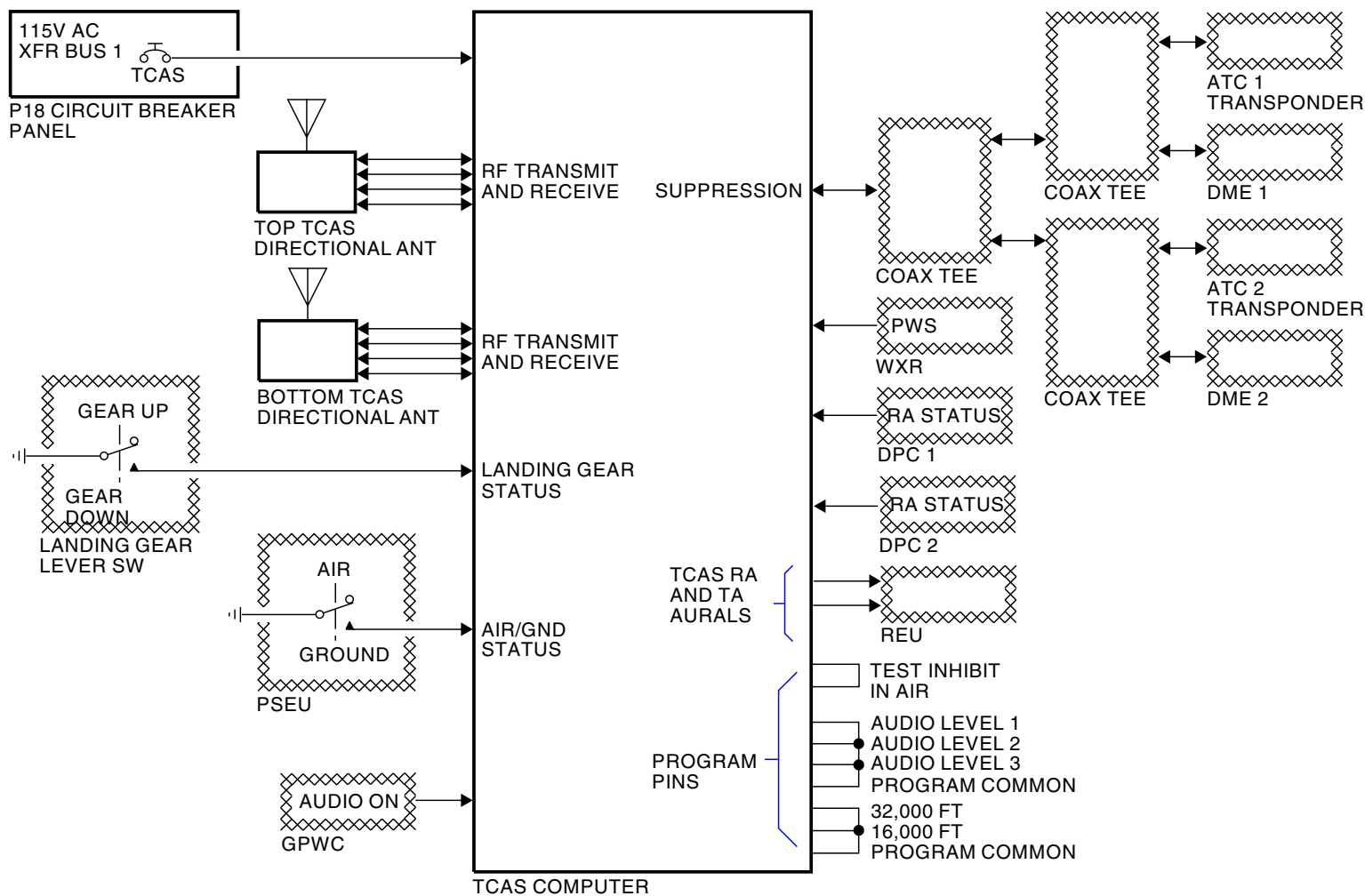
Program Pins

These are the functions for the program pins on the TCAS computer:

- Does not show airplanes that are on the ground when own airplane is below 1750 feet AGL
- Inhibits self-test in the air
- Controls the audio level of the voice outputs
- Sets the airplane altitude limit of 48,000 feet so TCAS does not command a climb or increase climb above this altitude.

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TCAS - POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS



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TCAS - POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS

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TCAS - DIGITAL INTERFACES

General

The TCAS computer has digital interfaces with these components:

- ATC 1 transponder
- ATC 2 transponder
- Radio altimeter 1 transceiver
- Radio altimeter 2 transceiver
- Left air data inertial reference unit (ADIRU)
- Display processing computer 1 (DPC 1)
- Display processing computer 2 (DPC 2)
- Flight data acquisition unit (FDAU).

ATC Transponder - Control and Coordination Data

When you select an ATC transponder, it sends this ATC control panel data to the TCAS computer:

- The TCAS mode selection (TA only or TA/RA)
- Control of the altitude limits for the TCAS display that shows on the navigation display (ND).

The TCAS computer uses this data from the ATC transponder to calculate the climb or descent to prevent a collision:

- 24-bit airplane address
- Barometric altitude
- Maximum true airspeed.

The TCAS computer sends this to the ATC transponder:

- General TCAS operational status
- Mode S coordination data.

Radio Altimeter Inputs

The TCAS computer gets radio altitude from radio altimeter 1 and 2 transceivers although only one input is necessary for TCAS operation. The data is used by the TCAS computer to calculate some sensitivity levels.

At approximately 1700 feet, the TCAS computer uses radio altitude together with barometric altitude to determine intruders that are on the ground and therefore no threat to the TCAS airplane.

At 1000 feet radio altitude, the TCAS computer inhibits resolution advisories and TA ONLY will show on the NDs.

TCAS Inputs from ADIRU

The left ADIRU supplies these inputs to the TCAS computer:

- Airplane roll attitude
- Airplane pitch attitude
- Airplane heading.

NOTE: Airplane heading is the only ADIRU input used by the TCAS computer.

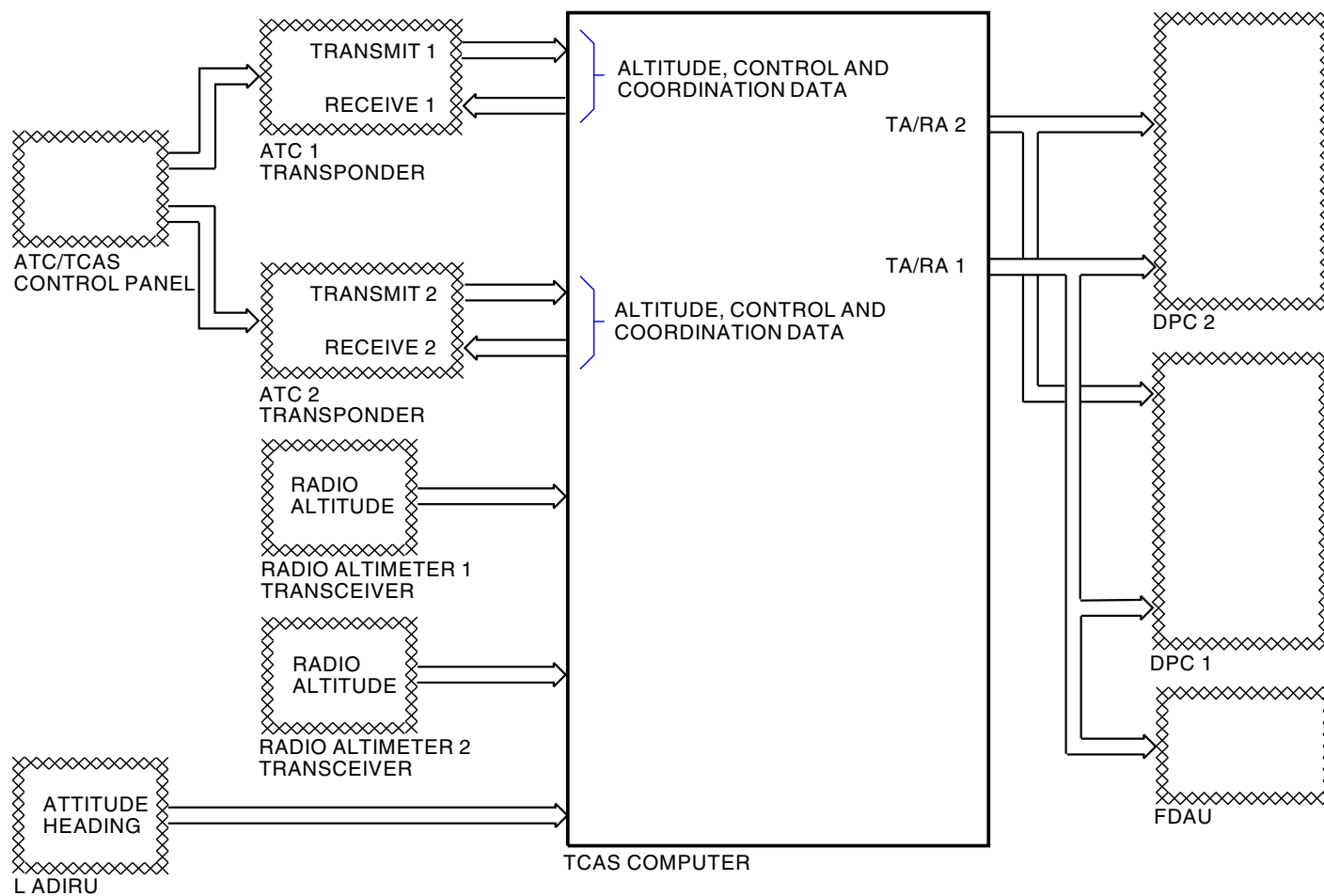
TCAS Outputs to DPCs

The TCAS computer supplies resolution advisory (RA) and traffic advisory (TA) data to the DPCs. This includes all traffic data for TCAS displays.

TCAS Outputs to the FDAU

The FDAU receives the same TCAS data that goes to the DPCs.

TCAS - DIGITAL INTERFACES



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TCAS - DIGITAL INTERFACES

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TCAS - TCAS COMPUTER

Purpose

The TCAS computer is the main component of the TCAS. It controls these functions:

- Surveillance
- Tracking
- Advisory
- Air-to-air maneuver coordination.

The TCAS computer sends signals which tell the flight crew to make one of these maneuvers:

- Keep the current flight plan
- Make flight maneuvers to prevent a possible collision with other airplanes in the area.

Physical Description

The TCAS computer is a 6 MCU size unit. It weighs 28 lbs (11.3 kg).

Functional Description

The TCAS computer transmits 1030 MHz pulse-coded interrogation signals. It receives 1090 MHz pulse-coded reply signals from intruder airplanes with an ATC transponder.

Front Panel LED Indications

These are the status light emitting diodes (LEDs):

- A green PASS to show that there is no TCAS computer failure
- A red FAIL to show a TCAS computer failure
- A red UPPER ANT to show a top TCAS antenna failure
- A red LOWER ANT to show a bottom TCAS antenna failure
- A red RAD ALT to show no radio altitude data from the RA
- A red HDNG to show no heading data from the ADIRU
- A red R/A to show a DPC display function failure

- The red T/A does not operate

Performance Management Recording

The TCAS computer has a slot for a Personal Computer Memory Card International (PCMCIA) card. The recorder function provides the capability to store information about TCAS events for post-flight analysis. The PCMCIA card device programming is done at depot level, or by a field service representative in the event of very problematic troubleshooting. These are the RECORD light emitting diodes (LEDs):

- An ACTIVE to show card recording
- A FULL to show card recording complete.

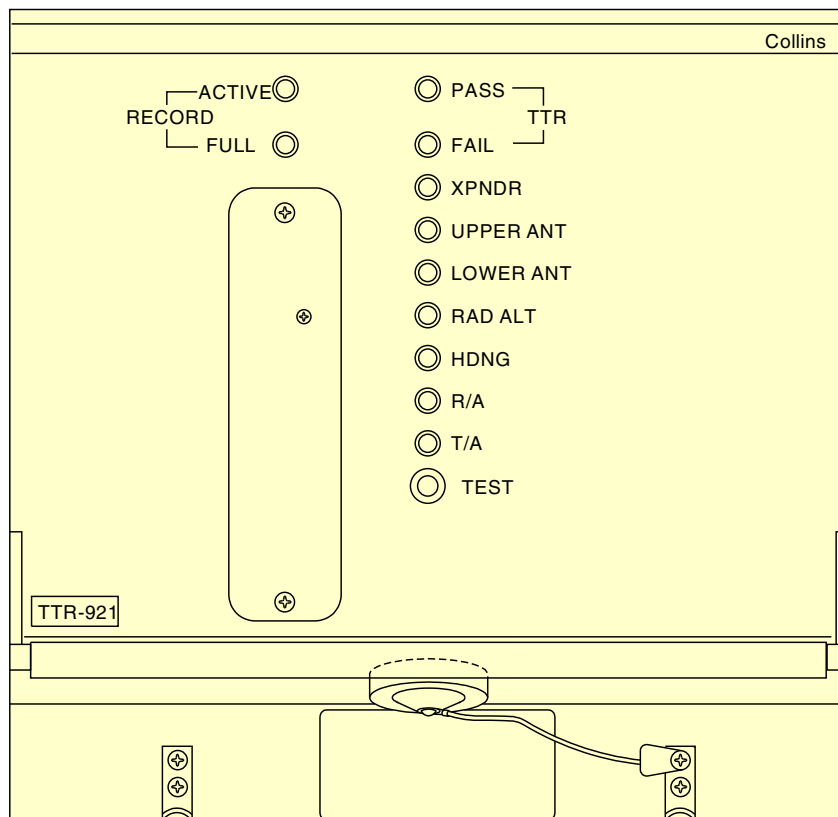
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TCAS - TCAS COMPUTER



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TCAS - TCAS COMPUTER

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TCAS - ATC/TCAS CONTROL PANEL

General

The ATC/TCAS control panel controls the TCAS computer.

Function Select Switch

You use the function select switch to select one of these TCAS modes:

- TA ONLY mode. This is the TA only mode. The displays show all targets except RAs.
- TA/RA mode. The displays show all targets. This is the normal mode of operation for TCAS.

You can use the test button in the center of the switch to do a test of the ATC and TCAS systems.

Above/Normal/Below Switch

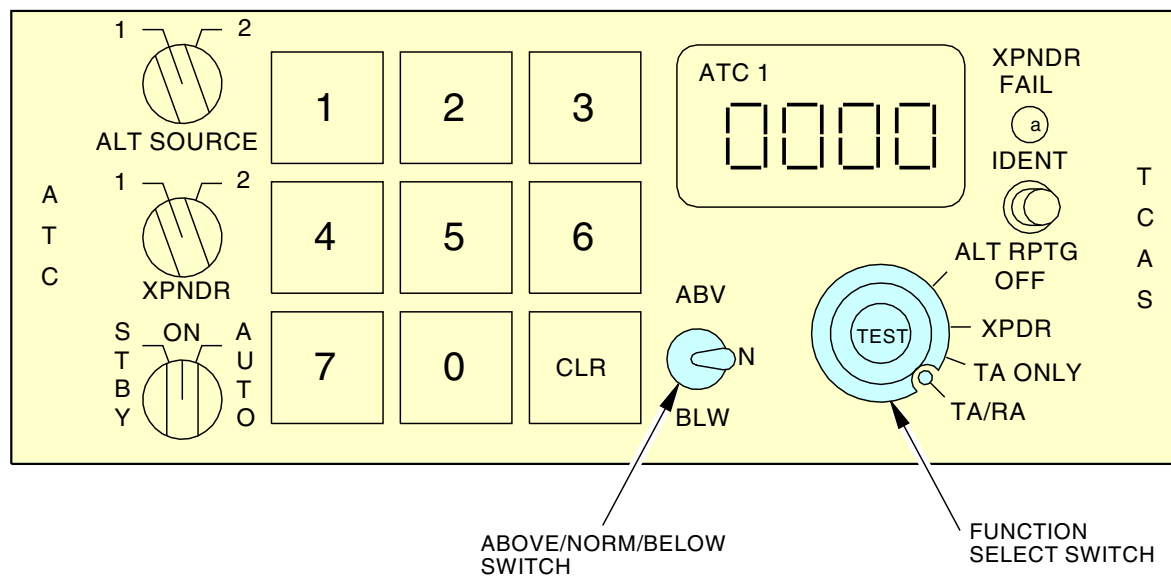
This switch selects the relative altitude limits to show other traffic on the display. Other traffic shows as a white diamond that is not filled.

The switch has these three positions:

- ABOVE - this makes the display show other traffic that is from 2700 feet below to 7000 feet above the present airplane altitude.
- NORM - this makes the display show other traffic that is from 2700 feet below to 2700 feet above the present airplane altitude.
- BELOW - this makes the display show other traffic that is from 7000 feet below to 2700 feet above the present airplane altitude.



TCAS - ATC/TCAS CONTROL PANEL



TCAS - ATC/TCAS CONTROL PANEL

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TCAS - TCAS DIRECTIONAL ANTENNA

General

The TCAS uses a top and bottom directional antenna. The antennas are the same and interchangeable.

Physical Description

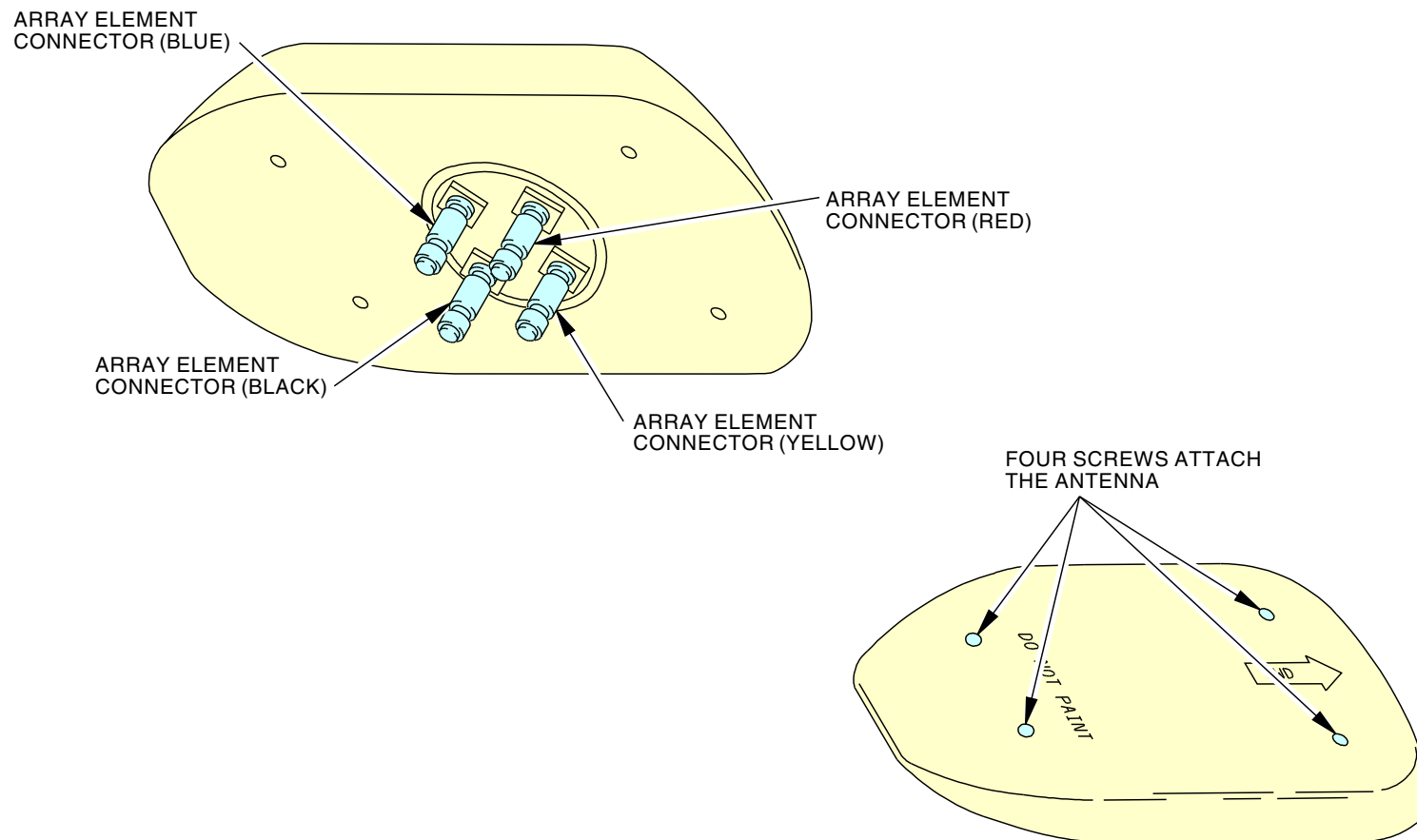
The directional antenna is a phased array antenna. There are four array elements on the antenna. Each element has a color coded connector. The TCAS computer sends transmit interrogation signals to the array elements with different phases. This makes the interrogation signal directional.

To attach the antenna cables, connect each coaxial cable with the array element connector that has the same color band.

Four screws attach the antenna to the airplane. The radiation side of the antenna shows FWD and DO NOT PAINT. To prevent the antenna from faults, do not paint the radiation surface or the backplate of the antenna.

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TCAS - TCAS DIRECTIONAL ANTENNA



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TCAS - TCAS DIRECTIONAL ANTENNA

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TCAS - FUNCTIONAL DESCRIPTION

General

The TCAS computer transmits interrogations to and receives replies from other airplanes. Airplanes that are tracked by TCAS are called targets. The TCAS computer uses these replies and data from other airplane systems to calculate if a target is a collision threat. The TCAS computer can communicate with other airplanes that have TCAS. The two TCAS computers can use the shared data to perform coordinated maneuvers and avoid potential collisions.

The TCAS computer also gets analog and digital inputs from other airplane systems. These inputs control TCAS and provide data for TCAS to track intruders. The TCAS computer sends display data to the MAX display unit (MDU) display processing computers (DPCs).

The TCAS computer has these circuits:

- Input/output (I/O)
- Speech Processor
- Central processing unit (CPU) and memory
- Suppression circuit
- Signal Processor
- Receiver
- Transmitter
- Beam steering and attenuator
- BITE.

I/O

The I/O circuit gets this on-board airplane systems data:

- Magnetic heading data from the left ADIRU
- Coordination and control data from the ATC transponder system
- Barometric altitude from the left or right ADIRU from the active ATC
- Radio altitude from the radio altimeters
- Resolution advisory status from the DPCs
- Landing gear down discrete from the landing gear lever switch

- Aural inhibit discrete interface with the GPWC
- Aural inhibit discrete interface with the weather radar
- Air/ground data from the PSEU.

Program pins set these parameters in the TCAS computer:

- Altitude limits
- Aural warning volume levels
- Self test inhibits
- Standby on ground
- Intruders on ground disabled.

The I/O circuits send this data to the CPU.

CPU

The CPU gets the data from the inputs of the I/O and puts it into memory. The CPU combines the input data and the data it receives from the signal processor. The CPU makes the necessary calculations for the TCAS displays and aural messages.

The CPU sends TCAS display data to the MDU DPCs. It shows on these indicators:

- Attitude indicators (AI)
- Navigation display (ND)
- Vertical speed indicators (VSI).

The CPU sends the display data to the head up display system.

The CPU sends the display data to the flight data acquisition unit (FDAU).

It also sends signals through the speech processor circuits to the REU to make TCAS aural.

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TCAS - FUNCTIONAL DESCRIPTION

Signal Processor

The signal processor gets bearing information from the receiver/processor and changes it to digital signals. The signal processor does these functions:

- Uses time measurement logic and the bearing information to calculate the intruder airplane range and bearing
- Detects the mode C or mode S pulses
- Controls the suppression circuit to send the suppression pulse when TCAS transmits
- Makes all signals necessary to receive and transmit mode S and ATCRBS interrogations through the receiver/transmitter circuits.

Suppression

The suppression circuit sends a suppression pulse when the TCAS computer transmits. The TCAS computer receives a suppression pulse when an onboard ATC transponder or DME interrogator system transmits. This suppression pulse stops the TCAS computer receiver and transmitter circuits.

Speech Processor

When there is a TA, RA, or during a self-test, the TCAS computer sends signals to the speech processor. The speech processor sends the aural alerts to the REU. The REU sends them to the flight compartment.

During aural annunciations the GPWC sends an analog discrete to the TCAS computer to prevent TCAS advisories.

During predictive windshear annunciations the weather radar sends an analog discrete to the TCAS computer to prevent TCAS advisories.

Receiver Processor

The receiver gets the target replies from the antennas. The receiver uses the phase of the received signals to determine the bearing of the target. The receiver sends the signal to the signal processor to calculate the range to the target. The receiver decodes the target altitude from the reply signal. The receiver also receives and decodes coordination replies from targets equipped with TCAS.

Transmitter

The transmitter has a 1030 MHz output. The transmitter gets signals from the signal processor. The transmitter sends the formatted signals to the beam steering and attenuator (ATT) circuits. The transmitter controls the beam steering circuits and whisper/shout attenuator.

Beam Steering and Attenuator Circuits

The beam steering circuits send the signals to the four antenna elements. During transmit, the beam steering circuit controls the phase relationships of the four RF outputs. The whisper/shout attenuator makes the output power smaller or larger based on the control signals from the transmitter.

During receive, the phase of the received signals is different in each element. These beam steering circuit sends the signals to the receiver.

The TCAS computer receives a discrete input from the landing gear lever switch. When the landing gear lever is down, the TCAS computer uses all four antenna elements equally for the bottom antenna. Thus, the bottom antenna operates as an omnidirectional antenna.

BITE

The TCAS computer has BITE. The BITE continuously monitors TCAS for system faults and interface faults during normal operation. Also, when you start a self-test, the BITE makes test signals and sends them to the signal processor and receiver/transmitter circuits. The BITE monitors for system faults and interface faults during the self-test.



TCAS - FUNCTIONAL DESCRIPTION

When the BITE detects a fault through the continuous fault monitor, the fault goes into the fault memory. It also goes to the I/O circuits for output to the MDU DPCs and the FDAU.

When the BITE detects a fault during a self-test, the fault data goes to the I/O and then to these systems:

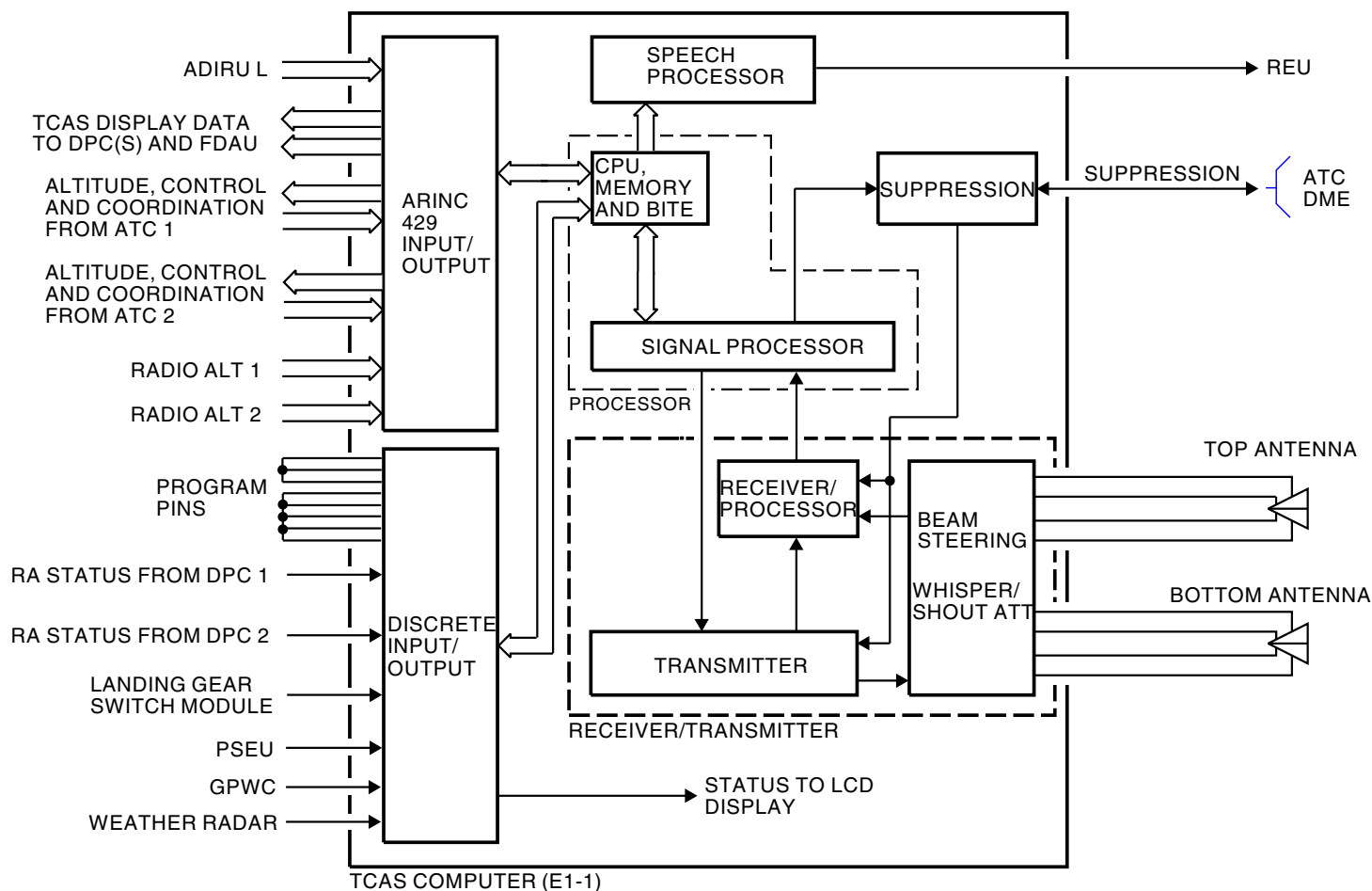
- DPCs
- REU
- FDAU
- TCAS computer status display if the test is started from the front panel.

Directional Antenna

The directional antenna has four elements spaced 90 degrees apart. Each element is independent of the others and has its own coaxial connector.

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TCAS - FUNCTIONAL DESCRIPTION



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TCAS - FUNCTIONAL DESCRIPTION

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TCAS - BASIC OPERATION

General

TCAS transmits these two types of interrogation signals:

- Whisper-shout for ATCRBS transponders
- Mode S.

The TCAS finds and monitors all of the airplanes within range that have ATCRBS or mode S transponders. The TCAS operates with its mode S transponders to interrogate traffic airplanes and calculate if they are a threat. The TCAS does not track airplanes that do not have a transponder. The TCAS tracks airplanes with transponders that do not reply with mode C information. These airplanes send framing pulses in response to a mode C interrogation. The TCAS uses the framing pulse replies to give range and bearing to the target. TCAS cannot give RAs for targets that do not report altitude.

The TCAS can calculate maneuver commands to prevent possible collisions with target airplanes.

If the traffic airplane also has TCAS, the two airplanes can agree on maneuvers that give a safe distance between them.

Whisper-Shout Interrogation

The TCAS uses an ATCRBS all-call whisper-shout interrogation to look for airplanes that have an ATCRBS transponder. The whisper-shout procedure changes the strength of the interrogation pulse in many steps. This lets TCAS interrogate intruders at different ranges. Intruders that reply are put on the TCAS roll call list and TCAS monitors them.

The airplanes that are near receive the lower power (whisper) interrogations. The airplanes that are far away do not receive these low power signals so they do not respond.

The TCAS transmits a suppression pulse as the interrogation power increases. The airplanes that are farther away receive the higher power (shout) interrogations. The airplanes that are near receive the interrogation and the suppression pulse so they do not reply.

Mode S Interrogation

Mode S transponders transmit a squitter signal once each second. The signals contain a 24-bit airplane address. The TCAS listens for mode S squitter signal transmissions from airplanes that have mode S transponders. When the TCAS receives an address, it puts that airplane on a roll call list. The TCAS then interrogates the mode S transponder of the traffic airplane with the discrete 24-bit airplane address on the roll call list.

TCAS Data Calculation

When the TCAS interrogates a target, the reply signal from the target usually contains the airplane altitude and any information requested by TCAS.

The TCAS computer uses the round-trip time of the reply signal to calculate the range and range rate of the target. It uses the direction of the reply to calculate bearing of the target. If the TCAS computer receives altitude data, it calculates these parameters of the traffic airplane:

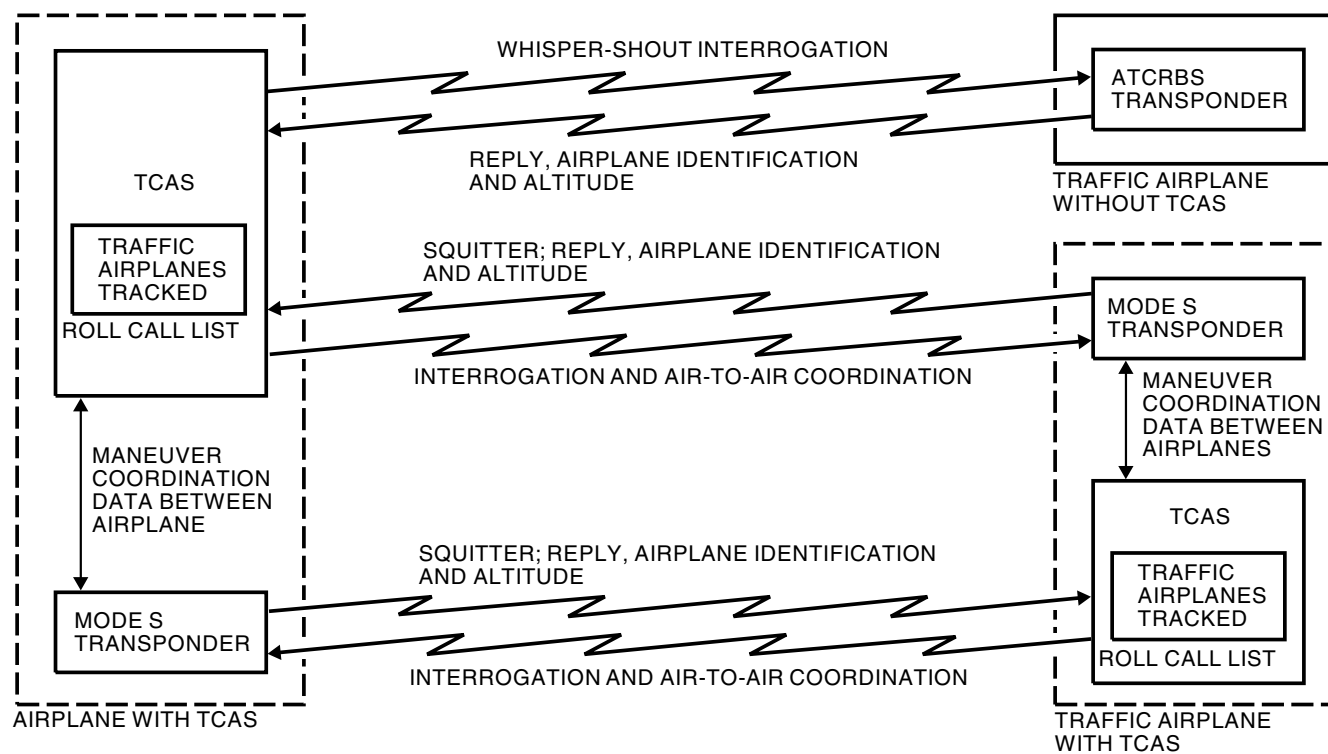
- altitude
- altitude rate
- relative altitude.

The TCAS computer uses the target data to calculate if the target is on a possible collision or near collision course with its flight path. If it is, the TCAS computer calculates traffic coordination maneuver data. This data and the position data go to the DPCs to make the TCAS displays. If TCAS advises that a maneuver be made it also sends an aural command to the flight crew.

Air-to-Air Coordination

If the target also has TCAS, the two TCAS computers communicate with each other using the mode S transponders. Both TCAS computers calculate an escape path if it is necessary. Both TCAS computers send the escape path to the mode S transponder in the other airplane. This sets up the air-to-air mode S data link between the airplanes.

TCAS - BASIC OPERATION



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TCAS - BASIC OPERATION

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TCAS - SURVEILLANCE AREA

General

The TCAS tracks and evaluates up to 30 airplanes that are in the surveillance area. Airplanes in the surveillance area are put into one of these four groups:

- Resolution advisory (RA) group
- Traffic advisory (TA) group
- Proximate traffic
- Other traffic.

TCAS has a maximum surveillance area that is 8700 feet above and below your airplane. It has a range of 40 nm.

RA and TA Groups

The TCAS forms two protected areas around its own airplane. The dimensions of these protected areas change with airspeed and altitude of the TCAS airplane and the closure rate of the target.

The protected area represents the time until the target will be at the closest point of approach (CPA) to the TCAS airplane. This protected area is called the TAU area.

To calculate the TAU, the TCAS computer uses this data:

- Own airplane altitude
- Target closure rate
- Target range and altitude.

Traffic advisory TAU and resolution advisory TAU define areas around the TCAS airplane that, if penetrated by a target within the required altitude restrictions, would produce the appropriate warning from the TCAS computer.

The TCAS computer uses six sensitivity levels (2-7). Level 7 is the most sensitive. At level 2, no resolution advisories may occur. Below 1000 feet, level 2 is used and above 20000 feet, level 7 is used. Sensitivity levels are set by the TCAS computer based on own airplane altitude.

The TA and RA times vary with sensitivity level. At sensitivity level 3, RA TAU is 15 seconds while at sensitivity level 7, RA TAU is 35 seconds.

Proximate Traffic and Other Traffic

Proximate traffic is an airplane with a relative altitude separation less than 1200 feet, is in a 6 nm radius of your airplane, and is not a TA or RA threat.

Other traffic is an airplane with a range more than 6 nm that is not a TA or RA threat. If the range is less than 6 nm, the relative altitude must be more than 1200 feet.

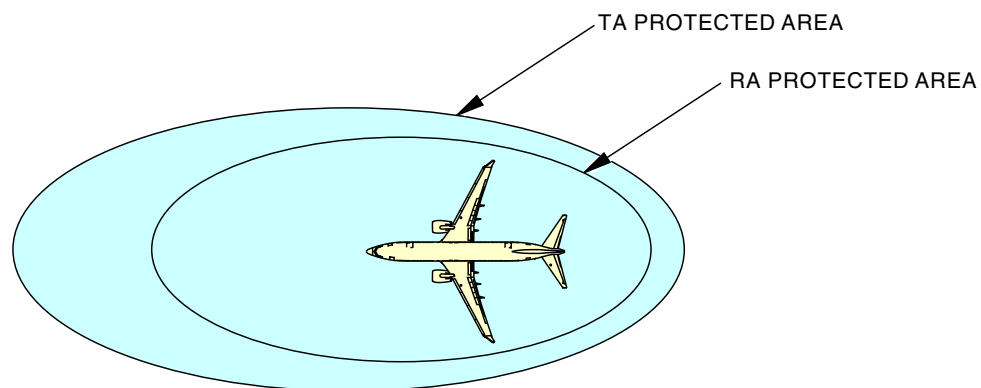
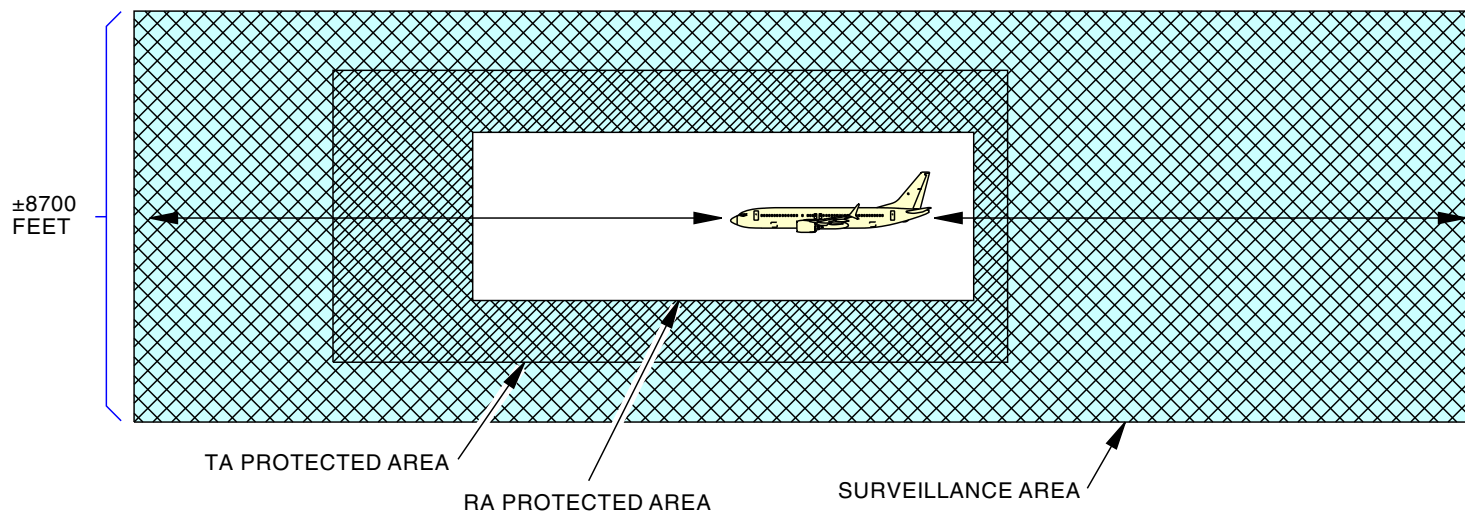
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TCAS - SURVEILLANCE AREA



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TCAS - SURVEILLANCE AREA

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EFFECTIVITY

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TCAS - CONTROL AND DISPLAY

General

The EFIS control panel and the ATC control panel control the TCAS data that shows on the displays.

The ND shows the relative altitude of the target above or below the symbol.

The ABOVE-NORM-BELOW switch changes the relative altitude limits for other traffic that show on the ND.

EFIS Control Panel

To show the TCAS data on the display, put the mode selector on the EFIS control panel in one of these modes:

- Expanded approach
- Expanded VOR
- Expanded map
- Centered map.

The range selector selects the range for the ND.

Push the TFC (traffic) switch on the range selector to let the ND show the TCAS data. When you do this, the TFC message and the TCAS symbols of any targets show on the display.

If the function selector on the ATC control panel is not in the TA or TA/RA position, the display does this:

- Shows an amber message, TCAS OFF (TCAS OFF shows in all ND modes)
- Removes all TCAS target symbols.

To remove the TCAS messages and symbols from the display, push the TFC switch again.

ATC/TCAS Control Panel

The ATC/TCAS control panel sends control data through the ATC Mode S transponder to the TCAS computer. The TCAS computer sends this data to the DPC for display.

The function selector puts the TCAS computer in the TA only or TA/RA mode. In the TA only mode, the TCAS does not supply RA traffic symbols or advisories. It also does not supply RA aural messages. The function selector can also put the TCAS computer in the test mode.

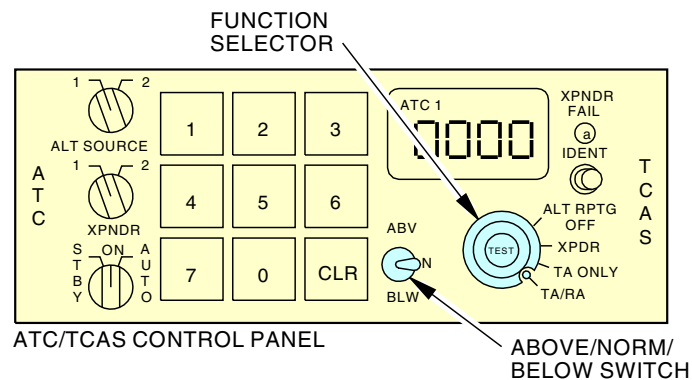
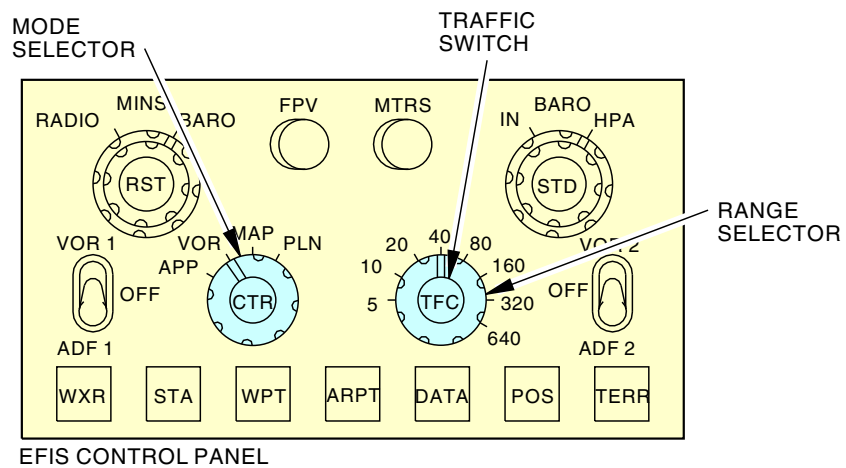
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TCAS - CONTROL AND DISPLAY

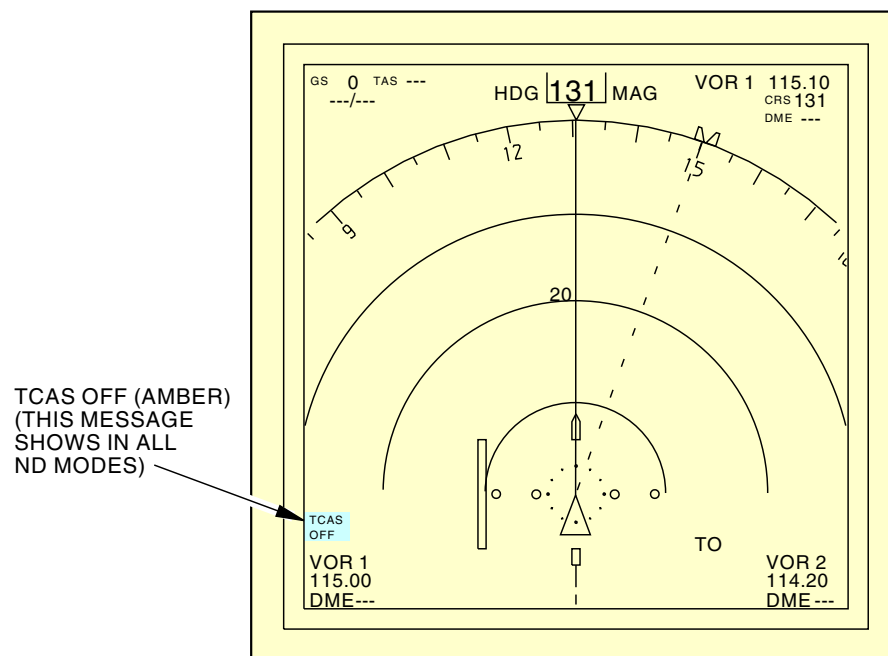


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TCAS - CONTROL AND DISPLAY

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TCAS - CONTROL AND DISPLAY



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TCAS - CONTROL AND DISPLAY

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TCAS - NAVIGATION DISPLAY

General

The TCAS computer puts traffic into these four groups:

- Other traffic shows as a white open diamond, and the altitude readout is white text
- Proximate traffic shows as a solid white diamond, and the altitude readout is white text
- Traffic advisory (TA) shows as a solid amber circle, and the altitude readout is amber text
- Resolution advisory (RA) shows as a solid red square and the altitude readout is red text.

Each traffic symbol has an altitude readout. A vertical motion arrow is also shown if the airplane vertical speed is greater than 500 feet per minute (fpm). The traffic symbols show in these navigation display modes:

- Center (CTR) MAP
- Expanded (EXP) MAP
- Expanded (EXP) VOR
- Expanded (EXP) APP.

Range Data

Push the TFC switch on the EFIS control panel to show TCAS data. The range the EFIS control panel selects also shows on the ND.

In addition to the range, the TCAS 3 nautical mile (nm) range ring shows for ranges greater than 5 nm and less than 160 nm.

Also, when you push the TFC switch, range arcs show on the ND.

Altitude Readout

Relative altitude shows in the same color as the traffic symbol on the NDs.

Altitude Separation

The TCAS computer calculates the altitude separation between own airplane and the target. It uses the barometric altitudes of the airplanes to do this. The altitude separation shows on the ND in hundreds of feet. If the traffic is above, the digits show above the traffic symbol with a plus (+) sign. If the traffic is below, the digits show below the traffic symbol with a minus (-) sign.

If the altitude separation is less than 100 feet, 00 shows.

If the altitude separation cannot be calculated, the altitude display does not show.

Vertical Motion Arrow

A vertical motion arrow shows on the right side of the traffic symbol. It is the same color as the traffic symbol.

The arrow points down if the traffic airplane goes down at a rate more than or equal to 500 fpm. The arrow points up if the traffic airplane is in a climb at a rate more than or equal to 500 fpm. The arrow does not show for rates less than 500 fpm.

TCAS Messages

The ND can show these messages for TCAS:

- TFC shows in cyan in the CTR MAP and EXP MAP, VOR and APP modes. It shows the TCAS traffic display is active. The TFC switch on the EFIS control panel must be set to ON.
- TA ONLY shows in cyan and in all modes. It shows that TCAS is not calculating RAs. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.
- TCAS TEST shows in cyan and in all modes. It shows that TCAS is in the test mode. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.

TCAS - NAVIGATION DISPLAY

- TCAS TEST FAIL shows on two lines when in test mode and the TCAS has a failure. TCAS and FAIL show in amber and TEST shows in cyan. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.
- TCAS FAIL shows in amber and in all modes. It shows that TCAS has failed. The TFC switch on the EFIS control panel must be set to ON.
- TCAS OFF shows on two lines in amber and in all modes. It shows that the ATC mode switch is not in TA or TA/RA. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.

OFFSCALE

The OFFSCALE message shows on the ND when an RA or TA is outside the current ND display area. The TFC switch on the EFIS control panel must be set to ON to show the OFFSCALE message. If an RA is outside the ND range, the OFFSCALE message shows in red. If a TA is outside the ND range, the OFFSCALE message shows in amber. If both a TA and RA are outside the ND range, the OFFSCALE message shows in red. This message shows in these navigation display modes:

- Center (CTR) MAP
- Expanded (EXP) MAP
- Expanded (EXP) VOR
- Expanded (EXP) APP.

TRAFFIC

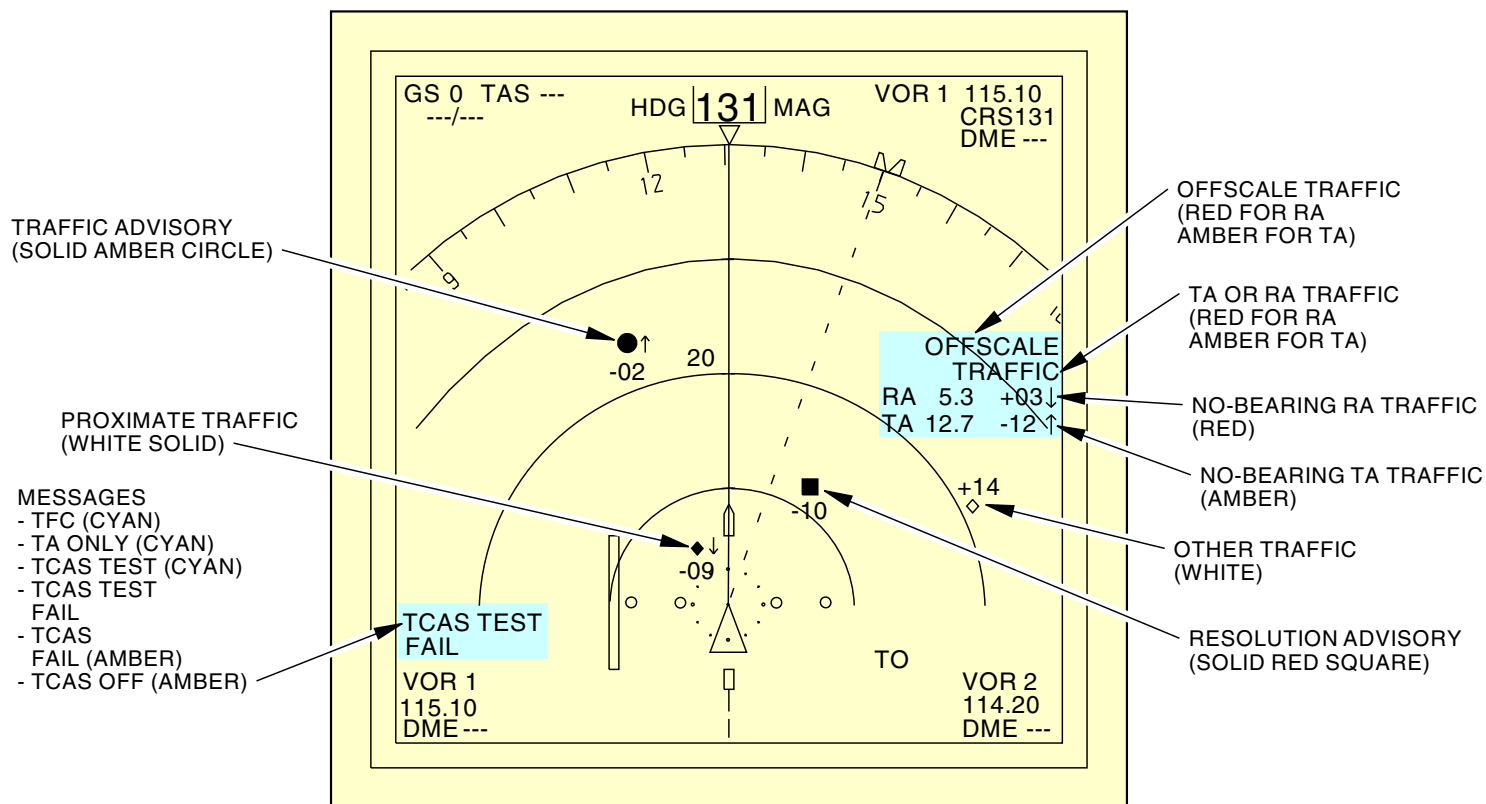
The red TRAFFIC message shows any time there is an RA. The amber TRAFFIC message shows any time there is a TA and no RA. The TRAFFIC message shows in all ND formats with the TFC switch on the EFIS control panel set to ON or OFF.

RA and TA No-Bearing Traffic

The no-bearing RA and TA messages show on the ND when TCAS loses the bearing of the RA or TA traffic. The bottom directional antenna becomes an omnidirectional antenna when the landing gear is down. When this happens, the bottom antenna cannot find the bearing of the intruder traffic. The bearing is NCD. Because of this, the no-bearing messages show on the ND.

If a TA becomes no-bearing traffic, an amber TA with the range, altitude, and vertical motion arrow shows on the ND. If an RA becomes no-bearing traffic, a red RA with the range, altitude, and vertical motion arrow shows on the ND. Only two no-bearing traffics may show.

TCAS - NAVIGATION DISPLAY



TCAS - NAVIGATION DISPLAY

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TCAS - ATTITUDE INDICATOR DISPLAY

General

These are the two types of TCAS vertical resolution advisories that can show on the attitude indicator (AI):

- TCAS RA - down advisory
- TCAS RA - up advisory.

These symbols only show for an RA when:

- The function selector on the ATC control panel is in the TA/RA position
- The TCAS communicates with threat airplanes that give their altitude.

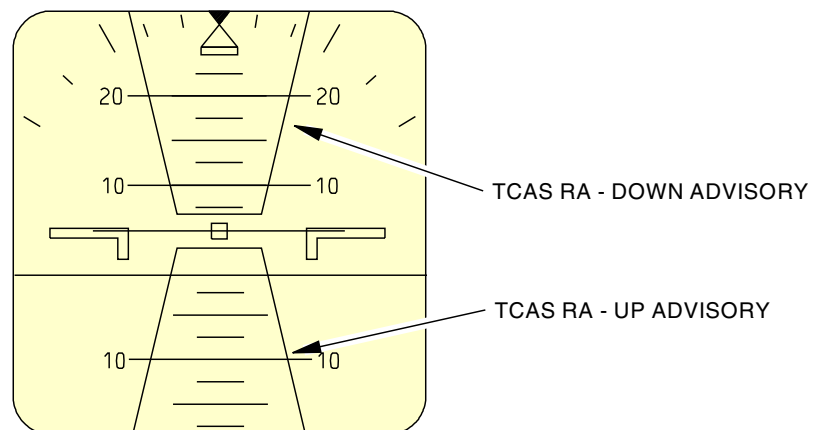
Description

The red advisories show on the attitude display. They tell the flight crew to avoid some pitch movements.

The flight crew uses the advisories to avoid a possible collision with threat airplanes.

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TCAS - ATTITUDE INDICATOR DISPLAY



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TCAS - ATTITUDE INDICATOR DISPLAY

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TCAS - VERTICAL SPEED INDICATOR DISPLAY

General

These are the two types of TCAS advisories that can show on the vertical speed indicator (VSI):

- TCAS preventive down advisory
- TCAS preventive up advisory.

Description

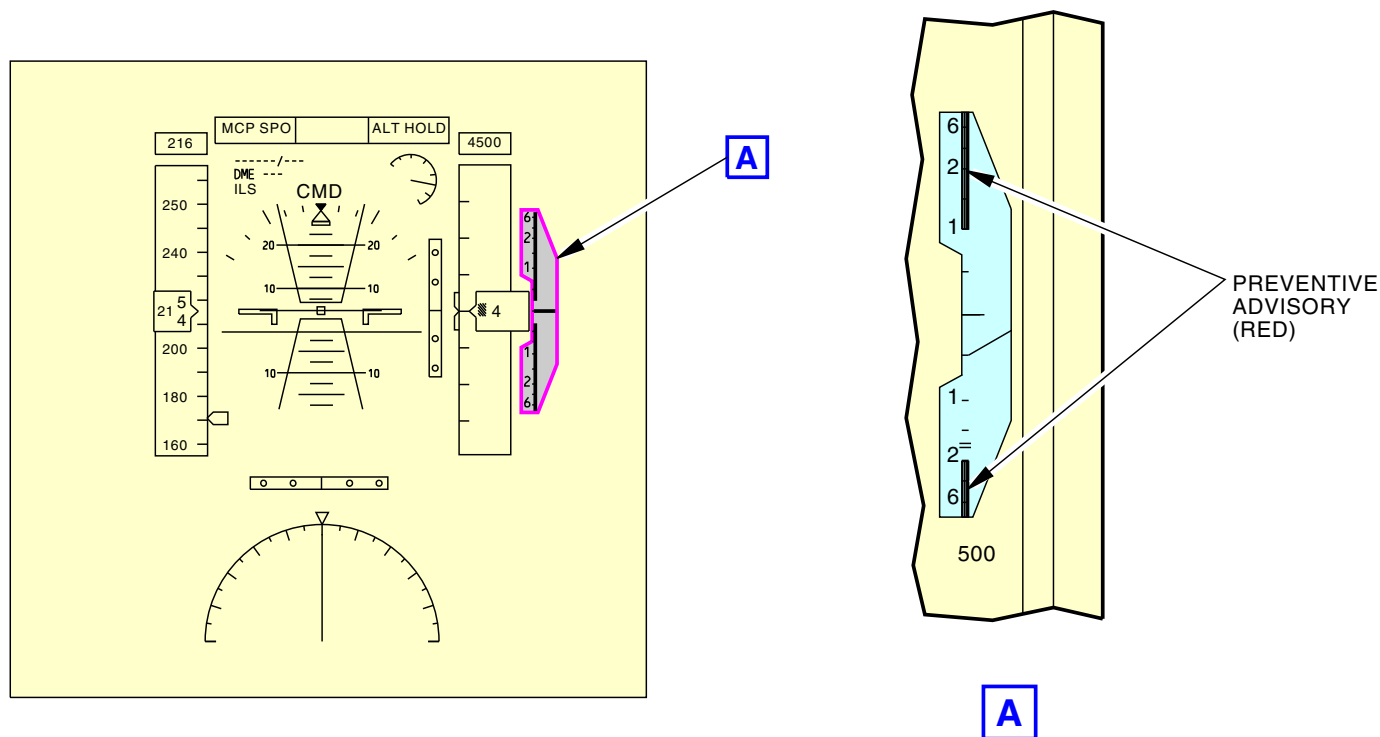
The red bands on the VSI are preventive advisories. They tell the flight crew the vertical speeds to avoid. The VSI shows these two bands:

- Red TCAS preventive up advisory
- Red TCAS preventive down advisory.

The flight crew uses the advisories to avoid a possible collision with threat airplanes.

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TCAS - VERTICAL SPEED INDICATOR DISPLAY



TCAS - VERTICAL SPEED INDICATOR DISPLAY

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**TCAS - AURAL MESSAGES****General**

Aural advisory messages occur during these conditions:

- Traffic advisories (TA)
- Resolution advisories (RA)
- TCAS system tests.

Traffic Advisory Aural

When a traffic advisory occurs, the aural message TRAFFIC TRAFFIC comes on. This message tells the flight crew to monitor the display for intruder traffic.

Resolution Advisory

These are the two types of aural messages that can come on during a resolution advisory (RA):

- Preventive action RA
- Corrective action RA.

Preventive Action RA

This type of RA occurs when at the closest point of approach (CPA) the present vertical speed results in a safe altitude separation from the threat airplane. When this happens, the aural advisory is MONITOR VERTICAL SPEED - MONITOR VERTICAL SPEED. This message tells the flight crew to do these things:

- Maintain the flight path
- Do not fly into the area of RA pitch symbol on the ADI
- Do not fly vertical speeds that are in the red band areas on the VSI
- Maintain the vertical speed rate.

Corrective Action RA

This type of RA occurs when the altitude separation at the CPA is not safe. These RA aural advisories tell the flight crew to take corrective action to avoid a possible collision:

TCAS 6.04A:

- CLIMB - CLIMB - CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory.
- CLIMB CROSSING CLIMB - CLIMB CROSSING CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory. The flight path crosses through the flight path of the threat.
- REDUCE CLIMB - REDUCE CLIMB. The flight crew must reduce the rate of climb to avoid the preventive down advisory.
- DESCEND - DESCEND - DESCEND. The flight crew must descend at a rate to avoid the preventive down advisories.
- DESCEND CROSSING DESCEND - DESCEND CROSSING DESCEND. The flight crew must descend at a rate to avoid the preventive down advisory. The flight path crosses through the flight path of the threat.
- REDUCE DESCENT - REDUCE DESCENT. The flight crew must reduce the rate of descent to avoid the preventive up advisory.

TCAS 7.0:

- CLIMB - CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory.
- CLIMB CROSSING CLIMB - CLIMB CROSSING CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory. The flight path crosses through the flight path of the threat.
- ADJUST VERTICAL SPEED - ADJUST. The flight crew must reduce the rate of climb to avoid the preventive down advisory.
- DESCEND - DESCEND. The flight crew must descend at a rate to avoid the preventive down advisories.

**TCAS - AURAL MESSAGES**

- DESCEND CROSSING DESCEND - DESCEND CROSSING DESCEND. The flight crew must descend at a rate to avoid the preventive down advisory. The flight path crosses through the flight path of the threat.
- ADJUST VERTICAL SPEED - ADJUST. The flight crew must reduce the rate of descent to avoid the preventive up advisory.

TCAS 7.1:

- CLIMB - CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory.
- CLIMB CROSSING CLIMB - CLIMB CROSSING CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory. The flight path crosses through the flight path of the threat.
- LEVEL OFF - LEVEL OFF. The flight crew must reduce the rate of climb to avoid the preventive down advisory.
- DESCEND - DESCEND. The flight crew must descend at a rate to avoid the preventive down advisories.
- DESCEND CROSSING DESCEND - DESCEND CROSSING DESCEND. The flight crew must descend at a rate to avoid the preventive down advisory. The flight path crosses through the flight path of the threat.
- LEVEL OFF - LEVEL OFF. The flight crew must reduce the rate of descent to avoid the preventive up advisory.

Increase Corrective Action RA

This type of RA tells the flight crew to increase the corrective maneuvers because of maneuver changes from the threat airplane or because the flight crew did not react quickly enough to the initial RA:

- INCREASE CLIMB - INCREASE CLIMB. This follows the CLIMB advisory. The range of advised climb rates shifts to tell the flight crew to increase the climb rate.
- INCREASE DESCENT - INCREASE DESCENT. This follows the DESCEND advisory. The range of advised descent rates shifts to tell the flight crew to increase the descent rate.

- CLIMB, CLIMB NOW - CLIMB, CLIMB NOW. This follows the DESCEND advisory. A climb is now necessary to give safe vertical separation at CPA.
- DESCEND, DESCEND NOW - DESCEND, DESCEND NOW. This follows the CLIMB advisory. A descent is now necessary to give safe vertical separation at CPA.

Clear of Conflict

When the range of the threat airplane that causes an RA increases, the aural message CLEAR OF CONFLICT comes on.

Self-Test Aural

At the completion of the self-test, the TCAS computer sends the status aural to the flight compartment. TCAS SYSTEM FAIL indicates that the TCAS computer has a failure. TCAS SYSTEM TEST FAIL indicates an input to the TCAS system has a failure.

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TCAS - AURAL MESSAGES

AURAL MESSAGE	MESSAGE TYPE
TRAFFIC, TRAFFIC	TRAFFIC ADVISORY
MONITOR VERTICAL SPEED	RESOLUTION ADVISORY (PREVENTIVE ACTION) 1
MAINTAIN VERTICAL SPEED, MAINTAIN	
MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	
CLIMB, CLIMB	RESOLUTION ADVISORY (CORRECTIVE ACTION)
DESCEND, DESCEND	
CLIMB, CROSSING CLIMB CLIMB, CROSSING CLIMB	
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	
LEVEL OFF, LEVEL OFF	
CLIMB, CLIMB NOW CLIMB, CLIMB NOW	RESOLUTION ADVISORY (INCREASED CORRECTIVE ACTION) 2
DESCEND, DESCEND NOW DESCEND, DESCEND NOW	
INCREASE CLIMB, INCREASE CLIMB	
INCREASE DESCENT, INCREASE DESCENT	
CLEAR OF CONFLICT 3	CLEARED RESOLUTION ADVISORY
TCAS SYSTEM TEST PASS	SYSTEM TEST RESULTS
TCAS SYSTEM TEST FAIL	
TCAS LRU PASS, TCAS SYSTEM FAIL	

1 MONITOR/MAINTAIN VERTICAL SPEED COMES ON ONCE IF THE RA IS DOWNGRADED FROM A CORRECTIVE ADVISORY TO A PREVENTIVE ADVISORY

2 INCREASED CORRECTIVE ACTION RA FOLLOWS A CORRECTIVE ACTION RA

3 OCCURS WHEN THE RANGE OF THE THREAT INCREASES TO PREVENT THREAT

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TCAS - AURAL MESSAGES

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**TCAS - SELF-TEST INDICATIONS ON DISPLAYS****General**

You can start a self-test from the ATC/TCAS control panel or from the TCAS computer front panel test switch.

During a test, TCAS test signals go to these:

- NDs
- ADIs
- VSIs
- Front panel of the TCAS computer.

At the end of the test, a TCAS test aural goes to the flight interphone speakers.

TCAS Self-Test Indications - ND

If the test passes, the ND shows this data:

- A cyan message, TCAS TEST
- A red message, TRAFFIC
- Amber TA traffic symbol at the 9:00 position, - 200 feet relative altitude with an up vertical motion arrow and 2 nm from the airplane
- White other traffic symbol at the 11:00 position, +1000 feet relative altitude with no vertical motion arrow and 3.6 nm from the airplane
- White proximate traffic symbol at the 1:00 position, -1000 feet relative altitude with a down vertical motion arrow and 3.6 nm from the airplane
- Red RA traffic symbol at the 3:00 position, -1000 feet relative altitude with no vertical motion arrow and 2 nm from the airplane

If the test fails, the message TCAS TEST FAIL replaces the TCAS TEST message and no traffic shows. TCAS and FAIL shows in amber and TEST shows in cyan.

TCAS Self-Test Indications - VSI

If the test passes, the VSI shows the red prohibited vertical speed band from 0 to -6000 fpm. The VSI shows the red prohibited vertical speed band from +2000 to +6000 fpm. It also shows the green fly-to vertical speed band from 0 to +300 fpm.

If the test fails, The VSI will not show the RA red or green bands.

If the display is in the compacted mode, the ND does not show. The VSI shows the TCAS test messages when in the self-test. The TCAS message is in a box of the same color. These are the TCAS messages:

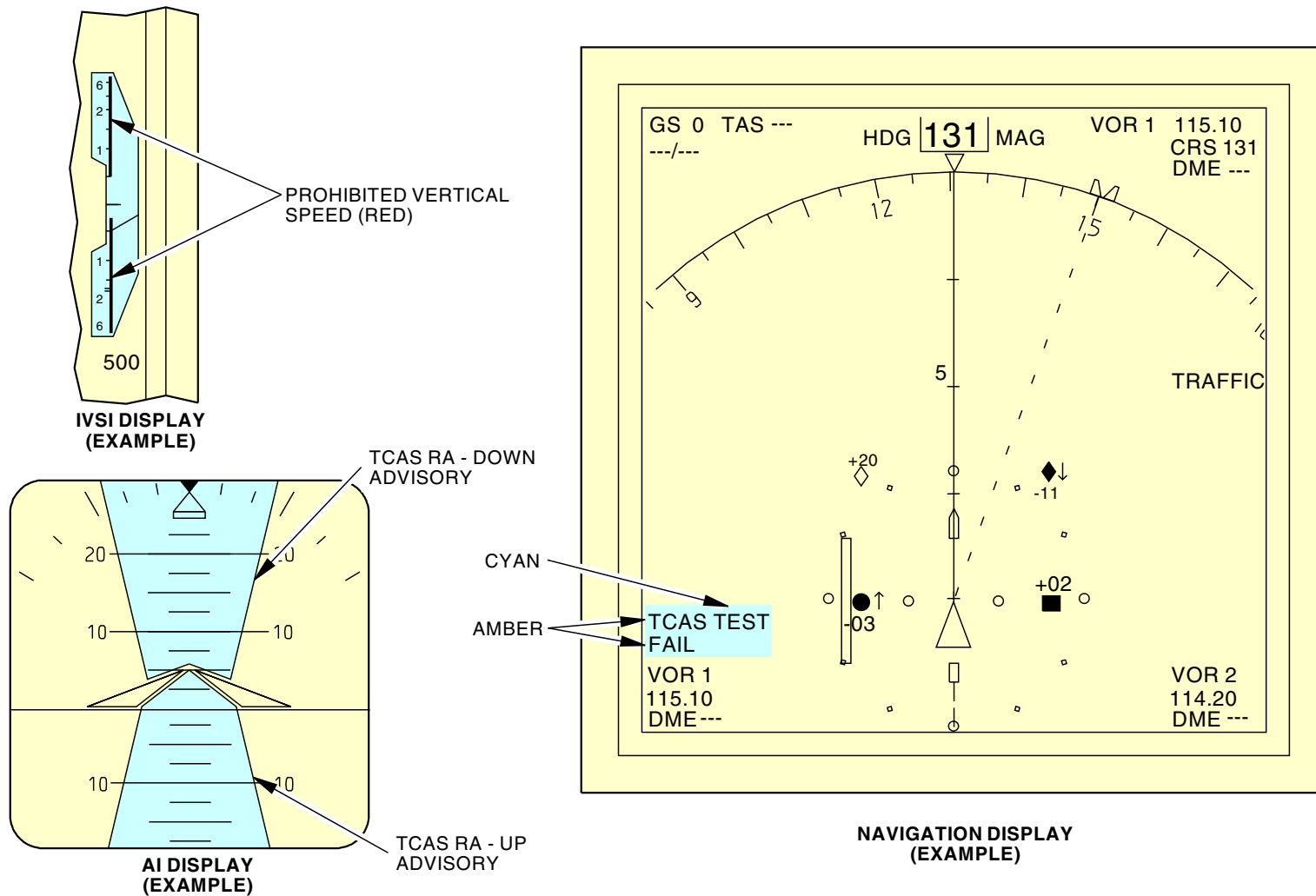
- TEST FAIL - cyan TEST and an amber FAIL display to show that TCAS did not pass the test
- TCAS TEST - cyan display to show that TCAS passed the test.

TCAS Self-Test Indications - AI

If the test passes, the AI shows the red RA up and down advisory cues.

If the test fails, the AI does not show any RA advisories.

TCAS - SELF-TEST INDICATIONS ON DISPLAYS



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TCAS - SELF-TEST INDICATIONS ON DISPLAYS

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TCAS - SUMMARY

General

This page is for reference purposes.

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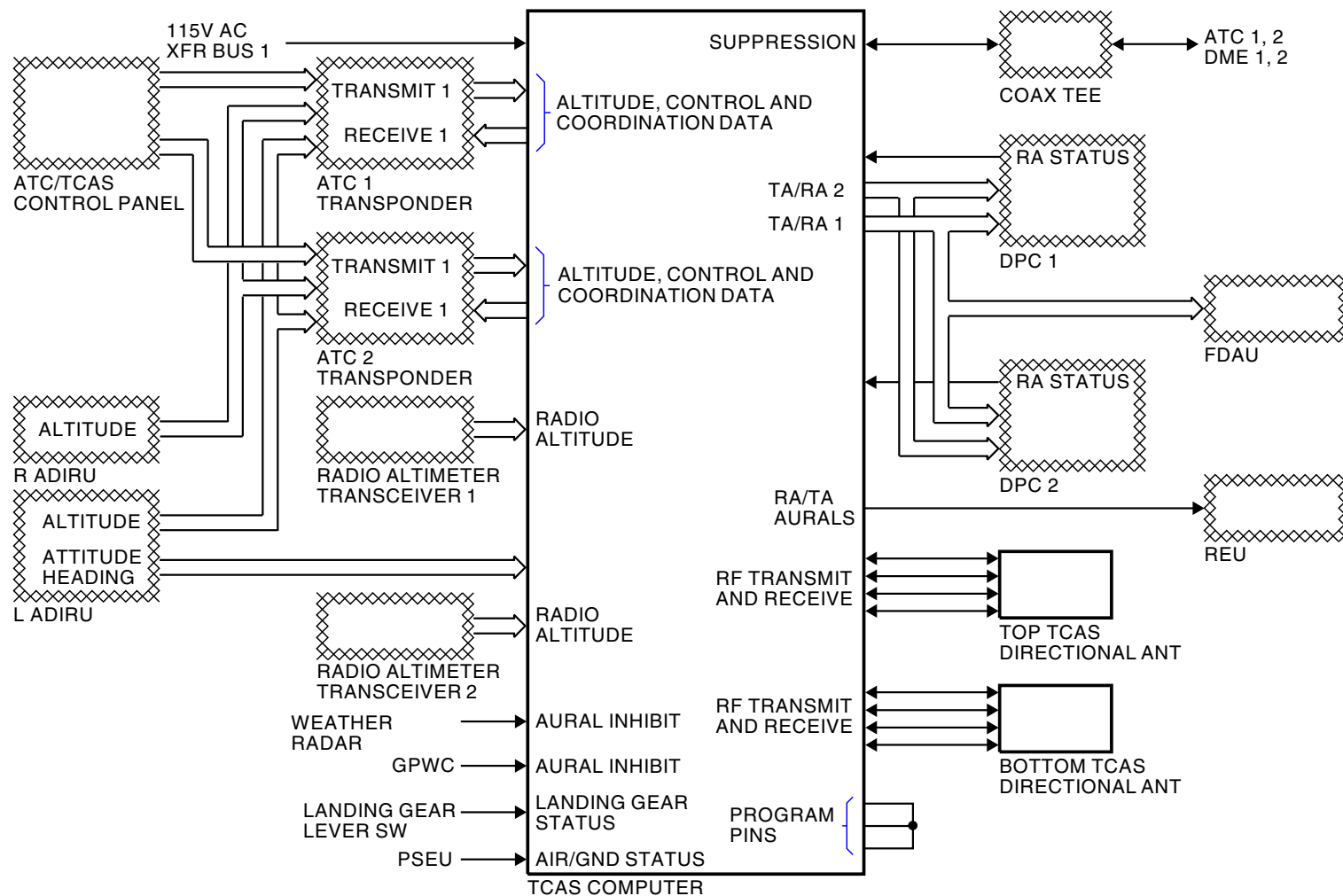
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TCAS - SUMMARY



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TCAS - SUMMARY

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GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION

Purpose

The ground proximity warning system (GPWS) alerts the flight crew of an unsafe condition when the airplane is near the terrain. It also supplies a warning for windshear conditions.

The GPWS uses global positioning system (GPS) and loadable software data bases to give the flight crew improved terrain awareness. This is done by the display of detailed terrain information for the area around the aircraft. The GPWS also warns the flight crew of an early descent.

Description

The GPWS uses aural messages, lights, and displays to give alerts in the flight compartment.

GPWS Modes

These are the GPWS modes:

- Mode 1 - Large descent rates
- Mode 2 - Too much of a closure rate when approaching terrain that is rising
- Mode 3 - Too much altitude loss during climbout (at takeoff or in go around) when the airplane is not in the landing configuration
- Mode 4 - Not enough terrain clearance
- Mode 5 - Too much deviation below the glideslope
- Mode 6 - Aural callouts when the airplane descends through selected radio altitudes
- Mode 7 - Warning for windshear conditions.

In addition to the GPWS modes 1 through 7, these two additional functions are used:

- Terrain clearance floor - early descent on approach
- Terrain awareness - display of terrain around the airplane.

Abbreviations and Acronyms

- ADI - attitude display indicator
- ADIRU - air data inertial reference unit
- alt - altitude
- AOA - angle of attack
- approx - approximately
- BITE - built-in test equipment
- capt - captain
- DPC - display processing computer
- DFCS - digital flight control system
- FDAU - flight data acquisition unit
- FMC - flight management computer
- F/O - first officer
- FPM - feet per minute
- FPS - feet per second
- GND PROX - ground proximity
- GPS - global positioning system
- GPWC - ground proximity warning computer
- GPWM - ground proximity warning module
- GPWS - ground proximity warning system
- G/S - glideslope
- ILS - instrument landing system
- inop - inoperative
- IVS - inertial vertical speed
- LED - light emitting diode
- LRU - line replaceable unit
- MCP - mode control panel
- mod - module
- ND - navigation display
- ovrd - override

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GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION

- P - press
- PFD - primary flight display
- PCMCIA - personal computer memory card international association
- pos - position
- PSEU - proximity switch electronic unit
- PWS - predictive windshear
- RA - radio altitude
- REU - remote electronics unit

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- RSAT - Runway Situational Awareness Tools

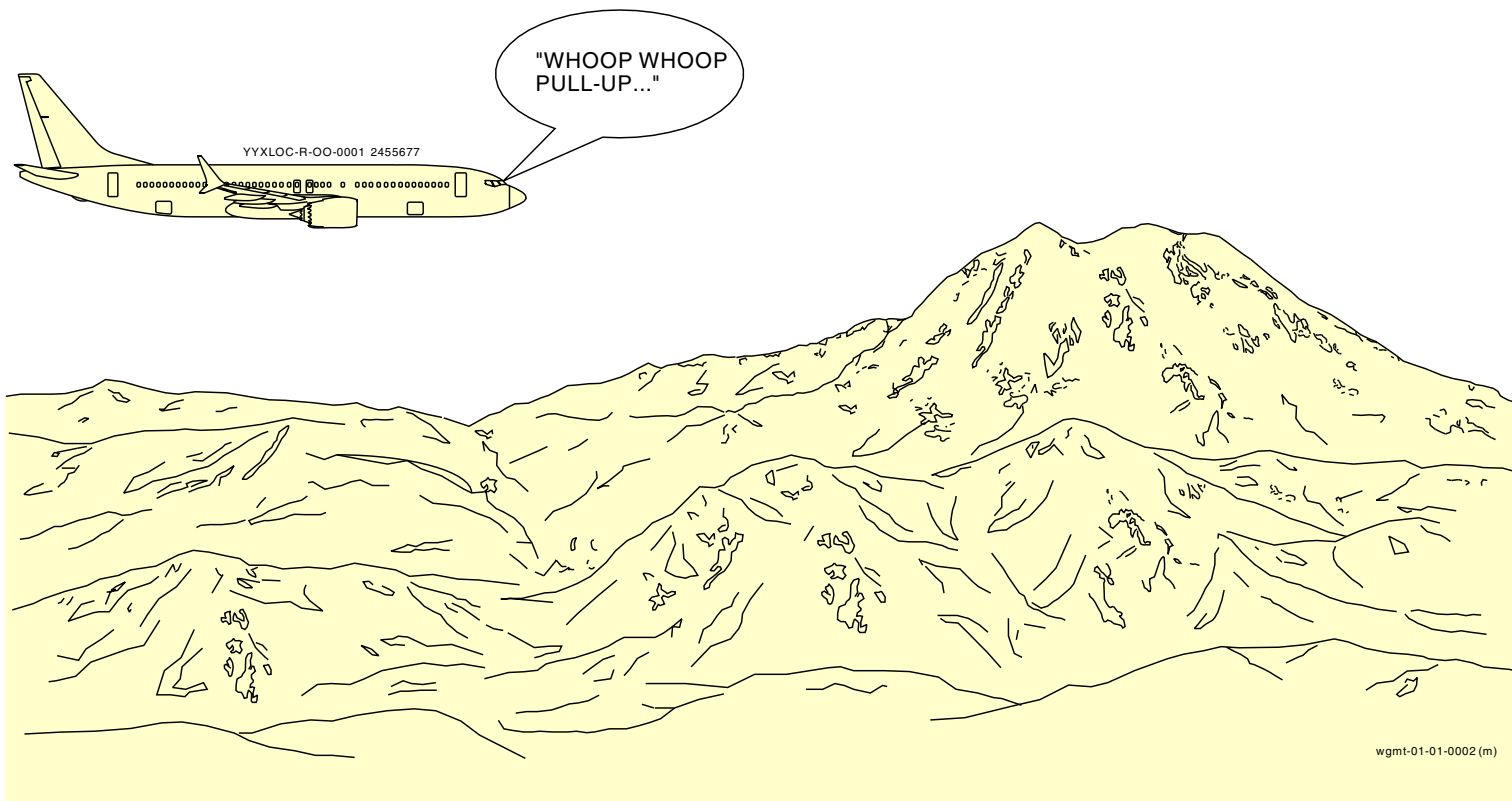
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- sec - second
- sw - switch
- sys - system
- TCAS - traffic alert and collision avoidance system
- TCF - terrain clearance floor
- TERR - terrain
- USB - universal serial bus
- WXR - weather radar system
- vert - vertical
- xfr - transfer
- xmtr - transmitter

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GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION



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GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION

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GPWS - GENERAL DESCRIPTION

General Description

The GPWS gives the pilots aural and visual warnings of unsafe conditions. The warnings continue until the pilots correct the condition. The system operates when the airplane is less than 2450 feet above the ground.

The enhanced GPWS function contains a worldwide terrain data base. The GPWC compares airplane position and track with this data base to find if there is a warning condition. This is the terrain awareness function.

The enhanced GPWS also contains an airport data base. This data base contains terrain information for all hard surface runways that are more than 3500 feet or longer. The GPWC compares airplane position and runway location to find if there is a warning condition. This is the terrain clearance floor (TCF) function.

The GPWS uses inputs from these units to calculate warning conditions:

- Ground proximity warning module (GPWM)
- Radio altimeter (RA)
- Air data inertial reference system (ADIRS)
- Stall management yaw dampers (SMYDs)
- Multi-mode receivers (MMRs)
- Flight management computer system (FMCS)
- DFCS MCP
- Weather radar (WXR)
- Display processing computers (DPCs).

GPWS visual warnings show on the max display system (MDS) display units, the below glideslope annunciators, and the GPWM.

GPWS aural warnings go through the remote electronics unit to the pilots headsets and flight deck speakers.

The GPWS sends inhibit signals to the TCAS and weather radar systems when GPWS calculates cautions and warnings.

The GPWS shows terrain that is forward of the airplane. This information goes to the DPCs for display. Alerts to the flight crew of an early descent during a landing also go to the DPCs for display.

Visual indications show on these:

- Captain and first officer primary flight displays
- Captain and first officer navigation displays
- Captain and first officer glideslope inhibit switches
- GPWM.

GPWS cautions and warnings go to the flight data acquisition unit (FDAU).

Aural messages go to the remote electronics unit (REU).

The enhanced GPWC is software loadable with the data loader control panel.

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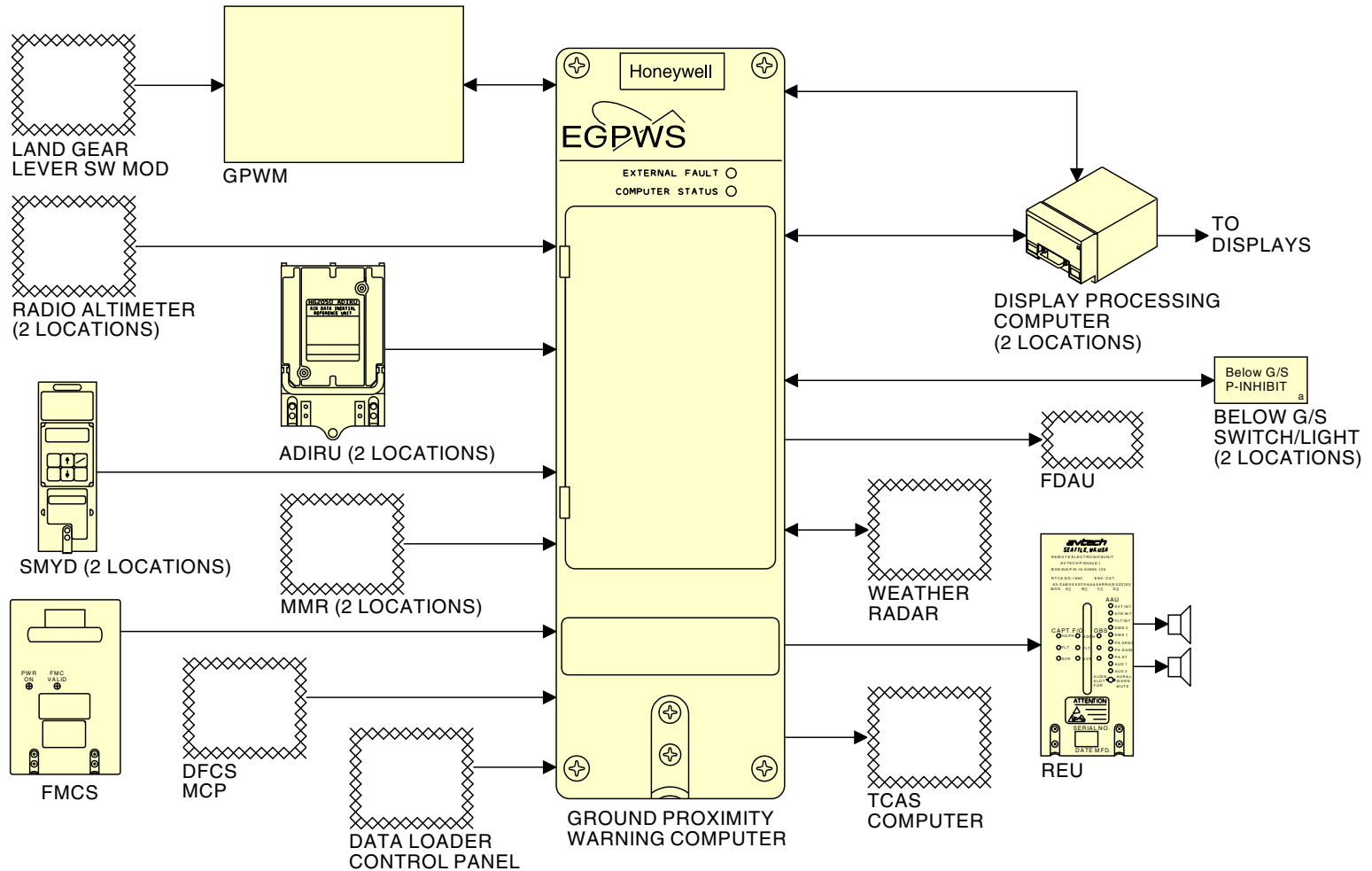
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GPWS - GENERAL DESCRIPTION



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GPWS - GENERAL DESCRIPTION

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GPWS - COMPONENT LOCATION

Flight Compartment

These are the GPWS components in the flight compartment:

- Capt and F/O Below G/S Switch/Light
- Ground proximity warning module.

These are the components in the flight compartment that interface with the GPWS:

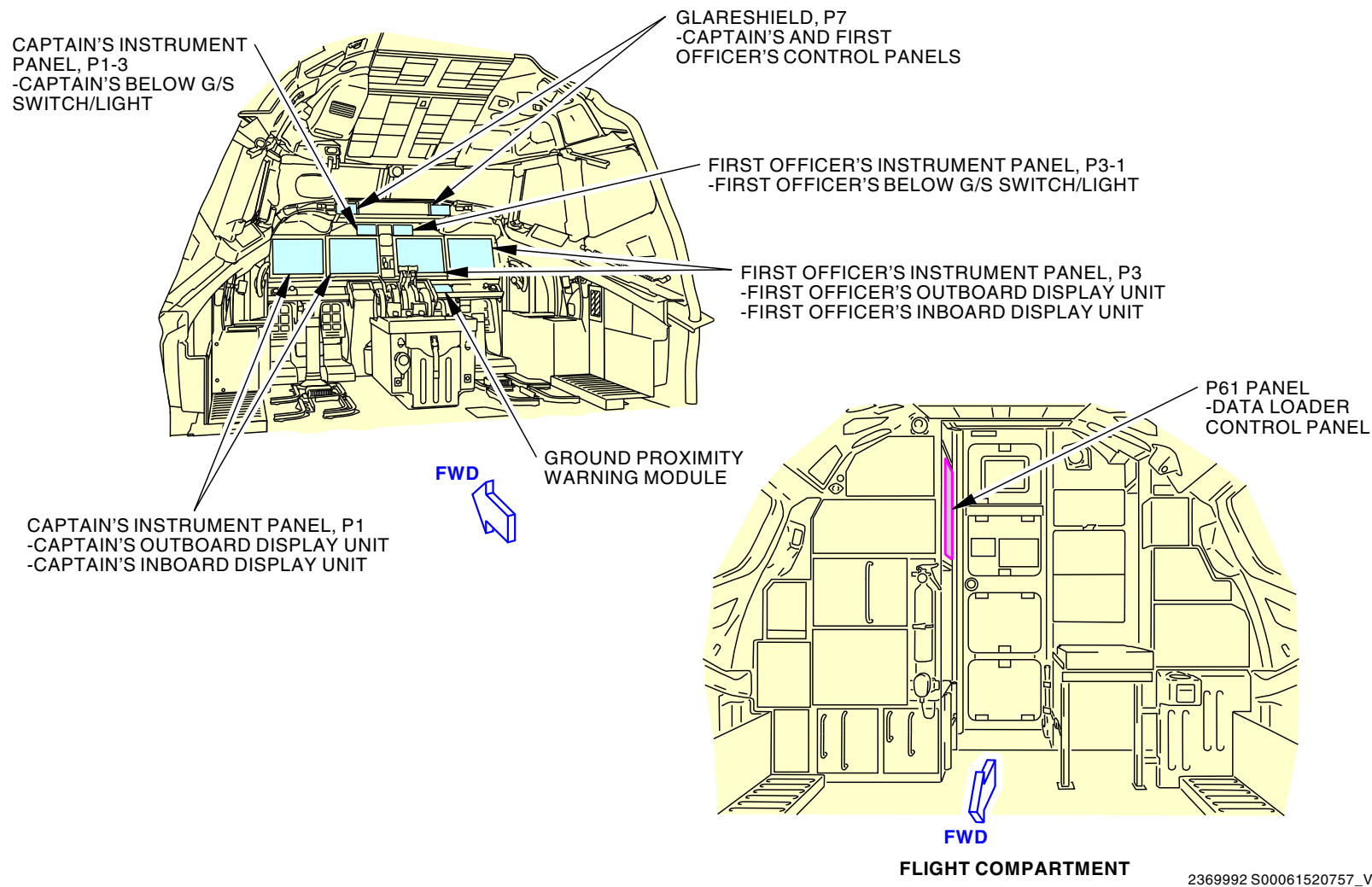
- Capt and F/O display units
- Capt and F/O EFIS control panels
- Data loader control panel

Electronic Equipment Compartment

The ground proximity warning computer (GPWC) is in the electronic equipment compartment on the E1-1 shelf.

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GPWS - COMPONENT LOCATION

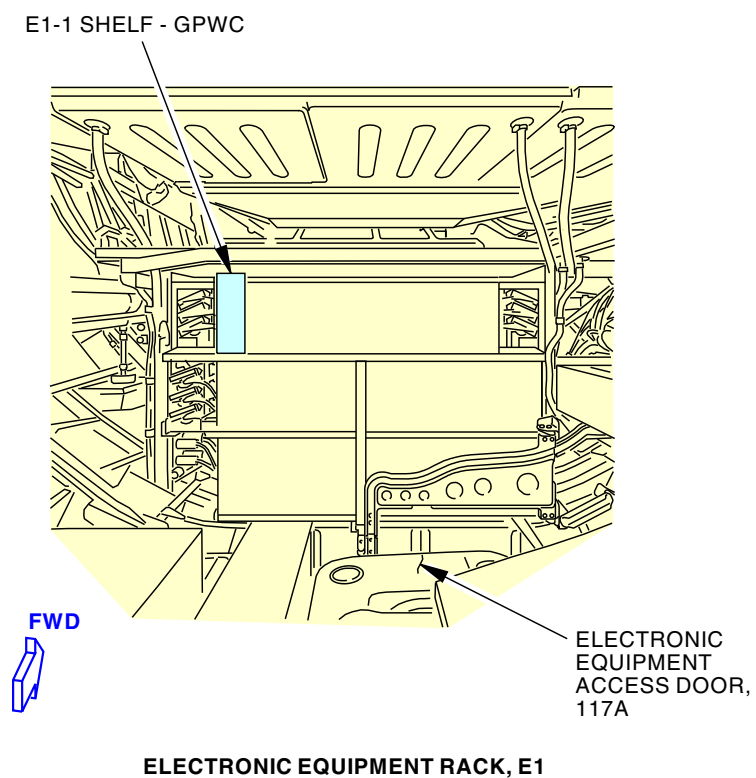


GPWS - FLIGHT COMPARTMENT COMPONENT LOCATION

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GPWS - COMPONENT LOCATION



GPWS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

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GPWS - POWER AND ANALOG INTERFACES

General

The ground proximity warning computer (GPWC) receives 115v ac from the GND PROX WARN circuit breaker on the P18 circuit breaker panel.

The terrain select discrete can be set manually with the TERR switch on the EFIS control panel or automatically by the pop up function. The pop up function lets terrain data show automatically on the navigation displays when there is a terrain awareness caution or warning. This function only occurs when both of the navigation displays are not currently showing terrain data.

Gear position from the landing gear lever switch module on P2-3 goes to the gear inhibit switch in the ground proximity warning module (GPWM). The GPWM sends the landing gear position discrete to the GPWC.

The gear inhibit switch in the inhibit position sends a discrete to the GPWC that simulates the landing gear in the extended position. GPWC uses gear position for these modes:

- Mode 2
- Mode 3
- Mode 4
- Mode 5.

When the flap inhibit switch on the GPWM is in the inhibit position, a flap inhibit discrete signal goes to the GPWC. This simulates a flaps landing position in the GPWC.

The GPWM terrain inhibit discrete prevents the enhanced function of the GPWS. The discrete does not affect the operation of modes 1 thru 7. These items are inhibited:

- Terrain cautions
- Terrain warnings
- Terrain displays
- Terrain aural messages.

The GPWM also sends a test discrete signal to the GPWC. The GPWC uses the test discrete to start a self-test of the GPWS.

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The GPWM runway inhibit switch sends a discrete ground to the GPWC to disable the runway situational awareness functions. These items are inhibited:

- Runway Situational Awareness Tools (RSAT).

The GPWC sends a RUNWAY INOP discrete to the GPWM to turn on the amber RUNWAY INOP light.

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The GPWC sends a GPWC INOP discrete to the GPW control module to turn on the amber INOP light.

The PSEU sends air/ground discrete data to the GPWC for in-air logic. This logic is used in these modes:

- Mode 2
- Mode 3
- Mode 4
- Inhibit BITE in air
- Flight leg counting.

The GPWC sends an inhibit discrete to the TCAS computer when the GPWC has a higher priority alert. This discrete inhibits the TCAS aural messages and downgrades TCAS resolution advisories (RAs) to traffic alerts.

GPWC aural messages have a higher priority than the TCAS aural messages with the exception of mode 6 aural messages. Mode 6 aural messages can occur at the same time as TCAS aural messages.

The GPWC also sends a predictive windshear inhibit discrete to the weather radar receiver transmitter when the GPWC has a higher priority alert. This discrete inhibits the PWS aural messages.

The program switch module supplies program pin selections to the GPWC. The options determine such parameters as:

- Airplane type

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GPWS - POWER AND ANALOG INTERFACES

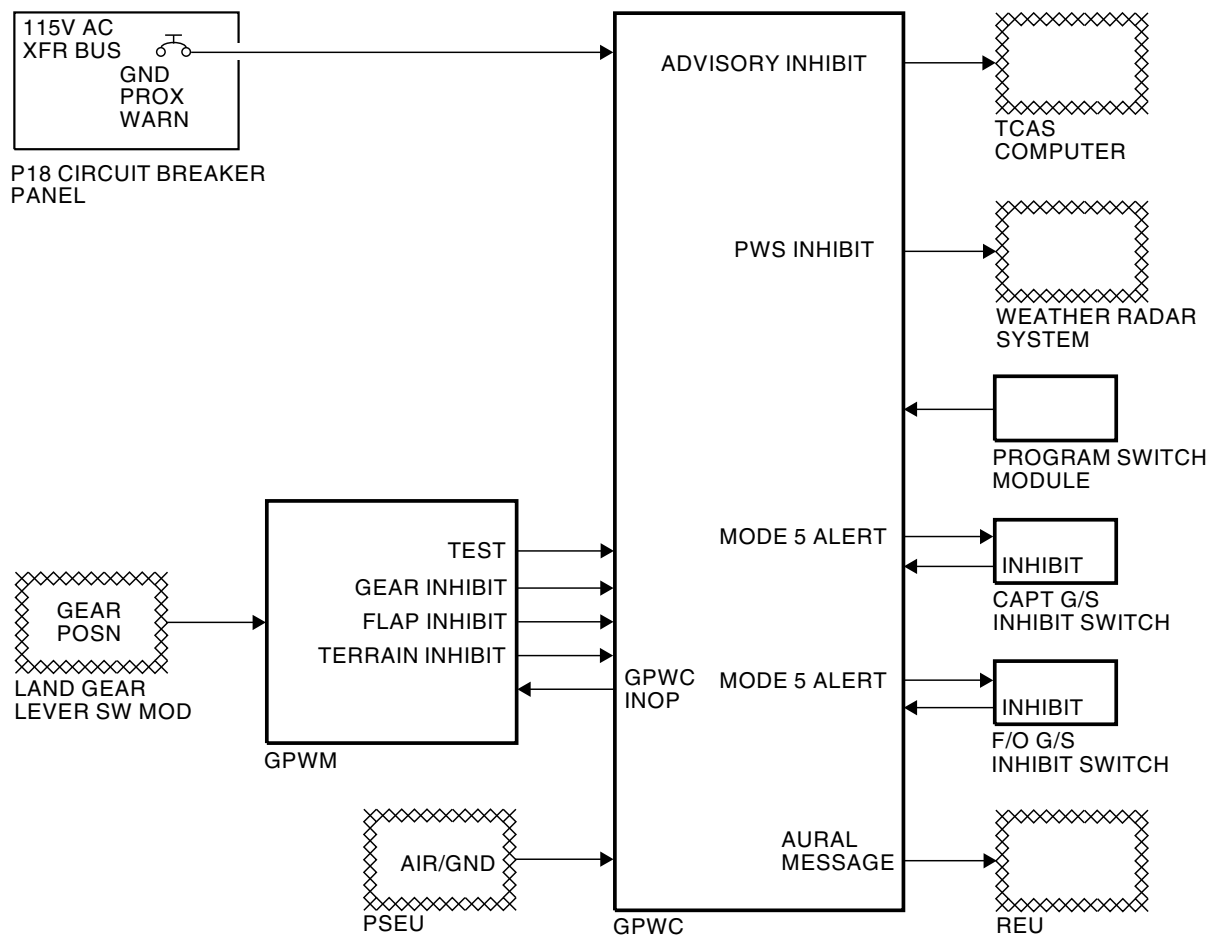
- Mode 6 callouts
- High or low audio volume.

The GPWC sends discretes to the captain and first officer glideslope inhibit switches. The lights come on for GPWC mode 5 alerts. When you push the light assemblies, a discrete goes to the GPWC to turn off the lights and stop the aural warnings.

GPWS alert and warning aural messages go to the remote electronics unit (REU). The REU sends the aural messages to the flight compartment.

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GPWS - POWER AND ANALOG INTERFACES



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GPWS - POWER AND ANALOG INTERFACES

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115V AC
XFR BUS

GND
PROX
WARN

P18 CIRCUIT BREAKER
PANEL

GEAR
POSN

LAND GEAR
LEVER SW MOD

TEST
GEAR INHIBIT
FLAP INHIBIT
TERRAIN INHIBIT
RUNWAY INHIBIT

GPWM

AIR/GND

PSEU

GPWC

ADVISORY INHIBIT

PWS INHIBIT

RUNWAY
INOP

MODE 5 ALERT

GPWC
INOP

MODE 5 ALERT

AURAL
MESSAGE

TCAS
COMPUTER

WEATHER RADAR
SYSTEM

PROGRAM SWITCH
MODULE

INHIBIT
CAPT G/S
INHIBIT SWITCH

INHIBIT
F/O G/S
INHIBIT SWITCH

REU

GPWS - POWER AND ANALOG INTERFACES

EFFECTIVITY
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GPWS - DIGITAL INTERFACES

General

The GPWC interfaces with other airplane systems on ARINC 429 data buses. These systems have digital interfaces with the GPWC:

- Left and right air data inertial reference units
- Radio altimeter 1 and 2
- Multi mode receivers 1 and 2
- Flight management computer 1 and 2
- DFCS mode control panel
- Stall management yaw damper 1 and 2
- Weather radar (WXR)
- Display processing computer (DPC) 1 and 2
- Flight data acquisition unit (FDAU).

The options for the EGPWS are contained in the Operational Program Configuration (OPC) software which is loaded through the data loader control panel (DLCP) into the GPWC.

Air Data Inertial Reference Unit

The left and right ADIRU ADR buses send this data to the GPWC:

- Computed airspeed
- True airspeed
- Barometric altitude rate
- Uncorrected altitude
- Barometric altitude.

This air data is used to determine cautions and warnings for GPWS modes 1, 2, 3, 4, and 7. The GPWC uses the data from the left ADIRU. If the left ADIRU data is invalid, it uses data from the right ADIRU.

The left and right ADIRU IR bus sends these inputs to the GPWC:

- Latitude
- Longitude

- Inertial altitude
- Inertial vertical speed
- Track angle magnetic
- Pitch attitude
- Roll attitude
- Body longitudinal acceleration
- Body normal acceleration
- Inertial vertical acceleration
- Pitch rate
- Ground speed
- True track
- True heading
- IR mode.

This IR data is used to determine cautions and warnings for GPWS modes 1, 2, 3, 7, terrain clearance floor (TCF), and terrain awareness. The GPWC uses the data from the left ADIRU. If the left ADIRU data is invalid, it uses data from the right ADIRU.

Radio Altimeter Receiver-Transmitter

The radio altimeters (RA) send radio altitude data to the GPWC. This data is used in modes 1 to 7 and TCF. The GPWC uses the data from RA 1. If RA 1 data is invalid, it uses data from RA 2.

Instrument Landing System

The ILS receiver in both MMRs send localizer and glideslope deviation data to the GPWC. Localizer deviation data is used in the envelope modulation function. Glideslope deviation data is used in mode 5 and the envelope modulation function. The GPWC uses the ILS data from MMR 1. If MMR 1 data is invalid, it uses ILS data from MMR 2.



GPWS - DIGITAL INTERFACES

Global Position System

The GPS in the MMRs sends this data to the GPWC:

- Latitude (coarse)
- Longitude (coarse)
- Latitude (fine)
- Longitude (fine)
- Ground speed
- True track.
- Altitude
- Vertical velocity
- Horizontal dilution of precision (HDOP)
- Vertical dilution of precision (VDOP)
- Horizontal figure of merit (HFOM)
- Vertical figure of merit (VFOM)
- Date
- Time (UTC)
- Horizontal integrity limit (HIL)
- Sensor status.

The GPWC uses the GPS data from MMR 1. If MMR 1 data is invalid, it uses GPS data from MMR 2.

Latitude and longitude (coarse and fine) information gives airplane position for the TCF and terrain awareness functions.

Ground speed, true track, altitude, and vertical velocity are used in the terrain awareness function.

Horizontal dilution of precision, vertical dilution of precision, horizontal figure of merit, and vertical figure of merit data is used for airplane position accuracy calculations.

Date and time information is used in the fault monitor process, which labels each fault with the date and time of occurrence.

The horizontal integrity limit is used to determine the current integrity limit and GPS non-isolatable satellite failures.

Sensor status lets the GPWC monitor the status of the GPS receiver IN THE MMR.

Flight Management Computer System

The primary FMC sends latitude, longitude, and magnetic track data to the GPWC. The GPWC uses this data in the envelope modulation function. If the FMC input is invalid, the GPWC uses latitude, longitude and magnetic track data from the ADIRS.

DFCS MCP

The digital flight control system (DFCS) mode control panel (MCP) sends selected course data to the GPWC. This data is used in mode 5 and the envelope modulation function.

Stall Management Yaw Damper

The stall management yaw dampers (SMYD) send this data to the GPWC:

- Indicated angle of attack (AOA)
- Corrected AOA
- Stick shaker AOA
- Flap position
- Minimum operating speed.

The inputs from the SMYD are used primarily in wind shear calculations.

DPCs

The display processing computers (DPCs) send this data from the EFIS control panels to the GPWC:

- Range
- Terrain select
- Radio minimums

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**GPWS - DIGITAL INTERFACES**

- Baro minimums.

Weather Radar Receiver-Transmitter

The weather radar RT sends predictive windshear caution and warning data to the GPWC. The GPWC contains aural prioritization logic that uses this data to determine which system cautions and warnings to inhibit. The GPWS, TCAS, and PWS systems are prioritized by the GPWC.

GPWC Outputs

The GPWC sends system status, caution, and warning data on an ARINC 429 data bus to the DPCs. The DPCs show system status, caution and warning annunciations on the captain and first officer primary flight display and the navigation display.

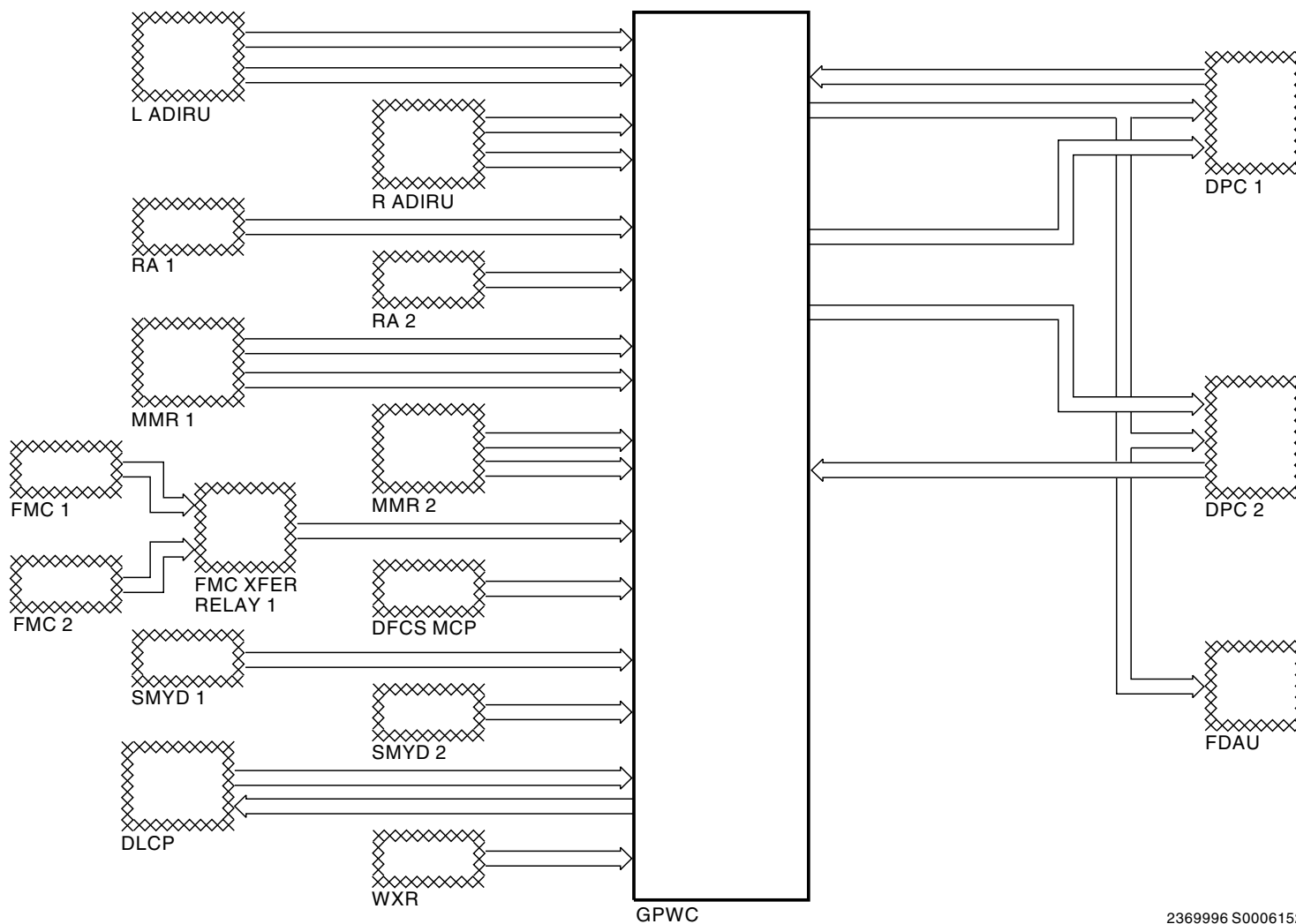
The GPWC sends caution, warning, and status discretes to the flight data acquisition unit (FDAU). The FDAU sends the GPWC data to the flight data recorder.

The GPWC sends terrain display data on an ARINC 453 data bus to the DPCs to show on the navigation displays.

The terrain data is sent when TERR is selected on the EFIS control panel or automatically for the pop-up mode. The pop-up mode occurs when a terrain caution or warning is calculated and the captain and the first officer navigation displays are not selected to show terrain data.

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GPWS - DIGITAL INTERFACES



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GPWS - DIGITAL INTERFACES

**GPWS - GROUND PROXIMITY WARNING COMPUTER****Purpose**

The ground proximity warning computer (GPWC) compares the airplanes flight profile, flap and gear position, and terrain clearance to find if there is a warning condition.

Description

The enhanced GPWC is the main component of the GPWS. The computer front panel contains two LEDs that show the computer is OK, or internal and external failures. The front panel also contains a self-test switch. The switch provides access to six self-test modes. The faults are annunciated through the flight deck speakers or through headphones connected to the jack below the switch.

You can load the Operational Program Configuration (OPC) software to configure optional features with the data loader control panel and a data loader.

You can load the terrain database with a USB mass storage device (MSD).

The front panel contains USB and Ethernet data load connectors and a status indicator.

The computer has front panel D-SUB (RS-232) type and Ethernet test connectors.

Physical Description

The GPWC is a standard ARINC 600, 2 MCU. The dimensions are 2.4 inches wide, 7.9 inches high, and 14.3 long. The computer weighs 7 pounds and uses 115v ac, 400 HZ single-phase power for operation.

The GPWC is cooled with air from the equipment cooling system. The cooling air for the GPWC is blow-through.

Front Panel

The GPWC front panel has two status LEDs and a door.

These are the two status LEDs on the front panel:

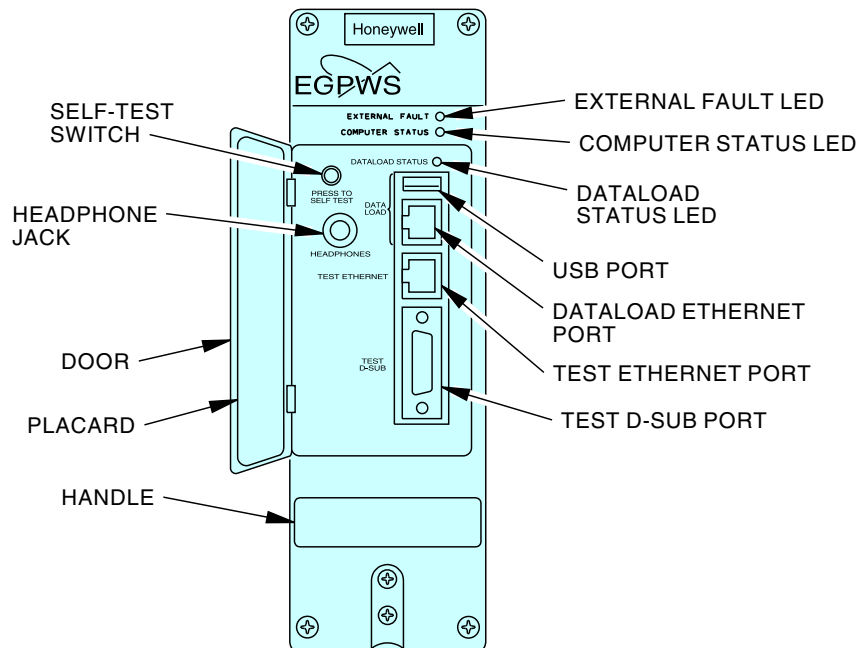
- EXTERNAL FAULT - amber LED turns on for a failure external to the GPWC.
- COMPUTER STATUS - green LED indicates the GPWC is okay or a red LED indicates an internal computer fault is detected.

The front panel door gives access to these:

- PRESS TO SELF TEST switch - starts a test of the GPWS
- Headphone jack - lets you hear self-test audio
- USB 2.0/3.0 dataload connector - for upload of software, databases, and download of history data.
- Dataload Status LED - shows the status of the upload or download operation. LED status usually shows green. The LED will show yellow when uploading software. The computer reboots after dataload is complete and LED status goes back to green.
- RJ45 Ethernet dataload connector - for upload of software, databases, and download of history data.
- RJ45 Ethernet test connector - for PC connection to run the WinViews test application for internal data monitoring.
- D-SUB (RS-232) test connector - for vendor use only.

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GPWS - GROUND PROXIMITY WARNING COMPUTER



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GPWS - GROUND PROXIMITY WARNING COMPUTER

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GPWS - EFIS CONTROL PANEL

Description

The EFIS control panel lets the flight crew choose the information they want to show on the navigation displays. These controls interface with the GPWS:

- TERR Map switch
- ND mode selector
- ND range selector.

TERR Map Switch

When you push the TERR map switch on the EFIS control panel, terrain data shows on the on-side ND. Push the TERR map switch again to remove the terrain data.

ND Mode Selector

Use the ND mode selector to choose an ND mode. These are the ND modes that show terrain data:

- Expanded APP (approach) mode
- Expanded VOR mode
- Expanded MAP mode
- Centered MAP mode.

When you push the TERR map switch the terrain data arms, even if it is not in the correct mode. The terrain data shows when you change the ND selector to a correct mode. The terrain data stays armed even if you push the TERR map switch again. Push the WXR map switch to disarm the terrain data and arm the weather data.

ND Range Selector

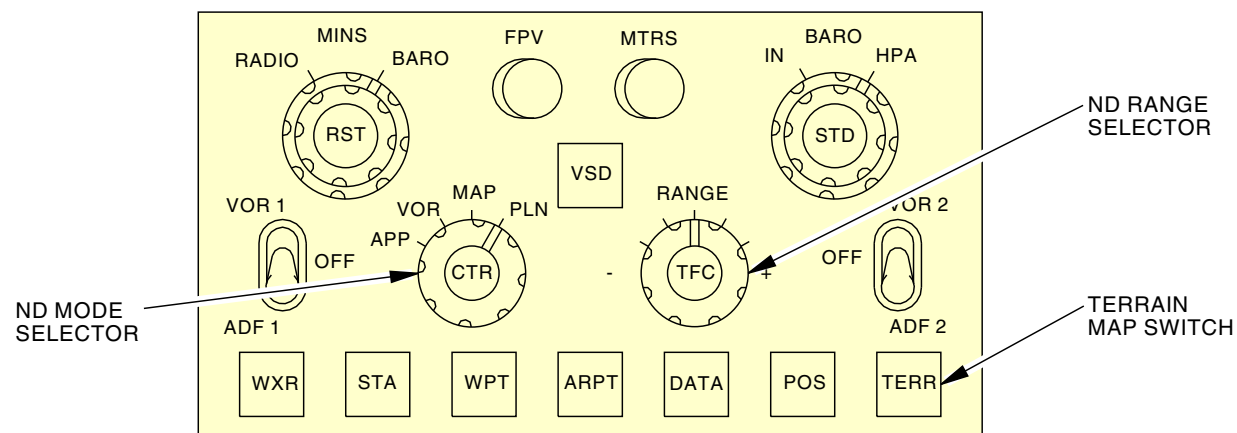
The EFIS control panel has an eight-position range selector. The range selections are 5, 10, 20, 40, 80, 160, 320, and 640 NM. The map mode shows the range at all times. Terrain data shows only in the 5NM through 320 NM selections. When the range selector is in the 640NM range, terrain data will only show to 320NM.

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GPWS - EFIS CONTROL PANEL



GPWS - EFIS CONTROL PANEL

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**GPWS - GROUND PROXIMITY WARNING MODULE****General**

The ground proximity warning module (GPWM) is the interface between the flight crew and the GPWS. The GPWM has an amber GPWS INOP light. The panel also has these switches:

- Test switch
- Flap inhibit switch
- Gear inhibit switch.
- Terrain inhibit switch.

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- Runway inhibit switch.

SIA ALL**GND PROX INOP light**

The amber INOP light on the GPWM comes on when there is a failure of the GPWC or if there is a failure of a critical input to the GPWC. The INOP light also comes on if the GPWC can not calculate windshear conditions. GND PROX INOP light also comes on during the GPWC self test.

SIA 015-999**RUNWAY INOP light**

The amber RUNWAY INOP light comes on if the runway awareness has failed or been disabled, the airport is not in the database, or GPS accuracy can not support runway awareness.

SIA ALL**Test Switch**

The test switch is a momentary action switch that lets you do a self-test of the GPWC from the flight compartment.

Momentarily push the test switch to start a self-test. There are six levels of self-tests that can be done from the GPWM. To make navigation of self-test levels faster, the test switch can be used to cancel self-test sequences and self-test levels. A short cancel stops a test sequence and a long cancel stops a self-test level. Push the test switch for less than two seconds for a short cancel and push the test switch for more than two seconds for a long cancel.

Inhibit Switches

The flap inhibit switch simulates a flaps down condition to the GPWC. The use of this switch prevents warnings when the flight crew makes a flaps up approach. When selected, the mode 4 warning TOO LOW FLAP is inhibited.

The gear inhibit switch simulates a gear down condition to the GPWC. The use of this switch prevents warnings when the flight crew makes a gear up approach. When selected, the mode 4 warning TOO LOW GEAR is inhibited.

The terrain inhibit switch sends a discrete ground to the GPWC. The discrete ground inhibits the terrain clearance floor (TCF) function and the terrain awareness function. When the switch is in the inhibit position, TCF and terrain awareness cautions and warnings do not show on the navigation displays and are not heard over the flight deck speakers. Also, when the terrain inhibit switch is in the inhibit position, the amber TERR INHIBIT message shows on both navigation displays.

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The runway inhibit switch sends a discrete ground to the GPWC. The discrete ground inhibits the runway situational and awareness functions. When the switch is in the inhibit position, all runway awareness caution and warning aural messages are not heard over the flight deck speakers. The aural messages that occurred while the system was inhibited may be heard after the system is re-enabled. If the switch is in the inhibit position, this inhibits:

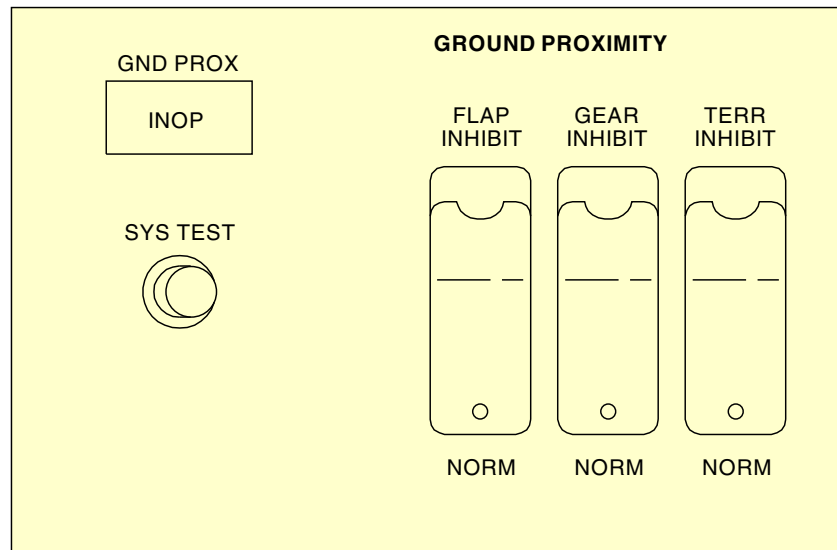
- Runway Situational Awareness Tools (RSAT).

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GPWS - GROUND PROXIMITY WARNING MODULE



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GPWS - GROUND PROXIMITY WARNING MODULE

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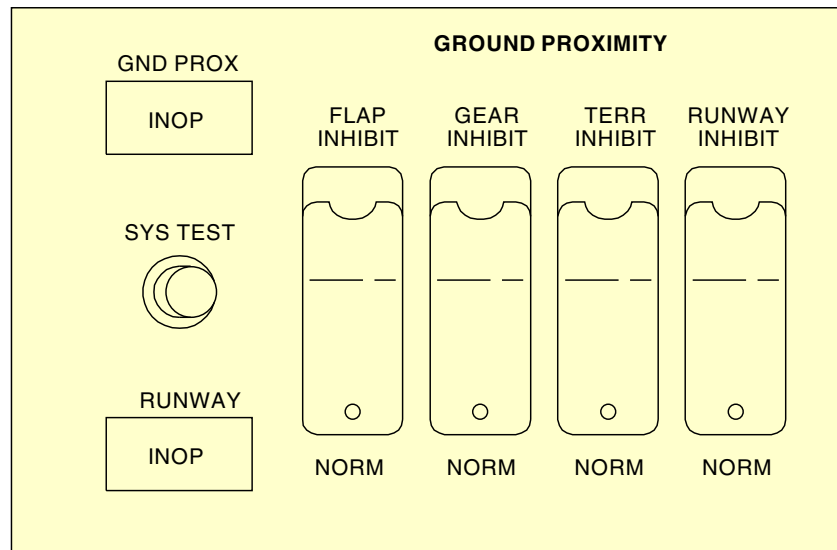
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GPWS - GROUND PROXIMITY WARNING MODULE



GPWS - GROUND PROXIMITY WARNING MODULE

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**GPWS - MODE 1 DESCRIPTION****Purpose**

Mode 1 supplies alerts and warnings for large descent rates when the airplane is near the terrain. This mode is independent of flap or gear positions.

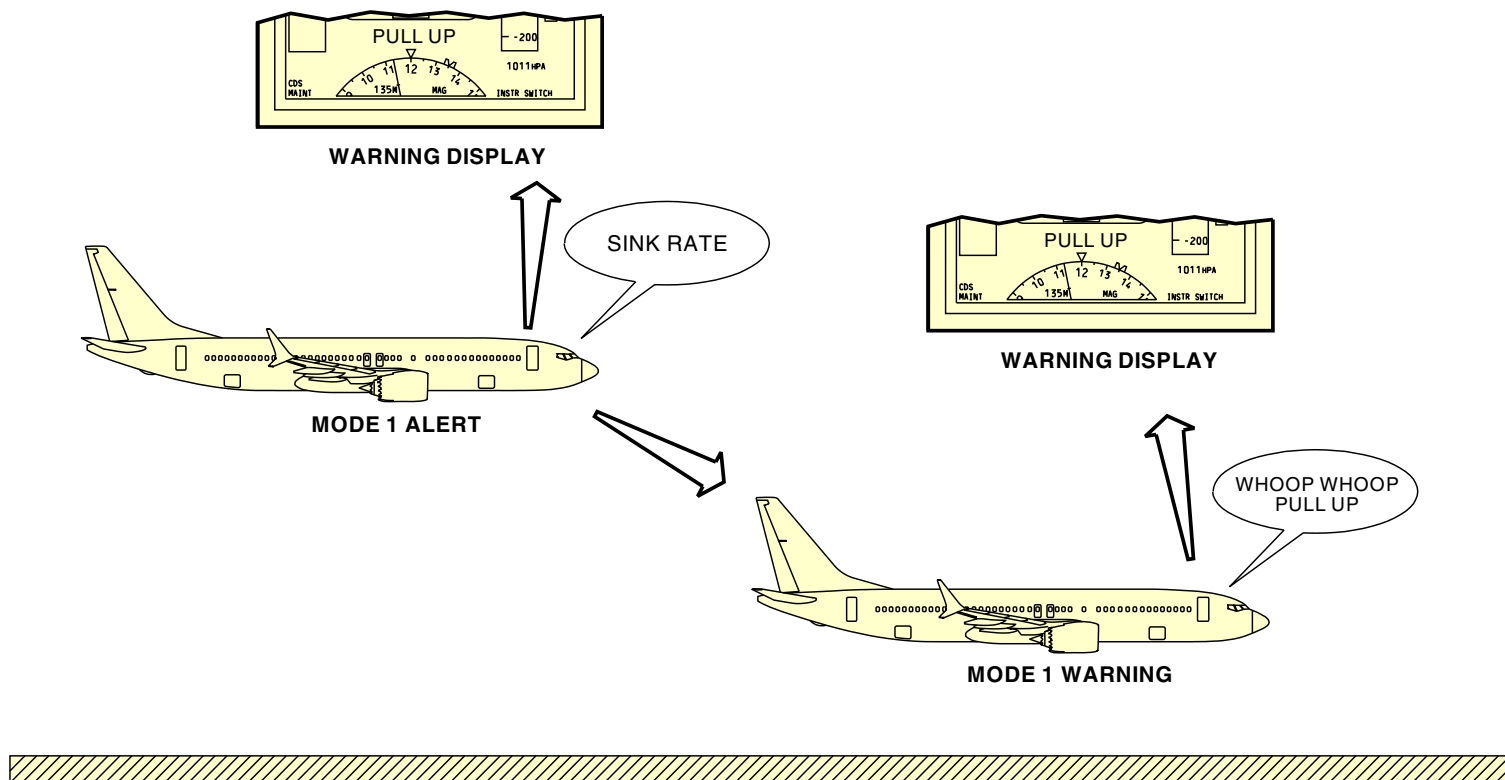
Description

The alert condition gives the aural message, SINK RATE and makes the PULL UP display on the attitude indication (AI). If the descent rate does not decrease, the alert condition changes to a warning condition.

The warning condition makes the red PULL UP warning on the AI and gives the aural message, WHOOP WHOOP PULL UP.

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GPWS - MODE 1 DESCRIPTION



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GPWS - MODE 1 DESCRIPTION

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**GPWS - MODE 1 FUNCTIONAL DESCRIPTION****General**

Mode 1 alert conditions and warning conditions can occur between 2450 feet and 10 feet radio altitude. The type of annunciation depends on the rate of descent and the radio altitude. The first annunciation is a caution. If the rate of descent does not decrease, the annunciation changes to a warning.

The LRUs that supply inputs for mode 1 operation are the radio altimeter transceivers and the left and right ADIRUs.

The GPWC uses this data to detect mode 1 cautions and warnings:

- Radio altitude
- Inertial vertical speed
- Barometric altitude rate.

The mode detector in the GPWC calculates the descent rate from the inertial vertical speed input. If it is not available, the mode detector uses an internally calculated altitude rate. If the IVS and the internally calculated rates are invalid, the barometric altitude rate from the ADIRU is used. When the GPWC uses barometric altitude rate, the lower altitude cutoff changes from 10 feet to 30 feet.

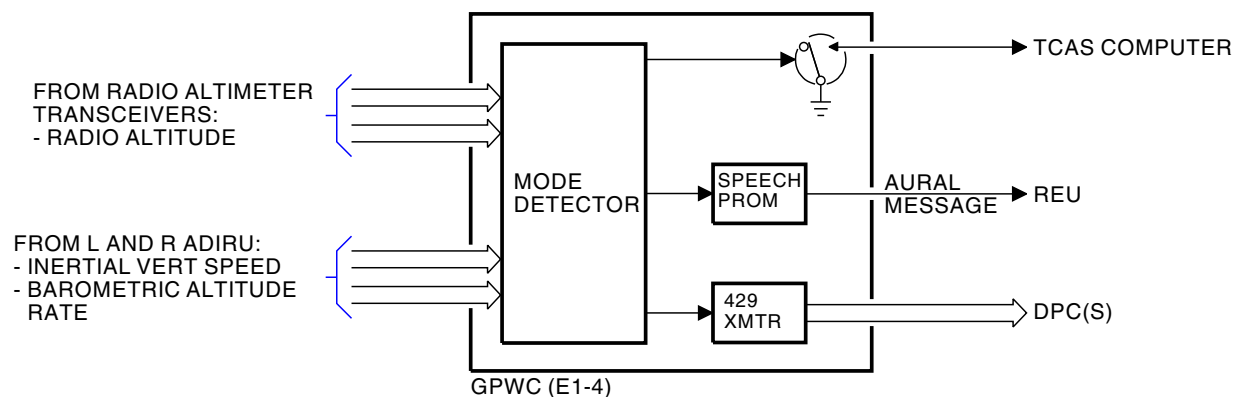
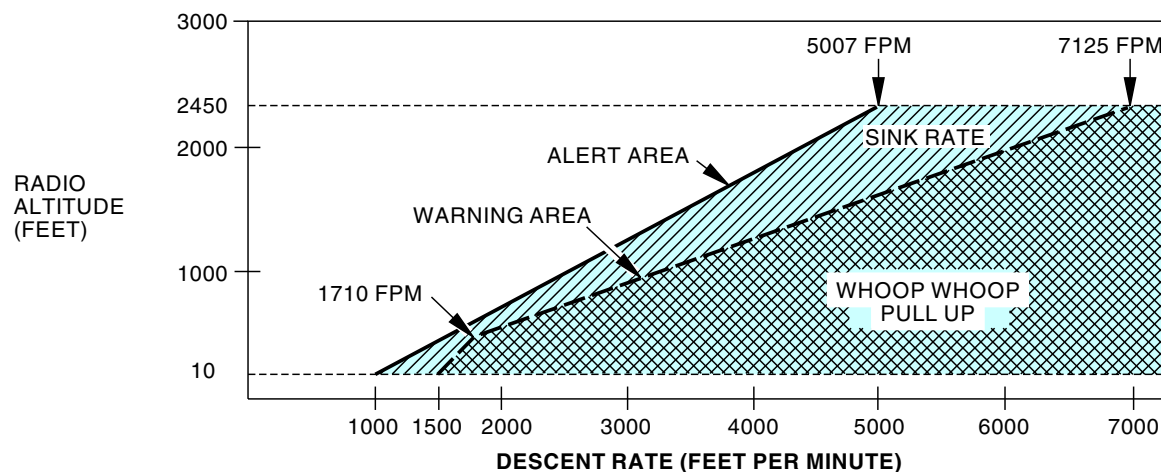
When there is a caution or warning condition, the mode detector sends a discrete to the speech prom to make the aural messages come on. The aural messages go to the remote electronics unit (REU) which sends them to the flight compartment speakers.

Caution and warning conditions cause the mode detector to send a signal on the ARINC 429 transmitter to the DPCs to show the PULL UP display.

When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages.

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GPWS - MODE 1 FUNCTIONAL DESCRIPTION



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GPWS - MODE 1 FUNCTIONAL DESCRIPTION

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**GPWS - MODE 2A DESCRIPTION****Purpose**

Mode 2 supplies alerts and warnings when the closure rate to the terrain is too large. Mode 2 has two submodes, mode 2A and mode 2B.

Description

Mode 2A occurs for a large closure rate if the flaps are not in the landing configuration and glideslope deviation is more than 2 dots. Flaps 30 or more is a landing configuration. Mode 2A can have two alert levels, a caution condition or a warning condition.

If the terrain closure is too large, the GPWC gives the TERRAIN aural caution message twice and PULL UP shows on the primary flight display (PFD).

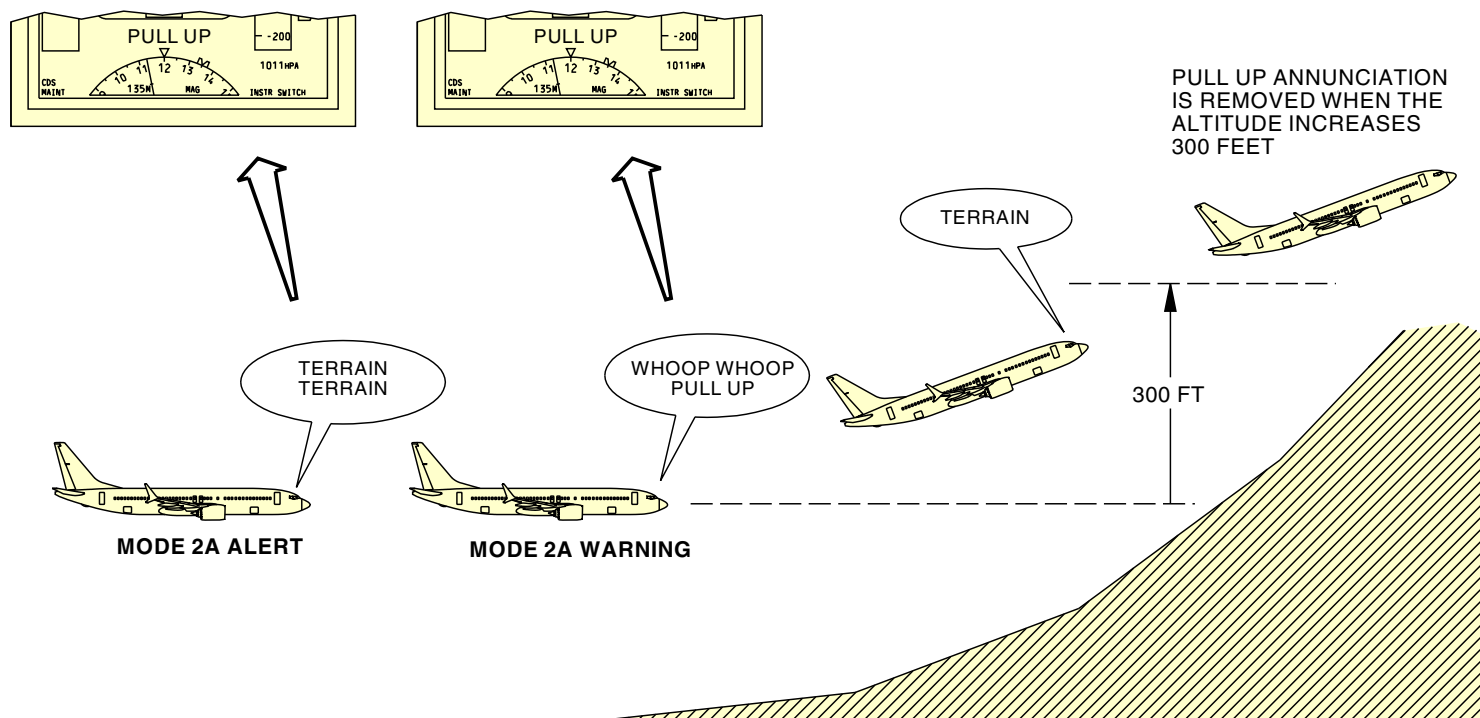
If the condition is not corrected, the caution aural message changes to the warning WHOOP WHOOP PULL UP message and PULL UP still shows on the PFD.

When the mode 2A envelope is no longer active due to either a terrain drop off or a pull up maneuver by the flight crew, the altitude gain function operates. PULL UP continues to show on the PFD until the altitude increases 300 feet or 45 seconds have elapsed. If there is still a terrain closure rate during this period, however, the GPWC also gives the TERRAIN aural caution message.

After a 300 feet increase in inertial altitude or the landing gear comes down, the PULL UP indications on the PFD stop and the aural warnings stop.

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GPWS - MODE 2A DESCRIPTION



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GPWS - MODE 2A DESCRIPTION

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**GPWS - MODE 2B DESCRIPTION****Purpose**

Mode 2B gives alerts for a large closure rate if the flaps are in the landing configuration (30 units or more).

Description

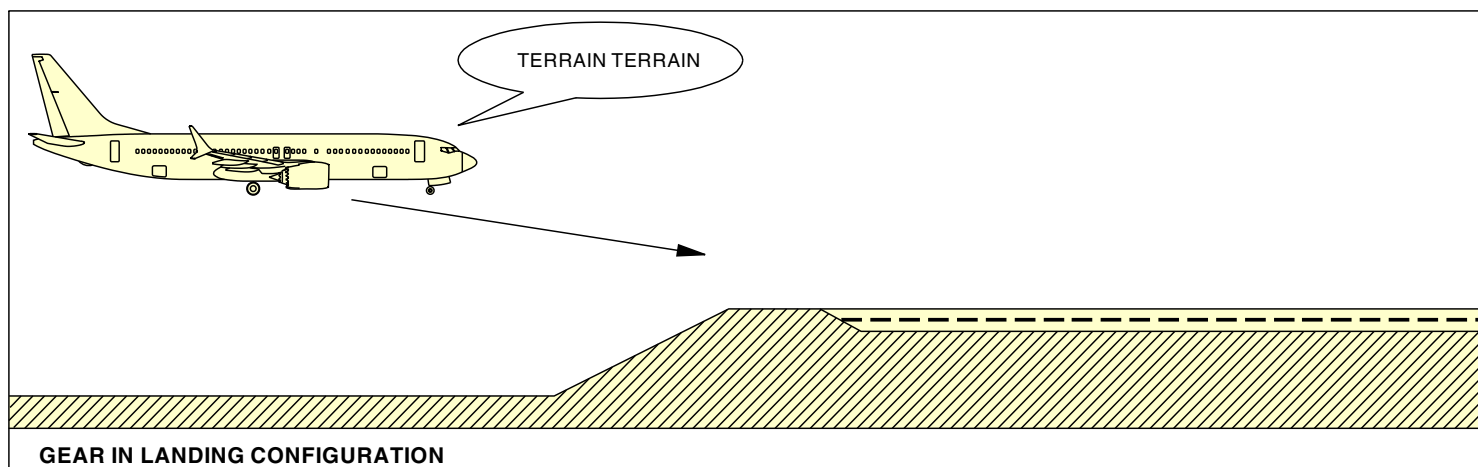
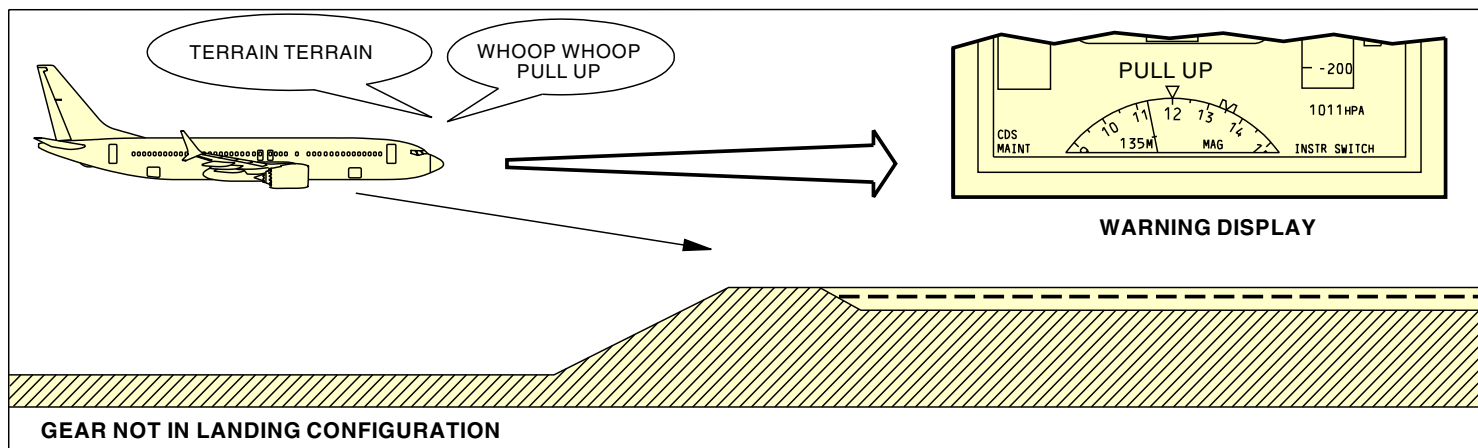
Mode 2B can have a caution condition or a warning condition.

If the terrain closure is excessive, the ground proximity warning computer (GPWC) gives the TERRAIN aural caution message repeatedly. If this condition lasts for more than 1.6 seconds, the GPWC gives the WHOOP WHOOP PULL UP aural warning message and a PULL UP annunciation on the PFD.

If the terrain closure is excessive and the landing gear is extended, the PULL UP aural warning message is replaced with the TERRAIN aural caution message.

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GPWS - MODE 2B DESCRIPTION



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GPWS - MODE 2B DESCRIPTION

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EFFECTIVITY

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**GPWS - MODE 2 FUNCTIONAL DESCRIPTION****General**

Mode 2A annunciations occur between 1650 feet radio altitude and 30 feet radio altitude for airspeed less than 220 knots. The top limit increases to 2450 feet radio altitude for airspeed between 220 knots and 310 knots.

Mode 2B annunciations can occur between 789 feet radio altitude and 30 feet radio altitude. The lower limit is between 30 feet and 600 feet radio altitude. The GPWC uses flap configuration and altitude descent rate to calculate the lower limit.

These are the LRUs that supply inputs for mode 2 operation:

- Left and right radio altimeter transceivers
- Left and right ADIRUs
- GPW module
- Stall management yaw dampers (SMYDs)
- Multi-mode receiver (MMR) 1 and 2
- Proximity switch electronic unit (PSEU).

This is the data the GPWC uses to detect mode 2 alerts and warnings:

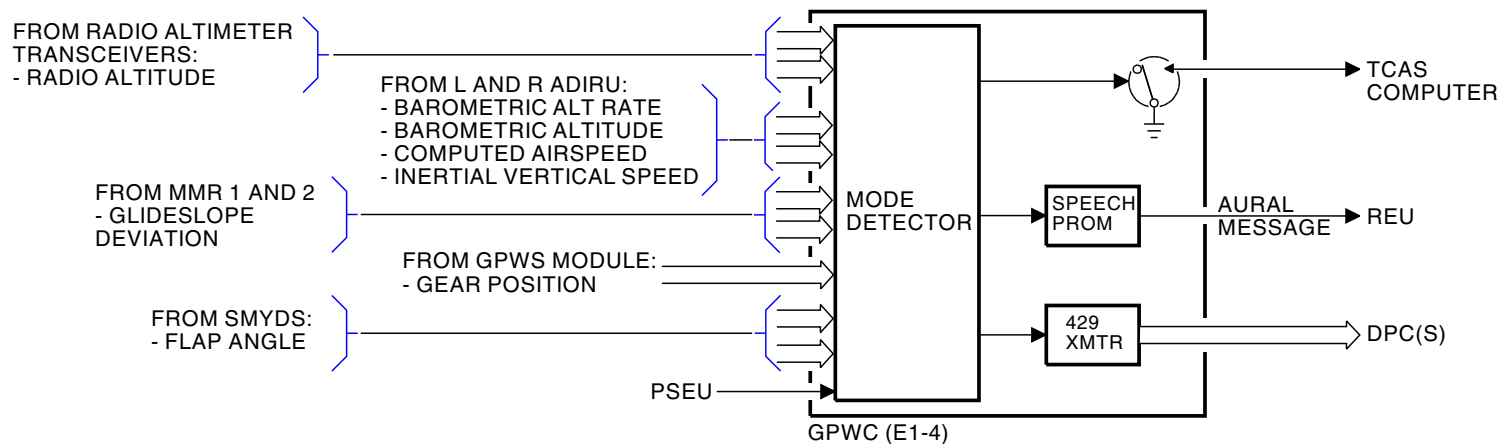
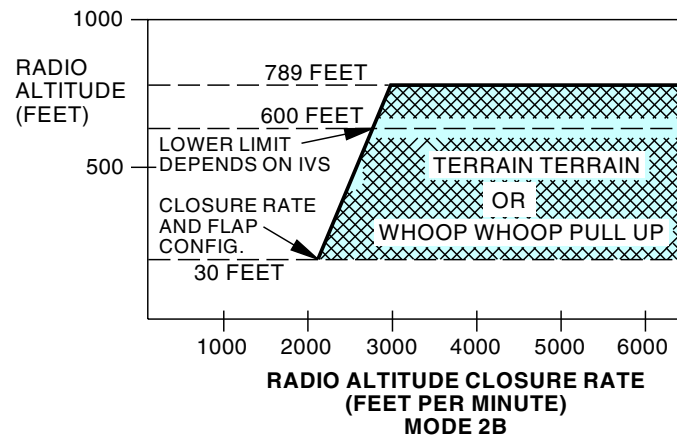
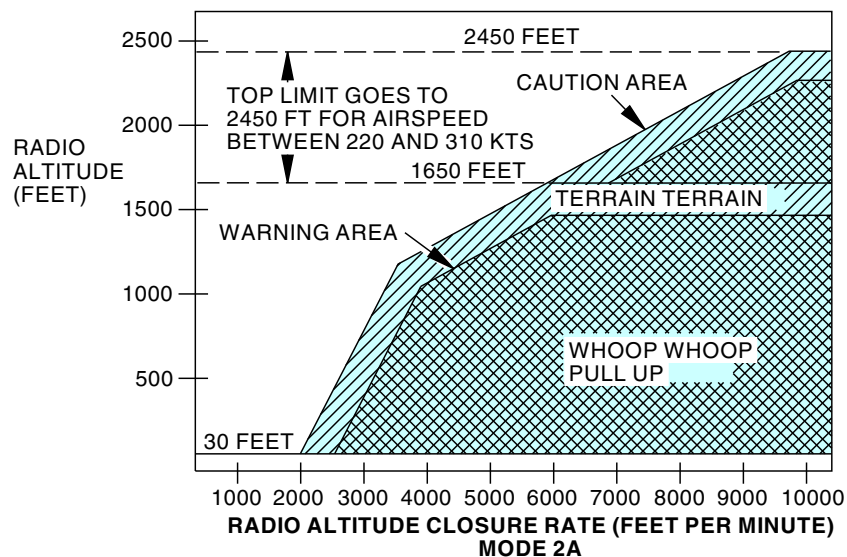
- Radio altitude
- Inertial vertical speed (IVS)
- Barometric altitude rate
- Barometric altitude
- Computed airspeed
- Flap and gear position
- Glideslope deviation
- Air/ground inputs.

When there is an alert condition or warning condition, the mode detector sends a discrete to the speech prom to make the aural messages come on. The aural messages go to the REU which sends them to the flight compartment speakers.

When there is a mode 2 warning condition, the mode detector also sends a signal on the ARINC 429 transmitter to the DPCs and the PULL UP message shows on the PFD.

When the GPWC gives a mode 2 aural message, a discrete goes to the TCAS computer to inhibit TCAS resolution advisories and TCAS aural messages.

GPWS - MODE 2 FUNCTIONAL DESCRIPTION



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GPWS - MODE 2 FUNCTIONAL DESCRIPTION

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**GPWS - MODE 3 DESCRIPTION****Purpose**

Mode 3 supplies alerts for a large altitude loss during takeoff or during a missed approach with the flaps not in the landing configuration (landing configuration for the flaps is 30 units or more) or landing gear not down. After the airplane gets to 1500 feet radio altitude, Mode 3 is not armed. When Mode 3 is not armed, Mode 4 is armed.

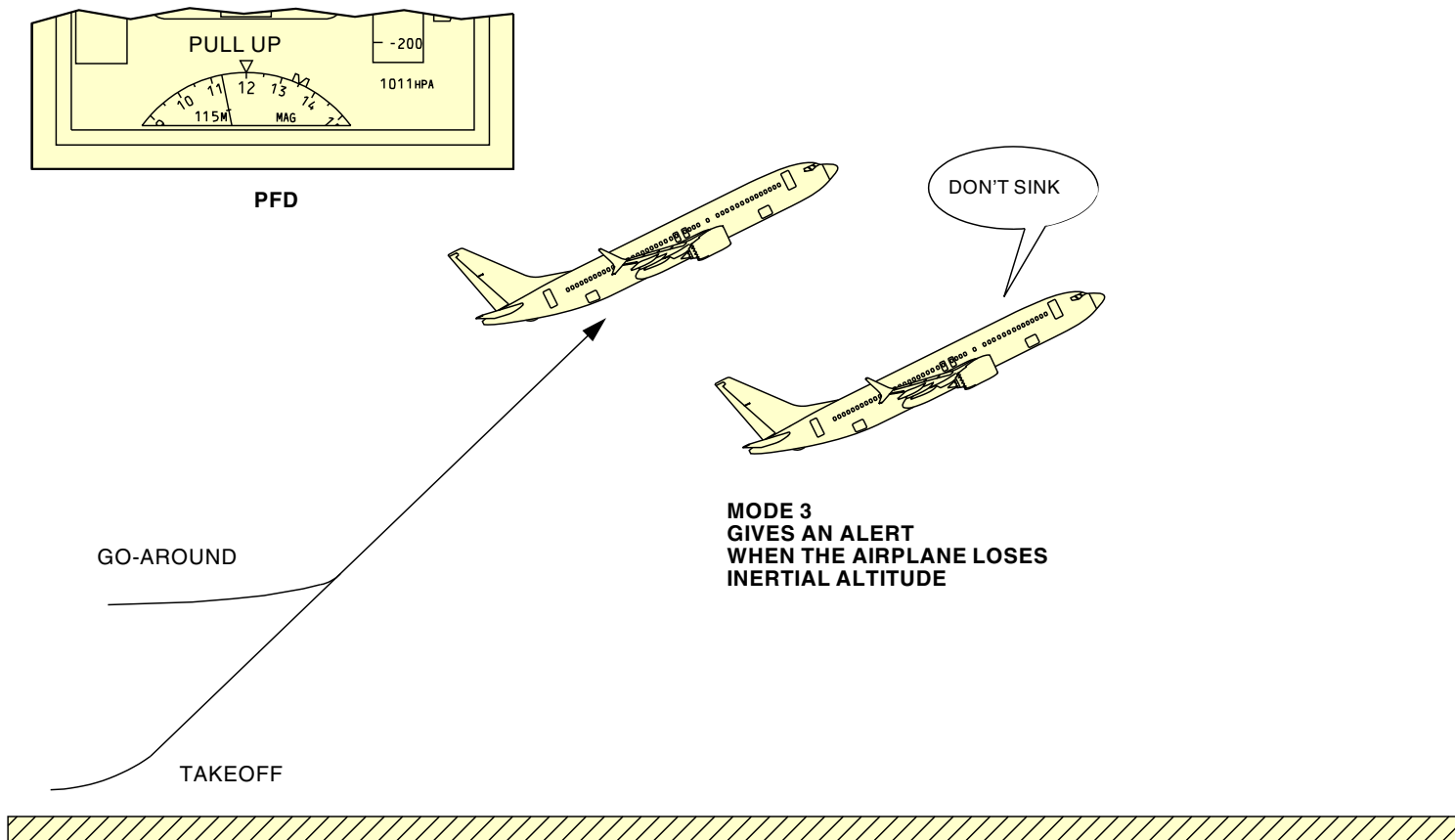
Description

Mode 3 gives an alert when the airplane loses too much inertial altitude after takeoff. The amount of inertial loss depends on the climb rate and radio altitude of the airplane. Mode 3 gives the aural message, DONT SINK.

When there is a GPWS mode 3 alert, the PFD shows the message, PULL UP.

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GPWS - MODE 3 DESCRIPTION



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GPWS - MODE 3 DESCRIPTION

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**GPWS - MODE 3 FUNCTIONAL DESCRIPTION****General**

Mode 3 operates when either of these conditions is true:

- Airplane climbs after going below 245 feet in landing configuration (gear down, flaps more than 30 units)
- Airplane takes off.

The Mode 3 alerts occur between 1500 feet and 30 feet. The alert conditions change with the airplane climb rate.

These are the LRUs that supply inputs for Mode 3 operation:

- Radio altimeter transceivers
- Left and right ADIRUs
- GPWS module
- Landing gear handle switch
- Stall management yaw damper (SMYD) 1 and 2.

The GPWC uses this data to detect Mode 3 alerts:

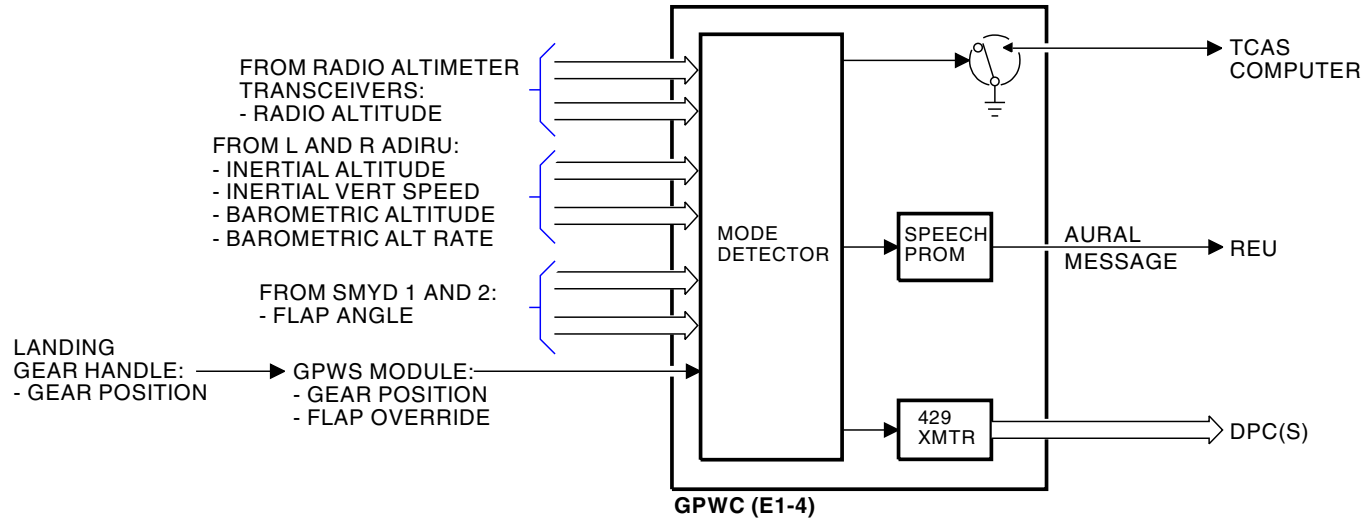
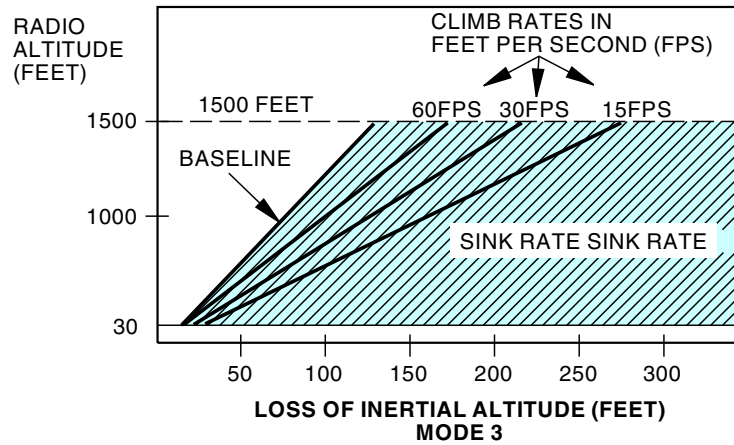
- Radio altitude
- Inertial altitude
- Inertial vertical speed
- Barometric altitude
- Barometric altitude rate
- Flap angle
- Gear position.

When there is a Mode 3 condition, the mode detector sends a discrete to the speech PROM to make the aural messages. The aural messages go to the REU which sends them to the flight compartment speakers. Also, the Mode 3 detector sends a discrete on an ARINC 429 data bus to the DPCs to show the warning message.

When the GPWC gives a Mode 3 aural message, a discrete goes to the TCAS computer to inhibit TCAS advisories and TCAS aural messages.

EFFECTIVITY	
SIA ALL	

GPWS - MODE 3 FUNCTIONAL DESCRIPTION



2370007 S00061520786_V3

GPWS - MODE 3 FUNCTIONAL DESCRIPTION

34-49-00-017

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-49-00

**GPWS - MODE 4 DESCRIPTION****Purpose**

Mode 4 supplies alerts when the airplane is too close to the terrain and the landing gear or flaps are not in the landing configuration (landing configuration for the flaps is 30 units or greater). Mode 4 has three submodes (4A, 4B and 4C).

Description

The GPWC gives a Mode 4A alert when the landing gear is not down. Mode 4A gives the aural messages TOO LOW GEAR at low airspeeds, or TOO LOW TERRAIN at high airspeeds.

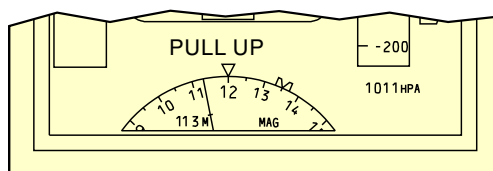
The GPWC gives a Mode 4B alert when the landing gear is down and the flaps are not in landing configuration. Mode 4B gives the aural messages TOO LOW FLAPS if the airplane is at low airspeed, or TOO LOW TERRAIN at high airspeeds.

The GPWC gives a Mode 4C alert for minimum terrain clearance. The minimum terrain clearance increases with radio altitude during takeoff and climb. Mode 4C gives the aural message, TOO LOW TERRAIN.

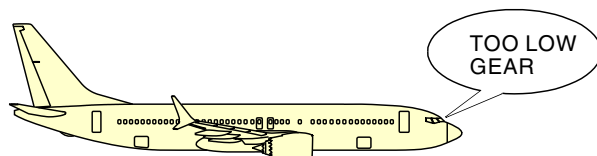
When the GPWC gives a Mode 4 alert, the mode detector also sends a discrete on an ARINC 429 data bus to the DPCs to show the PULL UP message on the PFD.

EFFECTIVITY	
SIA ALL	

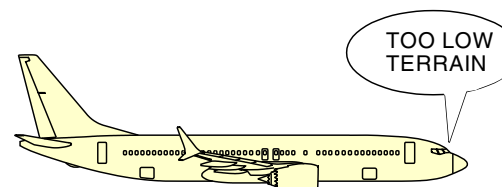
GPWS - MODE 4 DESCRIPTION



PFD DISPLAY



MODE 4A: AURAL MESSAGE FOR GEAR UP
AT LOW AIRSPEEDS



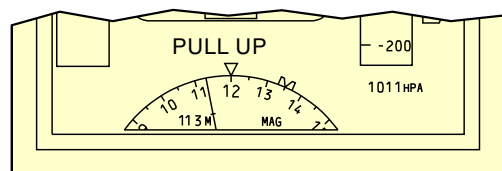
MODE 4A: AURAL MESSAGE FOR GEAR UP
AT HIGH AIRSPEEDS



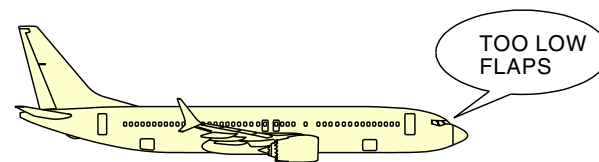
GPWS - MODE 4 DESCRIPTION

2370008 S00061520788_V2

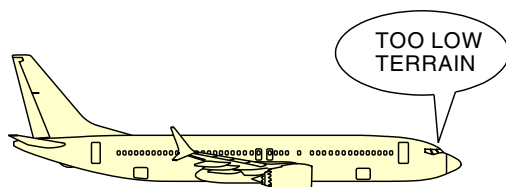
GPWS - MODE 4 DESCRIPTION



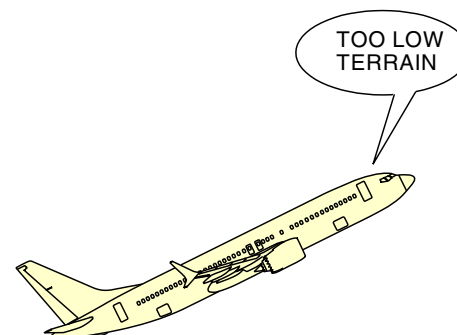
PFD DISPLAY



MODE 4B: AURAL MESSAGE FOR FLAPS UP AT LOW AIRSPEEDS



MODE 4B: AURAL MESSAGE FOR FLAPS UP AT HIGH AIRSPEEDS



MODE 4C: ALERT WHEN THE AIRPLANE DOES NOT HAVE SUFFICIENT TERRAIN CLEARANCE



2929056 S0000708079_V1

GPWS - MODE 4 DESCRIPTION

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**GPWS - MODE 4 FUNCTIONAL DESCRIPTION****General**

Mode 4 alerts occur between 1000 feet and 30 feet. The altitude limits for mode 4A and mode 4B are lower at low airspeed.

The Mode 4A alert occurs if the landing gear is not down below the altitude limit. The mode 4A altitude limit is 500 feet when the airspeed is less than 190 knots and it is 1000 feet at high airspeed. The mode 4A aural message TOO LOW GEAR changes to the aural message TOO LOW TERRAIN when the airspeed is more than 190 knots.

The Mode 4B alert occurs if the landing gear is down and the flaps are not in a landing configuration below the altitude limit (landing configuration for the flaps is 30 units or more). The Mode 4B altitude limit is 245 feet when the airspeed is less than 185 knots and it is 1000 feet at high airspeed. The mode 4B aural message TOO LOW FLAPS changes to the aural message TOO LOW TERRAIN when the airspeed is more than 185 knots.

The Mode 4C alert occurs if the airplane altitude is lower than the altitude value the GPWC stores in a filter. The filter begins operation during climb at 150 feet and stores 75 percent of the altitude. The filter stores up to 500 feet altitude for airspeed less than 190 knots (500 feet in the filter equals an airplane altitude of 667 feet). When the airspeed goes above 250 knots, the top limit goes to 1000 feet (1000 feet in the filter equals an airplane altitude of 1333 feet). Mode 3 changes to Mode 4 when the altitude gain filter gets to the upper limits.

The LRUs that supply inputs for mode 4 are:

- Left and right radio altimeter transceivers
- Left ADIRU IRS and air data buses
- Stall management yaw damper computers (SMYD)
- Landing gear handle switch
- GPWS module.

The GPWC uses this data to detect mode 4 alerts:

- Radio altitude
- Computed airspeed
- Flap angle

- Gear position.

When there is a Mode 4 condition, the mode detector sends a discrete to the speech PROM to make the aural message come on. The aural message goes to the REU which sends it to the flight compartment. When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages. The mode detector also sends a discrete on an ARINC 429 data bus to the DPCs to show the PULL UP message for any Mode 4 alert condition.

Mode 4 changes to mode 3 if the airplane goes below 245 feet in landing configuration (flaps down and gear down).

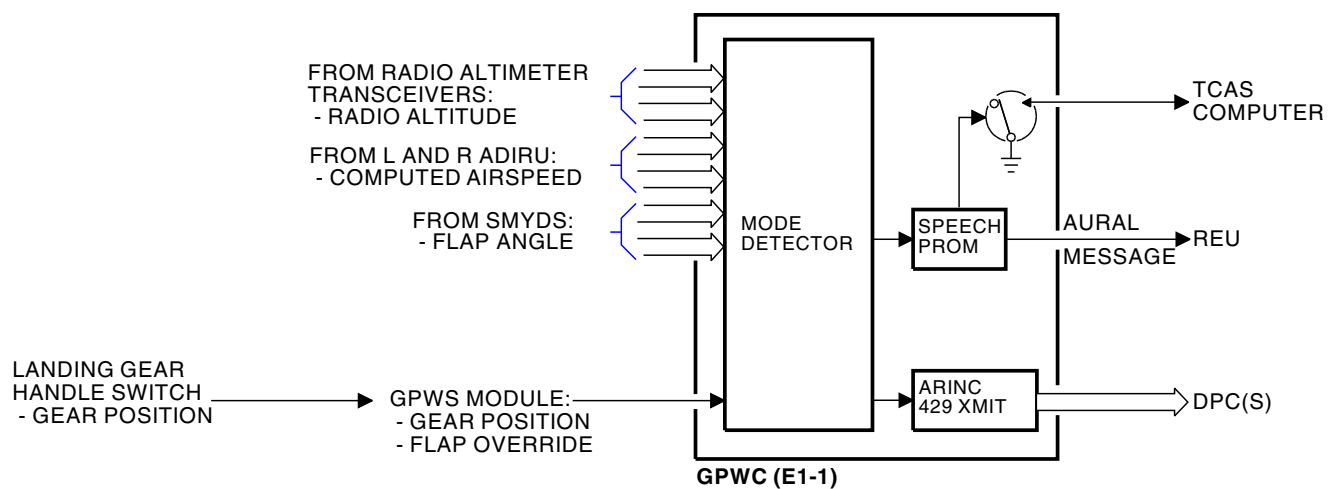
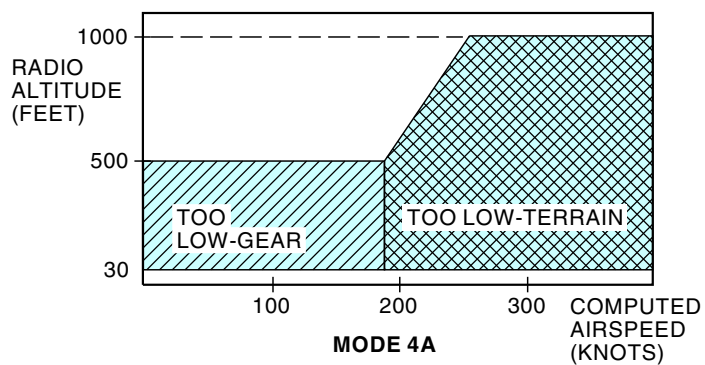
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EFFECTIVITY
SIA ALL

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPWS - MODE 4 FUNCTIONAL DESCRIPTION

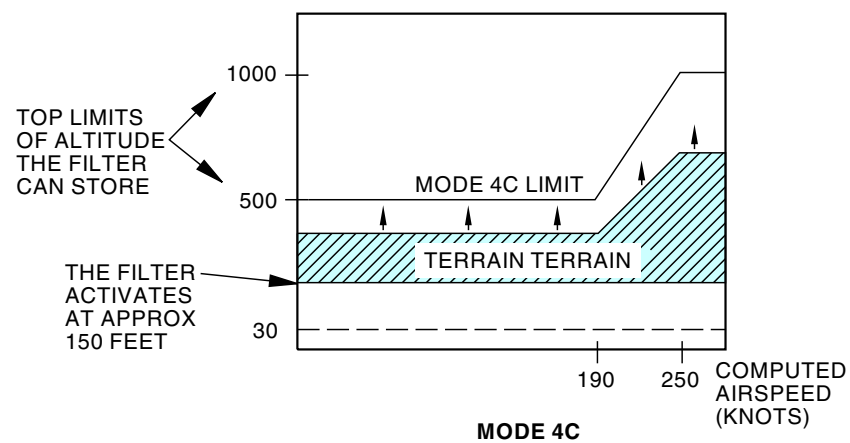
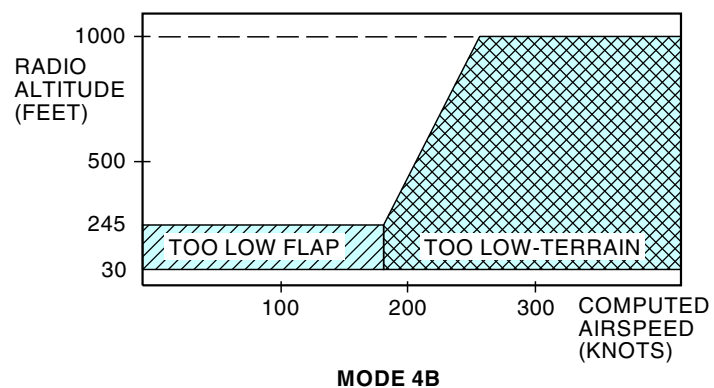


2370009 S00061520790_V3

GPWS - MODE 4 FUNCTIONAL DESCRIPTION

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GPWS - MODE 4 FUNCTIONAL DESCRIPTION



GPWS - MODE 4 FUNCTIONAL DESCRIPTION

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GPWS - MODE 5 DESCRIPTION

Purpose

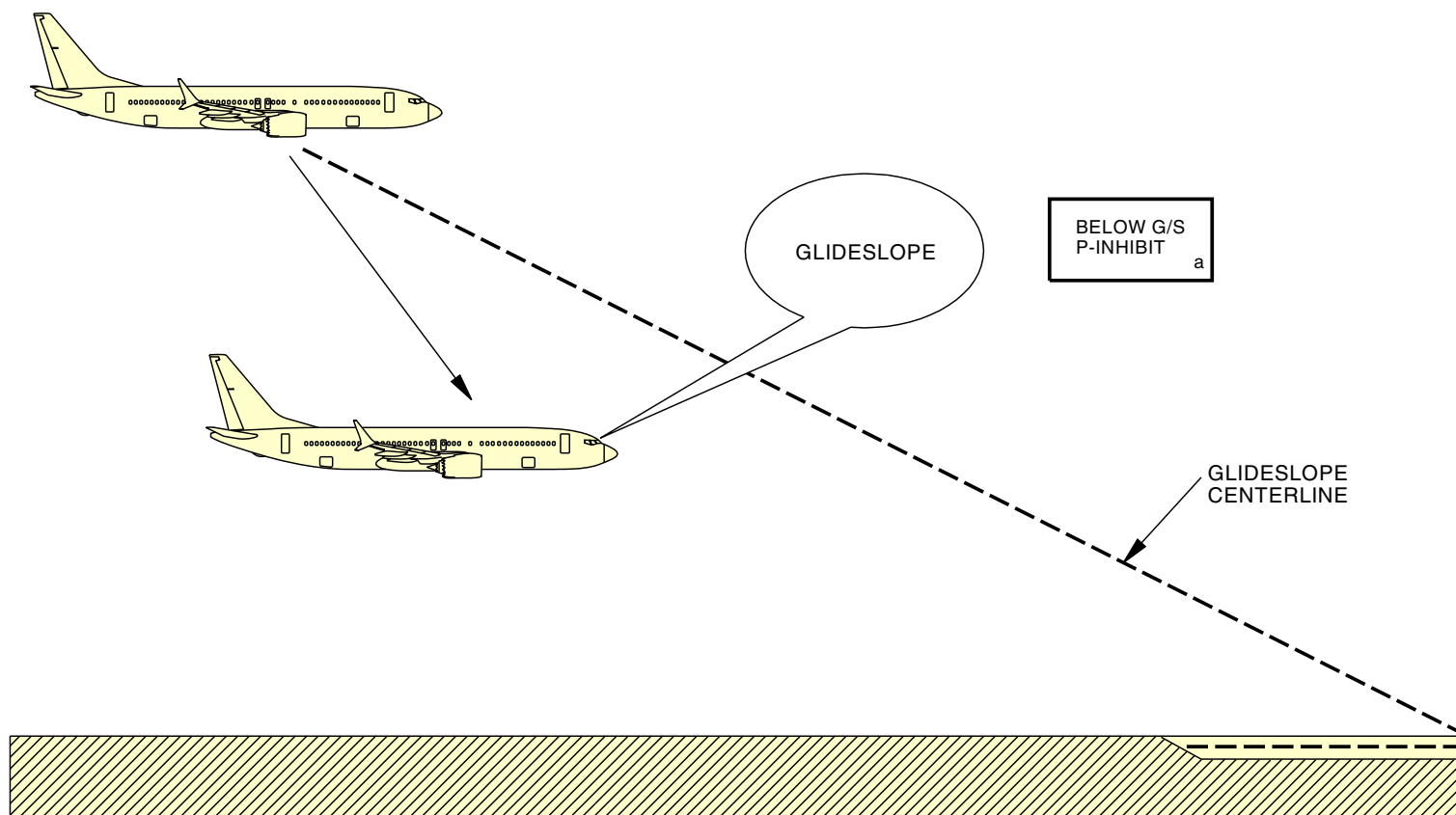
The GPWC gives a mode 5 alert when the airplane goes below the glideslope during approach if the landing gear is down.

Description

For mode 5 alerts, the GPWC gives the aural message GLIDESLOPE and the below glideslope lights come on. The volume level of the aural message increases and the message repeats faster as the terrain gets closer. You push the glideslope inhibit switch to inhibit or cancel mode 5 alerts.

EFFECTIVITY	
SIA ALL	

GPWS - MODE 5 DESCRIPTION



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GPWS - MODE 5 DESCRIPTION

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**GPWS - MODE 5 FUNCTIONAL DESCRIPTION****General**

Mode 5 alerts can occur between 1000 and 30 feet radio altitude. The interval between aural messages depends on altitude and glideslope deviation. Low volume audio occurs below 1000 feet down to 30 feet when the deviation is more than 1.3 dots. Normal volume audio occurs below 300 feet when the deviation is more than 2 dots.

These LRUs supply inputs for mode 5 operation:

- Radio altimeter transceivers
- DFCS mode control panel
- Landing gear handle switch
- MMRs
- FMCS
- GPW module.

The GPWC uses this data to calculate mode 5 alerts:

- Radio altitude.
- Selected runway heading
- Gear position
- Magnetic track
- Localizer and glideslope deviation

When there is an alert condition, the mode detector sends a discrete to the speech prom to make the aural message. The aural message goes to the REU which sends it to the flight compartment. Mode 5 arms when this data is true:

- Terrain clearance is less than 1000 feet
- Landing gear is down
- Glideslope signal is valid
- Airplane is not in a backcourse approach
- Localizer signal is captured.

Push the ground proximity Below G/S Switch/Light to inhibit or cancel mode 5 aural and visual alerts. If you push the switch before mode 5 alerts begin, you inhibit the aural message and visual annunciations. If you push the ground proximity glideslope inhibit switch during a mode 5 alert, you cancel the aural message and visual annunciations.

When you inhibit or cancel the alert, you can not activate it again unless the airplane leaves the mode 5 alert conditions or you cycle the landing gear.

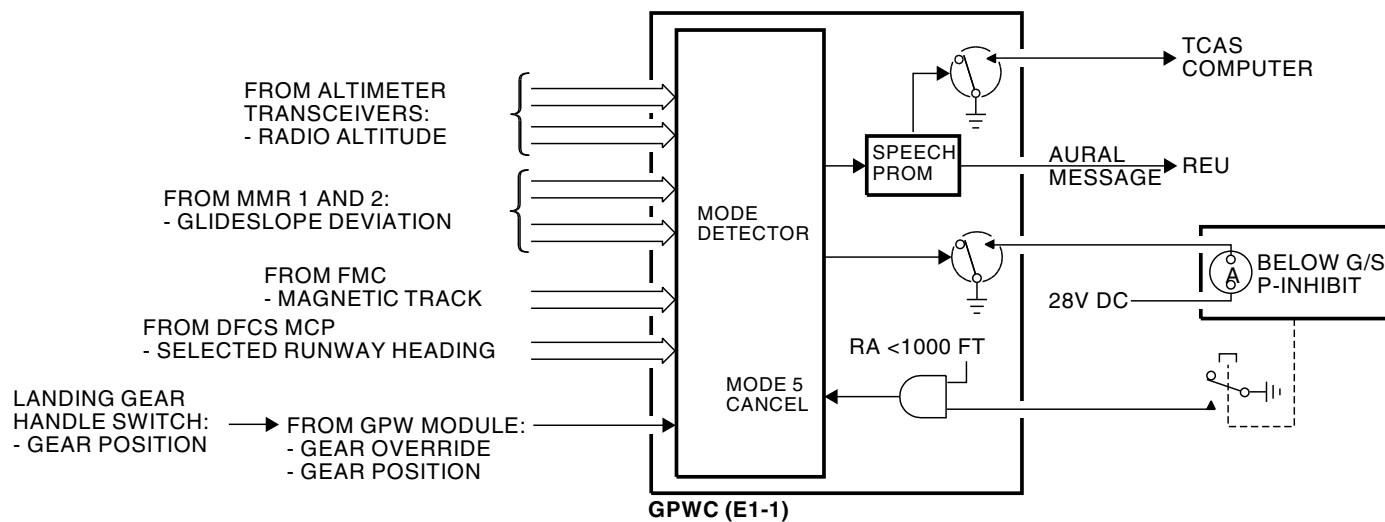
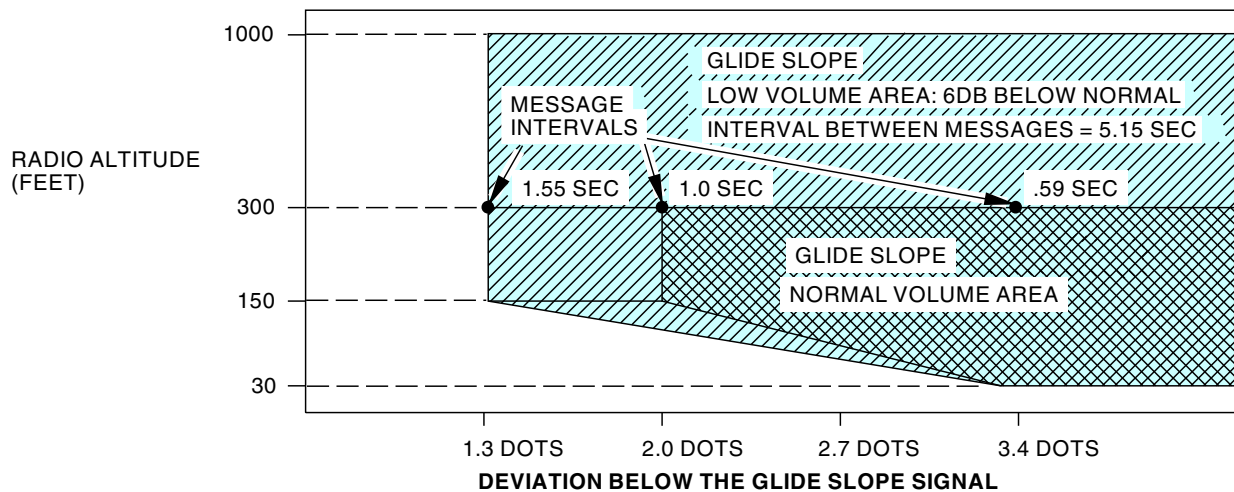
When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS advisories and aural messages.

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPWS - MODE 5 FUNCTIONAL DESCRIPTION



2370011 S00061520794_V1

GPWS - MODE 5 FUNCTIONAL DESCRIPTION

**GPWS - MODE 6 DESCRIPTION****Purpose**

The GPWC mode 6 supplies aural callouts when the airplane descends through set altitudes with the landing gear down. These are the options available for mode 6:

- Altitude callouts
- Minimums callout
- Approaching minimums callout
- Bank angle (roll alert) callout.

Altitude callouts start at 2500 feet. At 2500 feet, there is an option to give the aural TWENTY FIVE HUNDRED or give the aural, RADIO ALTITUDE.

The minimums callout option gives an aural callout when the airplane descends through the decision height altitude set on the EFIS control panels. These are the aural callouts the GPWC can give for decision height:

- MINIMUMS
- MINIMUMS, MINIMUMS
- DECISION HEIGHT.

There is also an approaching minimums option callout that tells the pilots when the airplane is near the decision height set on the EFIS control panel. The callout normally comes on when the airplane altitude is 80 feet above the decision height. The aural callouts for this option are:

- APPROACHING MINIMUMS
- APPROACHING DECISION HEIGHT
- PLUS HUNDRED (for this callout the altitude selection is set for decision height + 100 feet).

Mode 6 bank angle callouts occur when the airplane bank angle is more than 10 degrees between 30 feet and 130 feet altitude. Above 130 feet, the callout occurs at 35 degrees, 40 degrees, and 45 degrees. The aural message is BANK ANGLE, BANK ANGLE.

Description

The GPWC receives inputs from these units:

- Radio altimeter transceivers
- GPWS module
- Program switch module
- Left and right ADIRUs
- DPC 1 and 2.

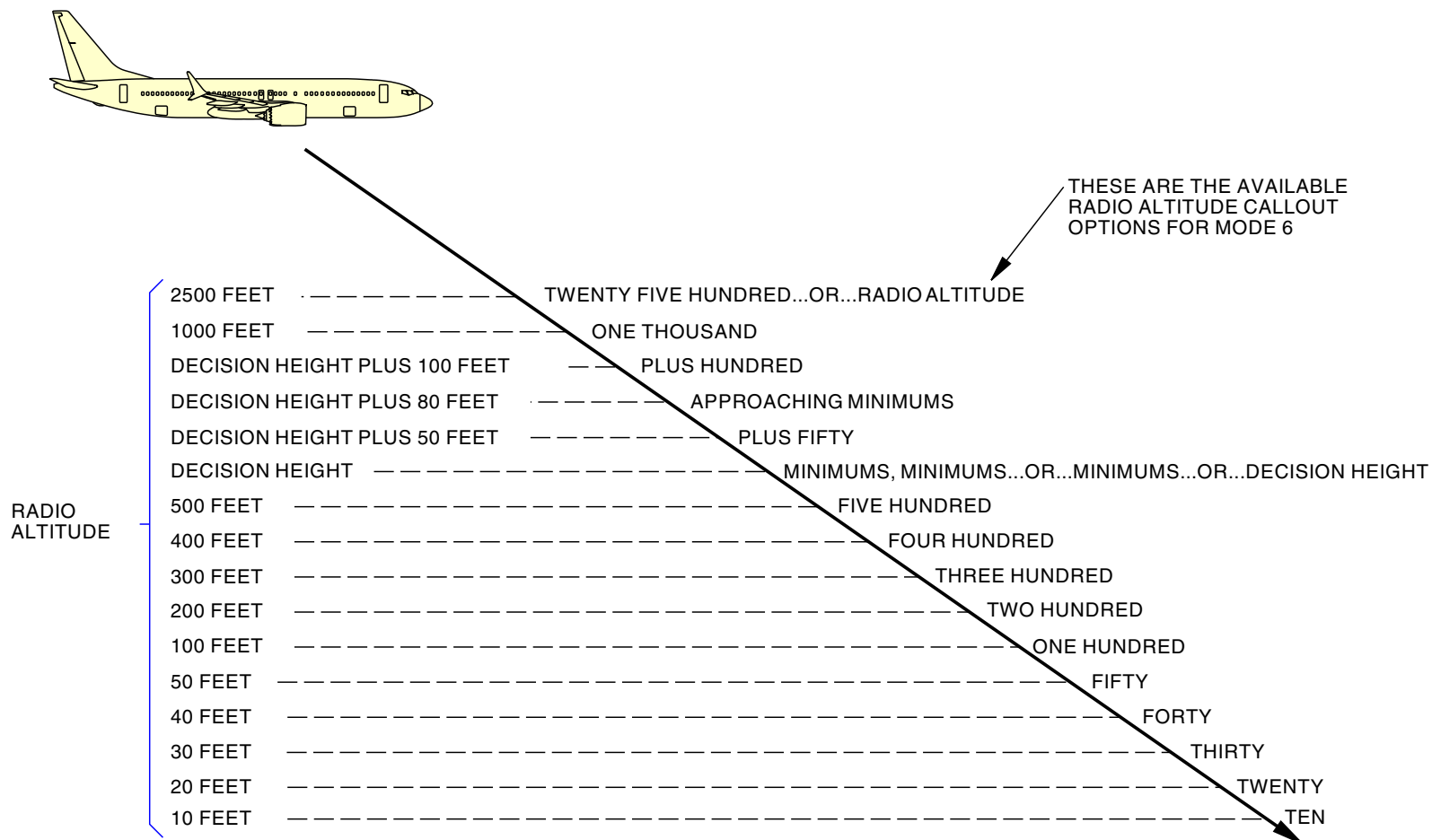
The GPWC uses this data to calculate mode 6 alerts:

- Radio altitude
- Landing gear position
- Program pin selection
- Roll attitude
- Decision height.

Mode 6 is armed when the airplane climbs through 1000 feet radio altitude. To reset mode 6, the airplane must climb above the radio altitude where the first altitude callout occurs.

EFFECTIVITY	
SIA ALL	

GPWS - MODE 6 DESCRIPTION



NOTE:

THE ABOVE SHOWS ALL THE AVAILABLE CALLOUT OPTIONS.

2820090 S0000651769_V1

GPWS - MODE 6 DESCRIPTION

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GPWS - MODE 7 DESCRIPTION

Purpose

The GPWC gives mode 7 warnings when there are horizontal and vertical windshear conditions during approach or takeoff.

Description

Windshear is the effect of large volumes of air that change direction rapidly. The most dangerous type of windshear is the microburst. When the airplane is near the terrain, a downward microburst gives the pilots very little time to react to the windshear effects.

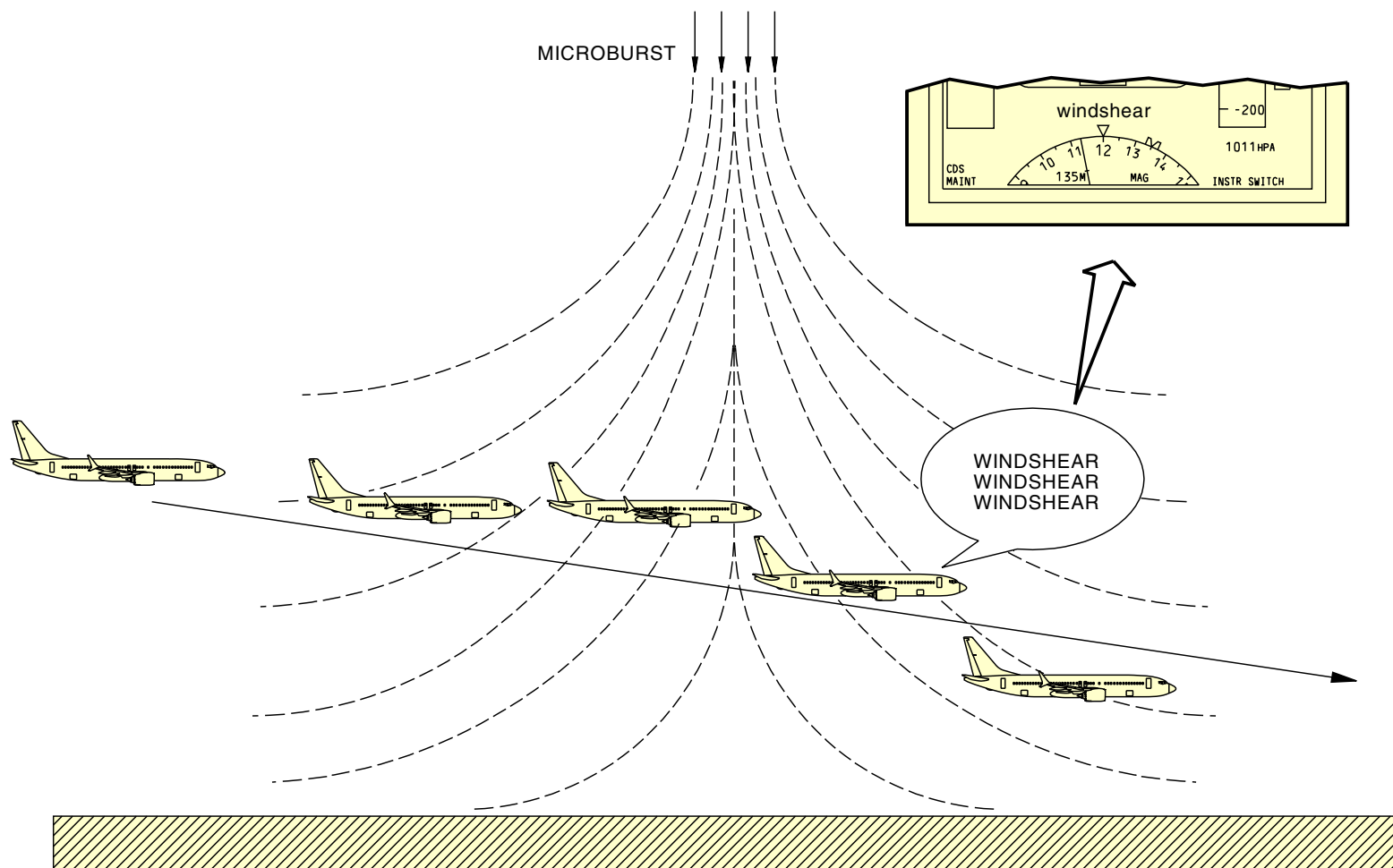
The initial effects on an airplane when it encounters the microburst are an increase in airspeed and lift. Because of the increased lift, the airplane increases altitude.

As the airplane continues through the microburst, the effects rapidly change to a loss in airspeed and lift. The airplane altitude now rapidly decreases.

For mode 7 warnings, the GPWC gives the aural message WINDSHEAR WINDSHEAR WINDSHEAR with a siren. The GPWC sends a discrete to the DPCs to make the red WINDSHEAR message show on the primary flight displays. Mode 7 warnings have the highest priority.

SIA ALL	EFFECTIVITY

GPWS - MODE 7 DESCRIPTION



2370013 S00061520798_V1

GPWS - MODE 7 DESCRIPTION

34-49-00



GPWS - MODE 7 FUNCTIONAL DESCRIPTION

General

These LRUs supply data for mode 7 operation:

- Radio altimeter 1 AND 2
- Left and right ADIRUs
- Stall management yaw damper 1 and 2.

The GPWC uses this data to detect windshear:

- Radio altitude
- Inertial vertical speed
- Pitch and roll angle
- Pitch rate
- Longitudinal acceleration
- Normal acceleration
- Vertical acceleration
- Indicated angle of attack (AOA)
- Corrected AOA
- Stick shaker AOA
- Flap angle
- Minimum operating speed
- True airspeed
- Computed airspeed.

When there is an windshear condition, the mode detector sends a discrete to the speech prom to make the aural message. The aural message goes to the remote electronic unit (REU) which sends it to the flight compartment.

When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages and downgrade TCAS resolution advisories to traffic alerts.

The mode detector also sends a discrete on the ARINC 429 data bus to the DPCs to show the WINDSHEAR message on the primary flight display (PFD).

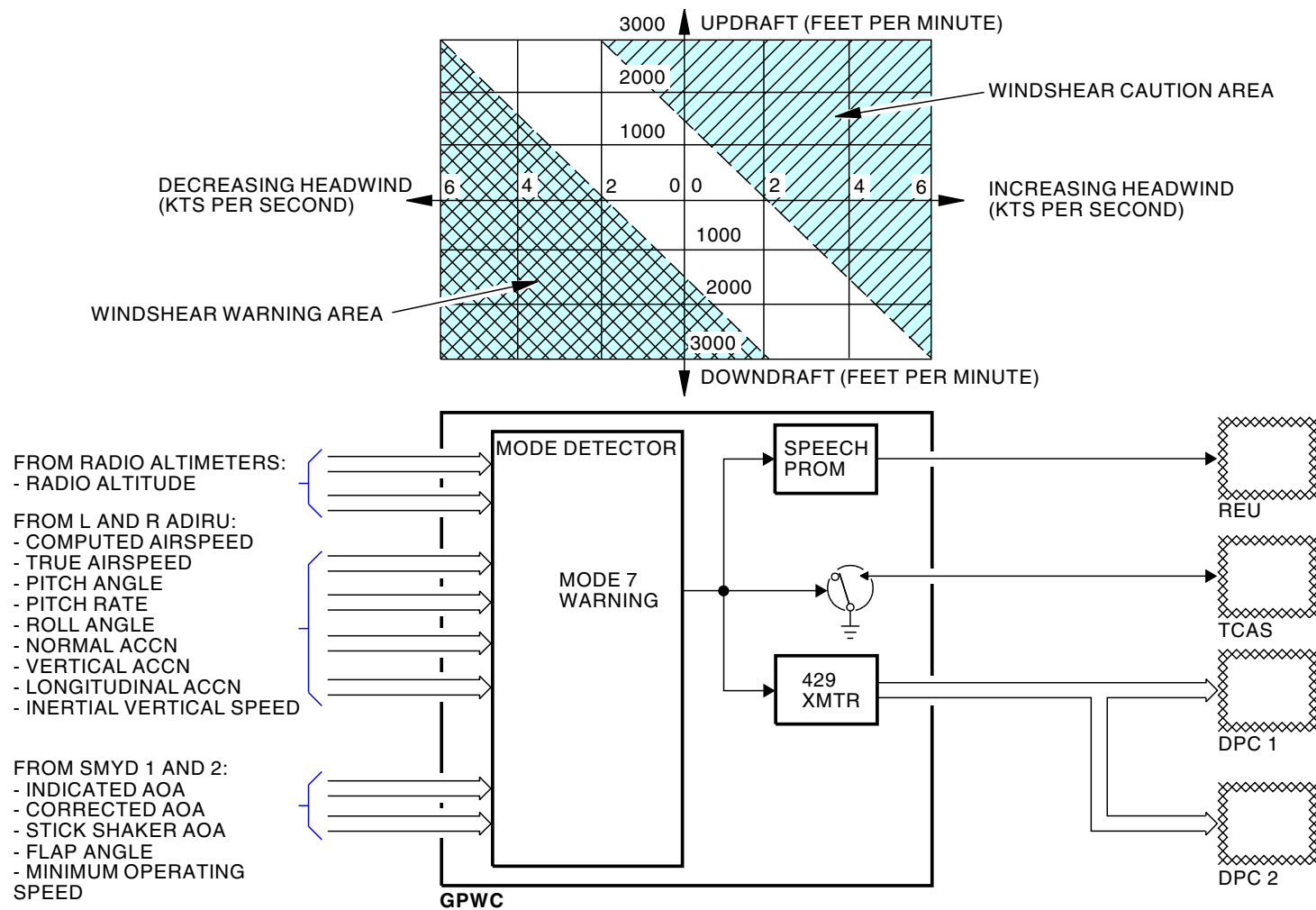
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GPWS - MODE 7 FUNCTIONAL DESCRIPTION



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GPWS - MODE 7 FUNCTIONAL DESCRIPTION



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ECCN 9E991 BOEING PROPRIETARY - See title page for details



GPWS - ENHANCED FEATURES FUNCTIONAL DESCRIPTION

Purpose

The Ground Proximity Warning Computer (GPWC) compares the airplane position, flap and gear position, and terrain clearance to find if an alert or warning condition exists.

Terrain Awareness Inputs

The GPWC receives inputs from these systems for the terrain awareness function:

- Global Positioning System (GPS) 1
- GPS 2
- Air Data Inertial Reference Unit (ADIRU) L
- ADIRU R
- MAX Display System (MDS)
- Landing gear switch module
- Weather Radar.

Aircraft position from the GPS 1 system is the primary input. If GPS 1 position is not valid, GPS 2 position is used. ADIRU position can be used for short periods of time when neither GPS 1 or 2 position is valid.

Airspeed Low Callout

An aural callout for AIRSPEED LOW is an airplane operation alert that the Enhanced Ground Proximity Warning Computer (EGPWC) calculates. The aural annunciation alert is to tell the flight crew about the low airspeed. This aural occurs when the calculated airspeed is 30 percent or more into the range from the top of the lower amber band to stick shaker speed.

Terrain Awareness Calculation

The GPWC has a world-wide terrain database in memory. The GPWC compares airplane position and track to the terrain database. If the GPWC finds there is a terrain threat, it makes an alert.

Terrain Display Output

The GPWC makes a digital map of the terrain forward of the airplane. It sends this digital map to the Display Processing Computers (DPCs) to show on the Navigation Displays (NDs). The display uses different colored dots to show terrain altitude relative to airplane altitude.

Terrain Alert Outputs

If the GPWC finds the airplane is 60 seconds from a terrain conflict, it makes a terrain caution alert. These are the caution alert indications:

- Alert aural message, CAUTION TERRAIN
- Amber message, TERRAIN on the ND
- Terrain display on both NDs (pop up function)
- Threat terrain on the ND changes from dots to a solid yellow color.

If the GPWC finds the airplane is 30 seconds from a terrain conflict, it makes a terrain warning alert. These are the warning alert indications:

- Aural message, TERRAIN, TERRAIN PULL UP
- Red PULL UP message on the Primary Flight Display (PFD)
- Red TERRAIN message on the ND
- Terrain display on both NDs if not selected on either one (pop up function)
- Threat terrain on the ND changes from dots to a solid red color.

Terrain Functional Description

The GPWC I/O processes input signals selection and formats the signals into the proper form for use by the GPWC.

The terrain processor function gets terrain data from the terrain and airport databases to create a set of digital elevation matrix overlays for use by the terrain threat detection and display processor function. Data for the nearest runway is processed for use by the terrain threat detection and display processor functions for the terrain clearance floor function. This data contains the length, runway center position, and altitude for the nearest runway that is 3500 feet or longer and is hard surfaced.

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EFFECTIVITY

SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**GPWS - ENHANCED FEATURES FUNCTIONAL DESCRIPTION**

The terrain threat detection and display processor function does the threat analysis with the terrain data within calculated caution and warning envelope boundaries below and forward of the aircraft. The results of this threat assessment are combined with background terrain data and the nearest runway data. This information is formatted into a terrain display image which goes to the terrain display output processor. When there is a terrain caution or warning condition, an aural alert goes to the audio output function.

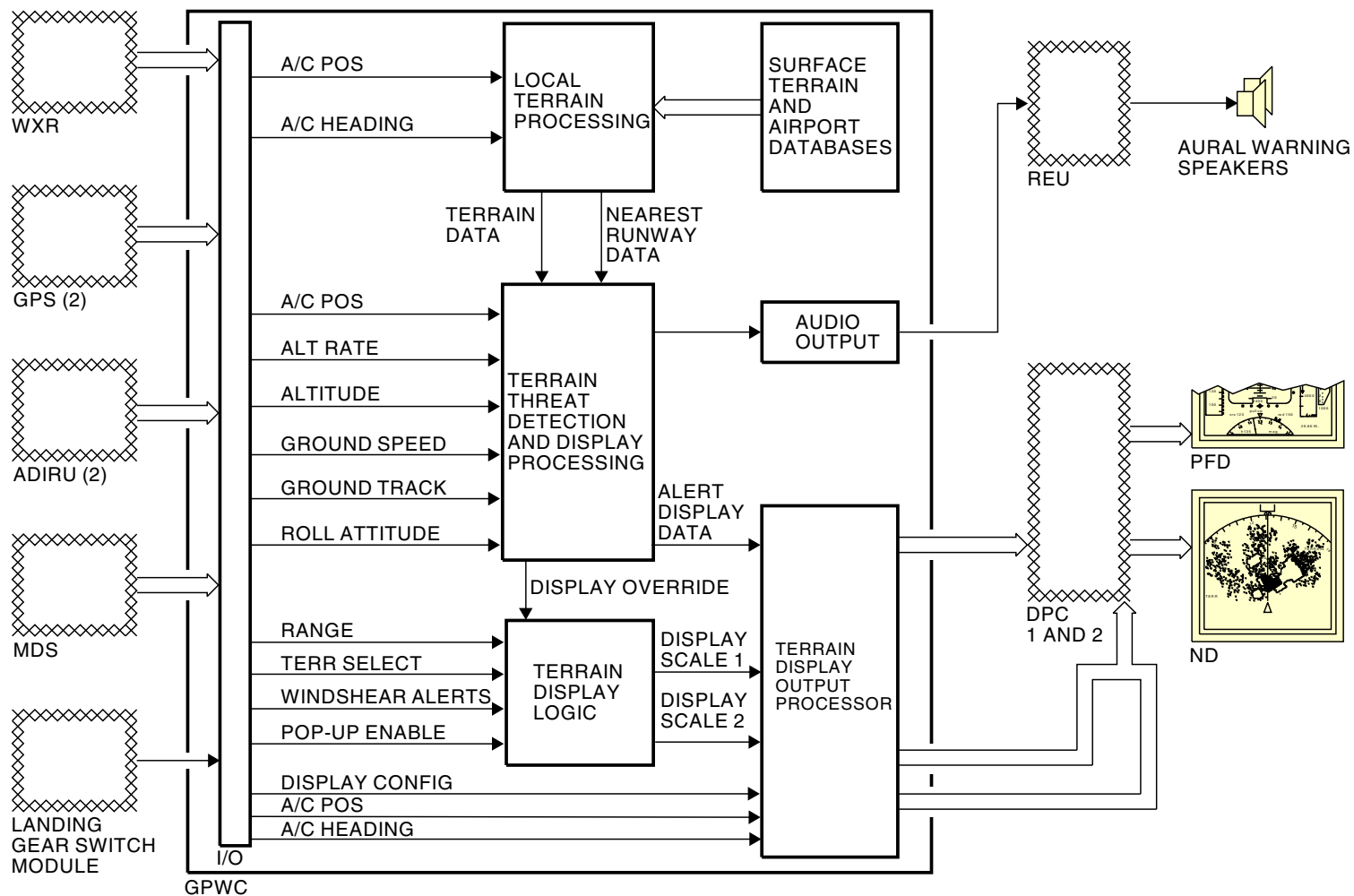
The terrain display logic processes the display format data. Inputs from the MDS, weather radar, and the terrain threat detection and display processor are used to determine the scale and what information is to show. From the MDS, the terrain logic processor uses terrain select digital discrete to select terrain to show on the Display Units (DUs) and range selection data. The terrain display logic processor lets each terrain display be scaled independently of each other. The weather radar has alerts that may have a higher priority than the GPWC. If there is a predictive windshear alert with a higher priority than the GPWC, the windshear alert and display show. Also, if the weather mode is selected for the captain and first officer displays and a terrain alert is detected, the pop-up mode will be enabled. This lets terrain alert information show automatically on the DUs.

NOTE: If either captain or first officer display has terrain selected, the pop up feature does not operate.

The terrain display output processor maintains a background display of terrain forward of the aircraft. When a caution or warning goes from the terrain threat detection and display processor, the background image is enhanced to highlight the terrain threat forward of the aircraft. The display scale is from the terrain display logic function. The background data shows as a variable density dot pattern in green, yellow, or red. The density and color show how close the relative terrain is to the aircraft altitude. The heading inputs are used to calculate the radar-like sweep display ahead of the aircraft. The terrain data goes out on two ARINC (Aeronautical Radio Incorporated) 453 data buses to the DPCs. Alert displays go out on an ARINC 429 data bus to the DPCs.

EFFECTIVITY	
SIA ALL	

GPWS - ENHANCED FEATURES FUNCTIONAL DESCRIPTION



2370015 S00061520802_V3

GPWS - ENHANCED FEATURES FUNCTIONAL DESCRIPTION



GPWS - TERRAIN CLEARANCE FLOOR

Description

Terrain clearance floor (TCF) alerts the flight crew when the airplane descends too low on approach. TCF uses airplane position and a runway database to find if there is an alert condition.

Terrain Clearance Floor Inputs

The ground proximity warning system (GPWS) receives airplane data from these systems:

- Global positioning system (GPS)
- Air data inertial reference system (ADIRS)
- Radio altitude (RA) system.

TCF uses this data:

- Latitude
- Longitude
- Radio altitude.

TCF uses GPS data for latitude and longitude. It uses IRS data if GPS data is not valid.

Terrain Clearance Floor Logic

The GPWC has a runway database in memory. The runway database is in the terrain database. The runway database contains the location of all hard surface runways in the world that are longer than 3,500 feet. TCF makes a terrain clearance envelope around the runway. The altitude of the envelope increases as the distance from the airport increases. GPWC compares airplane latitude, longitude, and radio altitude with TCF envelope data. If the airplane descends through the floor of the envelope, the GPWC makes an alert.

TCF makes an alert even if the airplane is in landing configuration.

The TCF function is active through the entire flight. When the aircraft is 15nm or more from a runway the floor is 700 feet AGL until the aircraft approaches another runway that meets the requirements. Then the floor decreases as shown on the graphic.

Terrain Clearance Floor Alert

If the GPWC finds that the airplane is below the TCF, it makes this caution alert:

- Aural message TOO LOW TERRAIN. This message repeats for each 20 percent loss of altitude.
- Message, TERRAIN on the ND in amber.

If descent continues, these alerts happen:

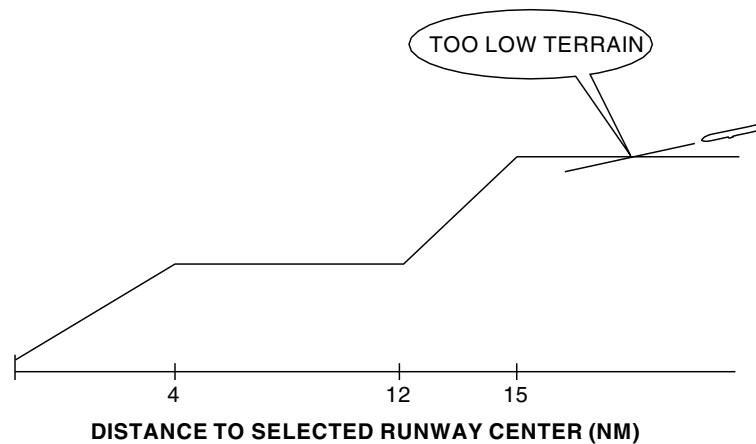
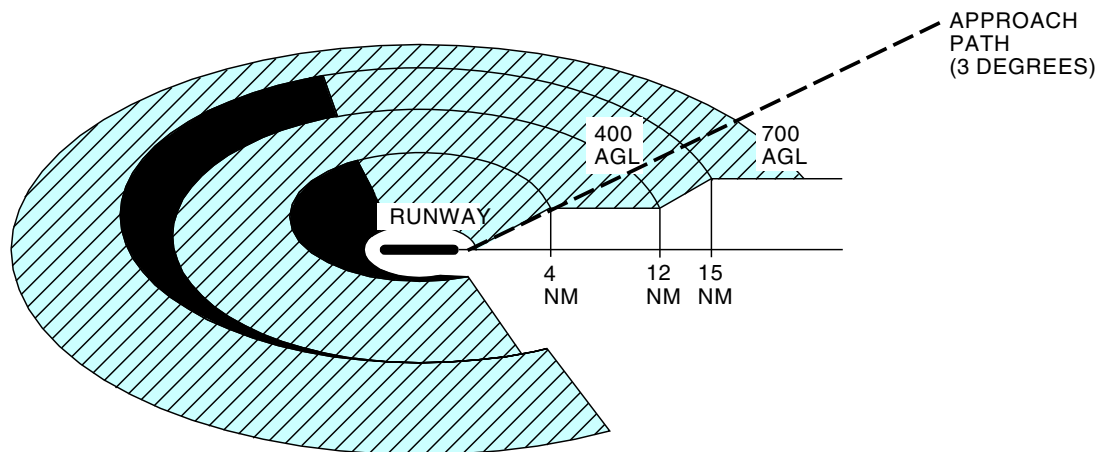
- Aural message PULL UP
- Message, TERRAIN on the ND in red
- Message, PULL UP on the PFD.

The GPWC inhibits TCF alerts for any of these conditions:

- Airplane is on the ground
- Less than 20 seconds after takeoff
- Less than 30 feet radio altitude.

EFFECTIVITY	
SIA ALL	

GPWS - TERRAIN CLEARANCE FLOOR



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GPWS - TERRAIN CLEARANCE FLOOR

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GPWS - RUNWAY FIELD CLEARANCE FLOOR

Description

Runway field clearance floor (RFCF) alerts the flight crew when the airplane descends too low on approach. RFCF provides improved alerts for runways at higher elevations when compared to the terrain below the approach path of the airplane.

Runway Field Clearance Floor Inputs

The ground proximity warning system (GPWS) receives airplane data from these systems:

- Global positioning system (GPS)
- Air data inertial reference system (ADIRS)
- Radio altitude (RA) system.

TCF uses this data:

- Latitude
- Longitude
- Radio altitude.

RFCF uses GPS data for latitude and longitude. It uses IRS data if GPS data is not valid.

Runway Field Clearance Floor Logic

Field clearance (height above the runway) is calculated by subtracting the elevation of the selected destination runway from the current altitude. Geometric altitude is used to find current altitude.

Geometric altitude is a calculated airplane altitude with these inputs:

- Pressure altitude
- GPS altitude
- Radio altitude
- Terrain elevation data
- Runway elevation data.

Geometric altitude decreases errors in corrected barometric altitudes which may have been caused by temperature extremes, non-standard altitude conditions or altimeter miss-sets.

The RFCF creates a circular band centered over the selected runway. Unlike the TCF envelope, the RFCF envelope extends only 5 nautical miles (NM) past the end of the runway and rises to a maximum height of 300 feet above the runway. The RFCF function also calculates a runway position error (KRF) based upon geometric altitude and runway data quality.

Runway Field Clearance Floor Alert

If the GPWC finds that the airplane is below the RFCF, it makes this caution alert:

- Aural message, TOO LOW TERRAIN.
- Message, TERRAIN on the ND in amber.

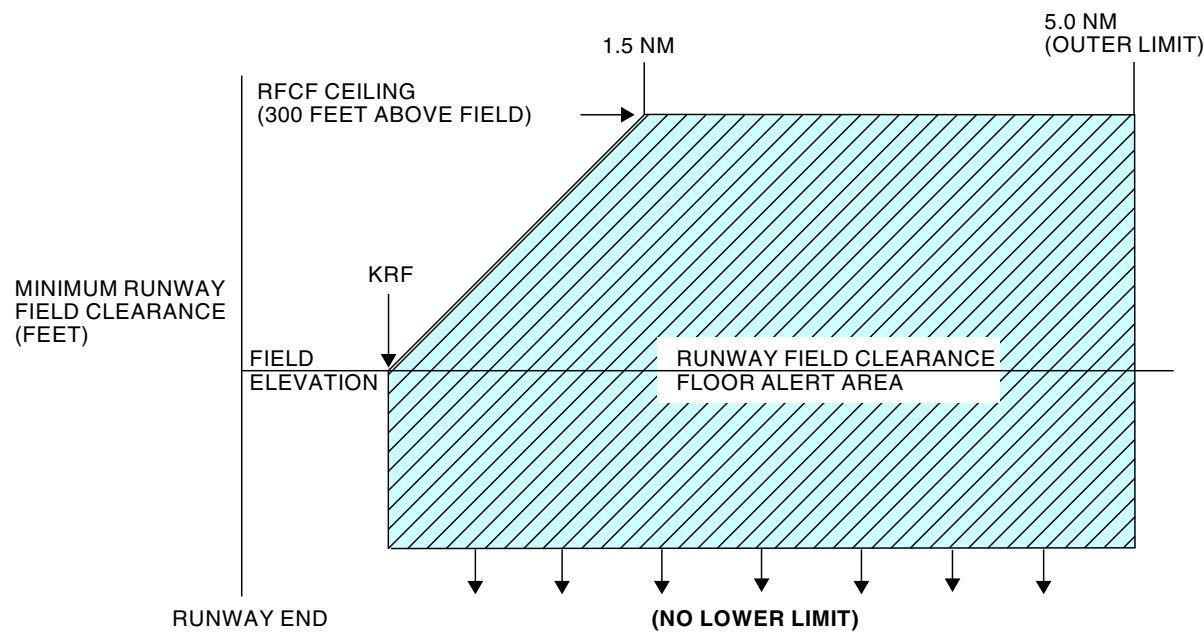
If descent continues, these alerts happen:

- Aural message, PULL UP
- Message, TERRAIN on the ND in red
- Message, PULL UP on the PFD.

The GPWC inhibits RFCF alerts for any of these conditions:

- Airplane is on the ground
- Less than 20 seconds after takeoff
- Less than 30 feet radio altitude.

GPWS - RUNWAY FIELD CLEARANCE FLOOR



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GPWS - RUNWAY FIELD CLEARANCE FLOOR

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**GPWS - RSAT - RUNWAY SITUATIONAL AWARENESS TOOLS****General**

The Ground Proximity Warning System (GPWS) Runway Situation Awareness Tools (RSAT) provide these aural and visual messages:

- Stabilized Approach Monitor (SAM)
- Overrun Warning (In Air)
- Overrun Warning (On Ground)
- Speedbrake Warning

Stabilized Approach Monitor (SAM)

The SAM increase the flight crew awareness of an unstable approach due to excessive approach speed, excessive approach angle or a long landing. The table shows the Enhanced Ground Proximity Warning Computer (EGPWC) aural alerts and associated Navigation Display (ND) visual messages.

Unstable Approach Criteria	EGPWC Aural Alert	ND Message
Current airspeed exceeds reference airspeed by 30 knots or more.	TOO FAST TOO FAST UNSTABLE UNSTABLE	UNSTABLE
Current approach angle is greater than the defined threshold.	TOO HIGH TOO HIGH UNSTABLE UNSTABLE	UNSTABLE
Airplane is airborne, below 100 feet radio altitude and is one third of the way beyond the runway touchdown point	LONG LANDING LONG LANDING	LONG LANDING

Overrun Warning - In Air

This alert provides a warning during approach, if there is a high risk of a runway overrun when maximum manual braking is applied. The EGPWC computes a predicted landing distance that includes approach distance, flare distance and ground roll distance. The overrun warning alert activates if the predicted airplane stopping point is beyond the runway end.

The EGPWC activates the following alerts:

- An aural message stating: OVERRUN, GO AROUND.
- A red visual GO AROUND message on the Primary Flight Display (PFD).

Overrun Warning - On Ground

This alert provides a warning after touchdown, if there is a high risk the airplane will overrun the runway given the current airplane speed and distance to the runway end.

The EGPWC activates the following alerts:

- An aural message stating: MAX BRAKES, MAX REVERSE.
- A red visual MAX REVERSE message on the PFD.

The flight crew is expected to immediately respond with maximum brakes and reverse thrust as necessary.

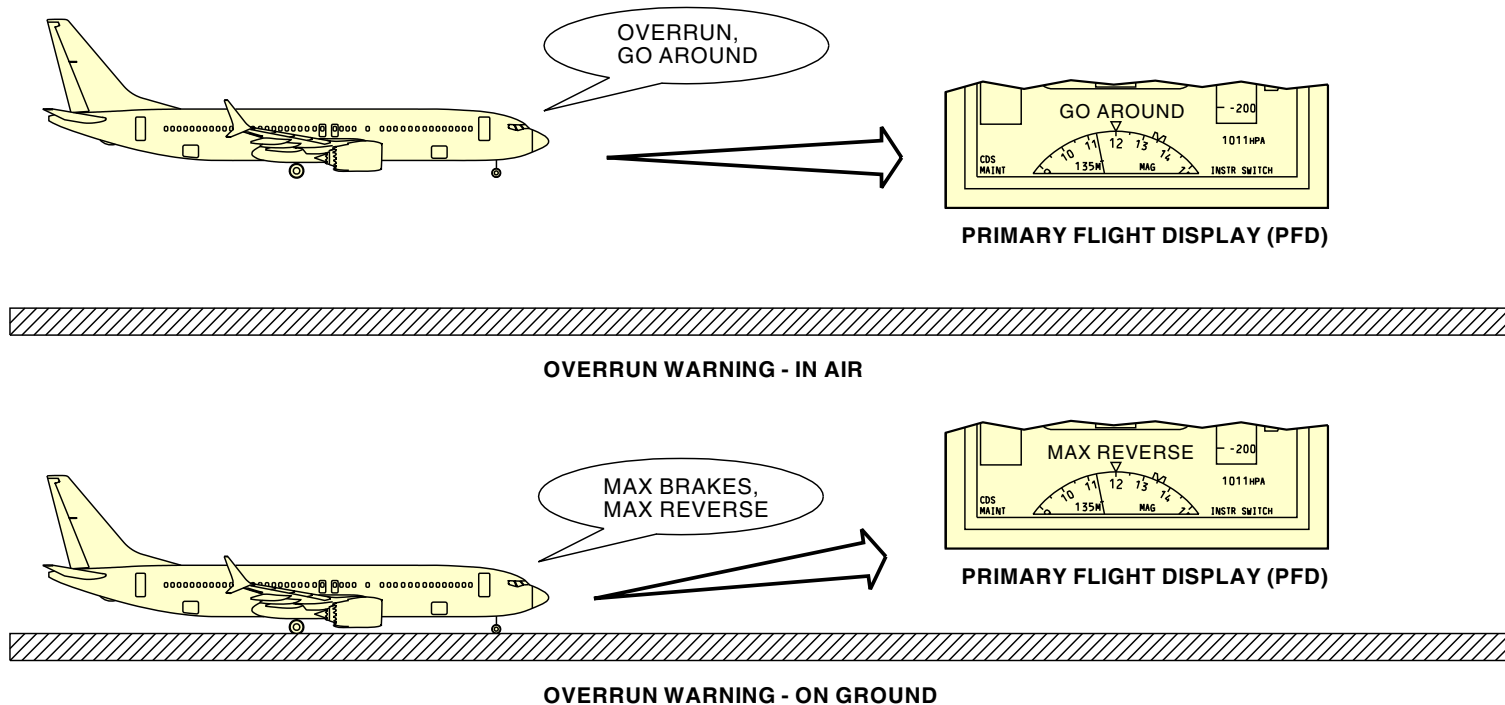
Speedbrake Warning

This alert provides a warning during a landing rollout or Rejected Takeoff (RTO) indicating that the speedbrakes are not deployed.

The EGPWC activates the following alerts:

- An aural message stating: SPEEDBRAKE, SPEEDBRAKE.
- A red visual SPEEDBRAKE message on the PFD.

GPWS - RSAT - RUNWAY SITUATIONAL AWARENESS TOOLS



GPWS - RAAS - RUNWAY SITUATIONAL AWARENESS

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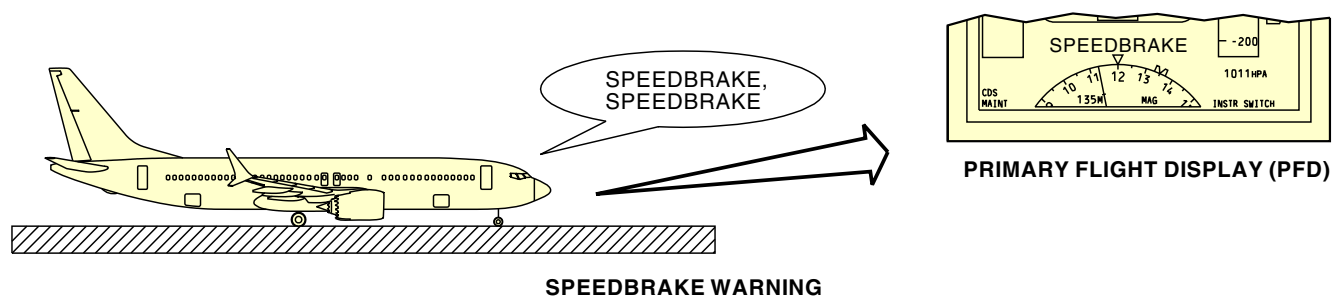
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPWS - RSAT - RUNWAY SITUATIONAL AWARENESS TOOLS



GPWS - RUNWAY SITUATIONAL AWARENESS

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**GPWS - SPEECH PROM****General**

The audio generator supplies aural messages for modes 1 through 7, terrain awareness (TA), terrain clearance floor (TCF), runway situational awareness tools (RSAT), and roll command alert system (RCAS). The audio generator also has callouts for:

- Selected radio altitudes
- Radio minimums
- Bank angle
- Autopilot
- V1.

Description

The audio generator sends only one message at a time to the audio amplifier. If more than one message discrete comes from the mode detector, the audio generator sends the message that has the highest priority. This makes sure only one message is sent at a time. From the audio amplifier, the audio goes to the remote electronics unit and on to the flight compartment speakers and headphones. Some remote electronics units have an AURAL WARN MUTE switch that can inhibit audio to the headphones. Warnings and cautions also go to the flight data acquisition unit for recording. There are hundreds of words necessary for the annunciation of all the possible BITE, caution, and warning messages. The graphic shows the possible GPWS modes with the caution and warning aural messages and their priority.

The audio generator gets inputs for message requests and volume levels from the mode logic detector. The test circuit gives an input for annunciation of all BITE information.

RSAT audio options include a female voice. The other indications, cautions, and warnings do not include a female voice.

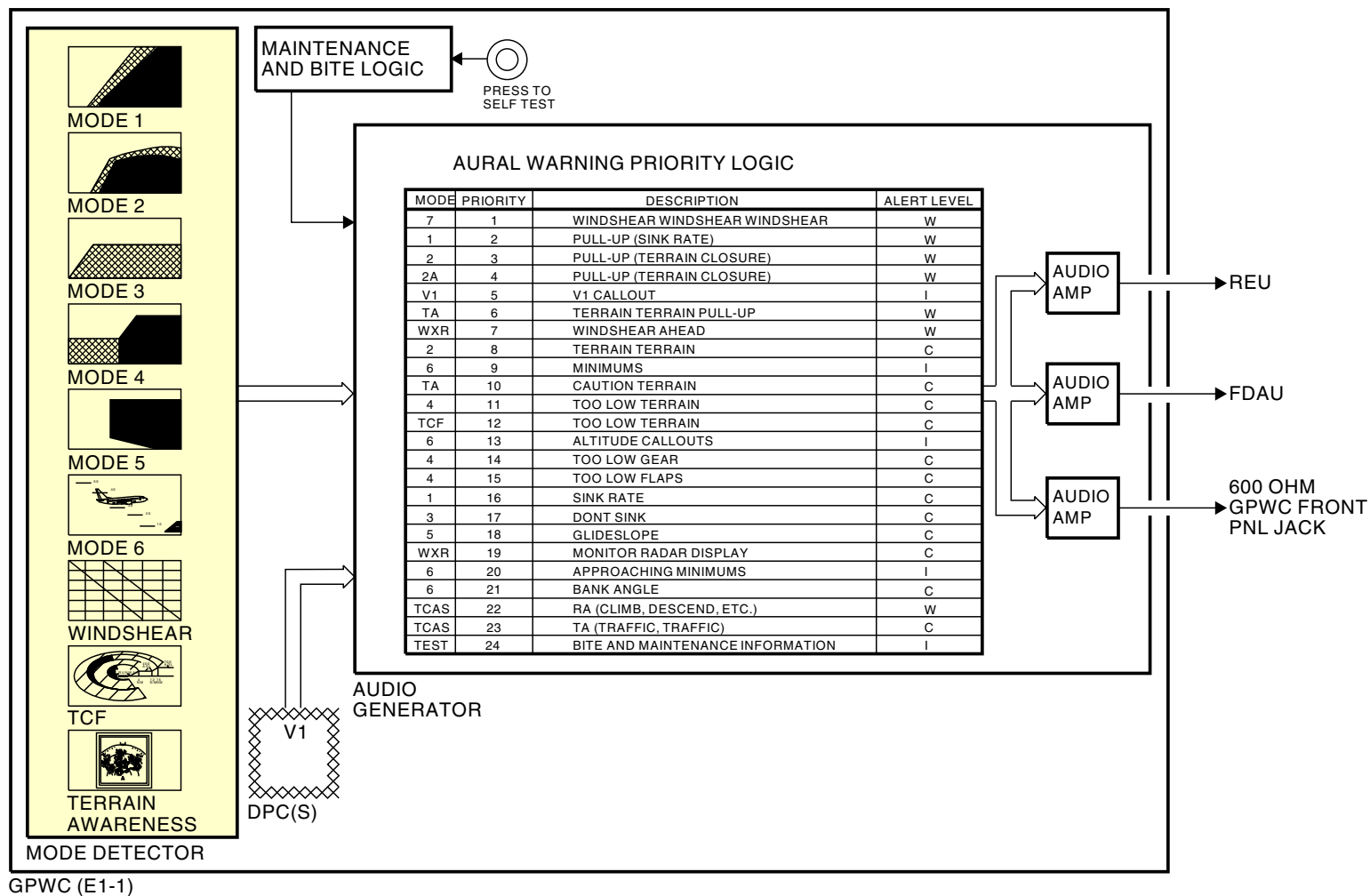
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GPWS - SPEECH PROM



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GPWS - SPEECH PROM

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GPWS - ENVELOPE MODULATION

Purpose

Some airports have unusual terrain clearances near the runway that cause nuisance messages by the GPWS. The most common is a mode 2 warning for an excessive closure rate due to rising terrain located at the end of a runway. Other GPWS modes affected by unusual terrain are modes 1, 4, and 5. Envelope modulation changes the different alert and warning areas to prevent alert messages that are not necessary.

Description

The airports that need envelope modulation are in the GPWC non-volatile memory and identified by their latitude and longitude. This latitude and longitude is called a snapshot area. A snapshot area is then followed, on an approach, by the envelope modulation area. The envelope modulation area has its own latitude and longitude. When the airplane is in a snapshot area, the GPWC looks at other airplane parameters to ensure that all the required data is valid and within tolerances. Once the snapshot requirements have been verified by the GPWC, and depending on which airport the airplane is approaching, one or more of the listed GPWS modes can be modified.

- Mode 1 - to allow higher altitude descent rates
- Mode 2(A and B) - to allow higher closure rates
- Mode 4 - to allow less minimum terrain clearance
- Mode 5 - to allow GLIDE SLOPE warnings at higher altitudes.

Not all airports require The same parameters. These are the monitored inputs:

- Latitude
- Longitude
- Radio altitude
- Localizer deviation
- Magnetic track
- Selected runway heading
- Barometric corrected altitude.

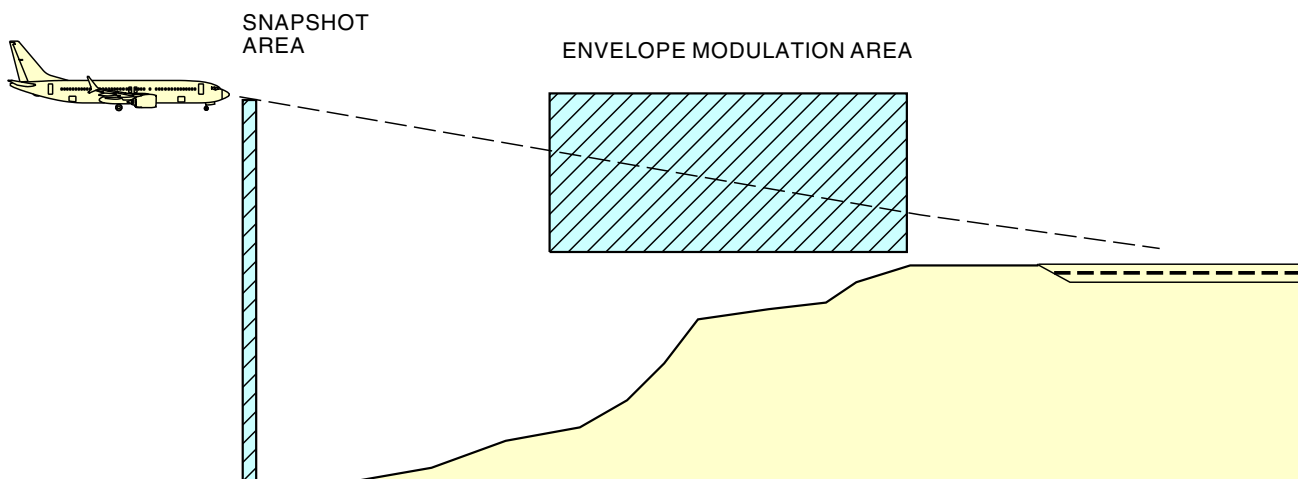
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GPWS - ENVELOPE MODULATION



MODE	TYPE OF MODULATION	PURPOSE OF MODULATION
1	INCREASE ALLOWABLE DESCENT RATE	ALLOWS HIGHER BAROMETRIC DESCENT RATES WITHOUT ALERTS OR WARNINGS
2	DECREASE THE ALERT/WARNING RADIO ALTITUDE LIMITS	LETS THE AIRPLANE FLY CLOSER TO THE TERRAIN WITHOUT ALERTS OR WARNINGS
4	DECREASE THE ALERT/WARNING RADIO ALTITUDE LIMITS	DECREASES THE MINIMUM TERRAIN CLEARANCE FOR AIRSPEEDS MORE THAN 250 KTS FOR ALERTS
5	INCREASE ALERT AREA RA LIMITS REMOVE GEAR DOWN REQUIREMENTS	ALLOWS MODE 5 ANNUNCIATIONS AT HIGHER ALTITUDES OR WITHOUT GEAR DOWN

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GPWS - ENVELOPE MODULATION

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**GPWS - DISPLAYS****MDS Warning Annunciations**

The MAX Display System (MDS) can show these warning annunciations in the GPWS message field on the AI display:

- PULL UP (red)
- WINDSHEAR (red).

SIA 015-999

- MAX REVERSE
- GO AROUND
- SPEEDBRAKE

SIA ALL

The PULL UP warning annunciation shows for mode 1, 2, 3 and 4 conditions.

The WINDSHEAR warning annunciation shows for a mode 7 condition.

SIA 015-999

The MAX REVERSE warning annunciation occurs on the ground when there is a high risk of a runway overrun given the airplane ground speed and distance to the runway end.

The GO AROUND warning annunciation occurs during approach when there is a high risk of a runway overrun.

The SPEEDBRAKE warning annunciation occurs to alert the flight crew if the speedbrakes are not deployed during landing rollout or after a Rejected Takeoff (RTO) is initiated. The MDS generates the message and sends a signal to the Enhanced Ground Proximity Warning Computer (EGPWC) to generate the aural "SPEEDBRAKE, SPEEDBRAKE".

SIA ALL**Below G/S Switch/Light**

There are two BELOW G/S Switch/Lights. One for the captain and one for the first officer. The switch/lights are amber and come on for mode 5 alerts. The Below G/S Switch/Light can be pushed to stop the alert. This will also cancel the aural warning.

Ground Proximity INOP Light

The INOP light on the ground proximity warning module (GPWM) comes on for these conditions:

- GPWS inoperative
- Windshear inoperative.

Each of these conditions has inputs that are used to determine whether to turn the INOP light on or off. The inputs change when the aircraft is in the air mode or ground mode. These are the inputs for each condition and mode.

GPWS inop in air:

- SMYD
- ADIRU
- RA
- Program pin error
- Flap position error
- Air ground error
- Mode failure.

GPWS inop on ground:

- SMYD

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**GPWS - DISPLAYS**

- ADIRU
- RA
- DPC
- ILS
- Program pin error
- Flap position error
- Air ground error
- Mode failure.

Altitude callouts inop in air:

- DPC
- ADIRU
- RA
- Invalid altitude callout selection.

Altitude callouts inop on ground:

- DPC
- ADIRU (air data)
- RA
- Invalid altitude callout selection.

Windshear inop in air:

- RA
- ADIRU
- SMYD
- DPC
- Program pin error

Windshear inop on ground:

- RA
- ADIRU

- SMYD
- Program pin error.

NOTE: ADIRU in the attitude mode will not cause the windshear to be inop in air.

SIA 015-999**RUNWAY INOP light**

The amber RUNWAY INOP light on the GPWM comes on when the:

- Runway Situational Awareness Tools (RSAT) functions are invalid,
- Current airport is not in the terrain database
- GPS position is invalid
- Runway inhibit switch position is not known
- Runway inhibit switch is in the INHIBIT position and airspeed is greater than 250 knots for more than 60 seconds.

SIA ALL**34-49-00**

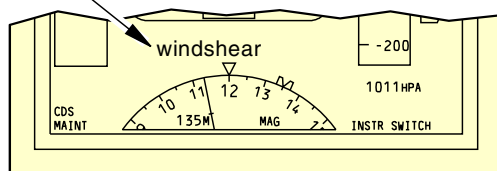
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GPWS - DISPLAYS

GPWS MESSAGE FIELD

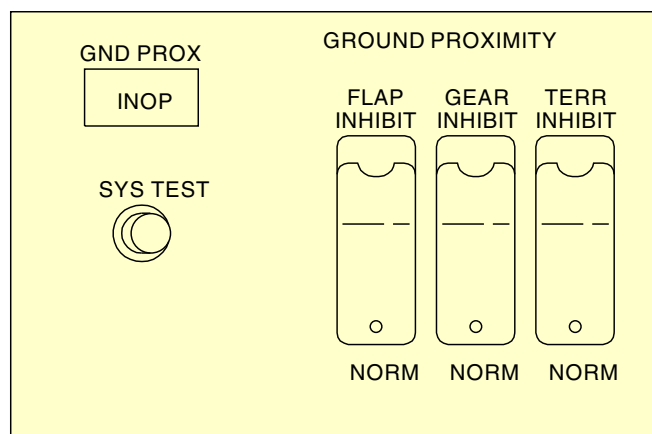


WARNING ANNUNCIATION

BELOW G/S
P-INHIBIT

a

BELOW G/S
SWITCH/LIGHT
(P1 AND P3)



GPWM

GPWS - DISPLAYS

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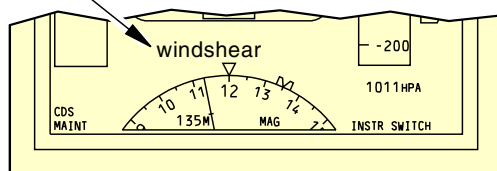
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GPWS - DISPLAYS

GPWS MESSAGE FIELD

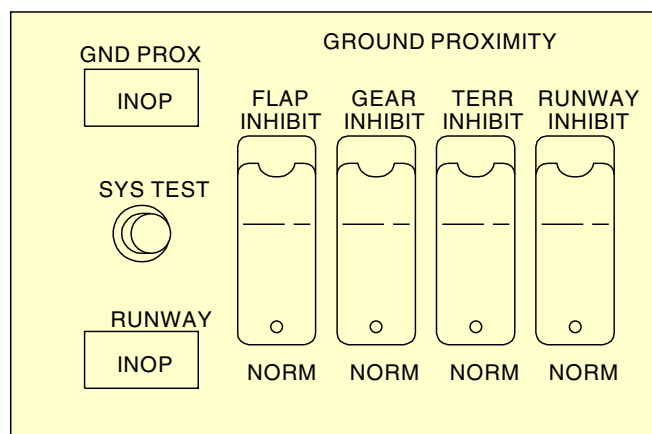


WARNING ANNUNCIATION

BELOW G/S
P-INHIBIT

a

BELOW G/S
SWITCH/LIGHT
(P1 AND P3)



GPWM

GPWS - DISPLAYS

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GPWS - TERRAIN AWARENESS DISPLAY

Terrain Awareness Display Data

The navigation displays (NDs) show this GPWS data:

- Terrain awareness display
- Vertical situation display
- GPWS system messages
- GPWS alert messages.

Terrain Awareness Display

The terrain awareness display on the NDs uses dots to show the terrain ahead of the airplane. Dot color and dot pattern density are based on the terrain altitude and airplane altitude. These are the dot colors and patterns the terrain display uses:

- High density red - Terrain more than 2,000 feet above airplane altitude
- High density yellow - Terrain 1,000 feet to 2,000 feet above airplane altitude
- Medium density yellow - Terrain 500 feet below to 1,000 feet above airplane altitude. Gear down changes this to 500 feet below to 250 feet above
- Medium density green - Terrain 500 feet below to 1,000 feet below airplane altitude. Gear down changes this to 500 feet below to 250 feet below
- Low density green - Terrain 1,000 feet below to 2,000 feet below airplane altitude
- Black - Terrain more than 2,000 feet below airplane altitude
- Magenta - Unknown terrain.

If GPWS detects a terrain caution alert, the threat terrain changes from dots to a solid yellow color. If GPWS detects a terrain warning alert, the threat terrain changes from dots to a solid red color.

On final approach, terrain near the runway does not show.

Peaks Mode Display

The peaks mode display shows terrain below the airplane on the navigation displays (NDs) during cruise. The display shows terrain data at all altitudes with various densities of green to show highest, mid, and lower level non-threatening terrain.

Terrain elevation numbers show in the bottom left of the navigation display for the highest and lowest terrain shown. The color of the numbers (red, amber and green) corresponds to the height from highest to lowest. These numbers show terrain in hundreds of feet above mean sea level (MSL). The display of red or yellow terrain is unchanged.

Obstacles Mode Display

The obstacle display and alerting display provides cautions and warnings for man-made obstacles 100 feet and higher. Obstacles show in the same way as terrain displays. The GPWC gives a CAUTION OBSTACLE aural message for a caution condition. For a warning condition, the aural message is OBSTACLE OBSTACLE PULL UP and PULL up shows on the PFD.

GPWS System Messages

These GPWS system messages show in cyan on the left side of the ND:

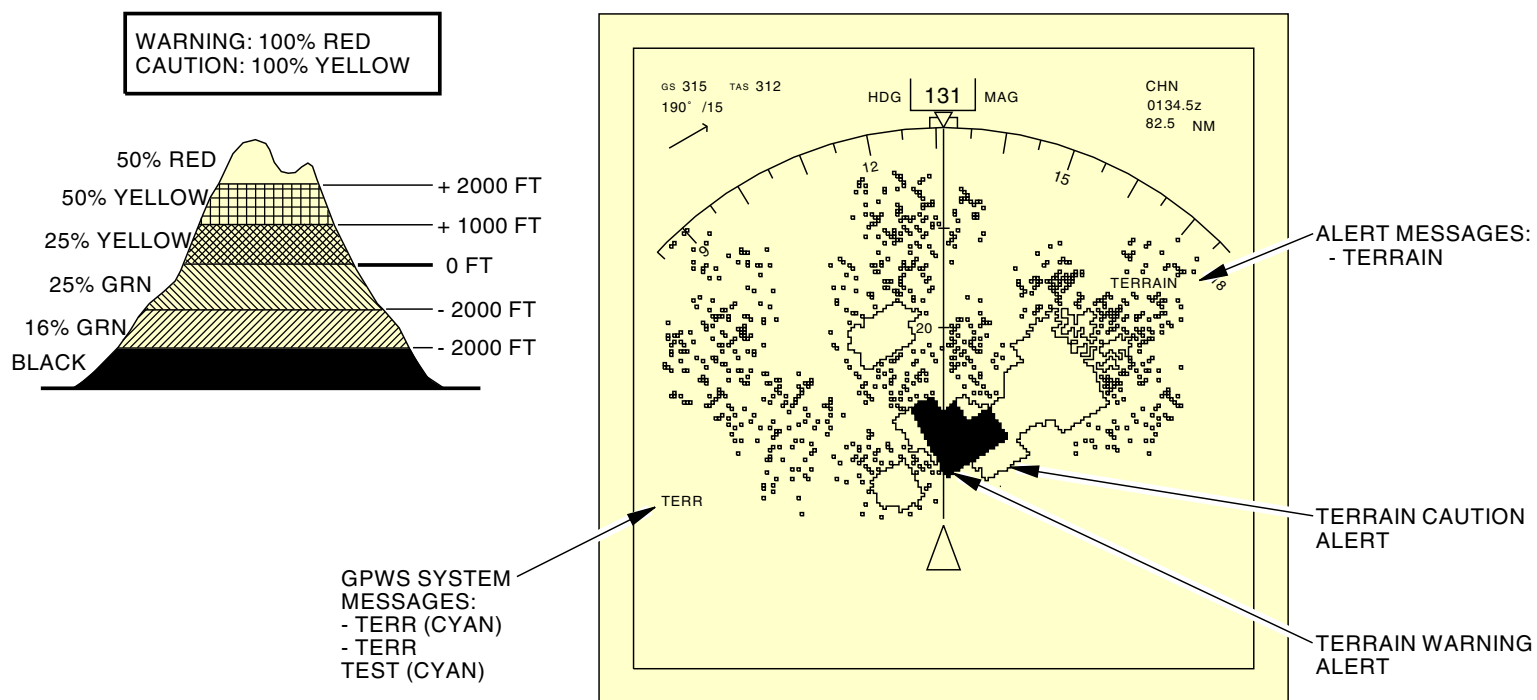
- TERR shows when terrain data displays
- TERR TEST show when the GPWS is in self-test mode.

GPWS Alert Messages

These GPWS alert messages show on the right side of the ND:

- TERRAIN (red) shows when a terrain awareness warning occurs
- TERRAIN (amber) shows when a terrain awareness caution occurs.

GPWS - TERRAIN AWARENESS DISPLAY



GPWS - TERRAIN AWARENESS DISPLAY

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GPWS - NON-NORMAL TERRAIN DISPLAYS

GPWS Non-Normal Messages

These messages show on the navigation display (ND) for GPWS non-normal conditions:

- System alert messages
- Range disagree messages.

GPWS System Alert Messages

These messages show in amber on the left side of the ND:

- TERR POS shows when airplane position data is not valid
- TERR INHIBIT shows when you push the terrain override switch on the GPW module
- TERR FAIL shows when the TCF or terrain awareness functions have failed.

NOTE: The TERR FAIL message shows in all display modes.

Terrain data does not show on either ND if there is a system alert message.

Range Disagree Messages

These alert messages show in amber on the ND when there is a range disagree fault:

- TERR RANGE DISAGREE shows when the GPWS range disagrees with the range selected on the on-side EFIS control panel
- MAP/TERR RANGE DISAGREE shows when the GPWS range, the on-side EFIS range, and the FMC range disagree.

Terrain data does not show on the ND if there is a range disagree message.

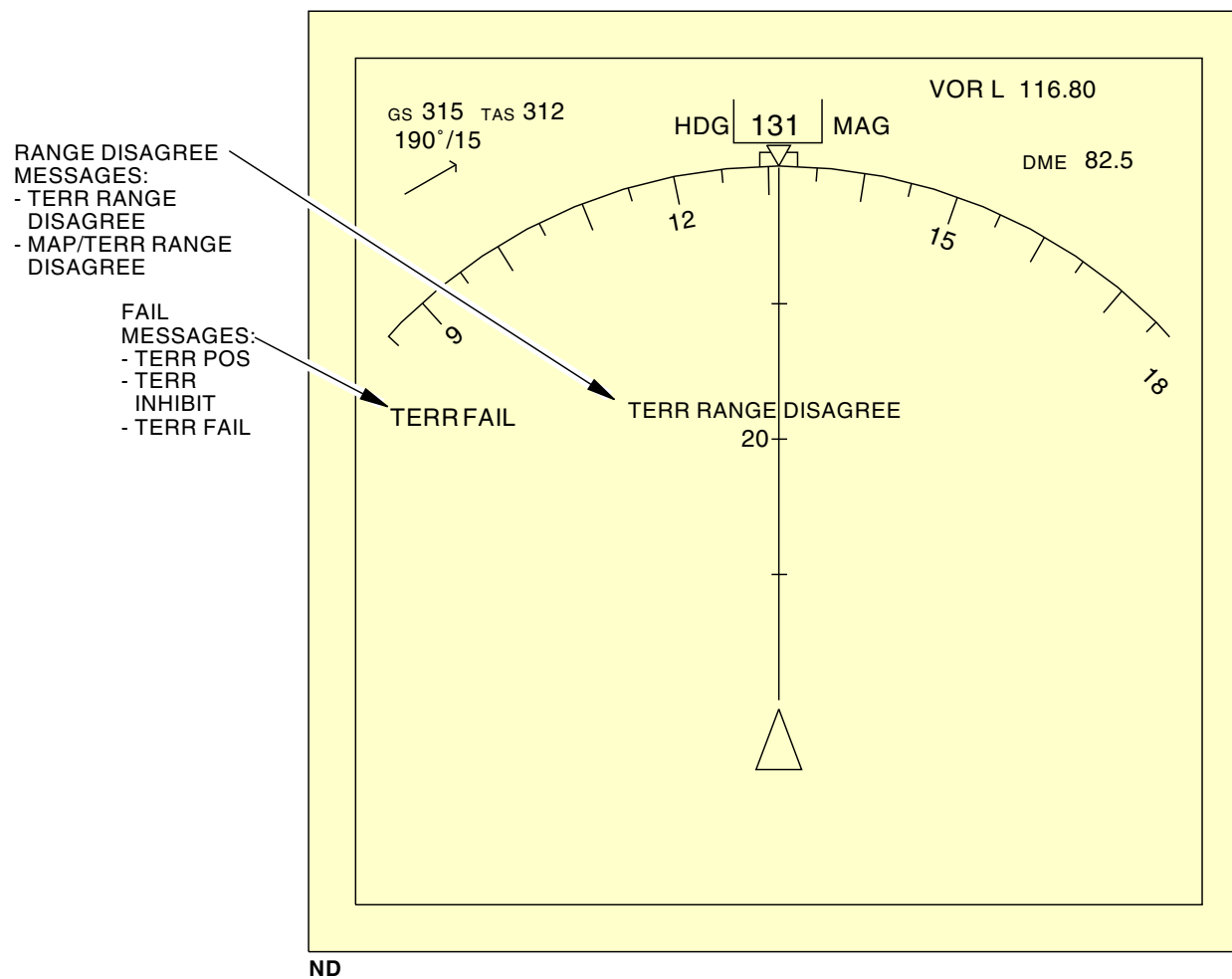
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GPWS - NON-NORMAL TERRAIN DISPLAYS



GPWS - NON-NORMAL TERRAIN DISPLAYS

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GPWS - SELF-TEST - LEVEL ONE

General

The ground proximity warning system (GPWS) has six levels of self-test. Each level provides different information about the GPWS. These are the six levels of self-test:

- GO/NO-GO operational test
- Current faults
- System configuration
- Fault history
- Alert/warning history
- Discrete input test.

Level one is the GO/NO-GO operational test. A level one test provides visual and aural annunciations on the flight deck.

Level One Test Preparation

These conditions must be true to do a level one test of the GPWS:

- Airplane on ground
- GPWS power on
- EFIS ND mode selector in correct mode (expanded APP, VOR, MAP, and centered MAP)
- TERR switch on EFIS control panel (CP) selected
- All interfacing systems installed and energized.

Level One Test Procedure

Use the test switch on the ground proximity warning module to begin a level one test. A level one test first does a test of these configuration conditions:

- Program pin parity
- Airplane configuration database validity
- Airplane type.

If the test finds a configuration fault, the self-test annunciates the fault and the self-test ends. If the GPWS passes the configuration test, the level one test continues.

Training Information Point

You can start a level one test from the front panel of the GPWC, but you cannot see the flight deck annunciations. Use the ground proximity warning module (GPWM) to start an operational test of the GPWS.

Short Level One Test - Normal Indications

These visual and aural annunciations are for a normal level one test:

- ND system message TERR TEST shows in cyan
- Ground proximity warning light on 0.7 seconds
- Glideslope lights on 0.7 sec and aural message GLIDESLOPE
- Pull-up message below the ADI on for 0.7 sec and aural WHOOP WHOOP PULL-UP
- Windshear message below the ADI on 0.7 sec and a two tone siren followed by the aural WINDSHEAR, WINDSHEAR, WINDSHEAR
- Terrain test pattern on the ND for 12 seconds and the aural message TERRAIN, TERRAIN, PULL-UP.
- Operational Program Configuration software part number and terrain database version number in the center of the terrain test pattern on the ND.

Long Level One Test

To start the long level one test, push and hold the test button for 5 seconds. This will do the short level one test then continue to give voice callouts for all customer selected items.

Training Information Point

To continue the GPWS BITE to the next level, push the test button after the GO-NO-GO (level 1) test is complete. No annunciation will instruct the operator to push the test button on the GPWM at the end of the go-no-go (level 1) test to continue with the BITE.

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GPWS - SELF-TEST - LEVEL ONE

Level One Self Test - Non-Normal Indications

The GPWS level one test fails for any of these conditions:

- Terrain test pattern does not show
- TERR FAIL message on the ND stays on
- You do not see and hear all annunciations.

Training Information Point

Some GPWS modes have the same annunciations. If you do not see and hear all annunciations, the test fails.

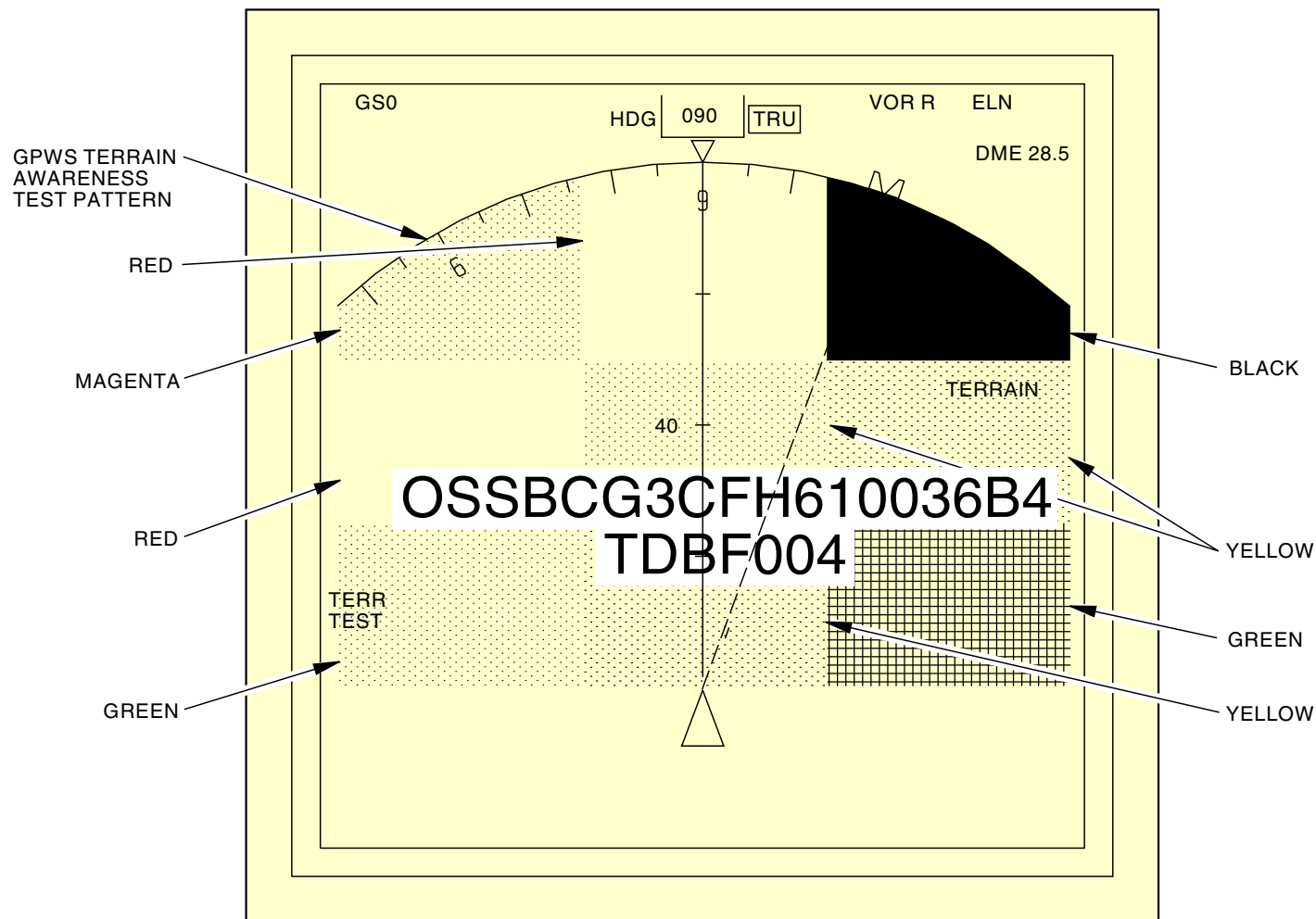
GPWS Mode Failures

These aural messages are for GPWS modes that do not function:

- GLIDESLOPE INOP
- GPWS INOP
- BANK ANGLE INOP
- CALLOUTS INOP
- WINDSHEAR INOP
- TERRAIN INOP.

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GPWS - SELF-TEST - LEVEL ONE



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GPWS - SELF-TEST - LEVEL ONE

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**GPWS - SELF-TEST - LEVELS 2-5****General Description**

The ground proximity warning computer (GPWC) has six levels of self test:

- 1 - GO/NO-GO operational test
- 2 - Current faults
- 3 - System configuration
- 4 - Fault history
- 5 - Alert/warning history
- 6 - Discrete input test.

Self-test levels 2-6 access is through the ground proximity warning module (GPWM) and the GPWC. When you use the GPWC, a 600 ohm headphone is necessary to listen to the test information. Plug the headphone into the jack on the front panel of the GPWC. If you do the tests from the flight deck, the information comes over the flight deck speakers.

Use the self-test button on the front panel of the GPWC or the self-test button on the GPWM to get access to levels 2-6. The self-test button has these two modes:

- Short cancel - push the button for less than two seconds
- Long cancel - push the button for more than two seconds.

Use the self-test buttons for these functions:

- Start self-test level one
- Go to the next item or flight leg within a test
- Go to the next self-test level
- End the self-test.

When test level 1 ends, there is no aural message, push the test button to continue. If you do not push the self-test button within three seconds, self-test ends. When test levels 2 through 5 end, there is an aural message PRESS TO CONTINUE. Push the self-test button to go to the next test level.

Level Two Self-test - Current Faults

A level two test begins with the aural message, CURRENT FAULTS. If there are no current faults, you hear the aural message NO FAULTS. If there are faults, the GPWC annunciates the faults one at a time. A short or long cancel ends the level two test.

Level Three Self-test - System Configuration

A level three test annunciates the GPWS configuration. A level three test begins with the aural message SYSTEM CONFIGURATION. A short cancel causes the test to go immediately to the next configuration item. A long cancel ends the level three test. A level three test provides this information:

- GPWC part number
- GPWC modification status
- GPWC serial number
- Terrain database version
- Envelope modulation database version
- Boot code version
- Aircraft type
- Audio menu
- Altitude callout menu number
- Selected options.

Level Four Self-test - Fault History

Level four test shows the GPWS fault history over the last ten flights.

A level four test begins with the aural message FAULT HISTORY. If there are no faults in the flight history memory, you hear the aural message NO FAULTS. If there are faults in the flight history memory, you hear the most recent faults annunciate first. You hear the faults in this order:

- FLIGHT X (X is the most recent flight leg number)
- Internal faults for flight X
- External faults for flight X

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**GPWS - SELF-TEST - LEVELS 2-5**

- Go to next oldest flight leg and repeat.

A short cancel causes the test to go immediately to the next flight leg. A long cancel ends test level four.

Level Five Self-test - Warning History

Level five test show GPWS alerts over the last ten flights.

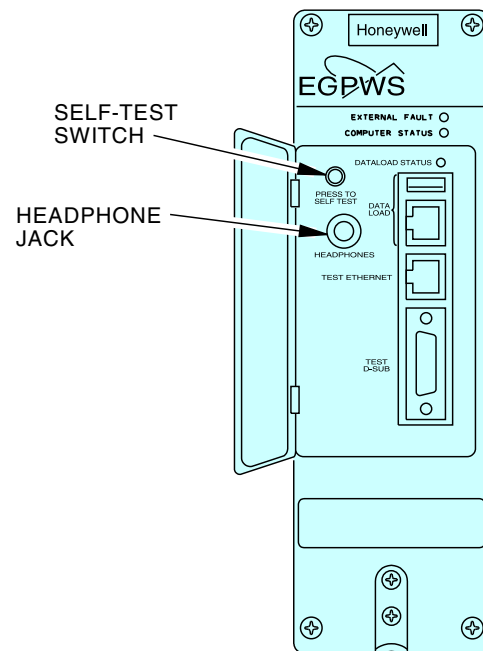
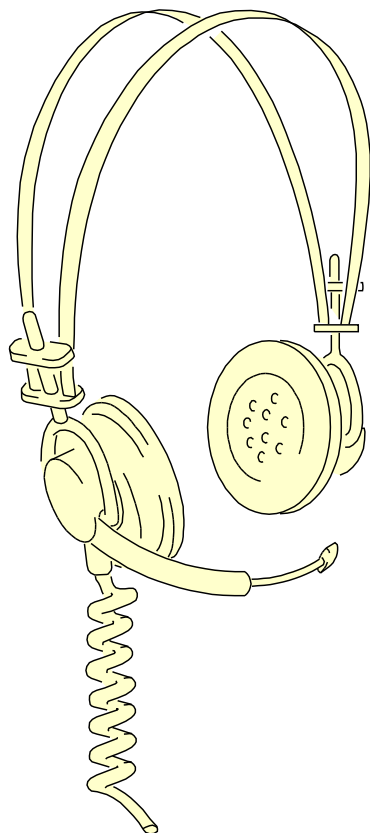
A level five test begins with the aural message WARNING HISTORY. If there are no alerts in the flight history memory, you hear the aural message NO WARNINGS. If there are alerts in the flight history memory, you hear the most recent alerts first. You hear the alerts in this order:

- FLIGHT X (X is the most recent flight leg number)
- GPWS alerts for flight X
- Go to next oldest flight leg and repeat.

A short cancel cause the test to go immediately to the next flight leg. A long cancel ends test level four.

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GPWS - SELF-TEST - LEVELS 2-5



GROUND PROXIMITY WARNING COMPUTER (GPWC)

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GPWS - SELF-TEST - LEVELS 2-5

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EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**GPWS - SELF-TEST - LEVEL 6****General Description**

The GPWC has a level six discrete input test.

The level six self-test can be done from the GPWC or the GPW module. Use a 600 ohm headphone to listen to the test information when you do the test from the GPWC. Plug the headphone into the jack on the front panel of the GPWC.

Use the self-test button on the front panel of the GPWC or the GPW module to get access to level six. The self-test buttons have these two modes:

- Short cancel - push the button for less than two seconds
- Long cancel - push the button for more than two seconds.

Use the self-test buttons for these functions:

- Start self-test level one
- Go to the next item or flight leg within a test
- Go to the next self-test level
- End the self-test.

When test levels 2 through 5 end, the aural message PRESS TO CONTINUE shows. Push the self-test button to go to the next test level. When the level one test ends, there is no aural message. If you do not push the self-test button within three seconds, the self-test ends.

Level Six Self-test - Discrete Input Test

A level six test finds changes in discrete inputs.

The test starts with the aural message DISCRETE TEST. If the condition of a discrete input changes, you hear the new state of the discrete.

NOTE: The landing gear handle must be in the Off position to test the gear inhibit switch on the GPW module.

NOTE: Before moving the landing gear handle install landing gear locking pins.

You hear the aural message DISCRETE INPUT TEST - PRESS TO CANCEL every 60 seconds. Push a short or long cancel to end the self-test.

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GPWS - SELF-TEST - LEVEL 6

DISCRETE INPUT	INPUT SOURCE	ANNUNCIATIONS
GEAR INHIBIT SWITCH	GPW MODULE	LANDING GEAR DOWN LANDING GEAR UP
FLAP INHIBIT SWITCH	GPW MODULE	LANDING FLAPS NOT LANDING FLAPS
BELOW G/S SWITCH/LIGHT	P1-3 AND P3-1	GLIDESLOPE CANCELLED GLIDESLOPE ENABLE
TERRAIN INHIBIT SWITCH	GPW MODULE	TERRAIN OFF TERRAIN ON

LEVEL 6 DISCRETE INPUT TEST

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GPWS - SELF-TEST - LEVEL 6

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GPWS - STATUS LEDS

Purpose

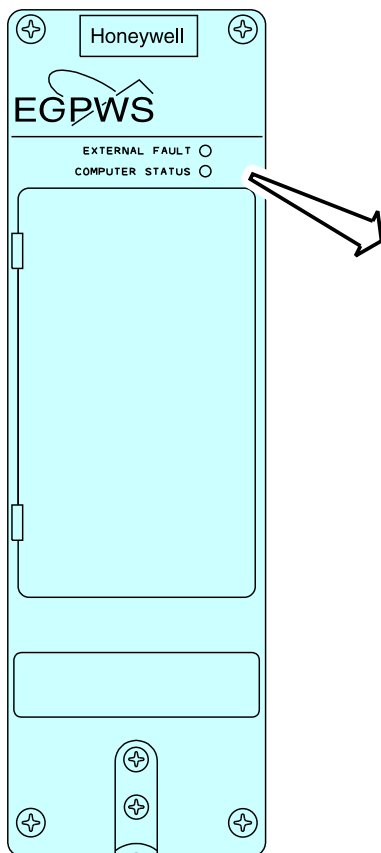
There are two status LEDs on the front panel of the ground proximity warning computer (GPWC). The LED indicators show the status of the GPWC when power is supplied. The LEDs turn on for these conditions:

- External fault - yellow
- Computer status - green/red.

The yellow external fault LED shows that the GPWC has detected an external interface fault. The green computer status LED shows the GPWC operation is normal and a red computer status LED shows an internal GPWC fault.

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	D633AM102-SIA

GPWS - STATUS LEDS



EXTERNAL FAULT	COMPUTER STATUS	CONDITION
OFF	OFF	EGPWC POWER OFF
OFF	RED	EGPWC INTERNAL FAULT EXISTS
OFF	GREEN	NORMAL OPERATION
AMBER	OFF	INVALID CONDITION
AMBER	RED	BOTH EGPWC INTERNAL AND GPWS EXTERNAL FAULTS EXIST
AMBER	GREEN	EGPWC EXTERNAL FAULT EXISTS

2370026 S00061520824_V1

GPWS - STATUS LEDS

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SIA ALL	EFFECTIVITY

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GPWS - MODE DESCRIPTION SUMMARY

General

This summary shows this information:

- GPWS modes
- Mode conditions
- Aural messages for each mode
- Annunciators or displays that come on.

SIA ALL	EFFECTIVITY
D633AM102-SIA	



GPWS - MODE DESCRIPTION SUMMARY

MODES	CONDITION			AURAL MESSAGE	PFD-RED MESSAGE	ND MESSAGE	GND PROX-G/S INHIBIT LIGHT
1	INITIAL ANNUNCIATION			SINK RATE...	PULL UP		
	WARNING			PULL UP...	PULL UP		
2A	FLAPS <30 AND G/S AND LOC DEV >2 DOTS	INITIAL ANNUNCIATION		TERRAIN TERRAIN	PULL UP		
		WARNING		PULL UP...	PULL UP		
		ALTITUDE GAIN FUNCTION: - STARTS WHEN MODE 2 CONDITION STOPS - STOPS WHEN 300 FT OF INERTIAL ALT IS GAINED OR 45 SECS ELAPSED		TERRAIN..	PULL UP		
2B	FLAPS >30 AND G/S OR LOC DEV <2 DOTS	FLAPS AND GEAR DOWN		TERRAIN..	PULL UP		
		FLAPS OR GEAR UP	INITIAL ANNUNCIATION	TERRAIN TERRAIN..	PULL UP		
			WARNING	PULL UP..	PULL UP		
3A	FLAPS <30 OR GEAR UP (FOR ALTITUDE LOSS OF 10% TO 20%)			DON'T SINK...	PULL UP		
3B	FLAPS <30 OR GEAR UP. RA LESS THAN THRESHOLD VALUE.			TOO LOW TERRAIN..	PULL UP		
4A	GEAR UP AND FLAPS <30	AIRSPEED <190 KNOTS AND RA <500 FT		TOO LOW GEAR..	PULL UP		
		AIRSPEED >190 KNOTS AND RA <1000FT		TOO LOW TERRAIN..	PULL UP		
4B	GEAR DOWN AND FLAPS <30	AIRSPEED <185 KNOTS AND RA <245 FT		TOO LOW FLAPS..	PULL UP		
		AIRSPEED >185 KNOTS AND RA <1000FT		TOO LOW TERRAIN..	PULL UP		
5	APPROACH AND GEAR DOWN	RA <1000 FT AND G/S DEVIATION >1.3 DOTS		GLIDE SLOPE... AT 1/2 VOLUME, FREQ PROPORTIONAL TO DEVIATION AND GROUND PROXIMITY.			X
		RA <300 FT AND G/S DEVIATION >2.0 DOTS		GLIDE SLOPE... AT FULL VOLUME, FREQ PROPORTIONAL TO G/S DEVIATION AND GROUND PROXIMITY.			X
6	PROGRAM PIN SELECTABLE			RADIO ALTITUDE CALLOUTS AS SELECTED BY PROGRAM PINS			
7	WINDSHEAR CONDITION			SIREN, THEN WINDSHEAR, WINDSHEAR, WINDSHEAR...	WINDSHEAR		
TA	60 SEC TO THREAT TERRAIN			CAUTION, TERRAIN..		TERRAIN	
	30 SEC TO THREAT TERRAIN			TERRAIN, TERRAIN, PULL UP..	PULL UP	TERRAIN	
TCF & RFCF	INITIAL PENETRATION OF TCF AND AFTER EACH 20% FURTHER RA LOSS			TOO LOW TERRAIN..		TERRAIN	
	WARNING			PULL UP...	PULL UP	TERRAIN	

2370027 S00061520826_V1

GPWS - MODE DESCRIPTION SUMMARY

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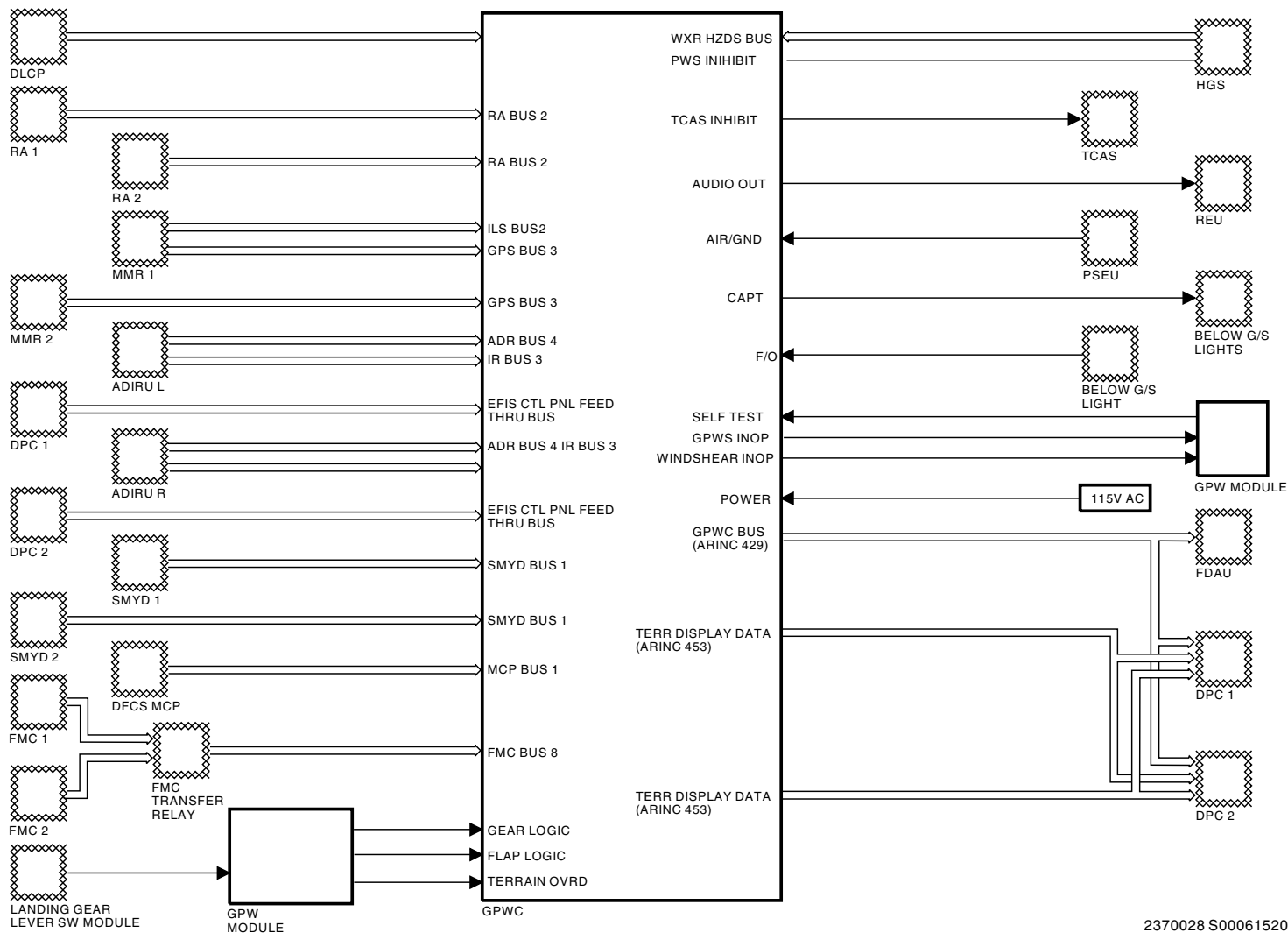
GPWS - SYSTEM SUMMARY

General

This graphic is for reference only.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

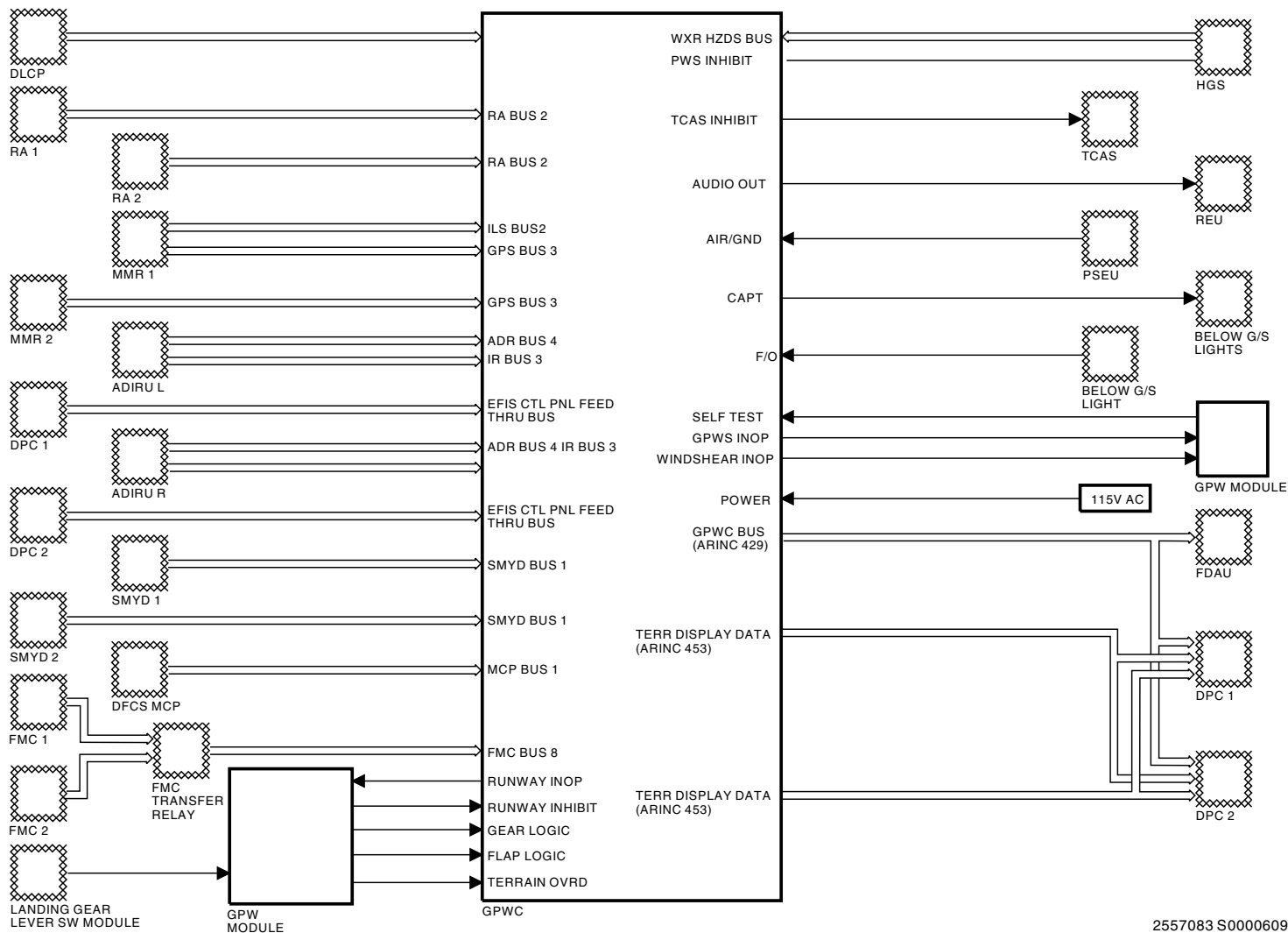
GPWS - SYSTEM SUMMARY



2370028 S00061520828_V3

GPWS - SYSTEM SUMMARY

GPWS - SYSTEM SUMMARY



2557083 S0000609776_V3

GPWS - SYSTEM SUMMARY

EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**VHF OMNIDIRECTIONAL RANGING (VOR) SYSTEM - INTRODUCTION****Purpose**

The VHF omnidirectional ranging (VOR) system is a navigation aid that gives magnetic bearing data from a VOR ground station to the airplane.

The VOR ground stations transmit signals that give magnetic radial information from 000 degrees to 359 degrees. All VOR stations reference the 000 degree to magnetic north.

- PWR - power
- REU - remote electronic unit
- RF - radio frequency
- VOR - VHF omnidirectional ranging.

Abbreviations and Acronyms

- ACP - audio control panel
- ADF - automatic direction finder
- DFCS - digital flight control system
- DFDAU - digital flight data acquisition unit
- DFDR - digital flight data recorder
- DME - distance measurement equipment
- DPC - display processing computer
- EFIS - electronic flight instrument system
- FCC - flight control computer
- FMC - flight management computer
- FMCS - flight management computing system
- GLS - GNSS landing system
- ILS - instrument landing system

SIA 006-999

- IMMR - integrated multi-mode receiver

SIA ALL

- LOC - localizer
- MCP - mode control panel
- MMR - multi mode receiver
- NAV - navigation
- NCD - no computed data
- PSEU - proximity switch electronics unit

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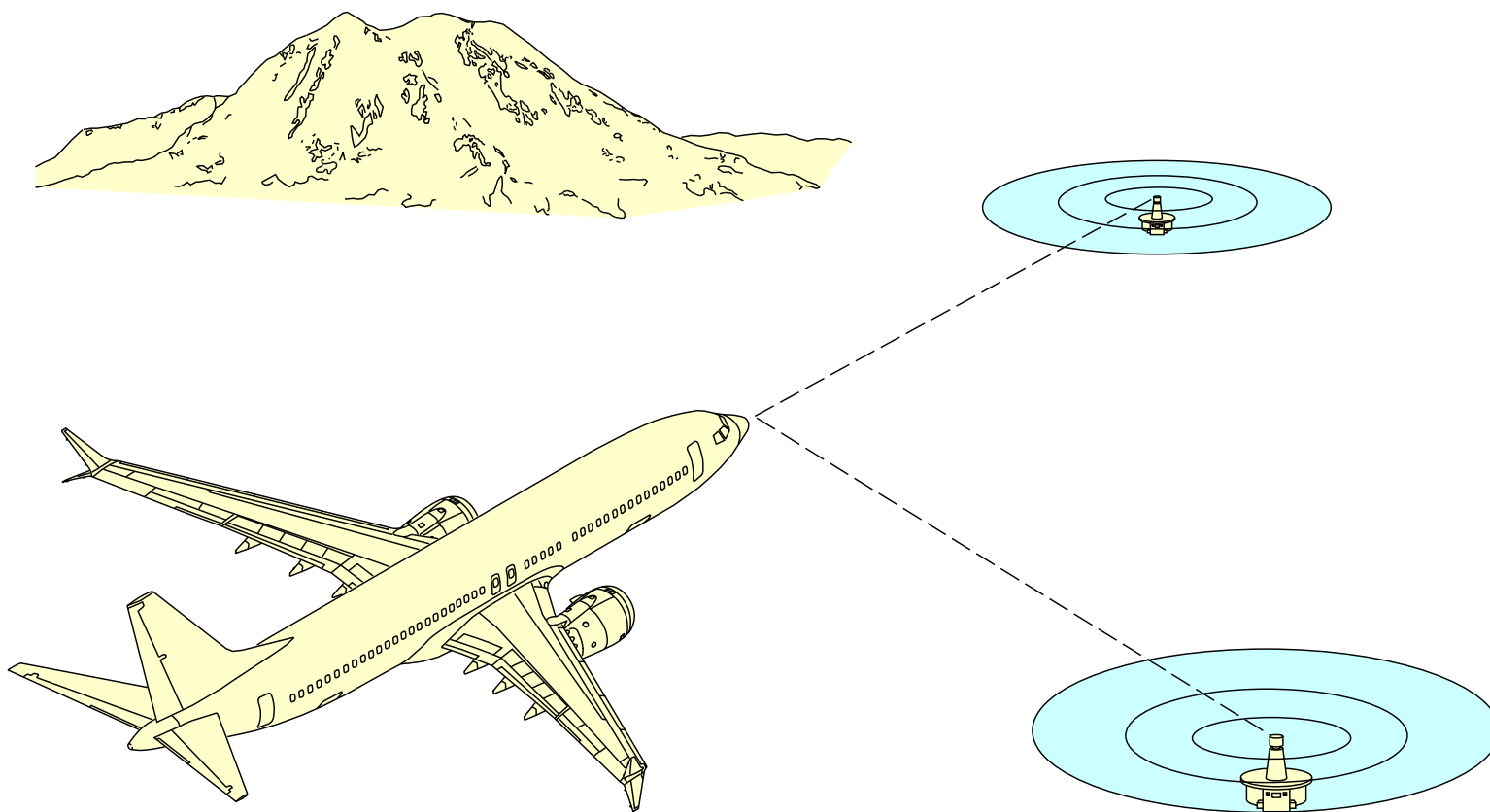
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ECCN 9E991 BOEING PROPRIETARY - See title page for details



VHF OMNIDIRECTIONAL RANGING (VOR) SYSTEM - INTRODUCTION



2370029 S00061520832_V2

VHF OMNIDIRECTIONAL RANGING (VOR) SYSTEM - INTRODUCTION

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VOR SYSTEM - GENERAL DESCRIPTION

General

SIA 006-999

The aircraft has two Integrated Multi Mode Receivers (IMMRs). The IMMRS have VOR, Instrument Landing System (ILS), Marker Beacon (MB) and Global Positioning System (GPS) functions. This section covers only the VOR operation of the IMMRS.

SIA 001-005

The VOR system has two VOR/Marker Beacon (VOR/MB) receivers. The receivers have VOR and marker beacon functions. This section covers only the VOR operation of the VOR/MB receivers.

SIA ALL

Description

The Navigation Control Panels (NCPs) give manual tune inputs to the receivers. Inputs into the NCP first go to the STANDBY window. Pushing the TFR button transfers the standby frequency to the ACTIVE window and the active frequency to the STANDBY window. There are two NCPs, one for the captain and one for the first officer.

SIA 006-999

The RF signals from the VOR/LOC antenna go directly to the IMMRS. The IMMRS use the RF signals to calculate station bearing and decode the Morse code station identifier signal and station audio.

SIA 001-005

RF signals from the VOR/LOC antenna go through power dividers, then to the VOR/MB receivers. The receivers use the RF signals to calculate station bearing and decode the Morse code station identifier signal and station audio.

SIA ALL

The receivers send VOR bearing data to the Display Processing Computers (DPCs) for display. The NAV select switch lets the crew select receiver 1 or receiver 2 as the source for the captain and first officer displays.

The receivers send station audio and Morse code station identifier signals to the Remote Electronic Unit (REU).

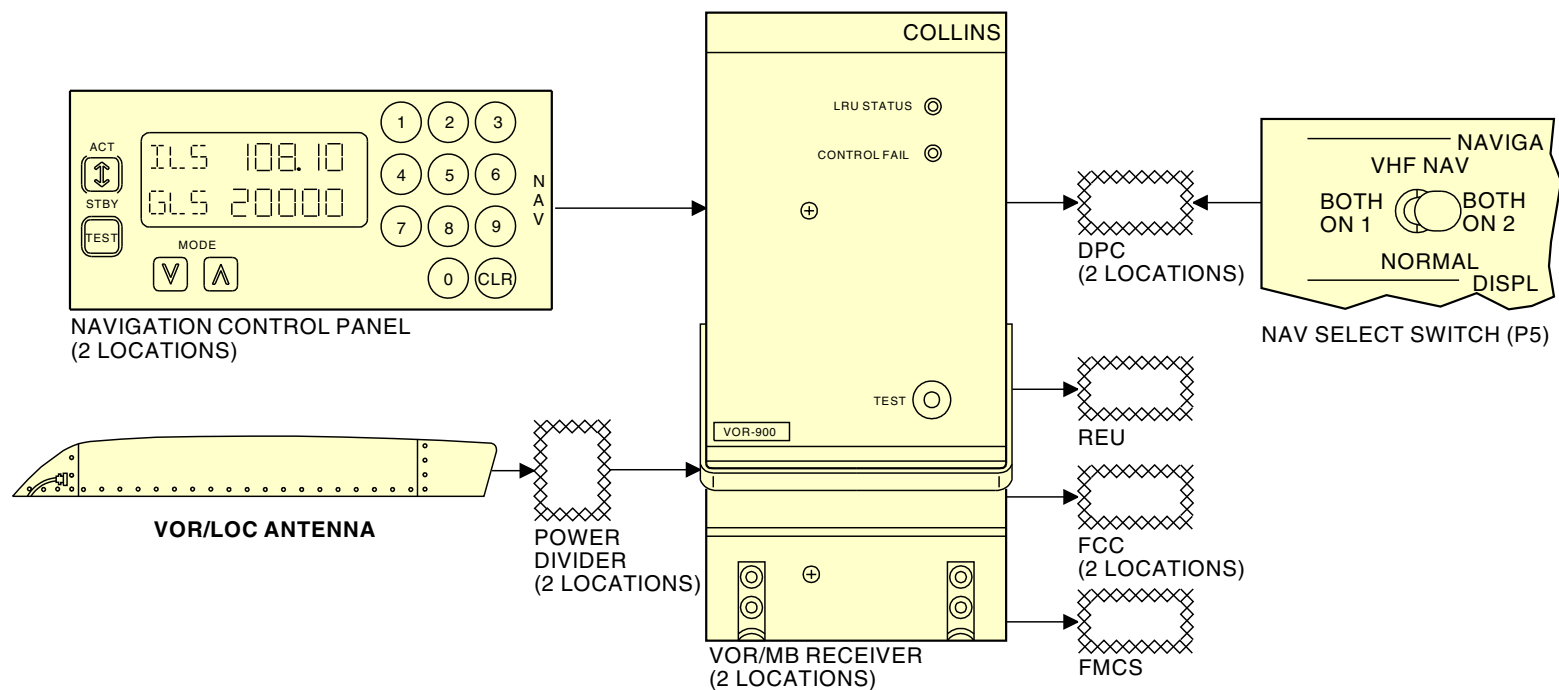
The receiver sends VOR bearing data to the FCCs for the DFCS VOR/LOC mode of operation. The bearing data also goes to the FMCs as a radio navigation aid for present position calculations. The digital flight data acquisition unit (DFDAU) sends VOR data to the Digital Flight Data Recorder (DFDR).

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VOR SYSTEM - GENERAL DESCRIPTION



2531797 S0000599615_V2

VOR SYSTEM - GENERAL DESCRIPTION

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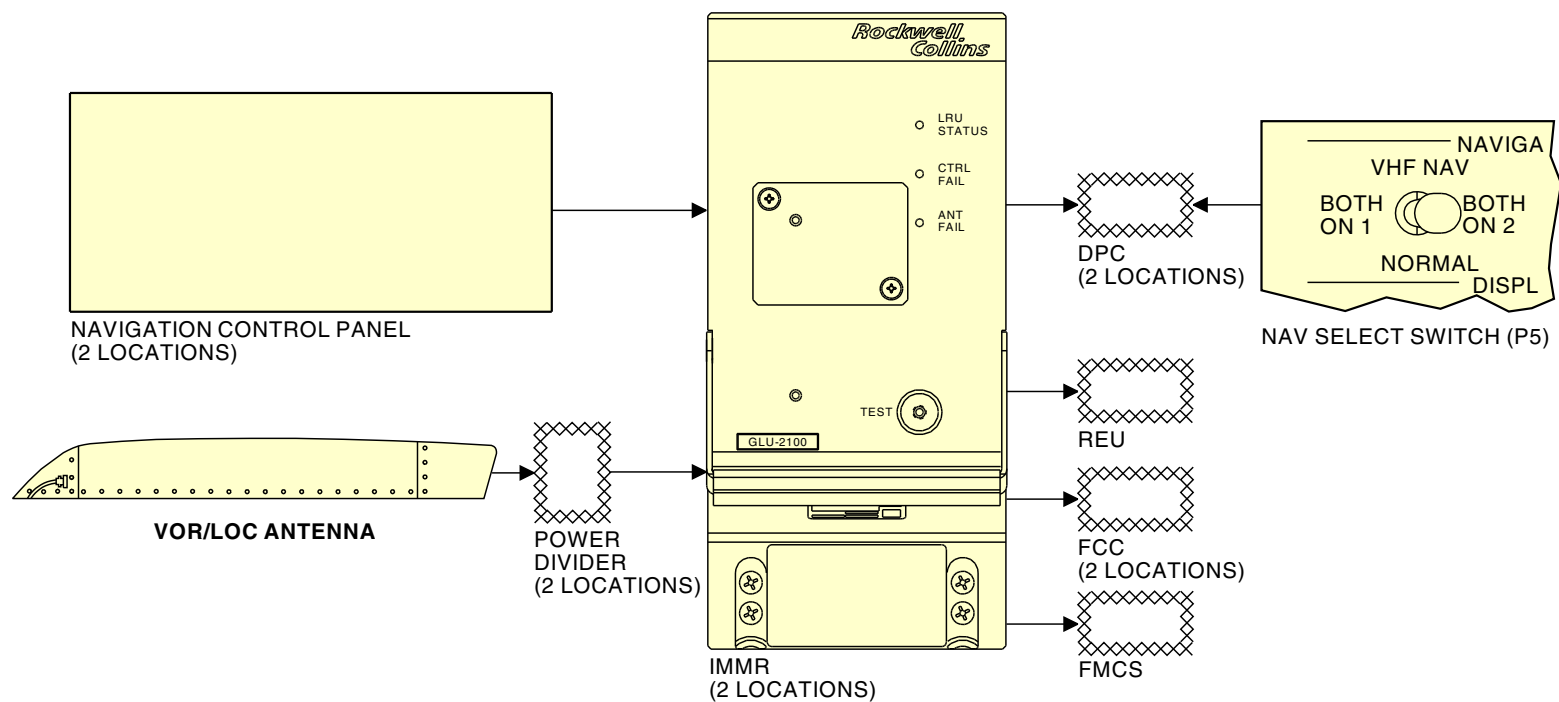
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VOR SYSTEM - GENERAL DESCRIPTION



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VOR SYSTEM - GENERAL DESCRIPTION



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ECCN 9E991 BOEING PROPRIETARY - See title page for details



VOR SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

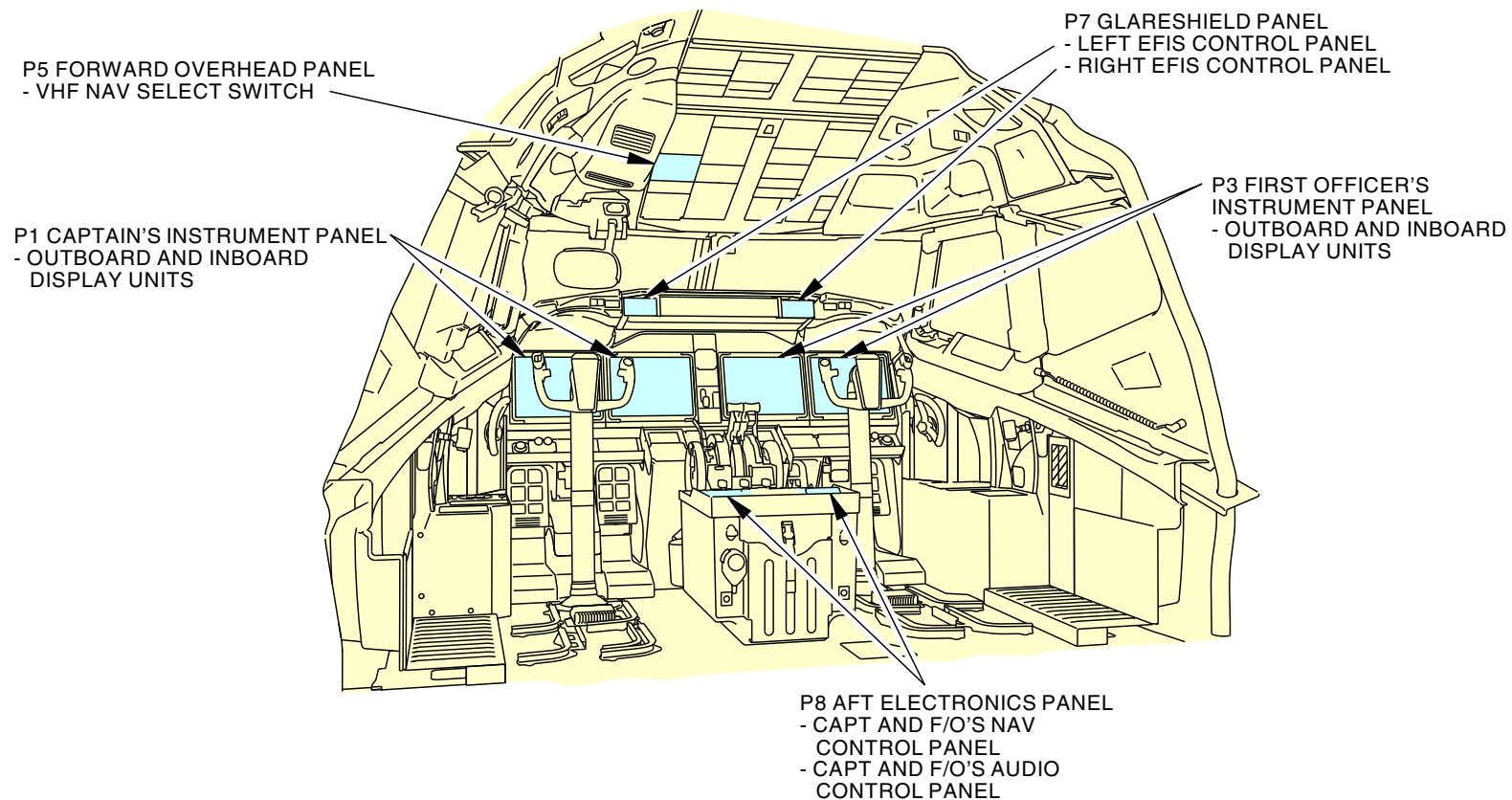
General

These are the components in the flight compartment that interface with the VOR system:

- Captain and first officer navigation displays
- Captain and first officer compass/mini-map displays
- Left and right EFIS control panels
- Captain and first officer NAV control panel
- Captain and first officer audio control panel
- VHF NAV transfer switch.

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VOR SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION



2370031 S00061520836_V2

VOR SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

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SIA ALL

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**VOR SYSTEM - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATIONS****General**

The VOR/LOC antenna is at the top of the vertical stabilizer.

SIA 006-999

The VOR function is inside the integrated multi-mode receiver (IMMR).
IMMR 1 is on the E1-2 shelf and IMMR 2 is on the E1-4 shelf.

SIA 001-005

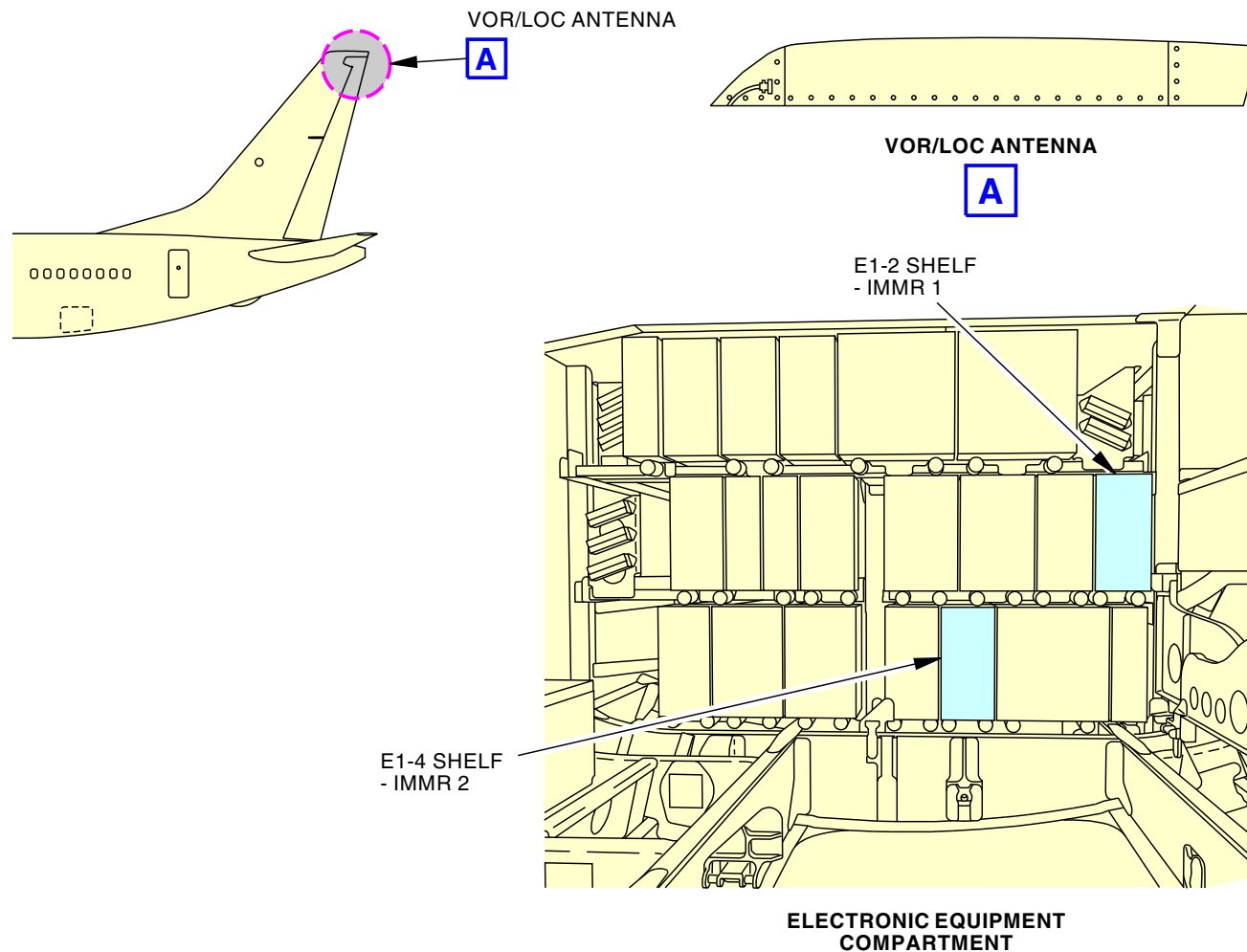
The radio frequency (RF) power dividers are on the side of the E1 rack.

VOR/MB receiver 1 is on the E3-2 shelf and VOR/MB receiver 2 is on the
E4-1 shelf.

SIA ALL

SIA ALL	EFFECTIVITY

VOR SYSTEM - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATIONS



2550938 S0000607085_V2

VOR SYSTEM - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATIONS

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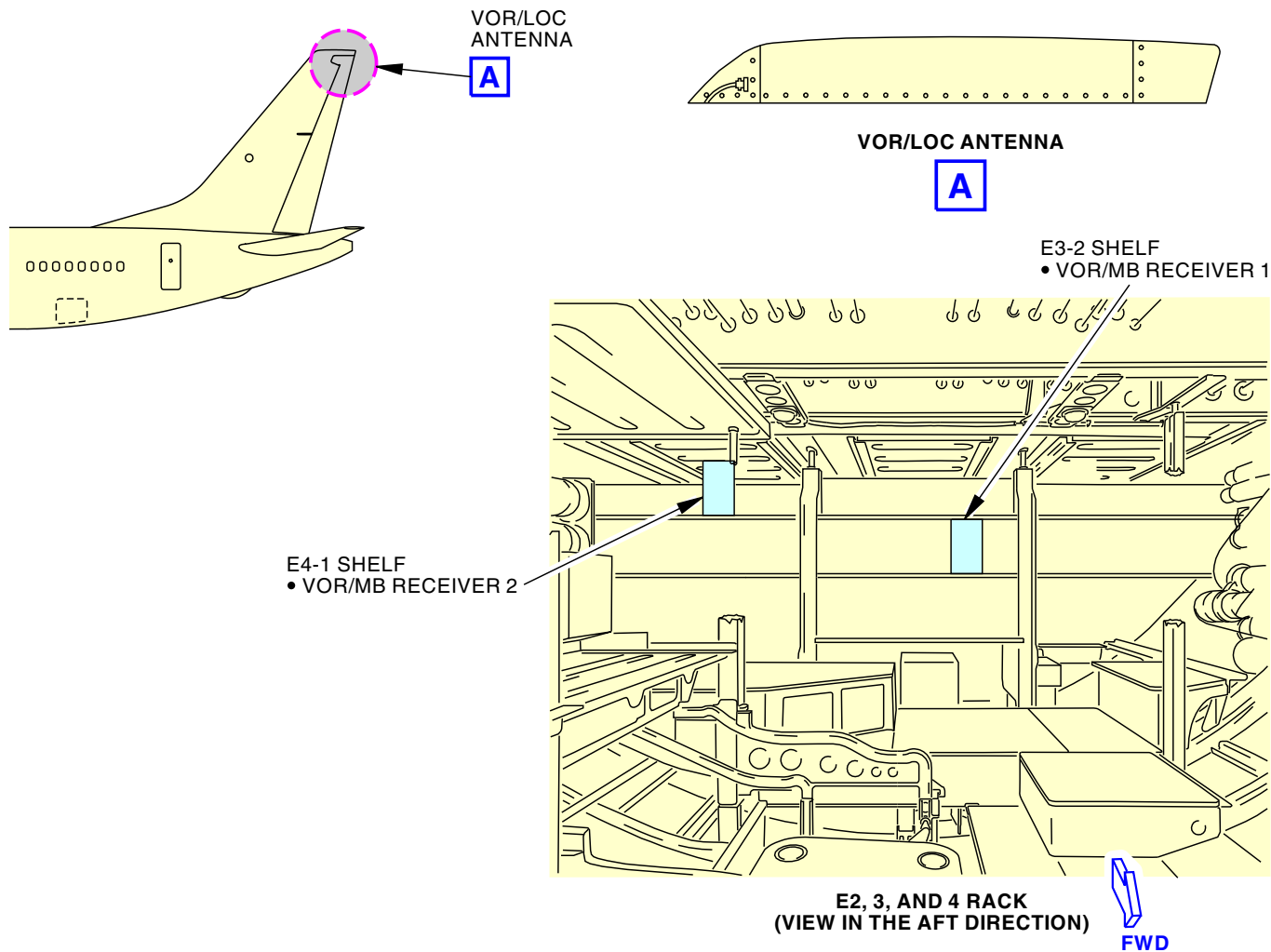
EFFECTIVITY
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

VOR SYSTEM - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATIONS



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VOR SYSTEM - ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATIONS

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EFFECTIVITY
SIA 001-005

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**VOR SYSTEM - POWER AND ANALOG INTERFACE****General****SIA 001-005**

These are the components that have power and analog interface with the VOR system:

SIA 006-999

These are the components that have power and analog interface with the IMMR and the integrated VOR system.

SIA ALL

- Circuit breakers
- VOR antenna
- Navigation Control Panels (NCPs)
- Proximity Switch Electronics Unit (PSEU)
- Remote Electronics Unit (REU).

Circuit breakers**SIA 006-999**

The Integrated Multi-Mode Receiver (IMMR) circuit breakers supply 115v ac power for receiver operation. IMMR 1 gets power from the ac standby bus, section 1 and IMMR 2 gets power from the ac transfer bus 2, section 2.

SIA 001-005

The VOR circuit breakers supply 115v ac power for receiver operation. Receiver 1 gets power from the ac standby bus, section 1 and receiver 2 gets power from the ac transfer bus 2, section 2.

SIA ALL

The NCP circuit breakers supply 115v ac for control panel operation. The captain control panel gets power from the ac standby bus and the first officer control panel gets power from the ac transfer bus 2.

The NCPs receive 28v dc for control panel monitor operation and for the ILS 28v dc tuned output when you tune an ILS frequency. The captain control panel receives 28v dc from the 28v dc standby bus, NAV sensor DC-1 circuit breaker. The first officer control panel receives 28v dc from the 28v dc bus 2, NAV sensor DC-2 circuit breaker.

VOR/LOC Antenna**SIA 006-999**

The VOR/LOC antenna sends RF signals to IMMR 1 and to IMMR 2 for use by the ILS and VOR/MB systems.

SIA 001-005

The VOR/LOC antenna sends RF signals through the RF power divider 1 and RF power divider 2, to the VOR/MB receivers.

SIA ALL**PSEU**

The receivers get air/ground inputs from the Proximity Switch Electronics Unit (PSEU). The receivers use the inputs to set the flight leg count for internal memory, and also inhibit test in the air.

REU

The Remote Electronics Unit (REU) receives Morse code station identifier signals and station audio from the receivers and supplies them to the flight interphone speakers and headsets.

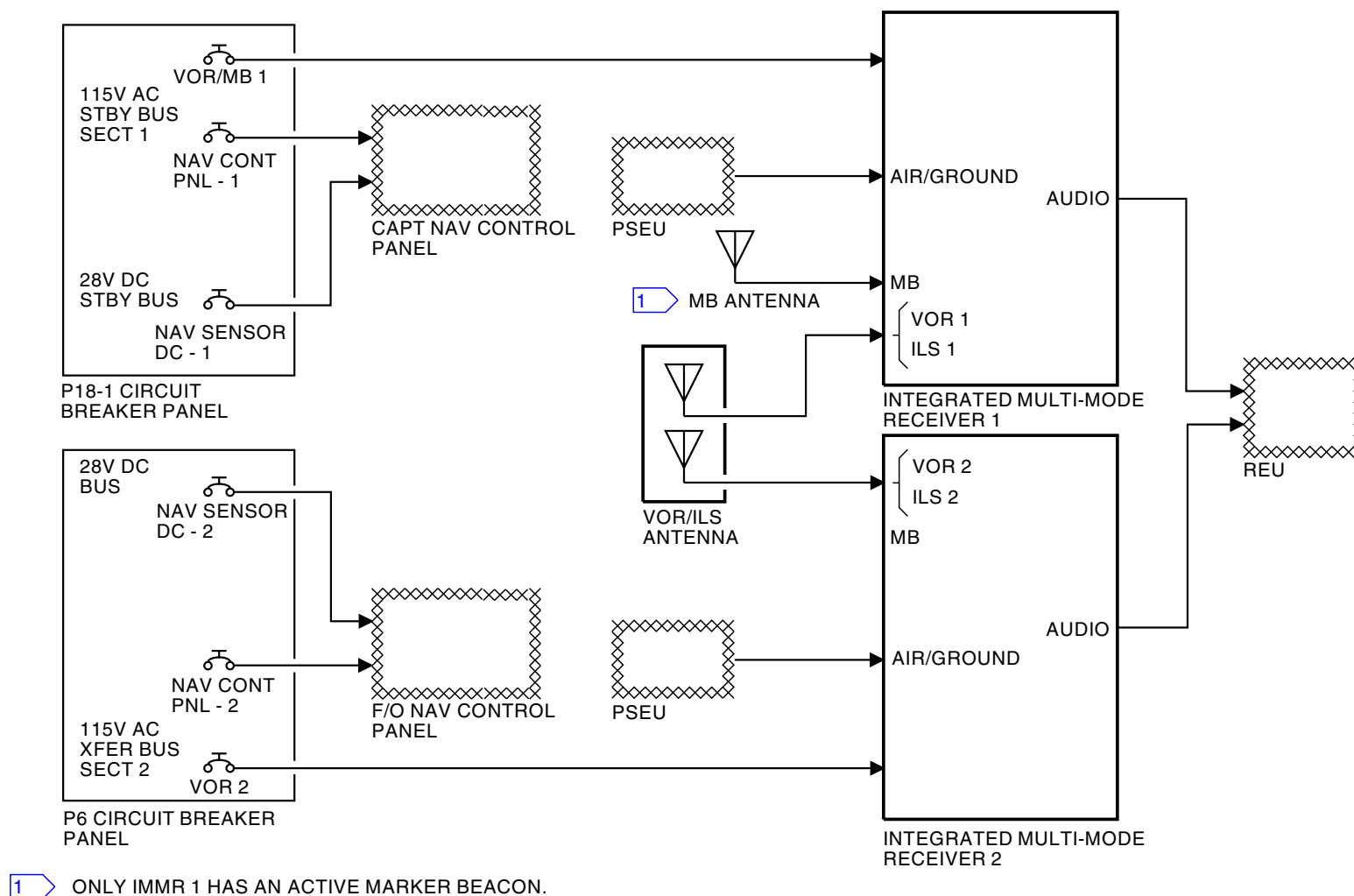
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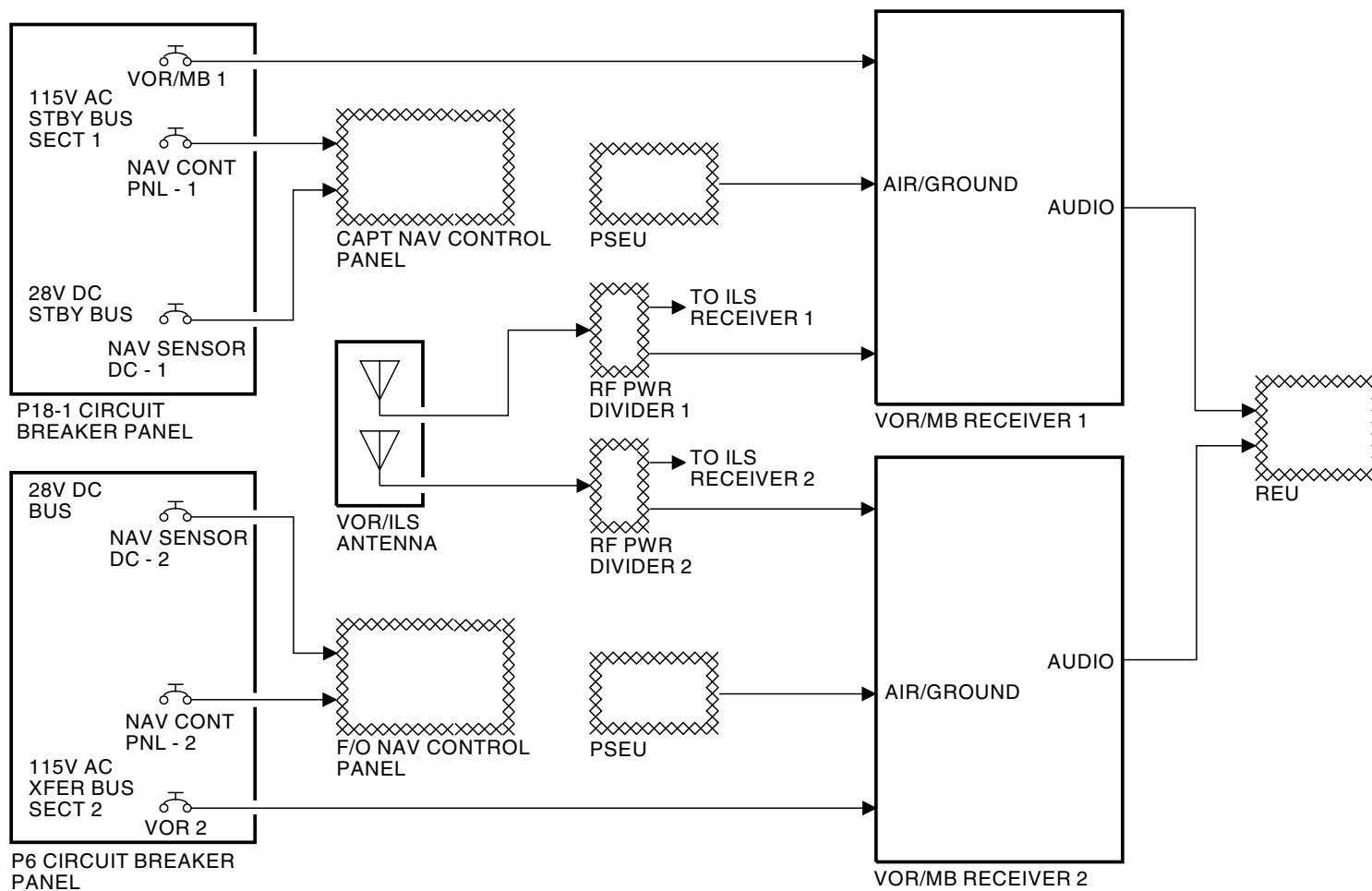
VOR SYSTEM - POWER AND ANALOG INTERFACE



2550939 S0000607086_V3

VOR SYSTEM - POWER AND ANALOG INTERFACE

VOR SYSTEM - POWER AND ANALOG INTERFACE



2370033 S00061520840_V1

VOR SYSTEM - POWER AND ANALOG INTERFACE

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**VOR SYSTEM - DIGITAL INTERFACE****General**

All digital interfaces are on ARINC 429 data buses. These are the components that have digital interface with the VOR system receivers:

- Captain and first officer NCP
- Digital flight data acquisition unit (DFDAU)
- Flight management computers (FMC 1, FMC 2)
- Flight control computer (FCC) A
- FCC B
- Display processing computer (DPC) 1
- DPC 2.

NAV Control Panel**SIA 006-999**

The captain and first officer NAV control panels send manual tune and test command inputs to the VOR/MB receivers. The NCPs send tune inputs and test commands out on two data buses. One data bus goes to the multi mode receivers (IMMR) and one data bus goes to the DME interrogators.

SIA 001-005

The captain and first officer NAV control panels send manual tune and test command inputs to the VOR/MB receivers. The NCPs send tune inputs and test commands out on two data buses. One data bus goes to the multi mode receivers (MMR) and one data bus goes to both the VOR receiver and the DME interrogators.

SIA ALL**VOR/MB Output****SIA 006-999**

The IMMRS each have two output buses. One output bus from each receiver goes to the on-side FCC. IMMR 1 supplies VOR data and status to FCC A. IMMR 2 supplies VOR data and status to FCC B. The FCCs use the data for the autopilot VOR mode of operation.

SIA 001-005

The VOR/MB receivers each have two output buses. One output bus from each receiver goes to the on-side FCC. VOR/MB receiver 1 supplies VOR data and status to FCC A. VOR/MB receiver 2 supplies VOR data and status to FCC B. The FCCs use the data for the autopilot VOR mode of operation.

SIA ALL

The other output bus of each receiver sends VOR data and status to these components:

- DFDAU for data to record by the digital flight data recorder
- FMC 1 and FMC 2 for position update calculations
- DPCs for VOR displays.

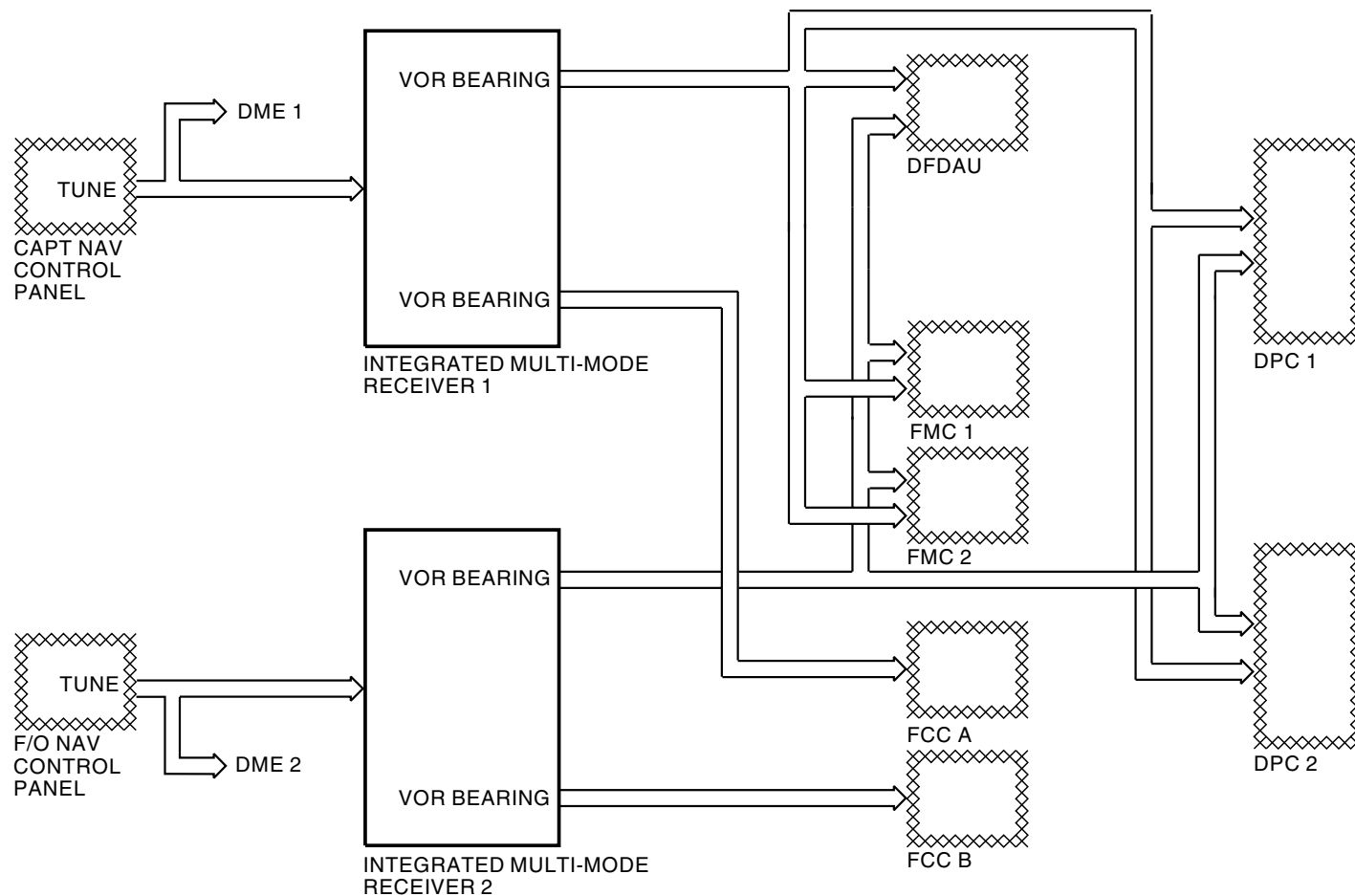
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VOR SYSTEM - DIGITAL INTERFACE



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VOR SYSTEM - DIGITAL INTERFACE

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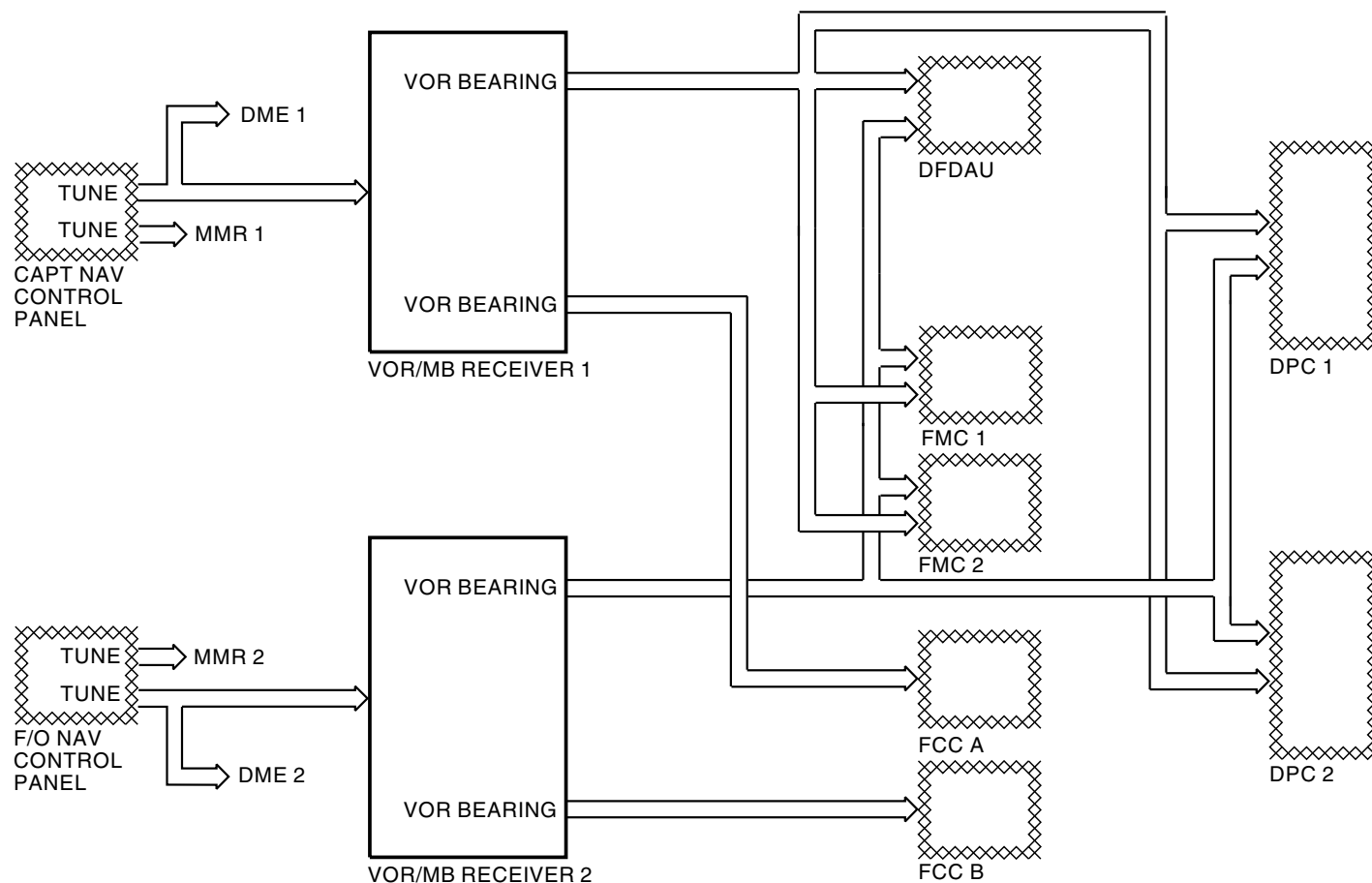
EFFECTIVITY
SIA 006-999

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VOR SYSTEM - DIGITAL INTERFACE



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VOR SYSTEM - DIGITAL INTERFACE

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VOR SYSTEM

General

The VHF Omnidirectional Ranging system supplies magnetic bearing data from a VOR ground station.

You do a test of the VOR system from the NAV control panel or from the test switch on the receiver front panel. When you do a test of the VOR function of the left receiver, you do a test of the VOR function and the marker beacon function at the same time. When you do a test of the VOR function of the right receiver, you do a test of the VOR function only. The marker beacon function for the right is not active.

Description

SIA 006-999

The VOR function in the IMMR is based on the ARINC 711-10 characteristic. The VOR function meets the performance of TSO C40c and of RTCA DO-196.

SIA 001-005

The VOR/MB receiver is a standard ARINC 600 3 MCU unit with dimensions approximately 3.74 x 7.87 x 14.76 inches. The receiver weighs approximately 9 pounds and uses 115v ac 400 Hz power for operation.

SIA ALL

The receiver has a non-volatile flight fault memory. Only shop personnel can use this feature.

Test and Indications

SIA 006-999

There are three light emitting diodes (LEDs) and a test switch on the front of the IMMR. The LEDs show the LRU status with a red or amber light when you do a test of the IMMR. The LRU STATUS LED shows the status of the receiver. The CTRL FAIL LED shows the status of the tune inputs from the navigation control panel (NCP). The ANT FAULT LED shows the status of the antenna being tested.

SIA 001-005

There are two light emitting diodes (LEDs) and a test switch on the front of the VOR/MB receiver. The LEDs show receiver test status when you do a test of the VOR/MB receiver. The red control fail LED shows the status of the tune inputs from the navigation control panel (NCP). The green or red LRU status LED shows the status of the receiver test.

SIA ALL

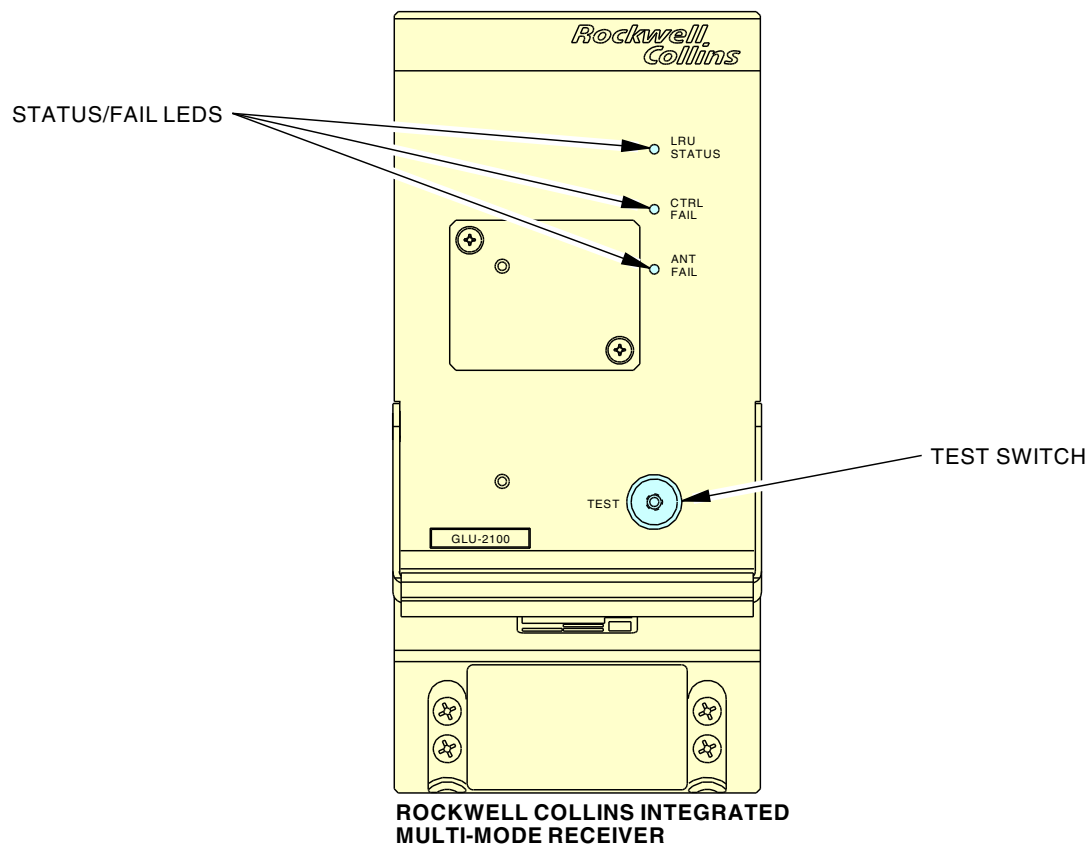
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VOR SYSTEM



VOR SYSTEM - MULTI-MODE RECEIVER

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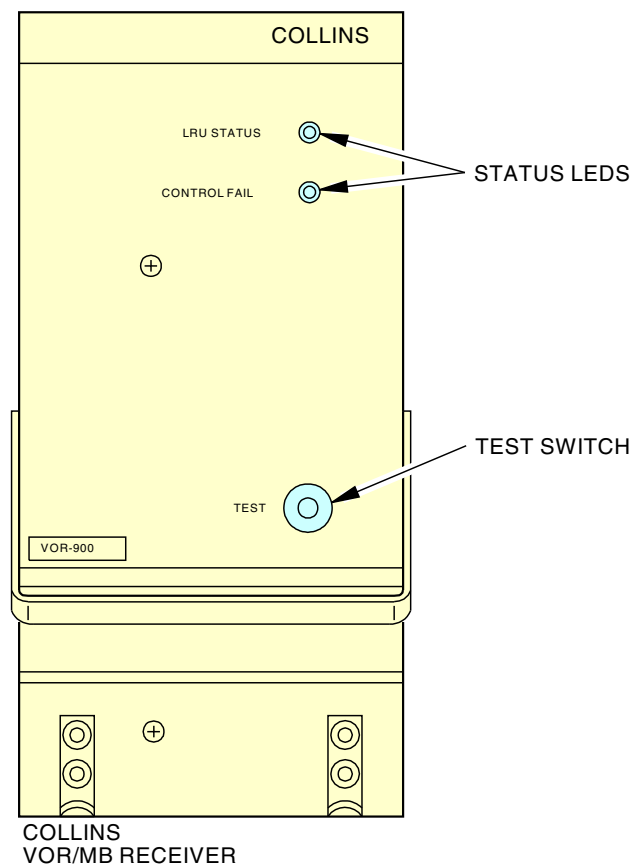
EFFECTIVITY
SIA 006-999

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

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VOR SYSTEM



2550942 S0000607090_V1

VOR SYSTEM - VOR/MB RECEIVER

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EFFECTIVITY
SIA 001-005

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**VOR SYSTEM - ANTENNA****General**

The VOR/localizer (VOR/LOC) antenna is on the top of the vertical stabilizer and inside the cap.

The VOR antenna receives RF signals in the frequency range of 108 MHz to 117.95 MHz. The antenna receives VOR and localizer frequencies.

SIA 006-999

The VOR/LOC antenna sends VOR signals to the integrated multi-mode receivers (IMMR) 1 and 2.

SIA 001-005

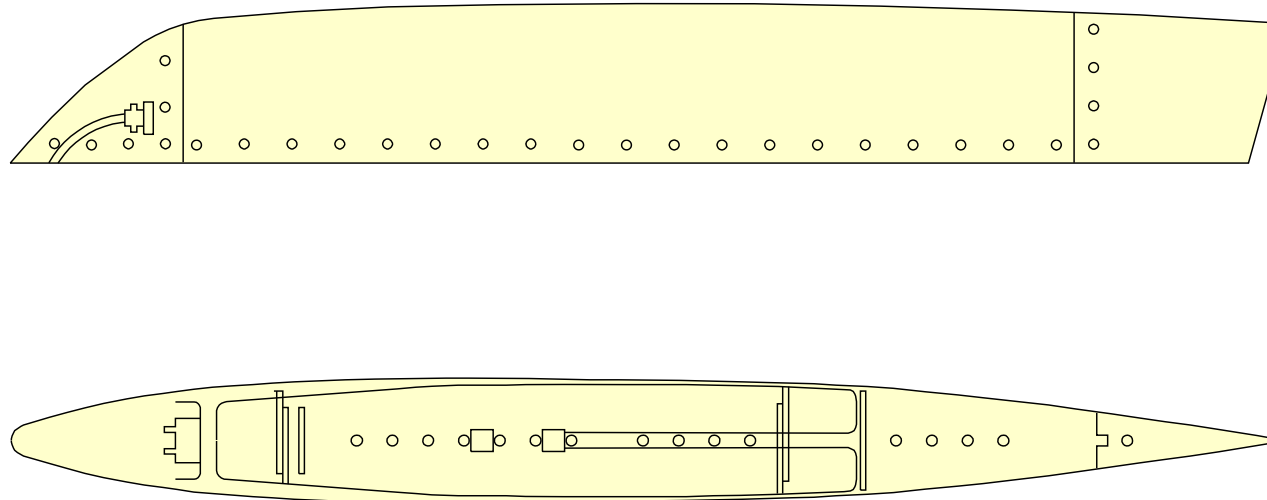
The VOR/LOC antenna sends VOR signals to VOR/Marker Beacon receivers (VOR/MB) 1 and 2.

SIA ALL**34-51-00**

SIA ALL	EFFECTIVITY
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VOR SYSTEM - ANTENNA



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VOR SYSTEM - ANTENNA

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SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



VOR SYSTEM - NAVIGATION CONTROL PANEL

General

The navigation (NAV) control panel supplies frequency/channel inputs and test commands to the DME, ILS, GLS and VOR navigation radios.

Operation

The NAV control panels have an active mode frequency/channel display window and a standby mode frequency/channel display window. The mode frequency/channel that shows in the active frequency/channel display window is the mode frequency/channel the navigation radios use for operation. The standby mode frequency/channel display window shows the next frequency/channel you will use.

The mode frequency/channel transfer button is a momentary action button. It transfers the mode frequency/channel in the standby frequency/channel display window to the active frequency/channel display window. When you push the button, the frequency/channel in the active frequency/channel display window transfers to the standby frequency/channel display window.

The MODE Select buttons are used to select one of the modes available (ILS, VOR, MLS, or GLS).

The numeric key pad (keys 0 thru 9) is used to set the frequency/channel in the standby frequency/channel display window.

The CLR button is used to erase one, several, or all digits of a frequency or channel value shown in the STBY display. If the CLR button is pushed for less than one second, only one digit is erased. If the CLR button is pushed for more than 1 second, the whole value shown in the STBY display is erased and replaced with underscores (_ _ _ _ _).

At power up, the frequency displays show the last frequency entry before power down.

The NAV control panel continuous BITE function monitors the operation. The NAV control panel shows PNL FAIL in the active and the standby frequency display windows when there is a control panel failure.

An internal monitor in the NAV control panel monitors the 28v dc input. If the monitor does not see the 28v dc, it shows the message BLANK in the active and the standby frequency display windows.

Test

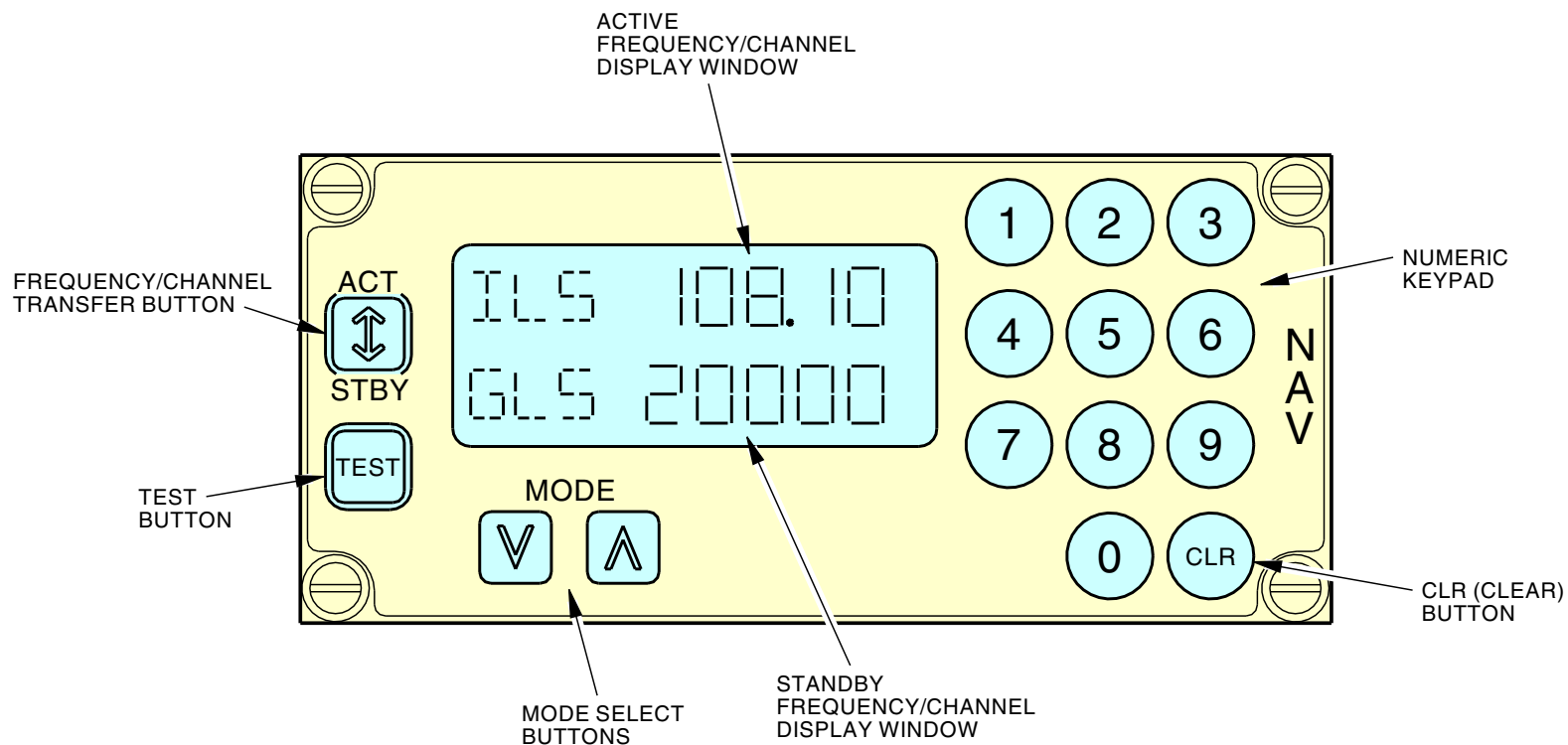
When you push the NAV control panel test switch, a test command goes out to the VOR/MB receiver, ILS receiver, GLS receiver, and DME interrogator. If a VOR frequency shows in the active frequency window, the test command goes to only the VOR/MB receiver. If an ILS frequency or GLS channel shows in the active frequency window, the control panel sends a test command to the ILS receiver or GLS receiver. If there is a DME frequency that is paired with the VOR or ILS frequency, a test command also goes to the DME interrogators.

NOTE: Ground Based Augmentation System (GBAS) must be available to run the GLS test.

When you do a test of the master dim and test system, the NAV control panel shows 888.88. The display shows for two seconds on, then one second off until the test is complete.

EFFECTIVITY	
SIA ALL	

VOR SYSTEM - NAVIGATION CONTROL PANEL



2533417 S0000599458_V1

VOR SYSTEM - NAVIGATION CONTROL PANEL

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VOR SYSTEM - FUNCTIONAL DESCRIPTION

General**SIA 006-999**

The aircraft has two Integrated Multi Mode Receivers (IMMRs). The IMMRS have VOR, Instrument Landing System (ILS), Marker Beacon (MB) and Global Positioning System (GPS) functions. This section covers only the VOR operation of the IMMRS.

SIA 001-005

The VOR system has two VOR receivers.

SIA ALLOperation**SIA 001-005**

Frequency tune inputs from the NCP go to an ARINC 429 receiver in the VOR system receiver, then to the processor. The processor sends the tune inputs to the frequency synthesizer to tune the receiver circuits.

SIA 006-999

Frequency tune inputs from the NCP go to the VOR system receiver integrated into the IMMR, then to the processor. The processor sends the tune inputs to the frequency synthesizer to tune the receiver circuits.

SIA ALL

The control panel sends a discrete to the REU when you tune a VOR frequency. The REU uses the discrete to select VOR audio inputs.

When you tune a VOR frequency, the control panel also sends a discrete to the DPCs. The DPCs use the discrete to display VOR or ILS as the frequency data source on the lower left corner of the captain and first officer NAV displays.

The processor sends fault data to the memory card. Only shop personnel can read the memory card contents.

The air/ground discrete input from the PSEU inhibits a VOR test when the airplane is in the air. The receiver also uses the discrete for flight leg count.

SIA 006-999

The RF signals from the VOR/LOC antenna go directly to the IMMRS. The IMMR circuits send audio and Morse code station identifier signals from the ground station to the audio processor.

SIA 001-005

RF input signals from the VOR/ILS antenna go through the power divider then to the receiver circuits in the VOR/MB receiver. The receiver circuits send audio and Morse code station identifier signals from the ground station to the audio processor.

SIA ALL

The audio processor sends the audio and Morse code station identifier signal to the audio output circuits then to the REU.

The Morse decoder circuit decodes the station identifier and puts it in digital format then sends it to the ARINC 429 transmitter. The display processing computers (DPC 1 & 2), use the data to show the station identifier.

The VOR system receiver circuits send the antenna inputs to the bearing processor which calculates the VOR station bearing. Data from the bearing processor goes to the ARINC 429 transmitter. The receiver transmits VOR bearing and receiver status on two output buses.

Output bus 1 goes to the onside FCC. Output bus 2 goes to these components:

- Digital flight data acquisition unit (DFDAU)
- Flight management computers (FMC)
- Display processing computers (DPC).

34-51-00**SIA ALL** EFFECTIVITY

D633AM102-SIA

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VOR SYSTEM - FUNCTIONAL DESCRIPTION

Test

SIA 006-999

When you push the test switch on the NAV control panel, a test command goes to the IMMR when a VOR frequency is the active frequency. When the processor receives a test command, it monitors the VOR and MB receivers operation and control input status. There is a test switch in the front panel of the IMMRs. Test results using this switch will show on the three status LEDs on the front panel of the IMMR.

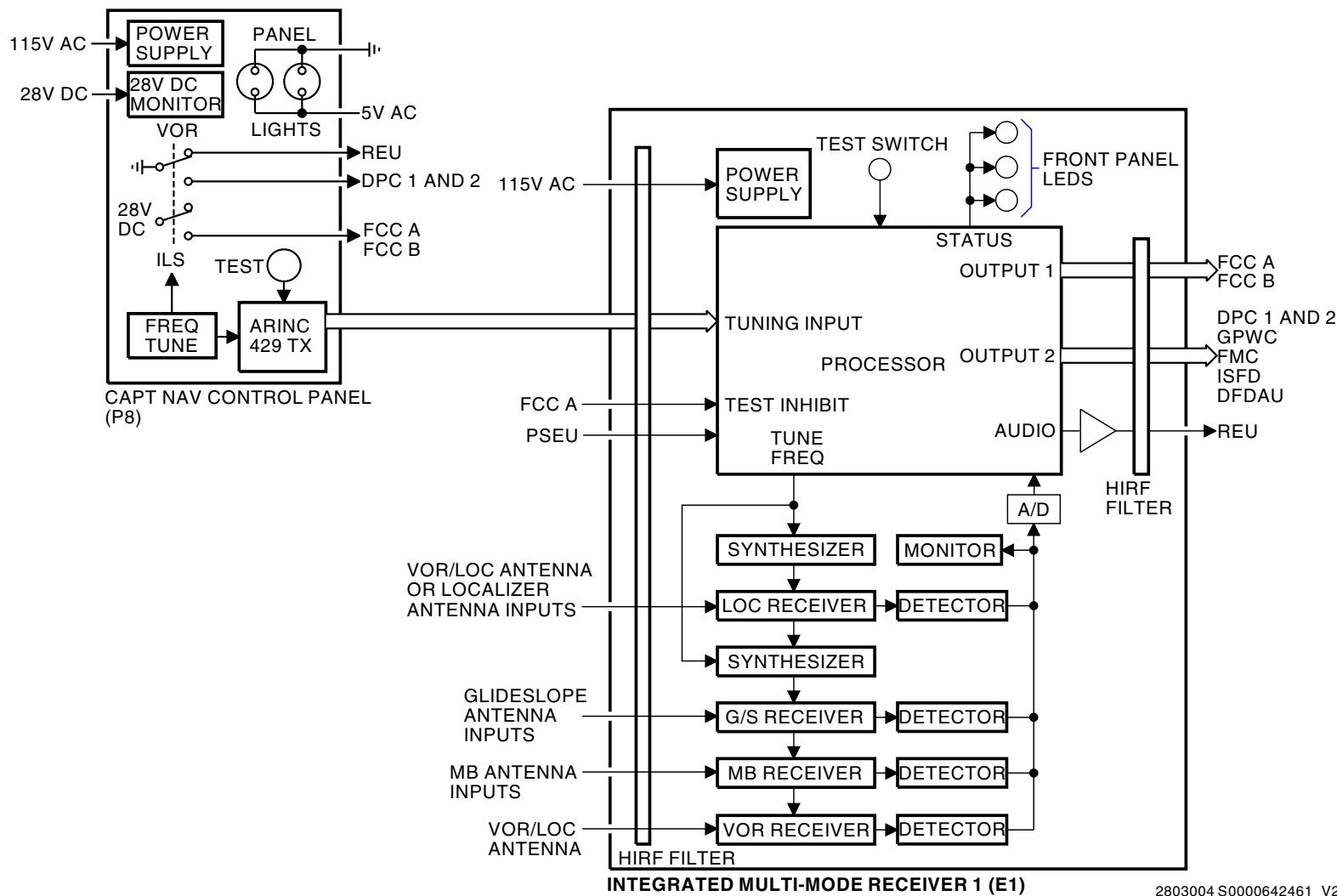
SIA 001-005

When you push the test switch on the NAV control panel, a test command goes to the receiver when a VOR frequency is the active frequency. When the processor receives a test command, it monitors the VOR/MB receiver operation and control input status. Test results show on the two status LEDs when you do a test from the front panel switches.

SIA ALL

SIA ALL	EFFECTIVITY

VOR SYSTEM - FUNCTIONAL DESCRIPTION

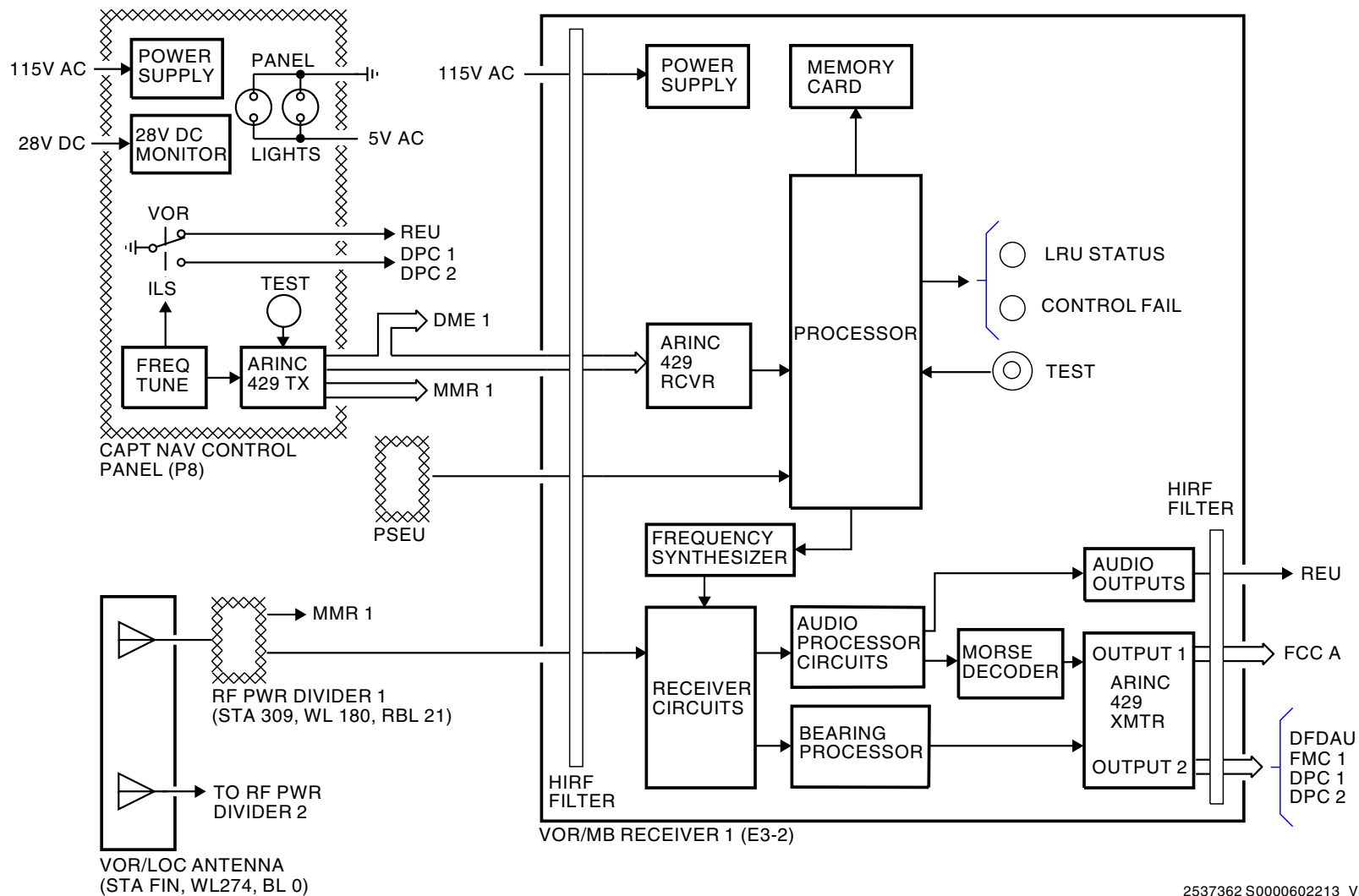


2803004 S0000642461_V2

VOR SYSTEM - FUNCTIONAL DESCRIPTION

34-51-00

VOR SYSTEM - FUNCTIONAL DESCRIPTION



2537362 S0000602213_V3

VOR SYSTEM - FUNCTIONAL DESCRIPTION

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VOR SYSTEM - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

Frequency Transfer Switch

The frequency transfer switch on the NAV control panel transfers the frequency in the standby window display, to the active window display.

The transfer switch also provides a discrete to the FCCs. The FCCs use the discrete to disengage the autopilot when the autopilot system is in the VOR mode and the crew changes the VOR frequency.

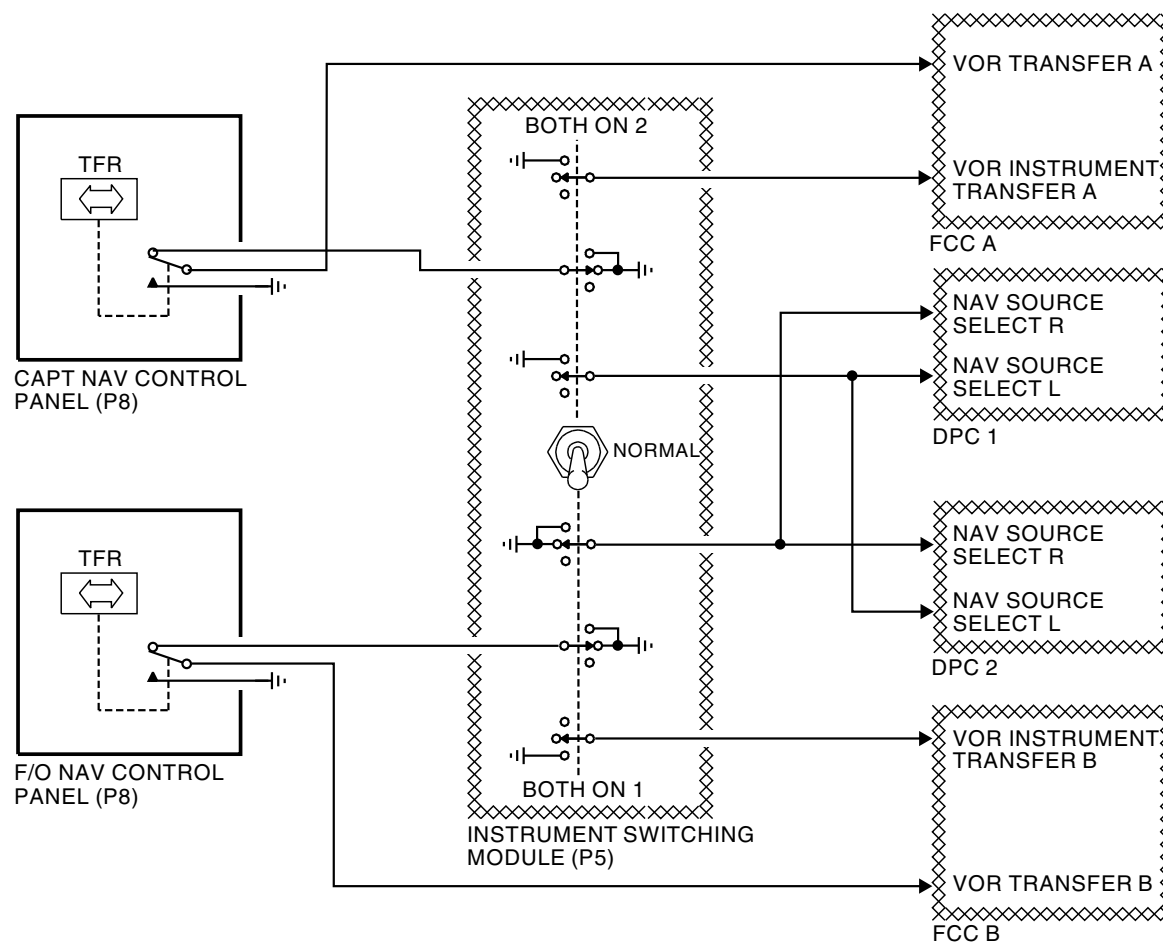
Instrument Switching Module

The instrument switching module on the P5 overhead panel provides discretes to the display processing computer (DPC) for display switching when you move the switch to the both on 1 or both on 2 position.

With the switch in the both on 1 position, the DPCs use VOR data from VOR system receiver 1 for display. With the switch in the both on 2 position the DPCs use VOR data from receiver 2 for display.

The instrument switching module also sends discretes to the FCC when you move the switch out of the normal position.

VOR SYSTEM - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING



2370039 S00061520852_V2

VOR SYSTEM - FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

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34-51-00



VOR SYSTEM - CONTROLS

EFIS Controls

To show VOR displays on the captain's and F/O's secondary EFIS display, set the mode selector on the EFIS control panel to the VOR position.

VOR data shows when the mode selector is in the VOR position and a valid VOR frequency is active on the navigation control panels (NCPs).

The VOR/ADF switches make the NAV display bearing pointers show either VOR or ADF station bearing. In the OFF position, the bearing pointers go out of view.

DFCS Controls

The digital flight control system (DFCS) mode control panel (MCP) supplies course data to the display processing computers (DPCs) for VOR displays. You use the DFCS MCP course select control to enter a course for the VOR station.

The DPC uses the course input and VOR bearing data from the VOR/MB receiver to calculate the airplane deviation from the VOR course.

Audio Control Panel Controls

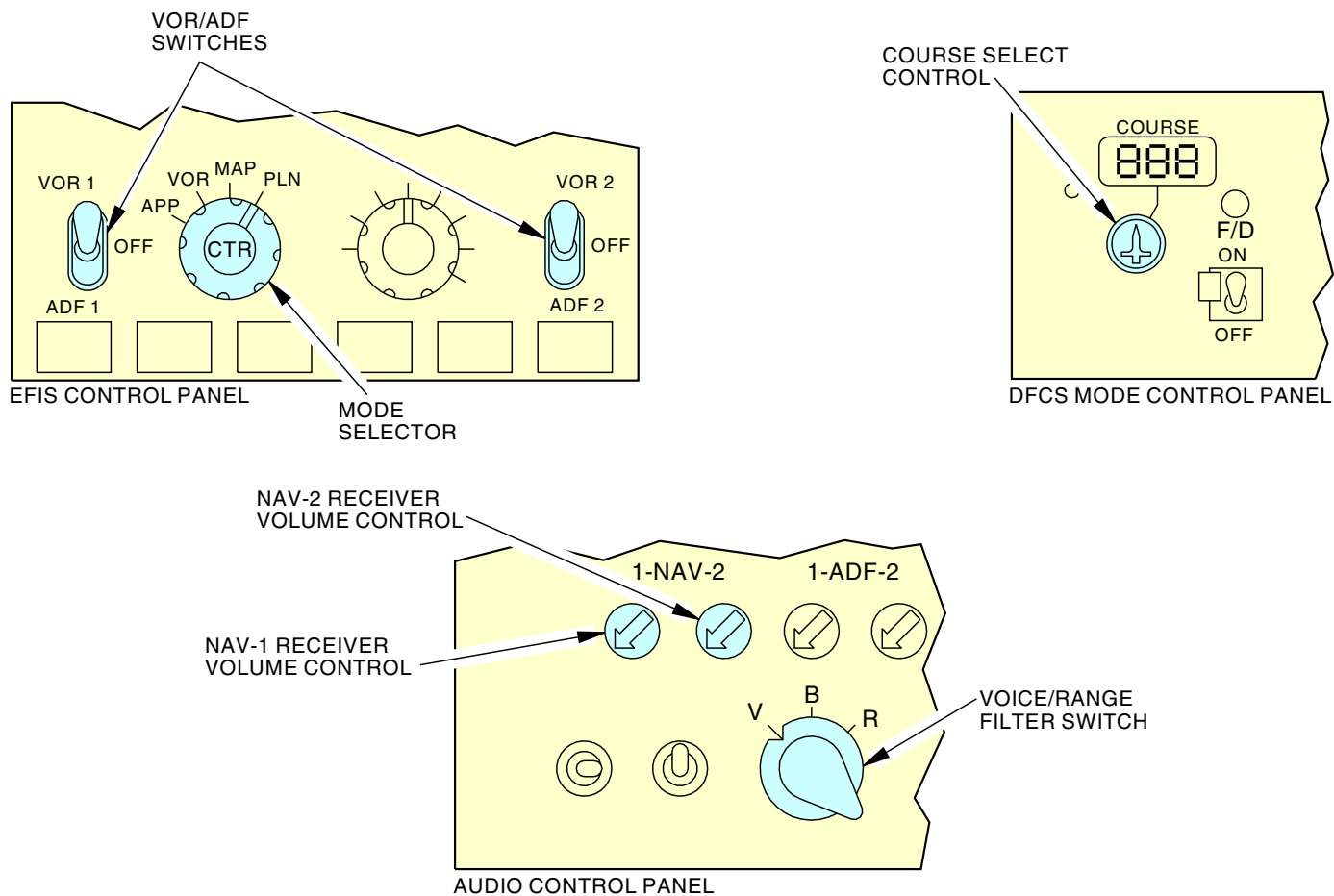
The audio control panels (ACP) permit the crew to listen to VOR station audio or the Morse code station identifier.

You use the ACP volume control switches to select the VOR/MB system you want to listen to. The NAV 1 volume control selects the VOR/MB receiver 1 audio and the NAV 2 volume control selects VOR/MB receiver 2 audio.

The voice/range selector permits you to listen to only voice audio in the voice (V) position. The range (R) position permits you to listen to the station Morse code identifier. With the selector in the both (B) position, you can listen to both the voice audio and the Morse code station identifier.

EFFECTIVITY	
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VOR SYSTEM - CONTROLS



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VOR SYSTEM - CONTROLS

34-51-00



VOR SYSTEM - NORMAL DISPLAYS

General

VOR data shows on the captain and first officer navigation displays. To show VOR displays, you must select the VOR mode on the EFIS control panels and enter a valid VOR frequency on the NCPs.

Bearing Pointers

Bearing pointers 1 and 2 show in green around the edge of the compass rose when you set the VOR/ADF switches on the EFIS control panels to the VOR position. There is a pointer head and tail for both bearing pointers. The bearing pointers show on the expanded displays if the VOR bearing is in the compass rose display limit. The bearing pointers can show VOR data in the APP, VOR, and MAP modes.

The DPCs remove the bearing pointers when the VOR bearing from the VOR system receivers is NCD. The DPCs also remove the bearing pointers when you set the VOR/ADF selector switches on the EFIS control panels to OFF.

The NAV data source shows in green at the bottom left and right corners of the display for bearing pointers 1 or 2. The display also shows the frequency or identifier for the active station.

Deviation Bar and Scale

The VOR deviation bar shows in magenta. The DPCs use VOR bearing from the VOR system receivers and course inputs from the DFCS mode control panel to calculate VOR deviation.

The scale is the standard four dot scale. One dot equals five degrees of deviation.

The DPCs remove the deviation bar for NCD deviation inputs from the VOR system receivers.

Selected Course Pointer

The course select control on the DFCS mode control panel sets the position of the selected course pointer.

TO/FROM Pointer and Indicator

The TO/FROM pointer is a small white triangle that shows as part of the selected course pointer. The TO/FROM pointer shows on the centered VOR display only.

The TO/FROM indicator shows at the bottom right corner of both the centered and expanded VOR displays. The DPCs use VOR bearing from the VOR system receivers and course inputs from the DFCS MCP to calculate TO/FROM pointer and indicator displays.

The TO indication shows when you enter a course on the DFCS MCP that takes you to the VOR station. The FROM indication shows when you enter a course that takes you away from the VOR station.

The DPCs remove the TO/FROM pointer and indicators for NCD and invalid displays.

NAV Data Source

The DPCs show the source of the data for the ND display in the upper right corner. The normal source for the captain NAV display is the VOR system receiver 1 and the normal source for the first officer is the receiver 2.

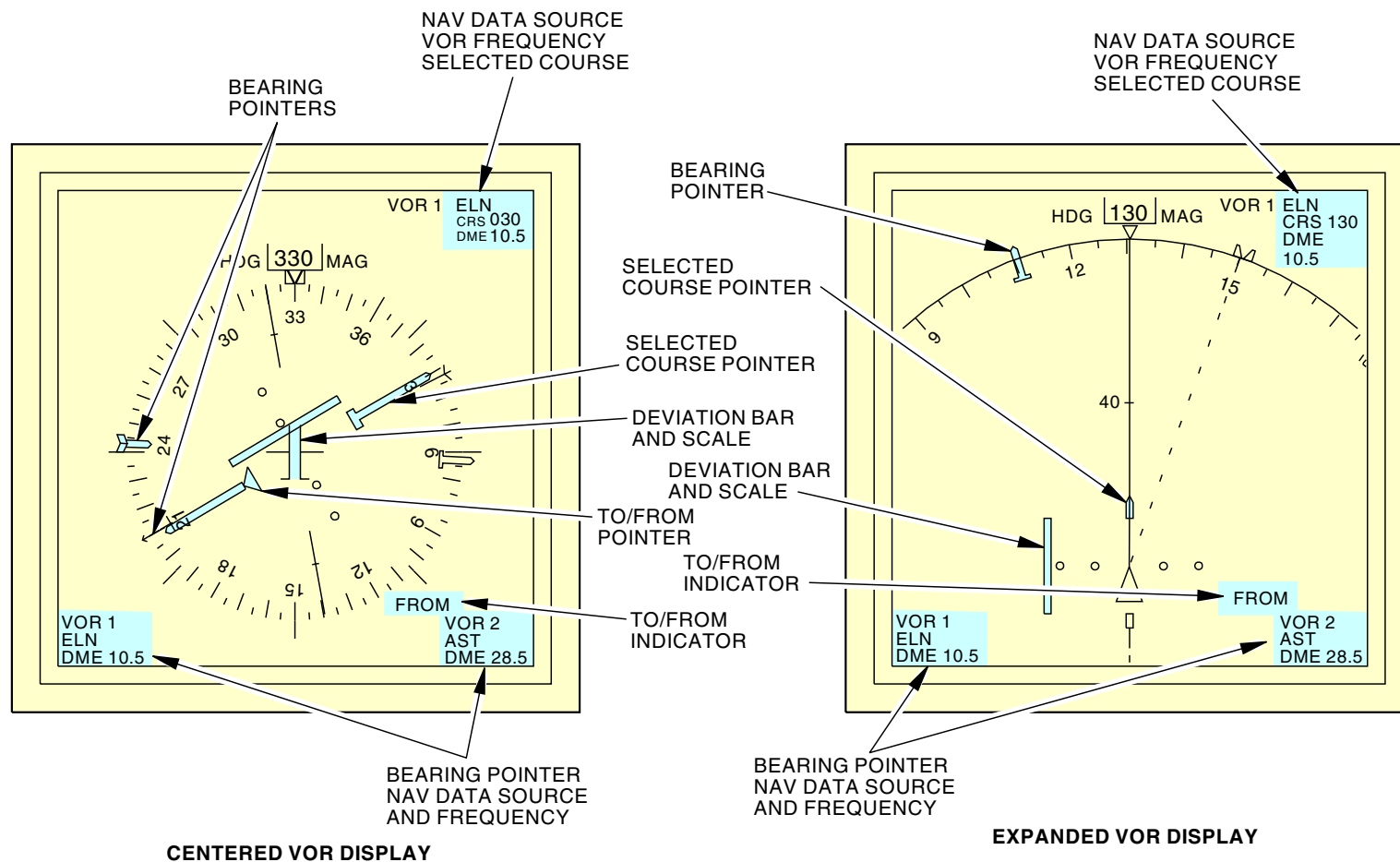
VOR Frequency

The VOR frequency shows in the upper right next to the NAV data source. The frequency from the NAV control panel goes through the VOR system receivers, then to the DPCs for display. The frequency shows in green. IF the VOR receiver gets a valid station identifier from the VOR station, the station identifier replaces the VOR frequency.

The DPCs change the VOR frequency to dashes for NCD inputs from the VOR system receivers.

EFFECTIVITY	
SIA ALL	

VOR SYSTEM - NORMAL DISPLAYS



2370042 S00061520858_V2

VOR SYSTEM - NORMAL DISPLAYS

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VOR SYSTEM - INVALID DISPLAYS

Invalid Display

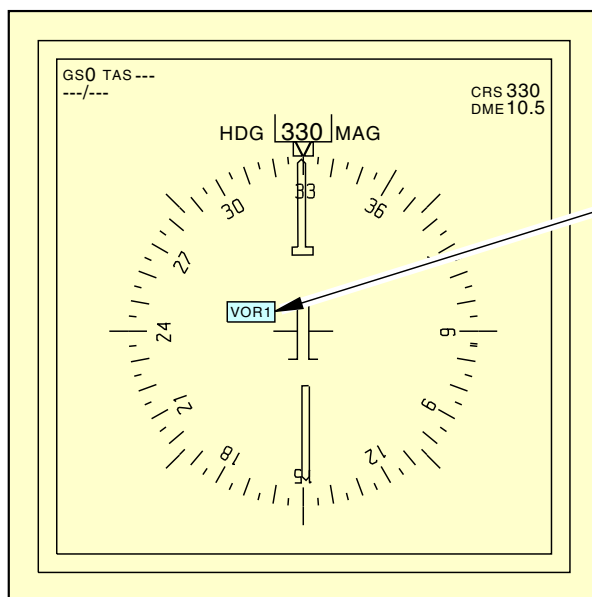
The DPCs remove these displays for invalid VOR system receiver inputs:

- Deviation bar and scale
- TO/FROM pointer and indicator
- VOR frequency
- NAV data source
- Bearing pointers.

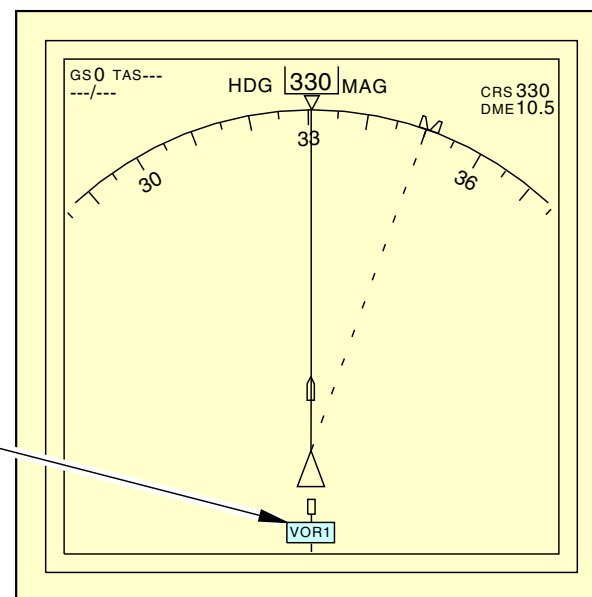
The DPCs show the amber VOR flags on both the centered and expanded VOR displays for VOR system receiver failures.

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	D633AM102-SIA

VOR SYSTEM - INVALID DISPLAYS



CENTERED VOR DISPLAY



EXPANDED VOR DISPLAY

VOR SYSTEM - INVALID DISPLAYS

2370043 S00061520860_V2



VOR SYSTEM - FRONT PANEL BITE

SIA 001-005

Test

Push the test switch on the front panel to start a test of the VOR receiver. The test results show on the light emitting diode (LED) status indicators. There are two status LEDs. The line replaceable unit (LRU) status LED can be red or green. The control fail LED is only red.

When you push the test switch, the receiver does a check of the internal receiver operation and its interface with the NAV control panel. The test takes 42 seconds.

This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU status and the control fail LEDs are red
- 2 to 4 seconds - the LRU status LED is green and the control fail LED is red
- 4 to 12 seconds - the LRU status and the control fail LEDs go off
- 12 to 42 seconds - test status shows.

The LRU status LED indicator shows green for an LRU test pass condition or red for an LRU test fail condition. The control fail LED shows red if there is no tuning input from the NAV control panel or if the signal is invalid.

SIA 006-999

Test

Push the test switch on the front panel to start a test of the IMMR. The test results show on the light emitting diode (LED) status indicators. There are three status LEDs. The line replaceable unit (LRU) status LED can be red or green. The control fail and antenna fail LEDs are only red.

When you push the test switch, the receiver does a check of the IMMR operation and its interface with the NAV control panel. The test takes 42 seconds.

This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, and the CTRL FAIL LEDs are red
- 2 to 4 seconds - the LRU status LED is green and the control fail and antenna LEDs are red
- 4 to 12 seconds - the LRU status, the control fail and antenna LEDs go off
- 12 to 42 seconds - test status shows.

The LRU STATUS LED indicator shows green for an LRU test pass condition or red for an LRU test fail condition. The CTRL FAIL LED shows red if there is no tuning input from the NAV control panel or if the signal is invalid. The ANT FAIL LED shows red if there is failure in the antenna system.

SIA ALL

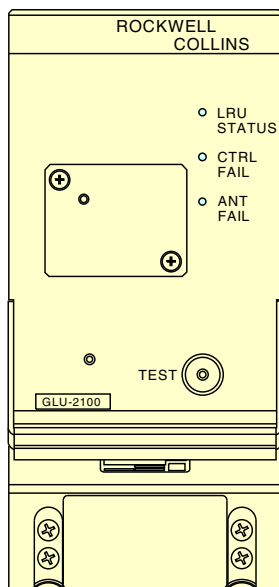
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SIA ALL EFFECTIVITY

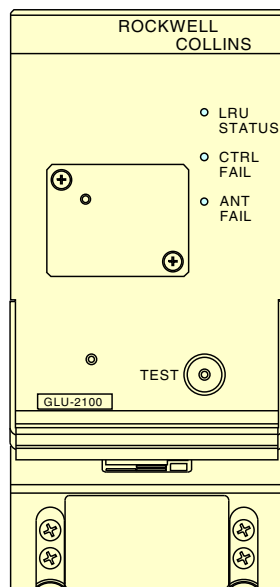
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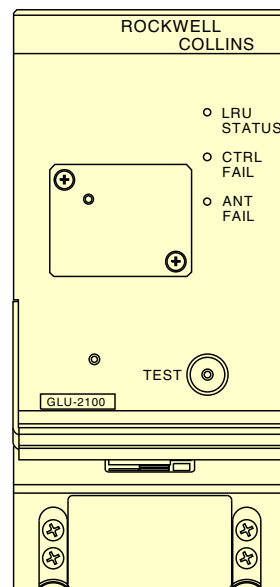
VOR SYSTEM - FRONT PANEL BITE



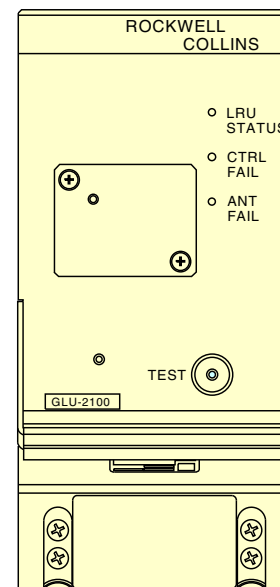
0-2 SECONDS
THE LRU STATUS, CONTROL
FAIL AND ANT FAIL LEDS ON
RED.



2-4 SECONDS
THE LRU STATUS IS GREEN,
CONTROL FAIL AND ANT FAIL
ARE RED.



4-16 SECONDS
ALL LEDS OFF.

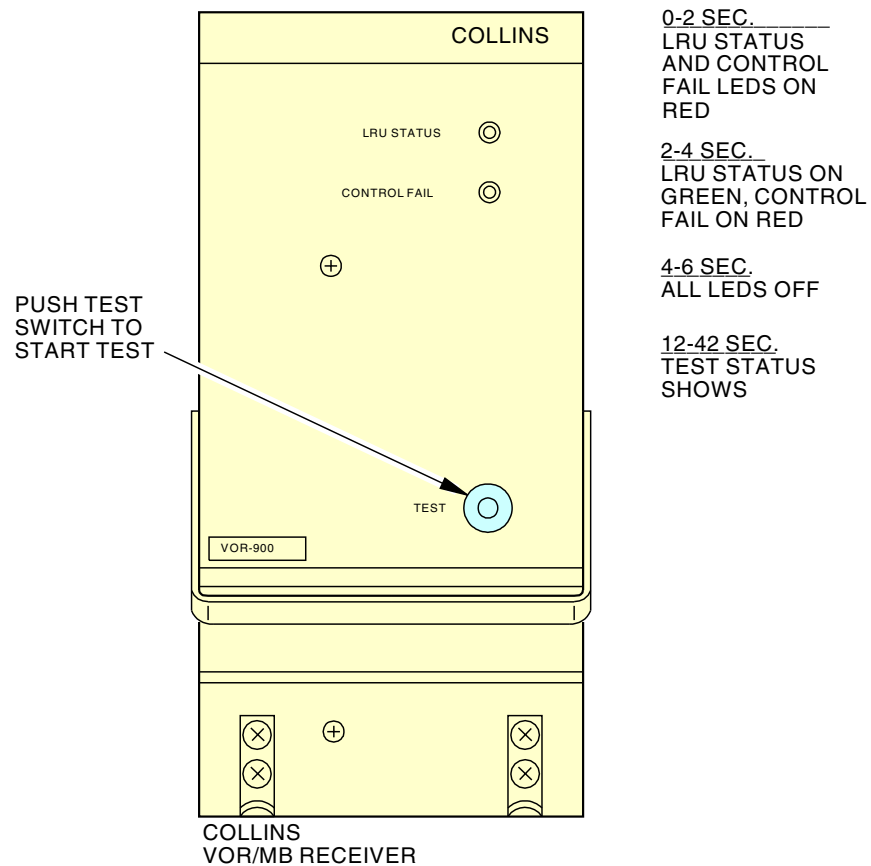


16-44 SECONDS
THE TEST STATUS SHOWS.

2801320 S0000641918_V1

MMR VOR SYSTEM - FRONT PANEL BITE

VOR SYSTEM - FRONT PANEL BITE



2550945 S0000607102_V1

VOR SYSTEM - FRONT PANEL BITE

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**VOR SYSTEM - SELF TEST****Test**

You can do a test of the VOR system from the flight compartment with the navigation control panels (NCPs). The captain's NCP does a test of receiver 1 and the first officer's NCP does a test of receiver 2.

You need to set these controls to do a test of the VOR system receivers:

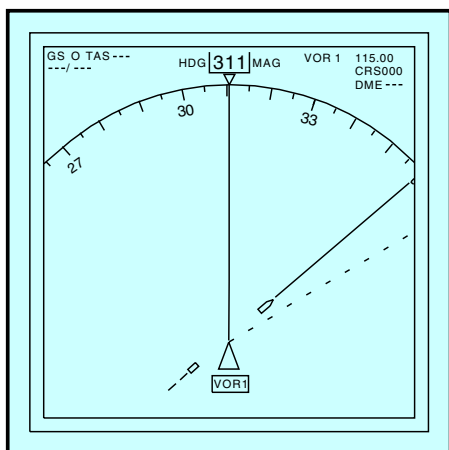
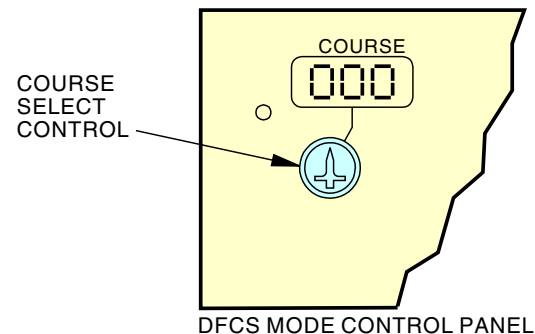
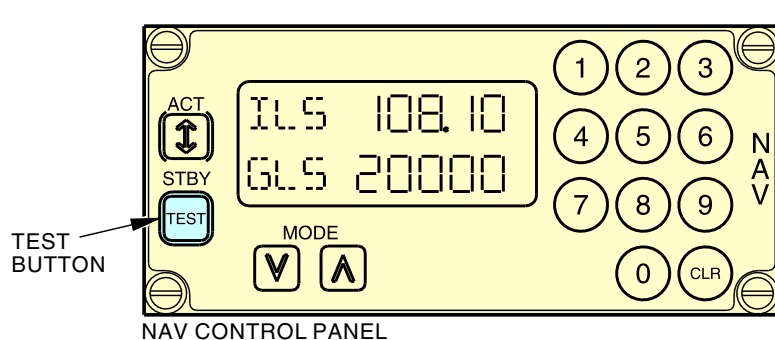
- Enter a valid VOR frequency into the active frequency display window on the NCP
- Set a selected course of 000 on the DFCS mode control panel
- Set the mode selector on the EFIS control panel to the VOR position
- Push the test switch on the NCP.

This is the flight compartment display sequence that shows during the VOR test:

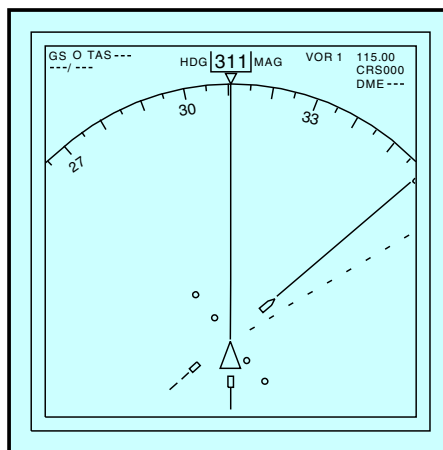
- Invalid display (VOR flag)
- NCD display (deviation bar out of view)
- Test display (deviation bar centered).

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	D633AM102-SIA

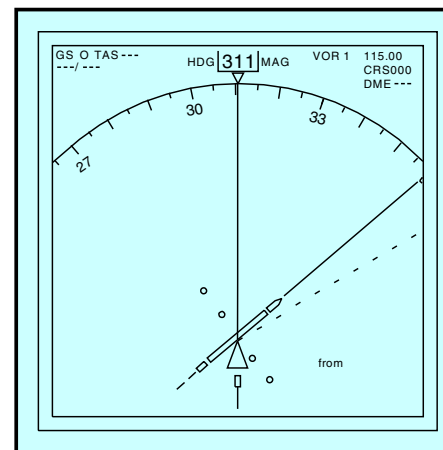
VOR SYSTEM - SELF TEST



INVALID DISPLAY



NCD DISPLAY



TEST DISPLAY

2533438 S0000599469_V1

VOR SYSTEM - SELF TEST

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34-51-00-017

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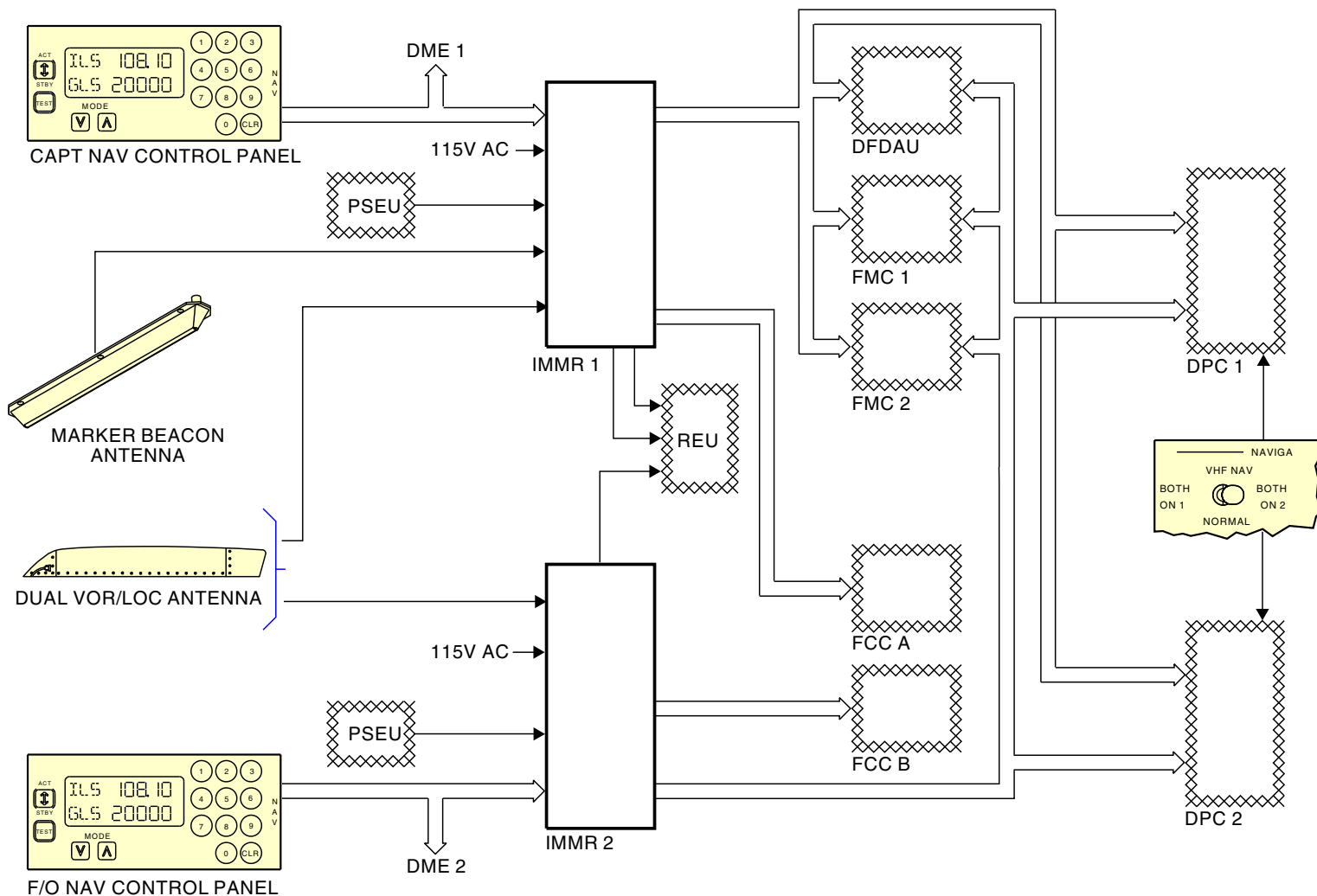
VOR SYSTEM - SYSTEM SUMMARY

General

This page is for reference.

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	D633AM102-SIA

VOR SYSTEM - SYSTEM SUMMARY

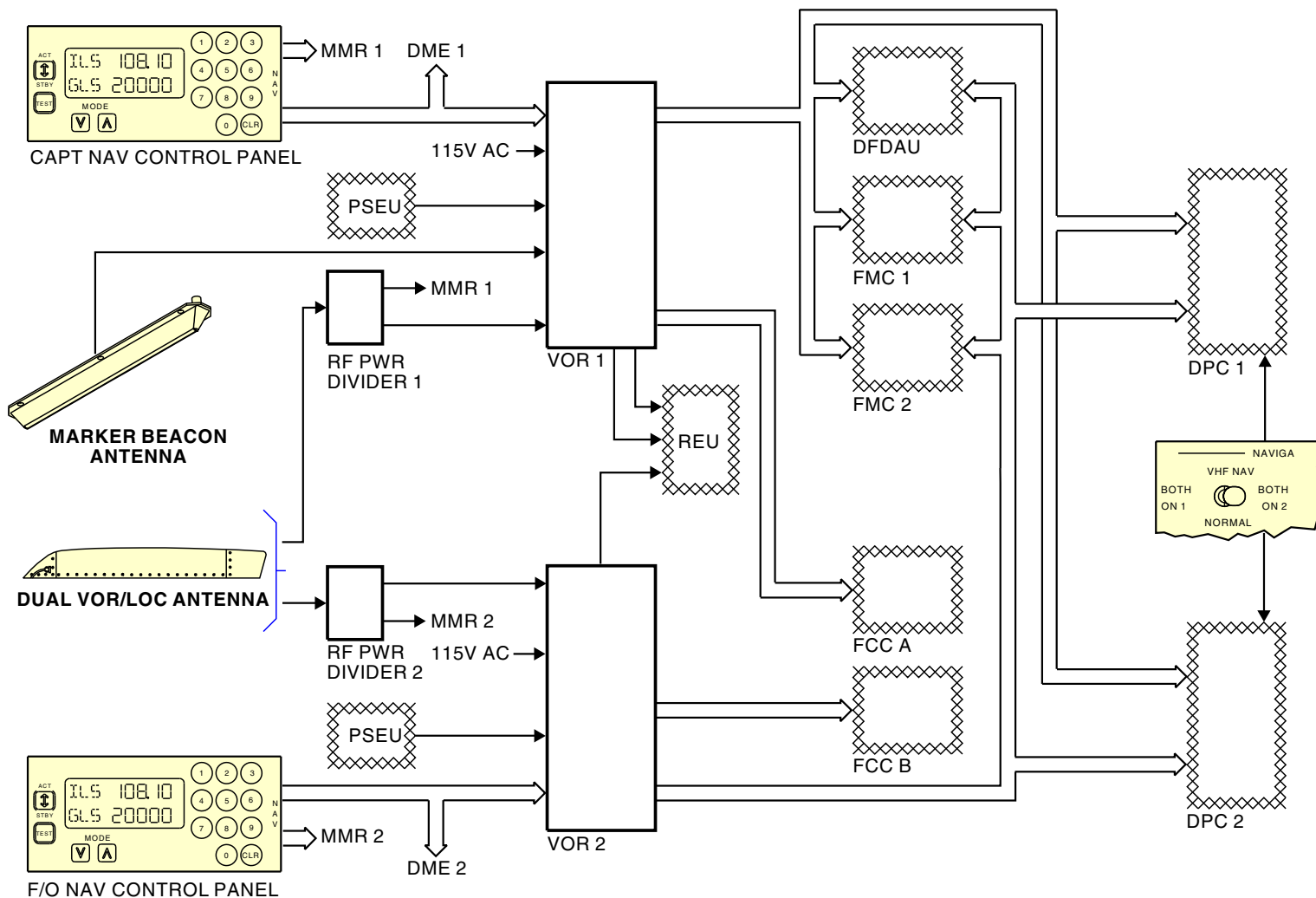


2550947 S0000607105_V2

VOR SYSTEM - SYSTEM SUMMARY

34-51-00

VOR SYSTEM - SYSTEM SUMMARY



2537364 S0000602215_V3

VOR SYSTEM - SYSTEM SUMMARY

34-51-00



AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION

General

The Air Traffic Control (ATC) ground stations interrogate the airborne ATC system. The ATC transponder replies to the interrogations in the form of coded information that the ground station uses.

The ATC transponder also replies to Mode S interrogations from the Traffic Alert and Collision Avoidance System (TCAS) of other airplanes or ground stations.

When a ground station or a TCAS computer from another airplane interrogates the ATC system, the transponder transmits a pulse-coded reply signal. The reply signal identifies and shows the altitude of the airplane.

- Maximum airspeed
- TCAS coordinating signals
- TCAS status
- Altitude
- Mode A identity code
- Twenty-four bit address

Abbreviations and Acronymns

- abs - absolute
- abv - above
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- AD - air data
- ADR - air data reference
- alt - altitude
- amp - amplifier
- ant - antenna
- ATC - air traffic control
- ATCRBS - air traffic control radar beacon system
- BITE - built-in test equipment

- blw - below
- bot - bottom
- coax - coaxial
- cntl - control
- CPU - central processing unit
- DME - distance measuring equipment
- ELEX - electrical
- FL - flight level
- gnd - ground
- ID - identification
- I/O - input/output
- ident - identification
- INS - instrument
- INT - interrogator
- LED - light emitting diode
- MAX - maximum
- MHz - mega hertz
- N - normal
- NC - not connected
- norm - normal
- pnl - panel
- PSR - primary surveillance radar
- RA - resolution advisory
- REL - relative
- RF - radio frequency
- rptg - reporting
- RX - receive
- SDI - source destination identifier
- sig - signal
- SLS - side lobe suppression

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SIA ALL EFFECTIVITY

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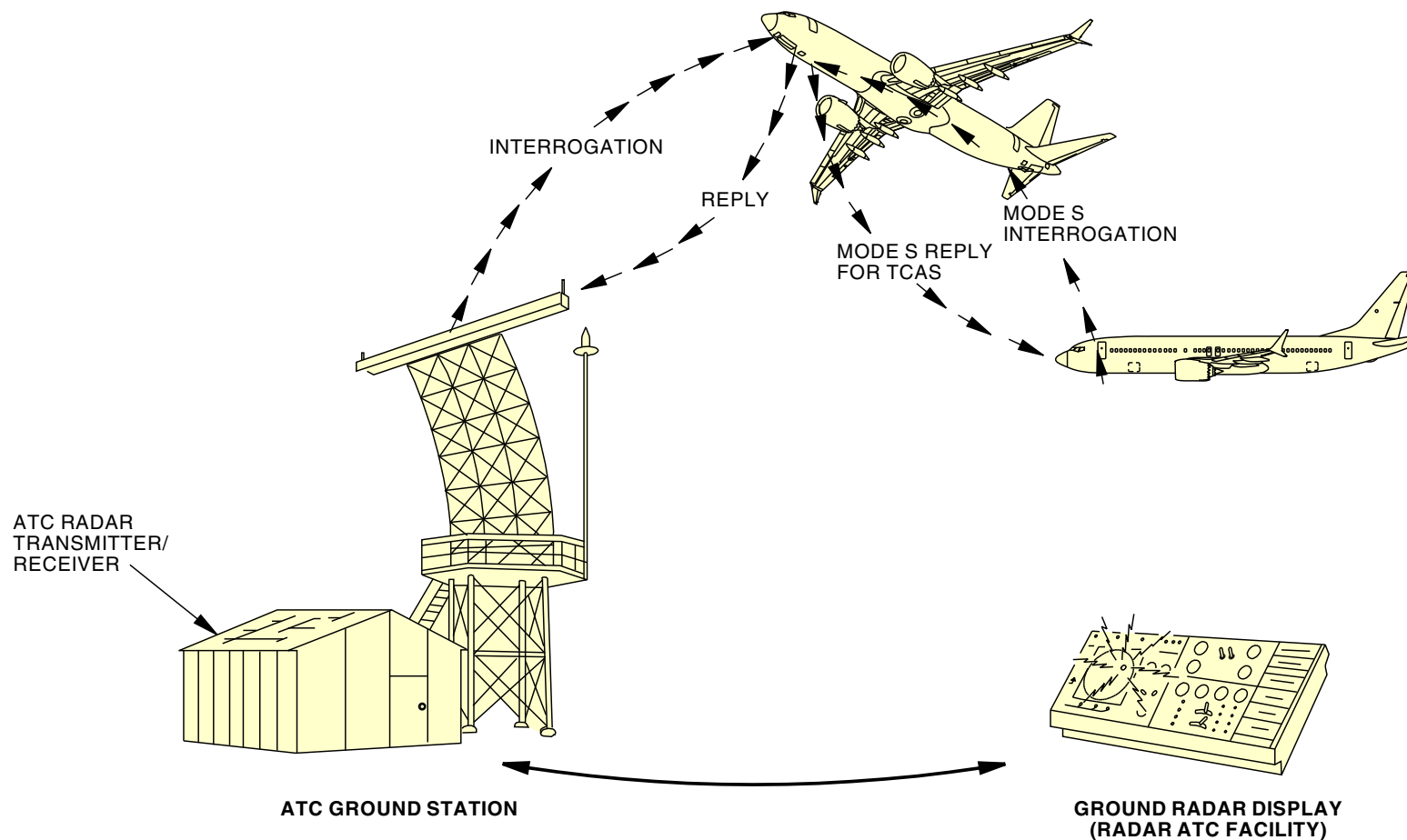
ECCN 9E991 BOEING PROPRIETARY - See title page for details



AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION

- SSR - secondary surveillance radar
- SPI - special purpose identification
- stby - standby
- sw - switch
- TA - traffic advisory
- TAS - true air speed
- TCAS - traffic alert and collision avoidance system
- tpr - transponder
- TX - transmit
- XFR - transfer
- xmtr - transmitter
- xpdr - transponder
- xpndr - transponder

AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION



2370047 S00061520870_V1

AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION

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EFFECTIVITY

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**ATC SYSTEM - GENERAL DESCRIPTION****General Description**

These are the components of the Air Traffic Control (ATC) system:

- Top antenna
- Bottom antenna
- ATC coaxial switch (2)
- ATC/TCAS control panel
- ATC transponder (2).

The two antennas transmit signals from the ATC transponder and send received signals to the ATC transponder. These signals go through the ATC coax switches.

The ATC/TCAS control panel sends identification and control data to the transponders. The ATC/TCAS control panel also allows selection of either transponder 1 or transponder 2.

The Air Data Inertial Reference Unit (ADIRU) supply barometric altitude data to the ATC transponders.

The ATC transponders receive selected altitude from the digital flight control system Mode Control Panel (MCP), Global Positioning System (GPS) position from the Multimode Receiver (MMR), and flight number ID data from the Flight Management Computer (FMC).

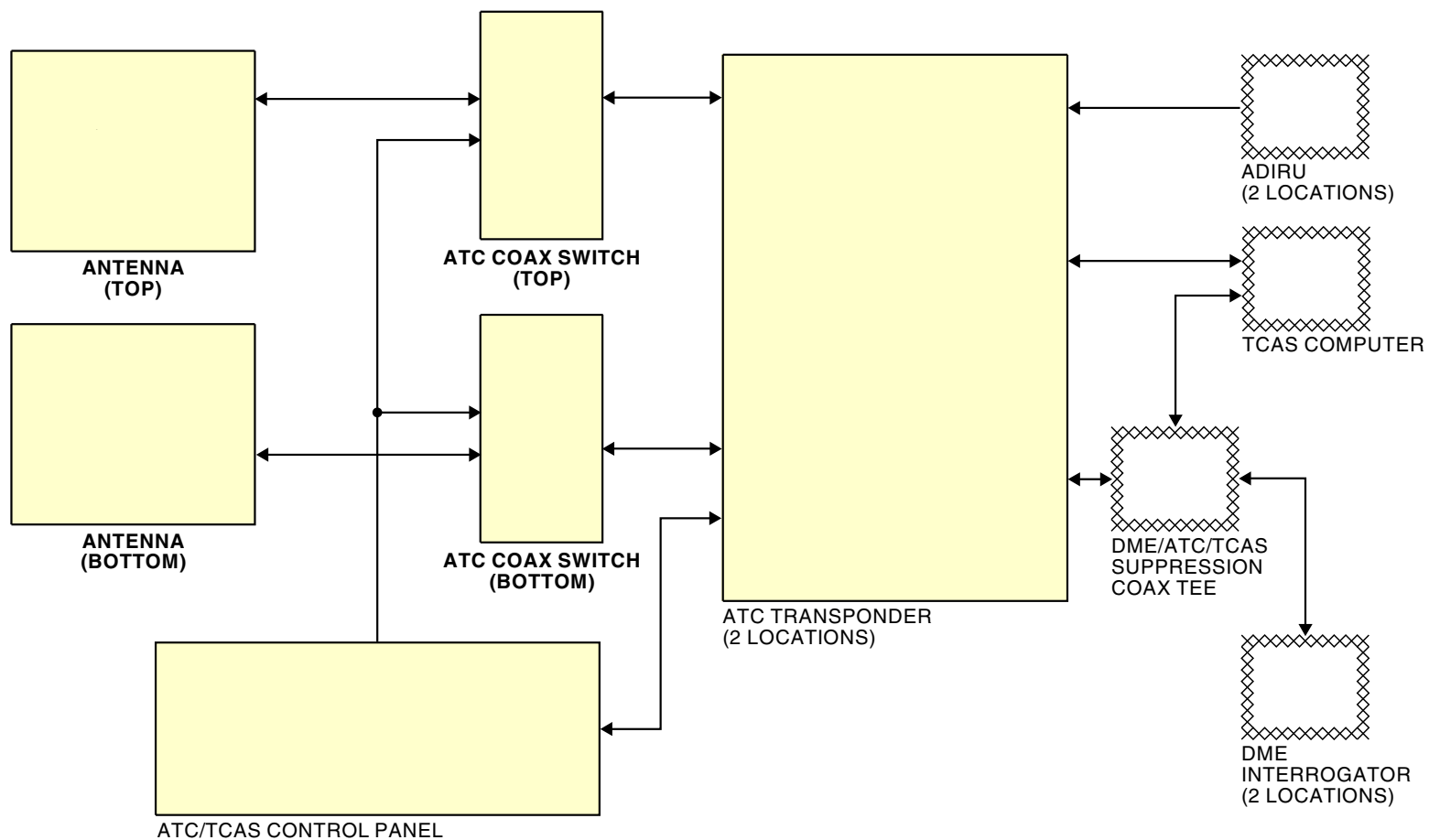
The ATC transponders interface with the Traffic Alert and Collision Avoidance System (TCAS).

The ATC transponders send and receive suppression pulses through the suppression coax tees. This prevents ATC transmissions from interfering with the Distance Measuring Equipment (DME) and TCAS system operations.

ADS-B is a surveillance system that uses a global navigation satellite system, aircraft avionics, and ground infrastructure to accurately and quickly transmit flight information, such as speed, heading, current position, aircraft identification, altitude and velocity. This information is then broadcast to the air traffic control centers in real time.

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ATC SYSTEM - GENERAL DESCRIPTION



2585584 S0000623929_V1

ATC SYSTEM - GENERAL DESCRIPTION

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	D633AM102-SIA

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**ATC SYSTEM - COMPONENT LOCATION****Flight Compartment**

The ATC/TCAS control panel is on the P8 aft electronics panel.

Electronic Equipment Compartment

These are the Air Traffic Control (ATC) transponder system components in the electronic equipment compartment:

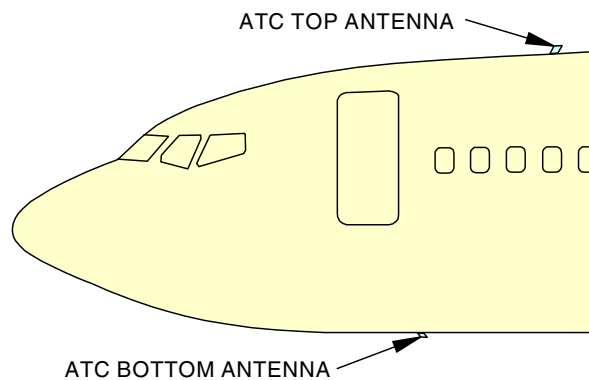
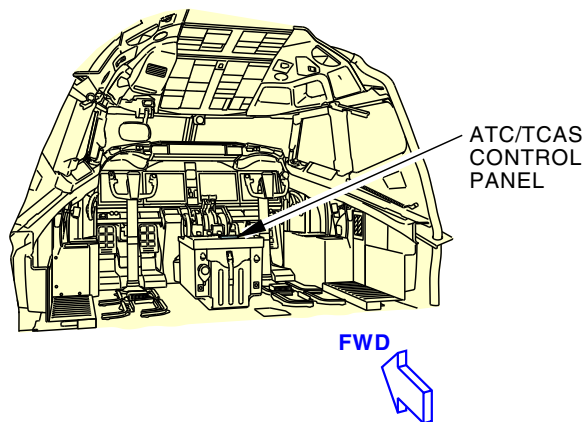
- ATC transponder 1
- ATC transponder 2
- Program switch module (2)
- Top ATC coax switch
- Bottom ATC coax switch

ATC Antenna Location

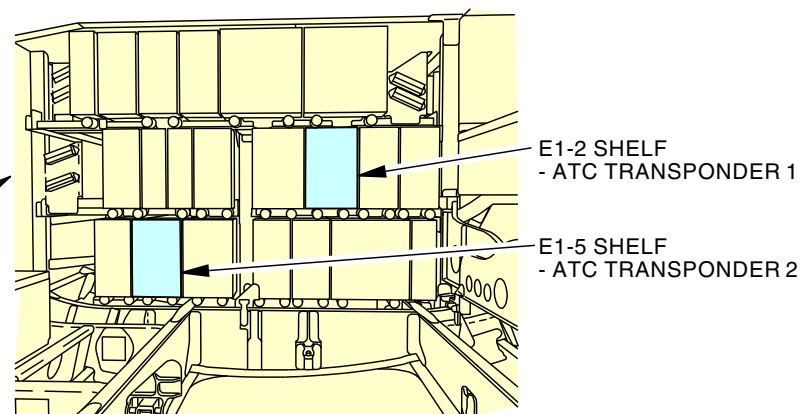
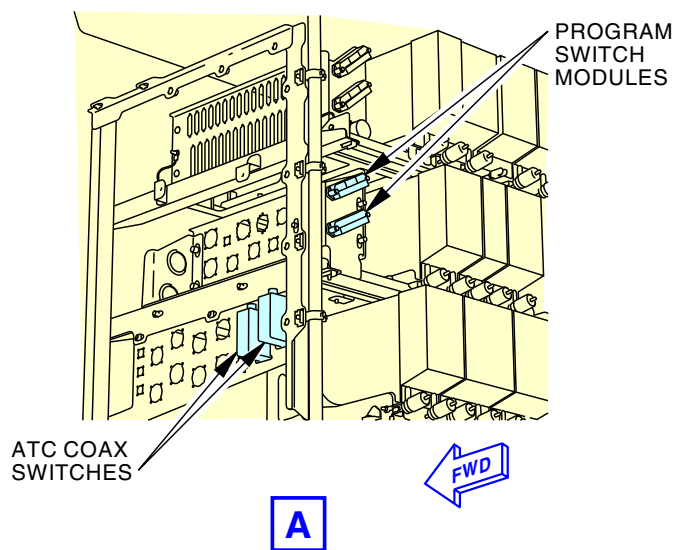
The ATC antennas are on the forward fuselage near the centerline. The top ATC antenna is at STA 430.25. The bottom ATC antenna is at STA 355.

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	D633AM102-SIA

ATC SYSTEM - COMPONENT LOCATION



ATC ANTENNA LOCATION



ELECTRONIC EQUIPMENT COMPARTMENT (VIEW IN THE FORWARD DIRECTION)

ATC SYSTEM - COMPONENT LOCATION

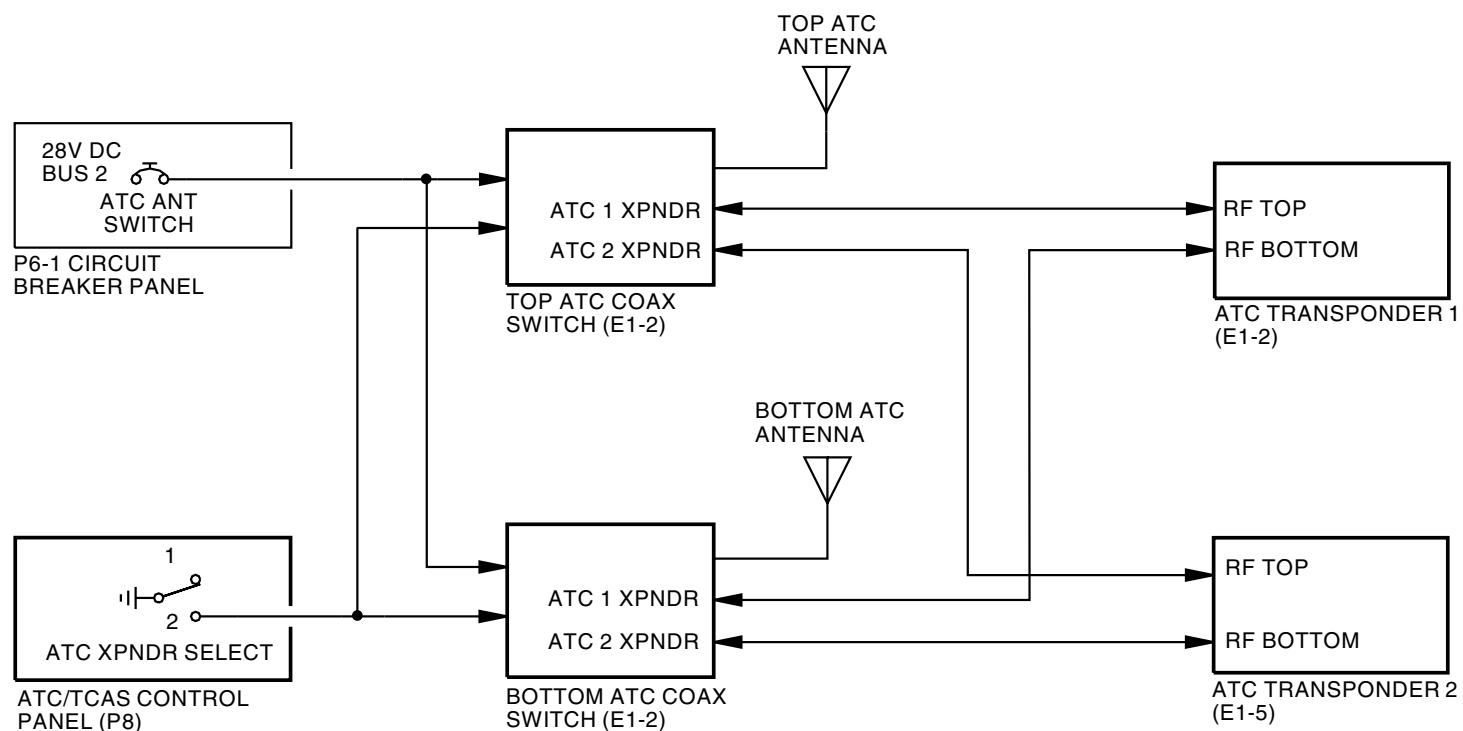
2370049 S00061520874_V2

**ATC SYSTEM - ANTENNA INTERFACE****General**

The Air Traffic Control (ATC) coax switches get power through the ATC ANT SWITCH circuit breaker. When you select ATC transponder 1 on the ATC/TCAS control panel, the ATC coax switches do not energize and the antennas connect to ATC transponder 1. When you select ATC transponder 2, the ATC/TCAS control panel sends a discrete ground to the ATC coax switches. This energizes the coax switches and connects the top and bottom antennas to ATC transponder 2.

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ATC SYSTEM - ANTENNA INTERFACE



2370050 S00061520876_V1

ATC SYSTEM - ANTENNA INTERFACE

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SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ATC SYSTEM - POWER, IDENTITY, CONTROL, AND AIR DATA INTERFACES****Power**

Air Traffic Control (ATC) transponder 1 gets 115V AC power from standby bus 1. ATC transponder 2 gets 115V AC power from transfer (xfr) bus 2. The ATC/TCAS control panel gets 115V AC power from both standby bus 1 and xfr bus 2.

Standby/On Discrete

The ATC/TCAS control panel sends a ground standby discrete to the transponder that is not in use.

Identity Code

The flight crew sets the four digit identity code and it shows on the ATC/TCAS control panel. Both transponders get the identity code from the ATC/TCAS control panel.

Control Data

The ATC/TCAS control panel also sends control data to the transponders. This control data does these functions:

- Permits Mode C and Mode S operation.
- Lets the transponder send the special position identification (SPI) pulse or airplane identification code.

Air Data

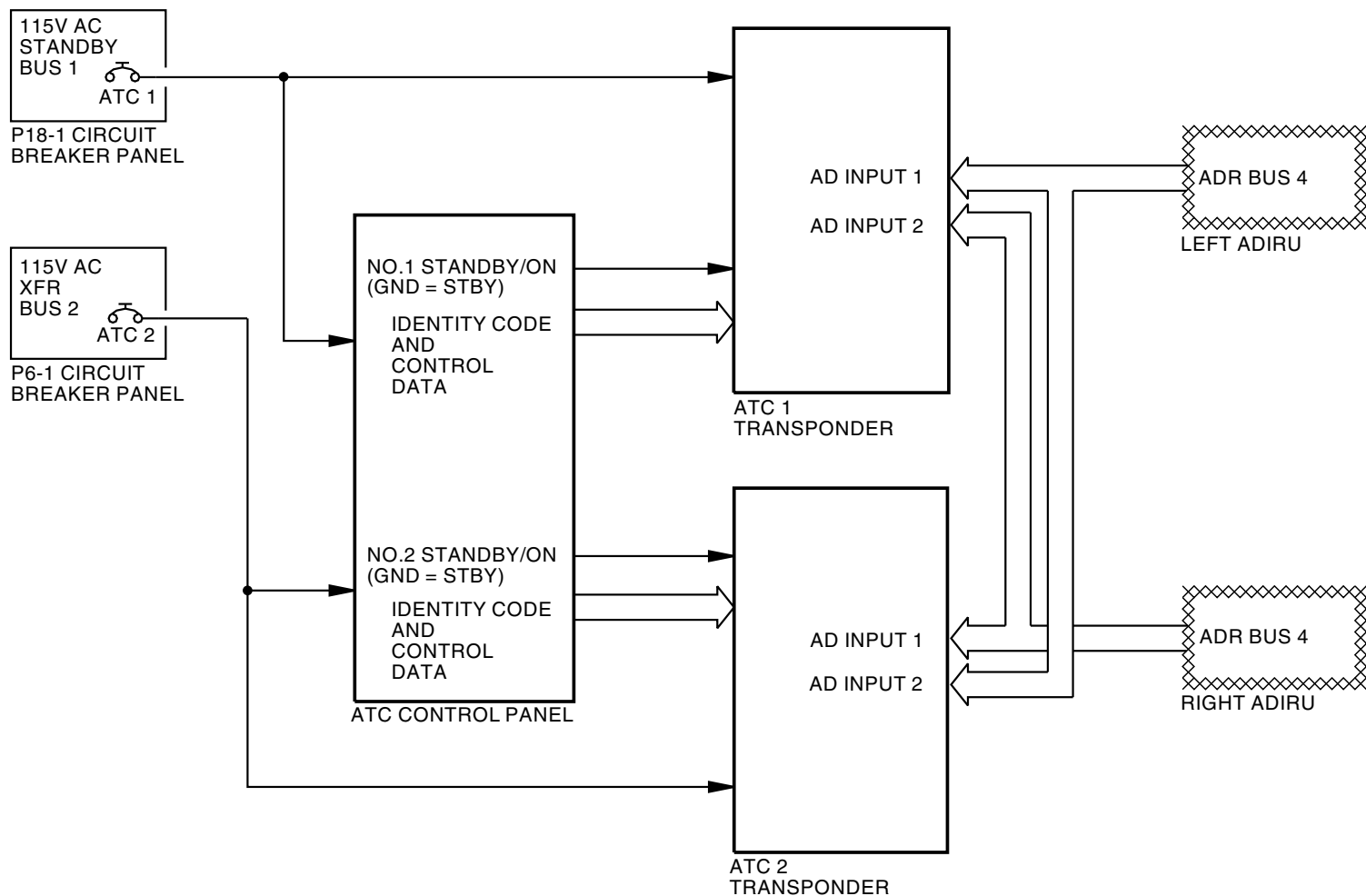
The Air Data Inertial Reference Unit (ADIRU) send air data to the ATC transponders.

ATC transponder 1 gets air data at AD input 1 from the left ADIRU air data reference (ADR) bus 4. The left ADIRU also supplies air data to the ATC 2 transponder from ADR bus 4.

ATC transponder 2 gets air data at AD input 1 from the right ADIRU air data reference (ADR) bus 4. The right ADIRU also supplies air data to the ATC 1 transponder from ADR bus 4.

EFFECTIVITY	
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ATC SYSTEM - POWER, IDENTITY, CONTROL, AND AIR DATA INTERFACES



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ATC SYSTEM - POWER, IDENTITY, CONTROL, AND AIR DATA INTERFACES

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EFFECTIVITY

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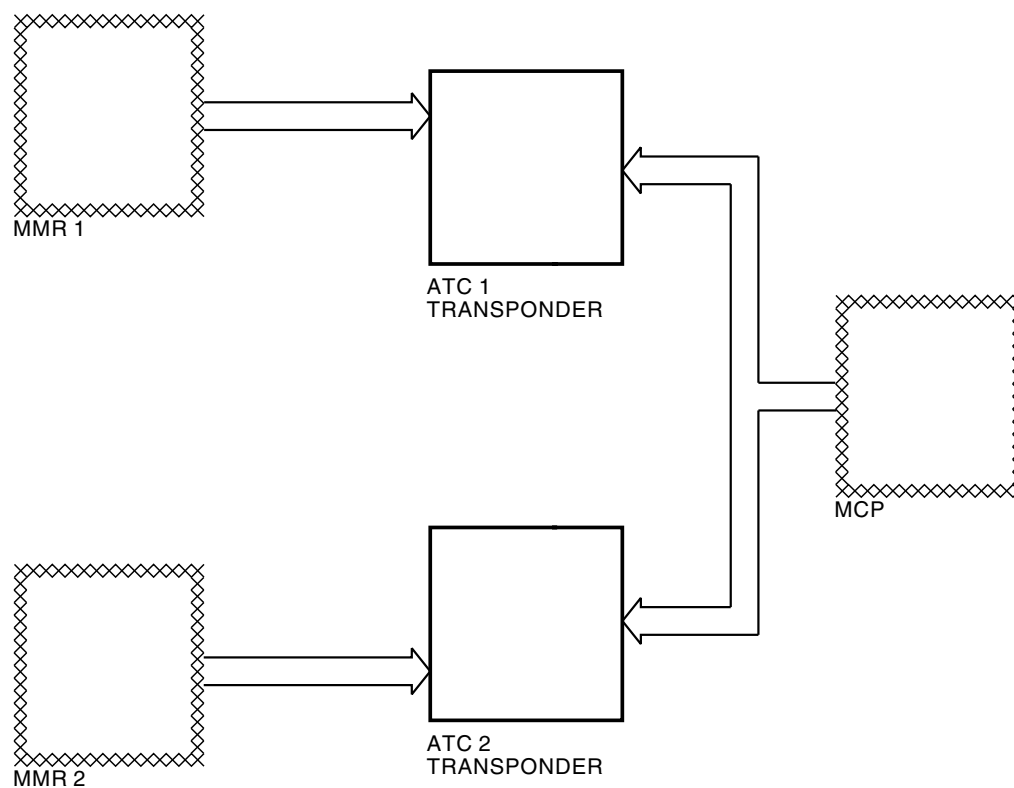
ATC SYSTEM - MMR AND MODE CONTROL PANEL INTERFACES

General

Each Multimode Receiver (MMR) can provide Global Positioning System (GPS) position data to their applicable Air Traffic Control (ATC) transponder. The Mode Control Panel (MCP) provides each transponder with data for selected altitude.

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ATC SYSTEM - MMR AND MODE CONTROL PANEL INTERFACES



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ATC SYSTEM - MMR AND MODE CONTROL PANEL INTERFACES

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**ATC SYSTEM - MAINTENANCE INTERFACE****PSEU**

The proximity switch electronics unit (PSEU) sends air/ground discretes through the ATC/TCAS control panel to the transponders.

These are the purposes of the air/ground discretes:

- Prevent ground tests of the Air Traffic Control (ATC) system in the air
- Prevent Mode A and Mode C replies on the ground
- Defines flight legs in the non-volatile memory.

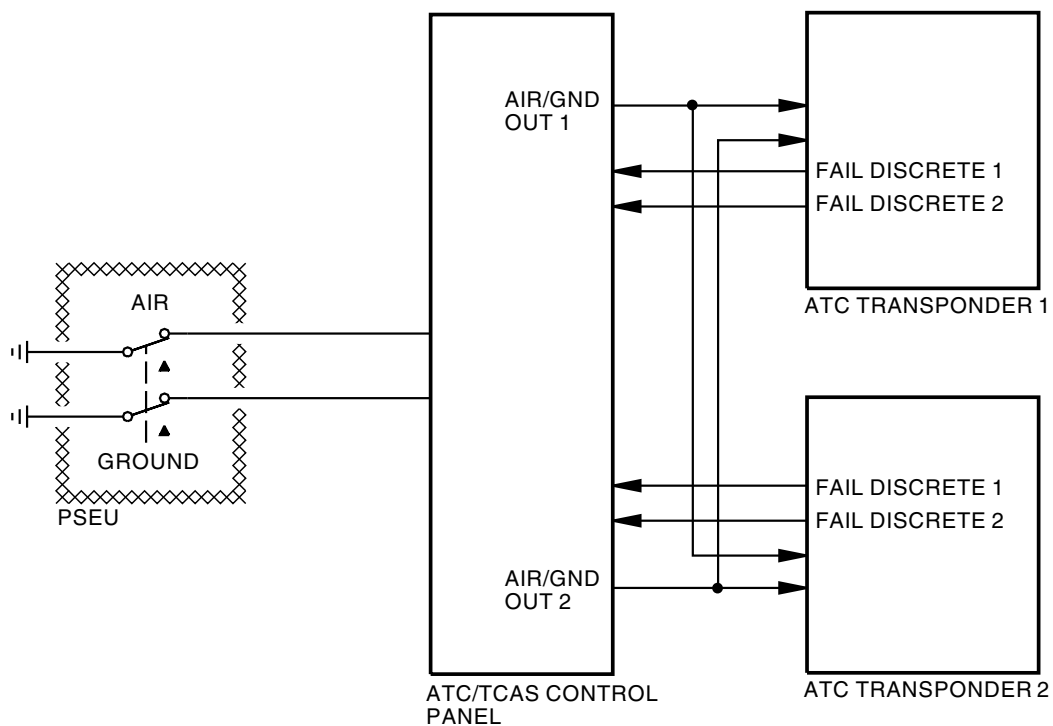
If an active mode is selected on the ground, Mode S and squitter replies are enabled.

Transponder Fail Discretes

Each transponder Built-In-Test Equipment (BITE) continually monitors the equipment for failures. If the BITE detects a failure, the transponder sends the fail discretes to the ATC/TCAS control panel.

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ATC SYSTEM - MAINTENANCE INTERFACE



ATC SYSTEM - MAINTENANCE INTERFACE

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EFFECTIVITY

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ATC SYSTEM - TCAS INTERFACE AND PROGRAM PINS

Program Pins

Each Air Traffic Control (ATC) transponder has these program pins:

- Airplane Mode S address
- Source Destination Identifier (SDI)
- Maximum true airspeed

There are 24 airplane address program pins on each transponder. A program switch module connects to the program pins. The program switch module supplies the open and ground connections necessary to make the 24-bit unique airplane identification.

The SDI defines the transponder as the ATC 1 or ATC 2 transponder.

The maximum true airspeed pins define the maximum true airspeed for the airplane. The transponder formats and sends the maximum true airspeed to the Traffic Alert and Collision Avoidance System (TCAS) computer.

Digital Data to TCAS

The active ATC transponder sends this data to the TCAS computer:

- The 24-bit mode S airplane identification. TCAS needs the airplane mode S identification for maneuver coordination.
- Barometric altitude
- Maximum true airspeed
- TCAS coordination message data
- ATC transponder system failure data

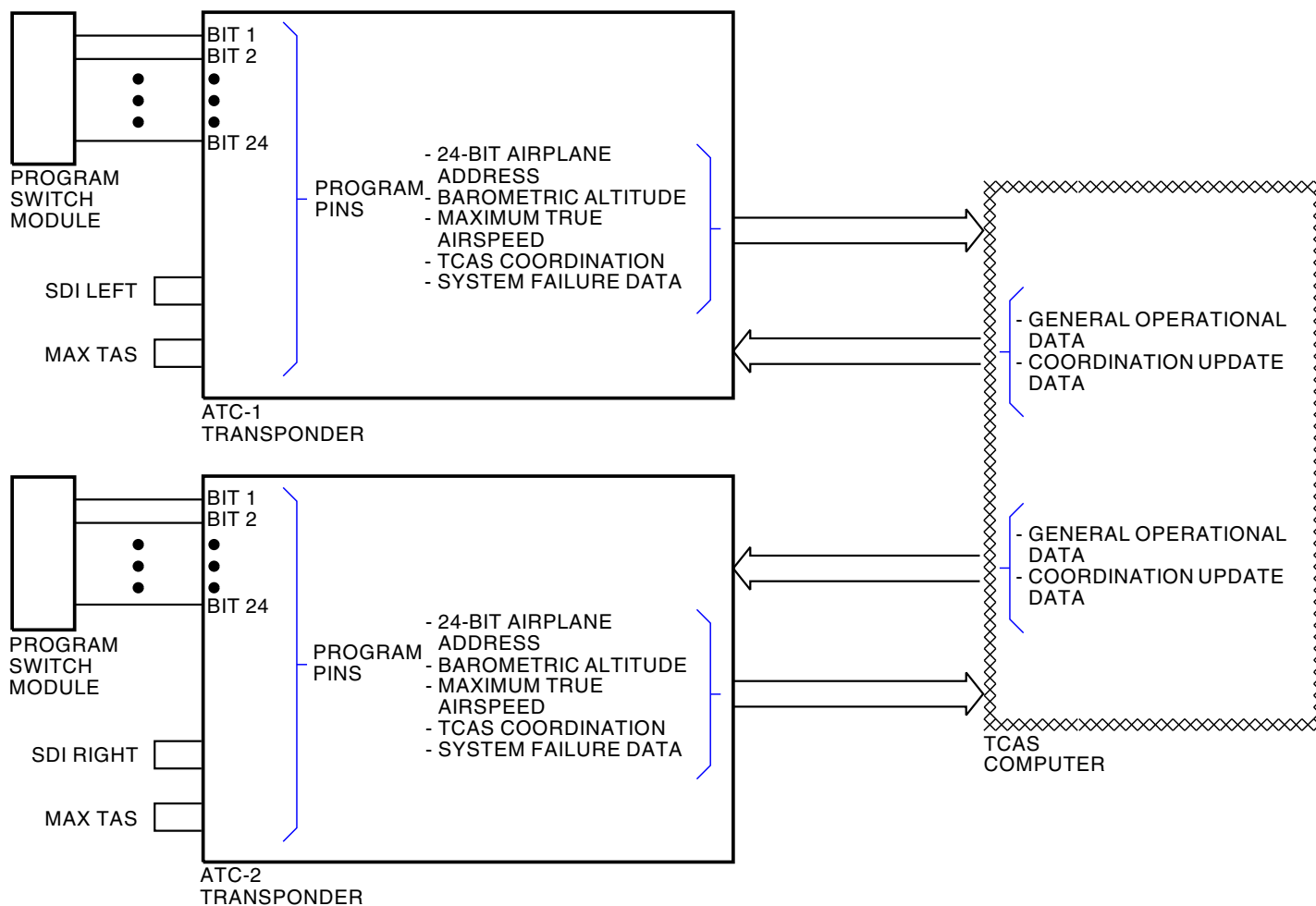
TCAS to Active Transponder

The TCAS computer sends this data to the active transponder:

- General TCAS operational data
- Coordination update data

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ATC SYSTEM - TCAS INTERFACE AND PROGRAM PINS



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ATC SYSTEM - TCAS INTERFACE AND PROGRAM PINS

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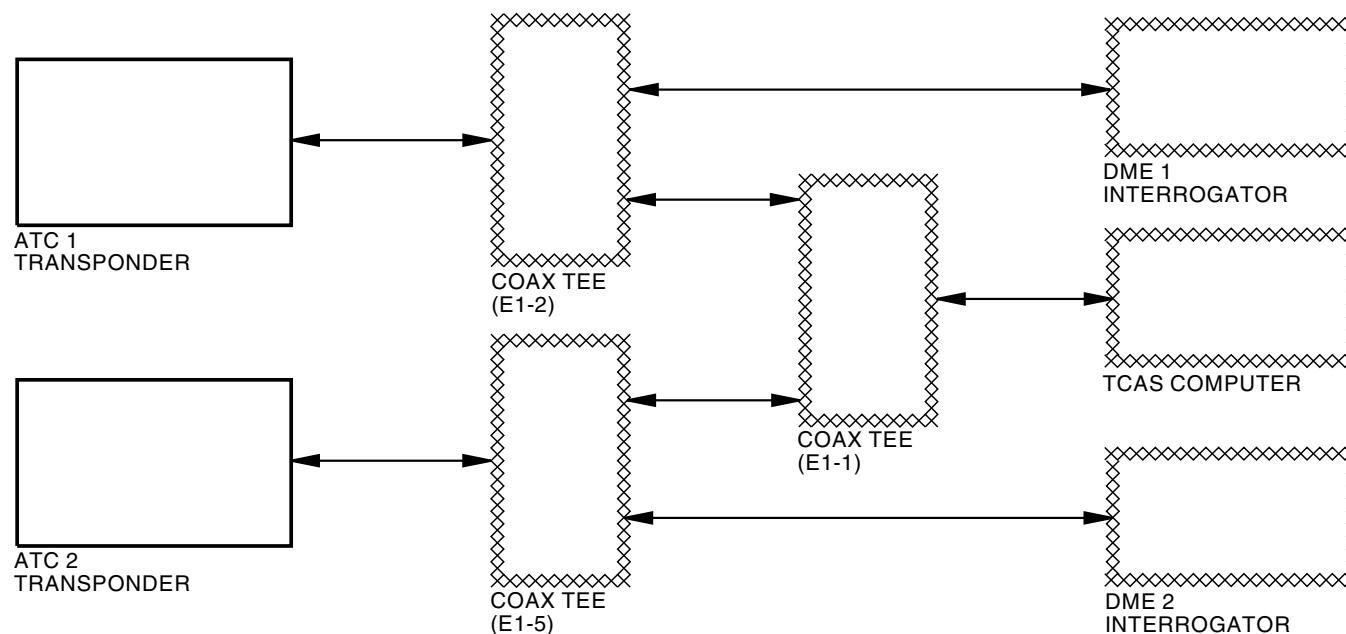
**ATC SYSTEM - SUPPRESSION INTERFACE****General**

The Air Traffic Control (ATC) transponders, Traffic Alert and Collision Avoidance System (TCAS), and the Distance Measuring Equipment (DME) interrogators operate in the same frequency band. There is a suppression interface between these units. This prevents damage to the receiver circuits during a signal transmission. The suppression circuits also prevent responses from onboard equipment.

The first unit to transmit sends a suppression pulse to a coax tee. The coax tee divides the suppression pulse and sends it to the different units, or to a different coax tee. This suppression pulse prevents the operation of the receiver circuits in the other units.

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ATC SYSTEM - SUPPRESSION INTERFACE



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ATC SYSTEM - SUPPRESSION INTERFACE

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ATC SYSTEM - ATC/TCAS CONTROL PANEL

General

The dual ATC/TCAS control panel controls the Air Traffic Control (ATC) transponder and the Traffic Alert and Collision Avoidance System (TCAS) computer.

These are the ATC controls and displays on the ATC/TCAS control panel:

- Transponder select switch
- Active system display
- Transponder code selectors
- Four digit identification code
- Transponder mode selector
- IDENT switch
- Altitude source switch
- Above-Normal-Below (ABV-N-BLW) switch
- Reply selector
- Fail light.

See the TCAS section for more information on TCAS controls (SECTION 34-45).

Transponder Select Switch and Active System Display

The transponder select switch is a two-position switch used to select ATC transponder 1 or ATC transponder 2 as the active transponder. When the flight crew selects the 1 position, the control panel sends a ground standby/on discrete to transponder 2 only. Transponder 2 is in standby. Transponder 1 is active.

When the flight crew selects the 2 position, the control panel sends an open standby/on discrete to transponder 2 to make it active. A ground standby/on discrete goes to transponder 1 and an antenna transfer discrete goes to the ATC coax switches. This puts transponder 1 in standby and makes the relays connect the ATC antennas to transponder 2.

The selected ATC system shows on the LCD active system display.

Identification Code Display and Selection

The flight crew uses the code selectors to set the four digits of the identification code. The four digits show on the liquid crystal display (LCD). Codes are from 0000 to 7777, with 4096 different selections.



CAUTION

DO NOT USE CODES 7500, 7600-7677, 7700-7775 AND 7777. THESE ARE EMERGENCY CODES.

Transponder Mode Selector

The transponder mode selector has several positions. These are the functions that the ATC system uses:

- STBY (standby) - A ground discrete goes to both transponders. This ground discrete prevents operation of the transponder, but does not prevent Built-In-Test Equipment (BITE) functions.
- ALT OFF (altitude reporting off) - The active transponder responds to ATC interrogations. The reply does not contain an altitude report.
- XPNDR (transponder) - The active transponder responds to ATC interrogations. Mode C and Mode S altitude replies contain altitude information.
- TEST - This push button on the top of the mode selector starts an ATC transponder functional test.

IDENT Switch

When the ATC controller requests the airplane identifier, the flight crew pushes the momentary IDENT switch. The transponder adds a special position identification (SPI) pulse to the interrogation reply for the next 18 seconds.

SIA ALL	EFFECTIVITY
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**ATC SYSTEM - ATC/TCAS CONTROL PANEL****Altitude Source Switch**

Use the two-position switch to set the source of altitude data for the ATC transponder. When you set the switch to the number 1 position, ADIRU 1 supplies the altitude data. When you set the switch to the number 2 position, ADIRU 2 supplies the altitude data.

Above-Normal-Below (ABV-N-BLW) Switch

The above-normal-below (ABV-N-BLW) switch changes the altitude envelope that shows the TCAS intruders on the navigation displays (NDs).

Reply Selector

The reply selector has these three positions:

- STBY - Sets the active transponder to the standby mode. In the standby mode, the transponder will not reply to ATC/Mode S interrogations.
- ON - Sets the active transponder to on. In this mode, the transponder will reply to ATC/Mode S interrogations.
- AUTO - Sets the active transponder to the auto mode. In this mode, the transponder will reply to ATC/Mode S interrogations when the airplane is in the air and will respond only to Mode S interrogations when on the ground.

XPNDR FAIL Light

The XPNDR FAIL light comes on for these conditions:

- Transponder failure
- Antenna failure
- Control data failure
- Altitude input failure.

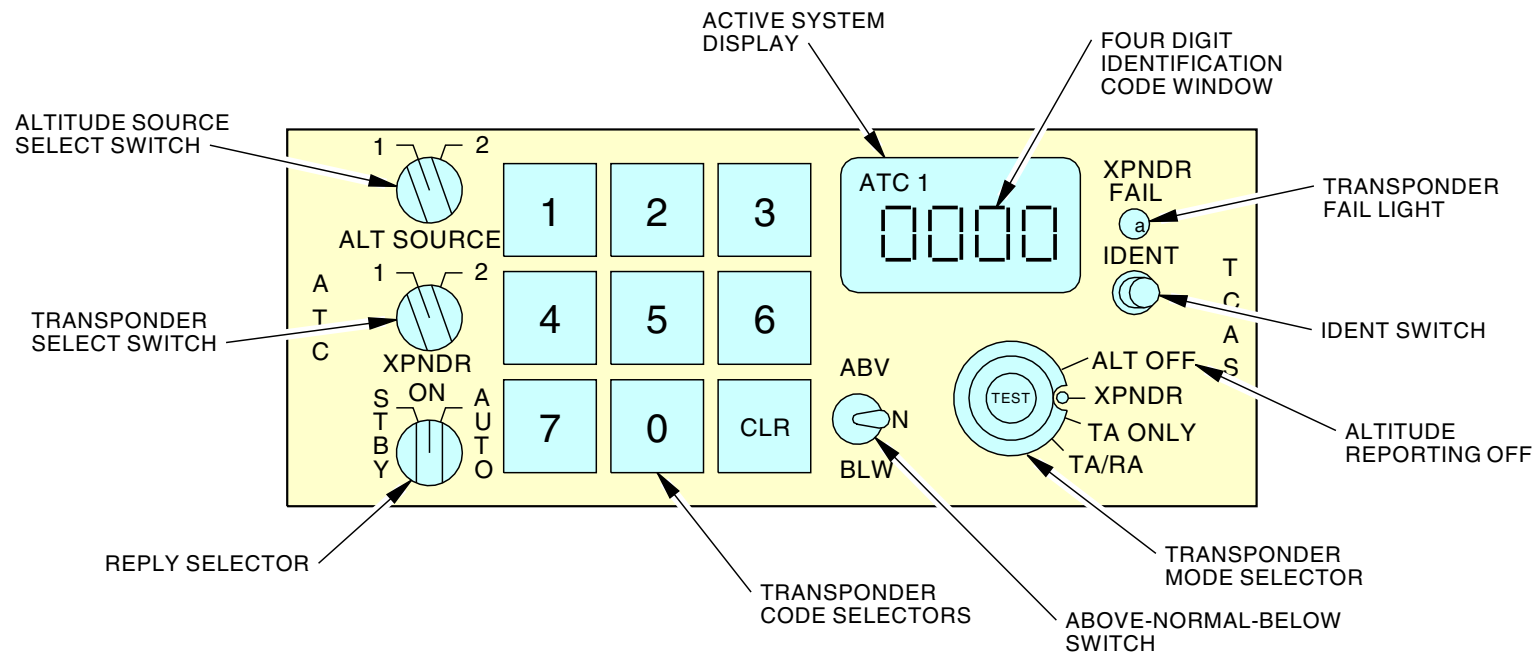
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EFFECTIVITY	
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ATC SYSTEM - ATC/TCAS CONTROL PANEL



ATC SYSTEM - ATC/TCAS CONTROL PANEL

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**ATC SYSTEM - ATC TRANSPONDER****General**

The Air Traffic Control (ATC) ground station interrogates the ATC transponder with a pulse-coded signal at a frequency of 1030 MHz.

The transponder responds with pulse-coded signals at a frequency of 1090 MHz.

Characteristics

The transponder responds to Air Traffic Control Radar Beacon System (ATCRBS) Mode A and Mode C interrogations. The transponder also responds to air traffic control and the Traffic Alert and Collision Avoidance System (TCAS) computer with the mode select (Mode S) format.

The ATC transponder has a non-volatile flight-fault memory.

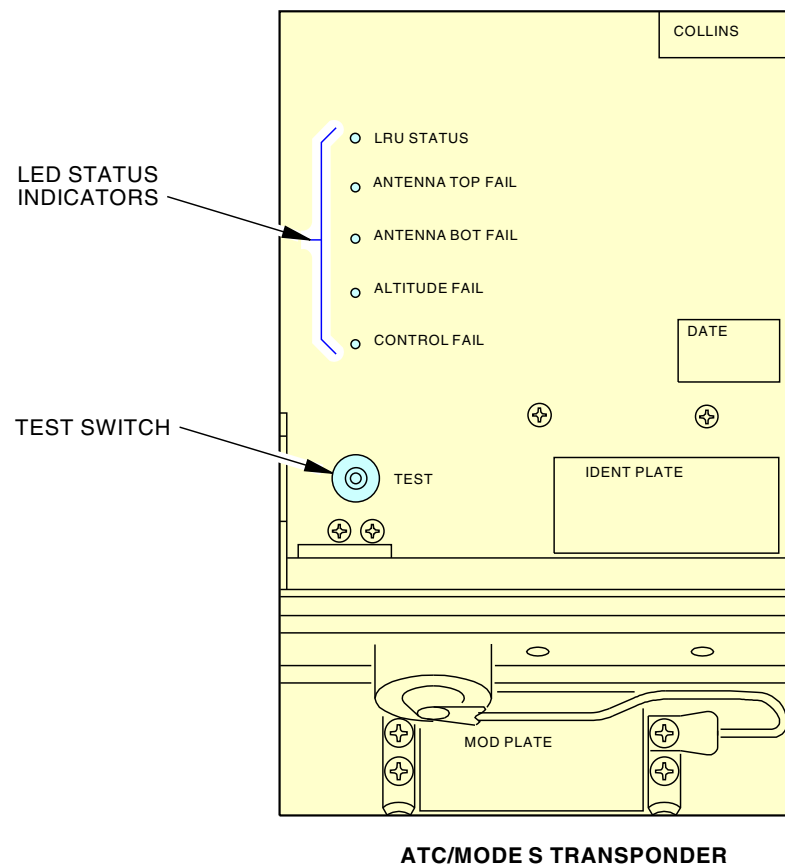
Front Panel Indications

The test switch starts a self-test.

The Light Emitting Diode (LED) status indicators on the front panel show for these conditions:

- LRU STATUS (green), if there are no LRU failures
- LRU STATUS (red), if there is an LRU failure
- ANTENNA TOP FAIL, if the top antenna fails
- ANTENNA BOT FAIL, if the bottom antenna fails
- ALTITUDE FAIL, if the altitude input from the ADIRU fails
- CONTROL FAIL, if the control panel input fails.

ATC SYSTEM - ATC TRANSPONDER



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ATC SYSTEM - ATC TRANSPONDER

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**ATC SYSTEM - ATC ANTENNA****Purpose**

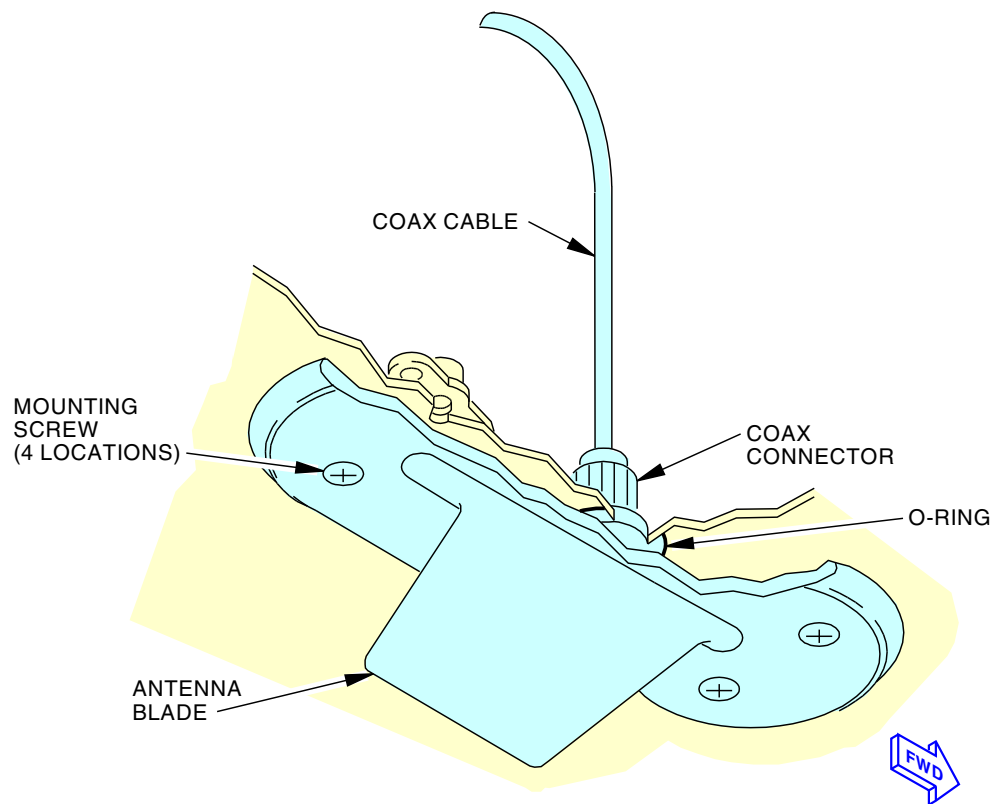
The Air Traffic Control (ATC) L-band blade antenna receives 1030 MHZ interrogation signals from ATC ground stations and other airplanes that have Traffic Alert and Collision Avoidance System (TCAS). The ATC transponder transmits the reply signals through the L-band antenna.

Physical Description

The coaxial cable connector connects to the antenna. The antenna has an O-ring moisture seal and attaches to the airplane by four screws. The ATC and Distance Measuring Equipment (DME) antennas are the same and are interchangeable.

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ATC SYSTEM - ATC ANTENNA



ATC SYSTEM - ATC ANTENNA

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**ATC SYSTEM - ATC COAX SWITCH****General**

The Air Traffic Control (ATC) coax switches connect the active ATC transponder to the top and bottom ATC antennas.

These are the electrical connector inputs:

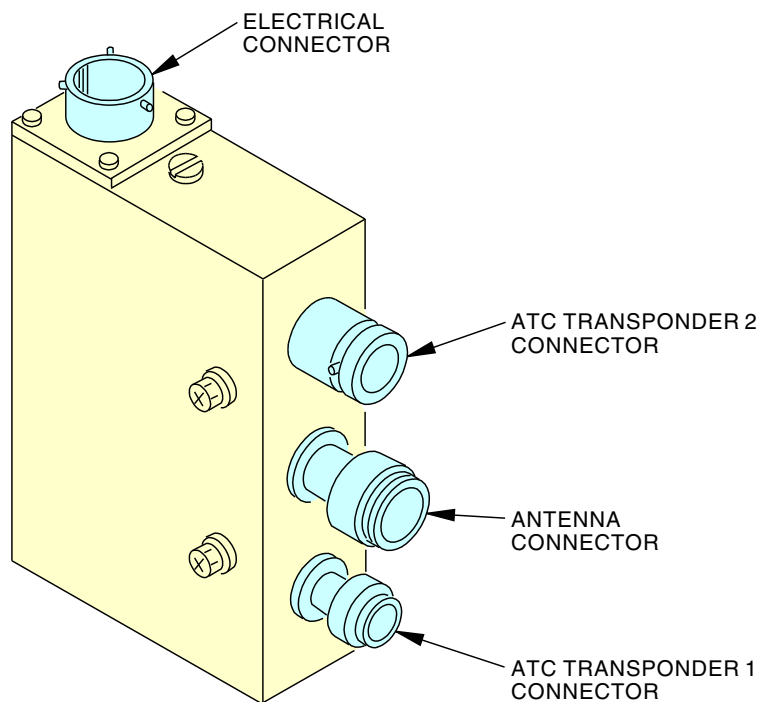
- ATC antenna switch circuit breaker
- ATC/TCAS control panel

The ATC coax switches supply an RF interface for the ATC system interrogation and reply signals. These are the connectors:

- ATC transponder 1 connector
- ATC antenna connector
- ATC transponder 2 connector

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ATC SYSTEM - ATC COAX SWITCH



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ATC SYSTEM - ATC COAX SWITCH

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ATC SYSTEM - INPUTS AND CONTROL

ATC Control Panel

The ATC/TCAS control panel controls the operation of the Air Traffic Control (ATC) transponders.

The microprocessor in the control panel gets inputs from these:

- Code selectors
- IDENT switch
- Mode selector.

The microprocessor changes these inputs into ARINC 429 digital data. The ATC control panel sends this data on an ARINC 429 data bus to the selected transponder:

- The identity code the flight crew selects to reply to interrogations
- Digital discretes for the position of the IDENT switch
- Digital discretes for ALT RPTG OFF or XPNDR mode
- Digital discrete for TEST.

The XPNDR 1-2 switch selects one transponder for operation. The selected transponder receives an open discrete from the control panel. A ground discrete goes from the panel to the other transponder to put it in the standby mode. This discrete also goes to the ATC antenna coax switches to connect the two ATC antennas to the selected transponder.

The STBY position of the reply selector sets the selected transponder to standby mode.

Air/Ground Input

The transponder can receive an air/ground discrete input from the proximity switch electronics unit (PSEU) through the control panel reply selector. Set the reply selector to ON and the discrete open causes the transponder to reply to all interrogations in the air and on the ground. Set the reply selector to AUTO for the air/ground discrete to control transponder replies. In the air, the transponder will reply to interrogations. On the ground, the transponder will not reply to mode A and mode C interrogations.

ATC Transponder Inputs

The transponder has an input/output (I/O) that has an interface with the ARINC 429 data and analog discretes from the control panel.

Control Inputs

The digital data bus from the control panel has three digital discretes. One shows if the mode selector on the panel is in the ALT RPTG OFF (altitude reporting off) position. If it is, the CPU does not permit the transponder to make a mode C reply or to give altitude information in a mode S reply.

The second digital discrete from the control panel shows the position of the IDENT switch. The pilot momentarily pushes the IDENT switch at the request of the ATC ground station. When this happens, the transponder sends a special position identification (SPI) pulse at the end of every normal mode A reply. It continues for 18 seconds. The SPI causes the airplane to be highlighted on the air traffic controller's radar screen.

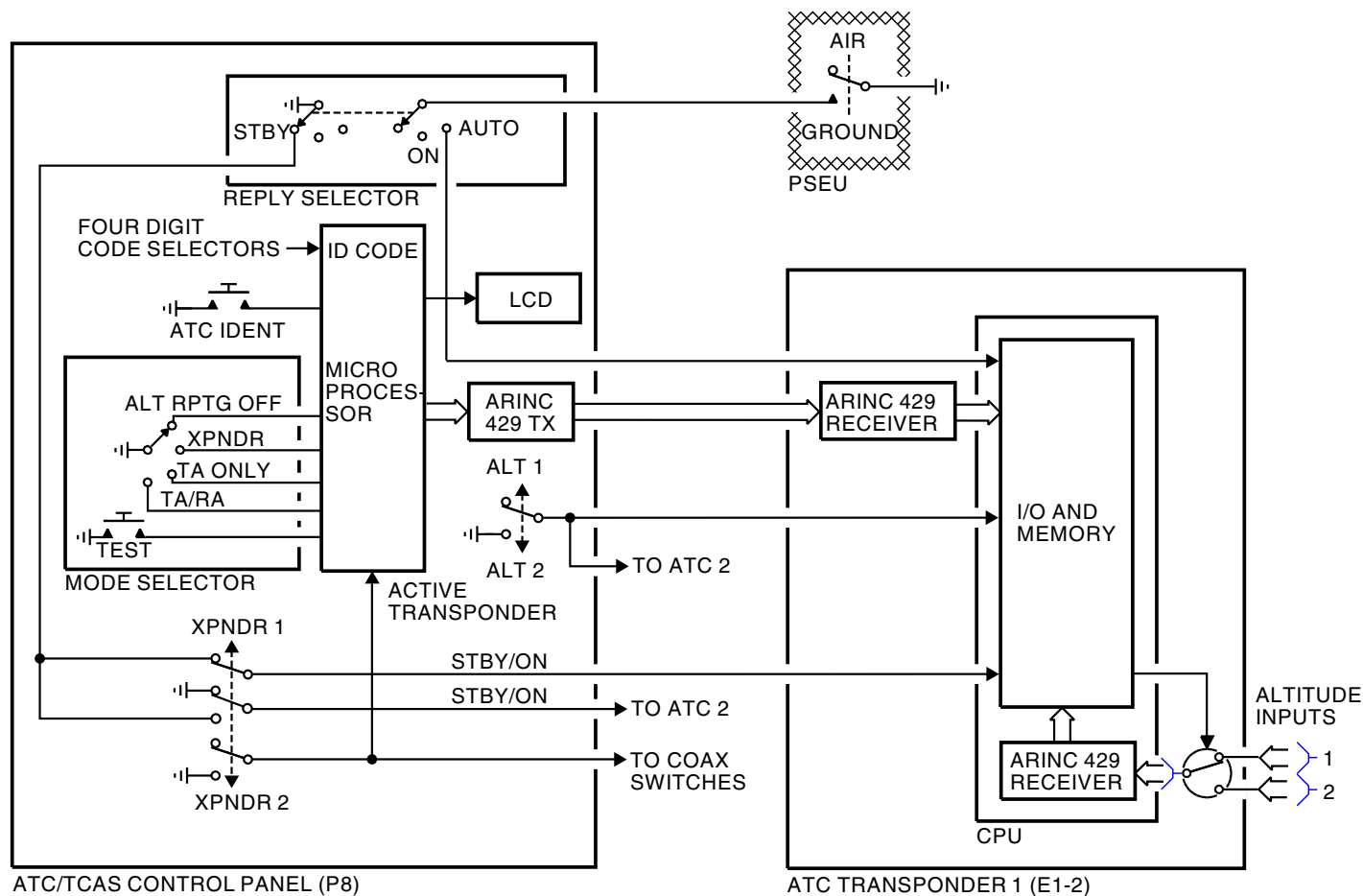
The third digital discrete from the control panel shows if TEST is selected. If it is, the transponder starts a functional self-test.

Altitude Inputs

The Air Data Inertial Reference Unit (ADIRU) send barometric altitude to each transponder. Each transponder uses only one ADIRU altitude input. Set the altitude source switch on the control panel to 1 to use input 1, or 2 to use input 2.

EFFECTIVITY	
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ATC SYSTEM - INPUTS AND CONTROL



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ATC SYSTEM - INPUTS AND CONTROL

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SIA ALL

EFFECTIVITY

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ATC SYSTEM - TRANSPONDER RECEIVE FUNCTION

General

The antennas send the interrogation signals to the transponder. The signals go through the diplexer circuits to two receivers. The 1030 MHz interrogation signal mixes with a 1090 MHz signal from the 1090 MHz oscillator. This makes an intermediate frequency signal that the signal processor uses.

Suppression

When the transponder gets a suppression pulse from another system, the signal processor circuits do not permit the receiver circuits to operate.

Antenna Select

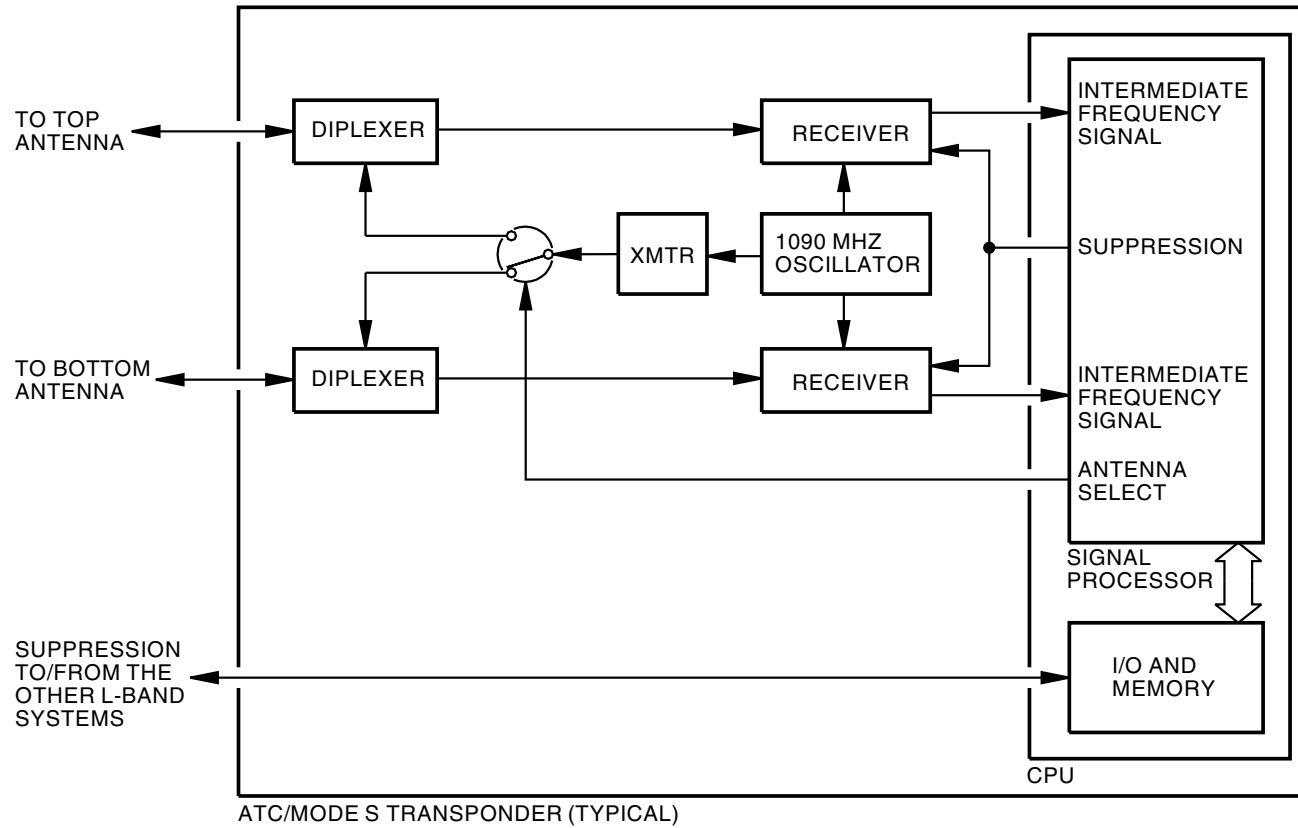
The antenna select circuit chooses the diplexer and antenna that supplies the strongest receiver signal. The transmission of the reply signal goes through the selected diplexer and antenna.

Signal Processor

The signal processor determines if the transponder receives a valid interrogation signal. It also determines the correct reply mode; Mode A, Mode C, or Mode S.

EFFECTIVITY	
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ATC SYSTEM - TRANSPONDER RECEIVE FUNCTION



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ATC SYSTEM - TRANSPONDER RECEIVE FUNCTION

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**ATC SYSTEM - TRANSPONDER TRANSMIT FUNCTIONAL DESCRIPTION****Transmit**

The Central Processing Unit (CPU) controls the transponder to reply to a Mode A, Mode C, or Mode S interrogation. The mode format circuits use the identity code, airplane altitude and the unique 24-bit airplane address from the memory to format the data for the reply signals.

The Mode A reply contains the airplane identity code.

The Mode C reply contains the airplane altitude.

The mode S replies contain a unique 24-bit airplane address, identity code, altitude information, and Traffic Alert and Collision Avoidance System (TCAS) information.

After the signal processor chooses the correct mode for the reply data, the modulator makes a reply signal in that format. The modulator uses the signal processor output to modulate a 1090 MHz carrier to make the transmission reply signal. The transmission reply signal goes to the power amplifier and then to the diplexer and to the Air Traffic Control (ATC) antenna.

The antenna select circuit makes the transmission signal go to the antenna that receives the strongest interrogation signal.

Test

When you apply power or do a test of the ATC transponder system, the Built-In-Test Equipment (BITE) does a check of the operational status of all the internal circuits and for the correct antenna impedance. The BITE circuits identify any failures and put them into the non-volatile memory.

The LEDs on the front panel of the transponder come on to report these conditions:

- Transponder status
- Antenna status
- Transponder control interface status
- Altitude interface status

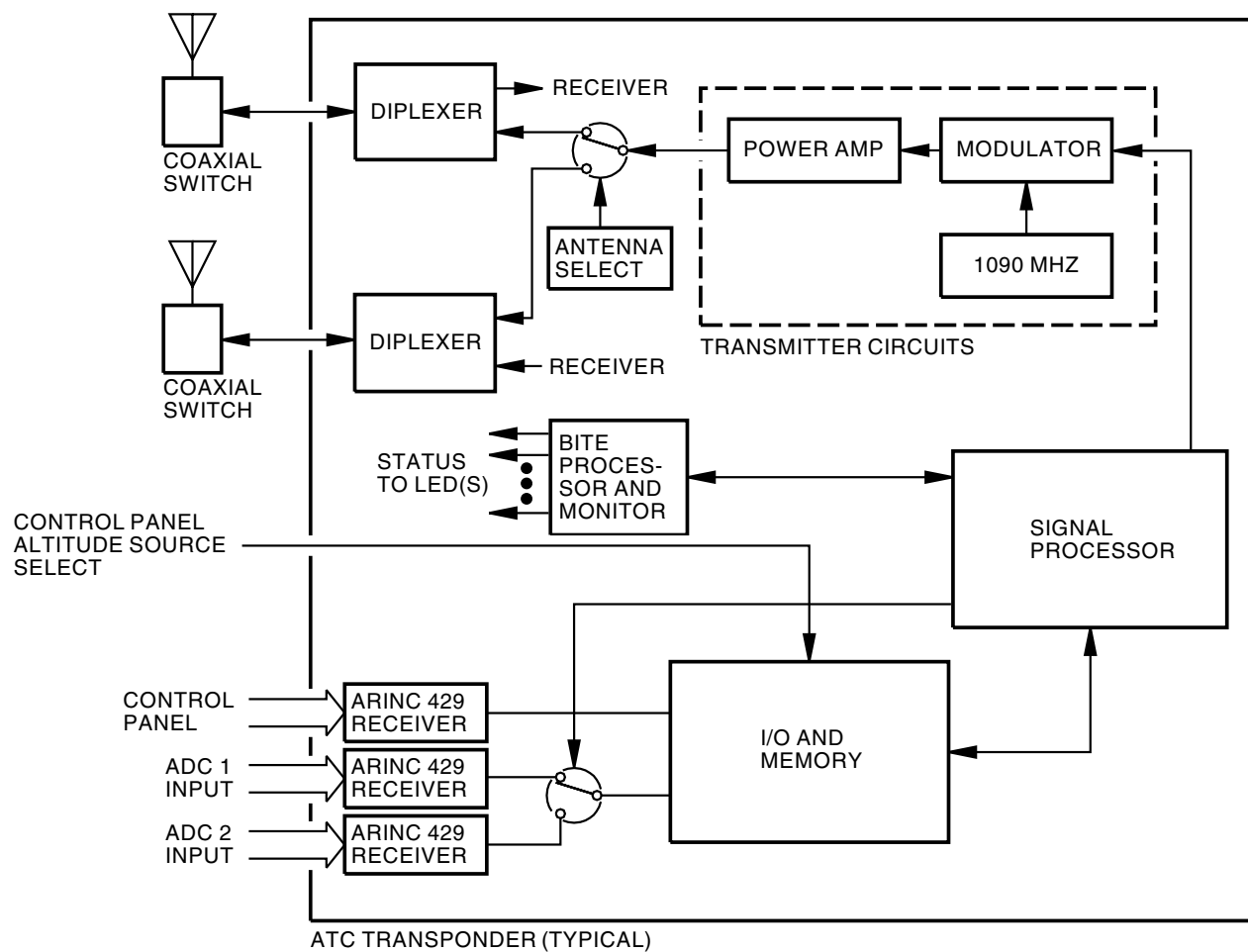
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ATC SYSTEM - TRANSPONDER TRANSMIT FUNCTIONAL DESCRIPTION



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ATC SYSTEM - TRANSPONDER TRANSMIT FUNCTIONAL DESCRIPTION

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**ATC SYSTEM - ANTENNA COAX SWITCH CONTROL****General**

Use the ATC/TCAS control panel to select the active Air Traffic Control (ATC) system. When you do this, the ATC/TCAS control panel sends a discrete open or ground to the top and bottom ATC coax switches. This connects the ATC transponder 1 or the ATC transponder 2 to the top and bottom ATC antennas.

ATC 1 System Select or Standby

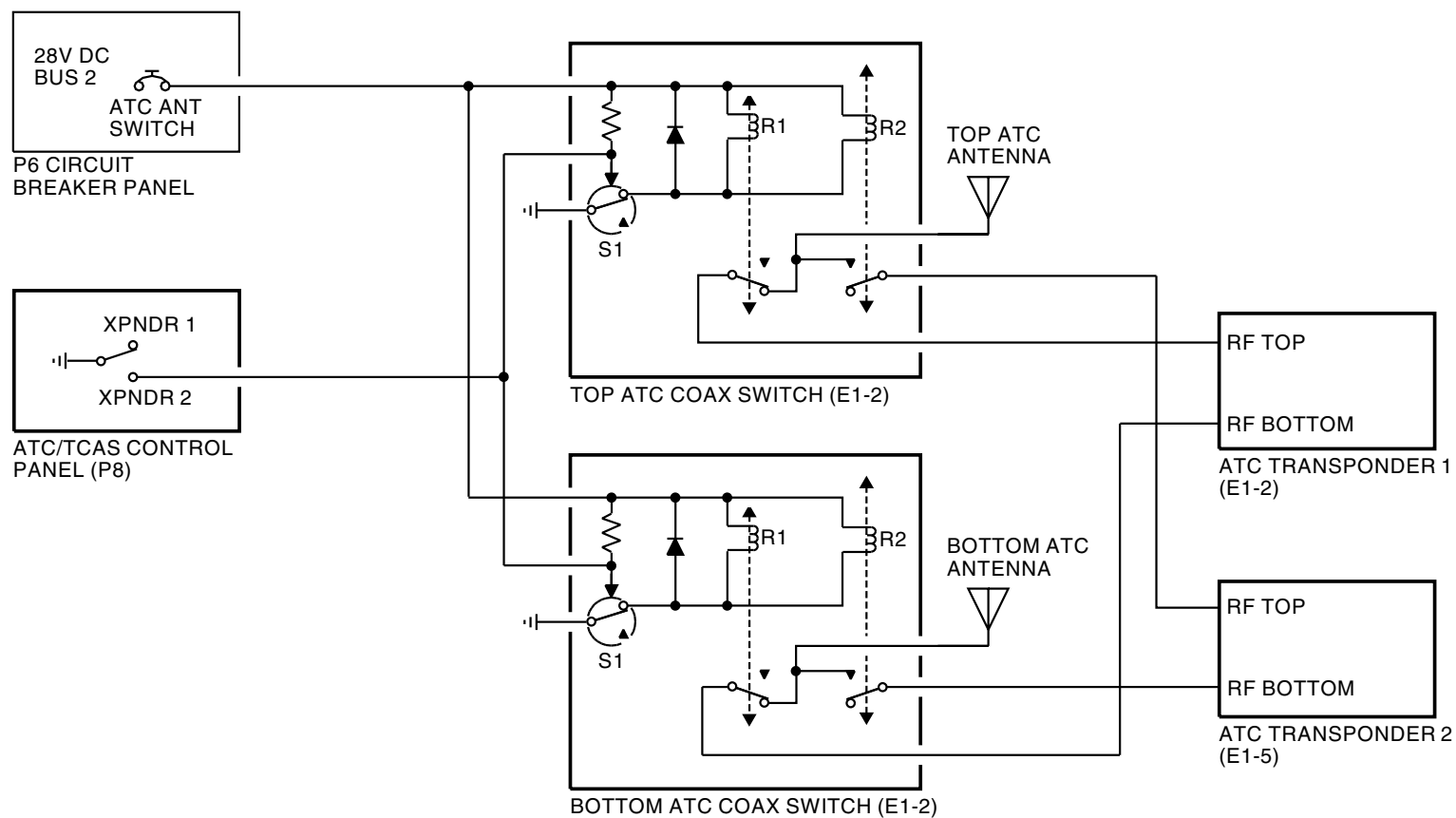
When the airplane power is on and when the ATC/TCAS control panel has the ATC transponder 1 selected, the S1 switches energize. This removes the ground to relays R1 and R2. They do not energize. The top and bottom antennas connect to ATC transponder 1.

ATC 2 System Select

With the ATC transponder 2 selected, switch S1 de-energizes to supply a ground to energize relay R1 and R2. The top and bottom antennas connect to the ATC transponder 2.

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ATC SYSTEM - ANTENNA COAX SWITCH CONTROL



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ATC SYSTEM - ANTENNA COAX SWITCH CONTROL

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**ATC SYSTEM - SELF TEST****General**

Push the TEST switch on the front of the transponder or select TEST on the ATC/TCAS control panel to start a self-test of the Air Traffic Control (ATC) system. During the test, the transponder Built-In-Test Equipment (BITE) circuits do these functions:

- Normal operation test
- Memory tests
- Simulated interrogation test of the receiver circuits
- Antenna impedance test
- TCAS interface test
- Valid control and altitude inputs monitor.

Test From the Front Panel

Push and release the test switch. All front panel light emitting diode (LED) status indicators turn red for two seconds. After two seconds, the LRU STATUS turns green and the other LEDs remain red. Then all the LEDs go off for two seconds. At this time, the applicable LEDs come on to show the condition of the ATC transponder system. After 30 seconds, all LEDs go off.

These are the LED status indicators and their related conditions:

- LRU STATUS (GREEN) - no LRU failures
- LRU STATUS (RED) - LRU failure
- ANTENNA TOP FAIL - top antenna fails
- ANTENNA BOT FAIL - bottom antenna fails
- ALTITUDE FAIL - altitude input from the ADIRU fails
- CONTROL FAIL - control panel input fails.

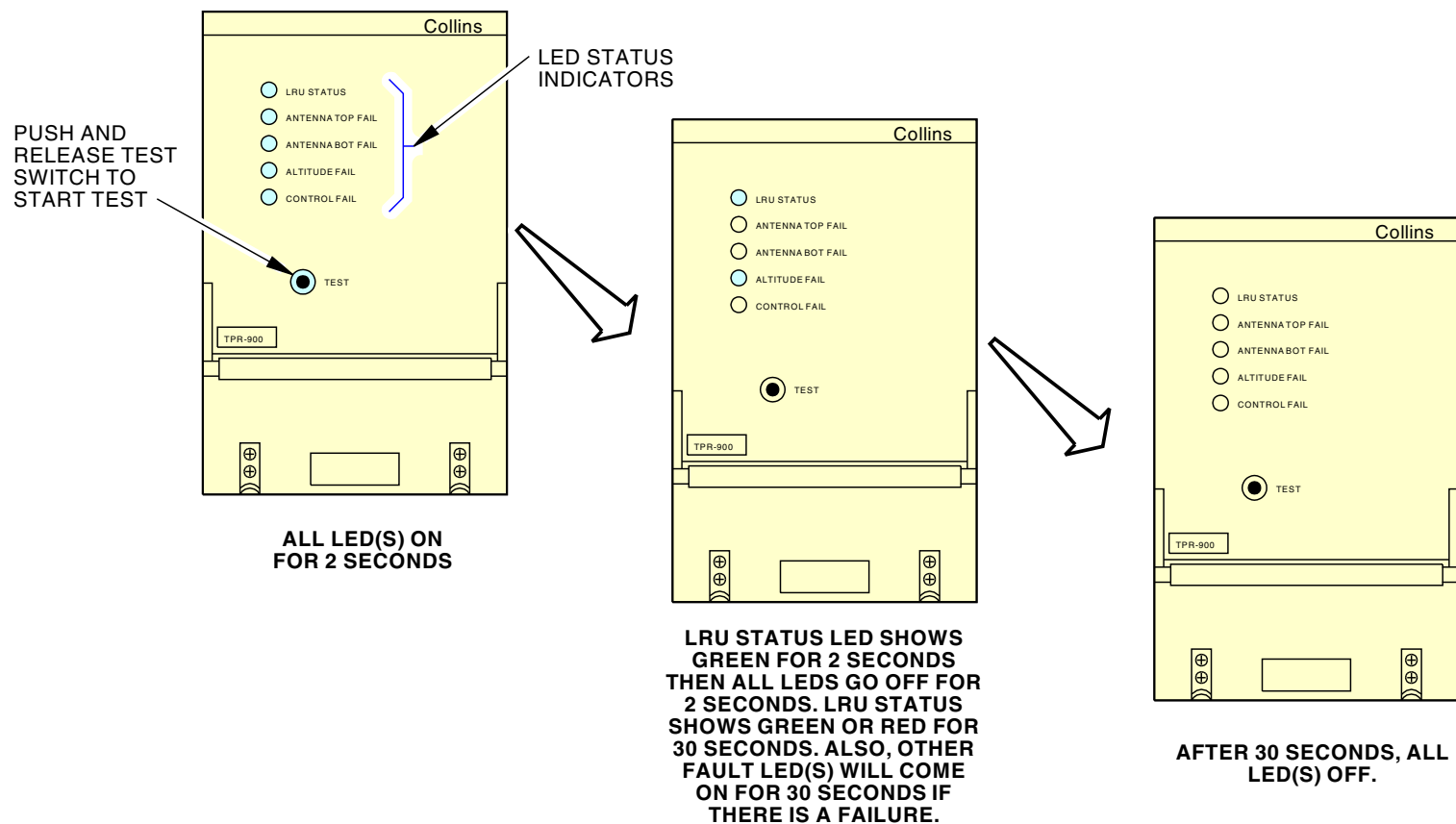
Test From the Control Panel

Push and release the test button on the control panel to start a self-test of the ATC system. The XPNDR FAIL light comes on for three seconds and then goes off if the test is successful. The XPNDR FAIL light stays on for any of these conditions:

- Antenna failure
- Transponder failure
- Control data failure
- Altitude input failure.

EFFECTIVITY	
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ATC SYSTEM - SELF TEST



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ATC SYSTEM - SELF-TEST

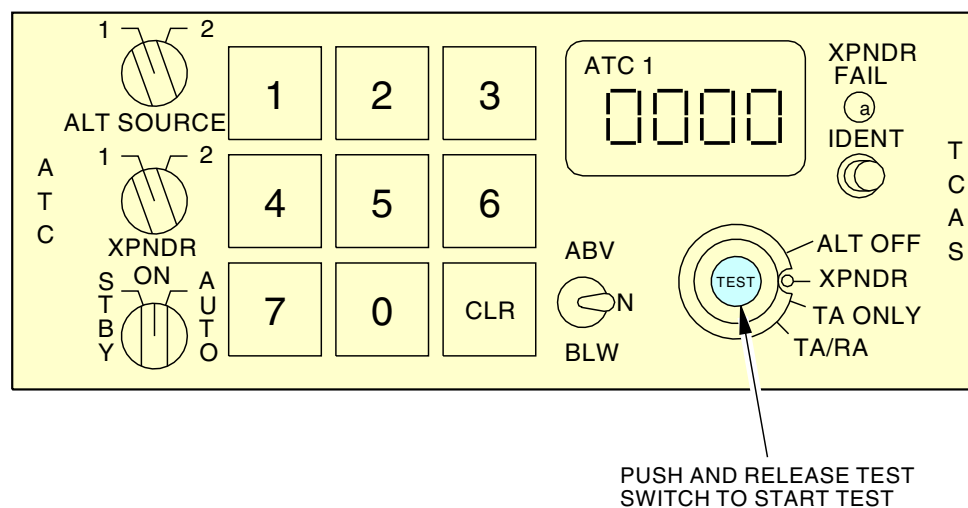
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ATC SYSTEM - SELF TEST



ATC SYSTEM - SELF-TEST

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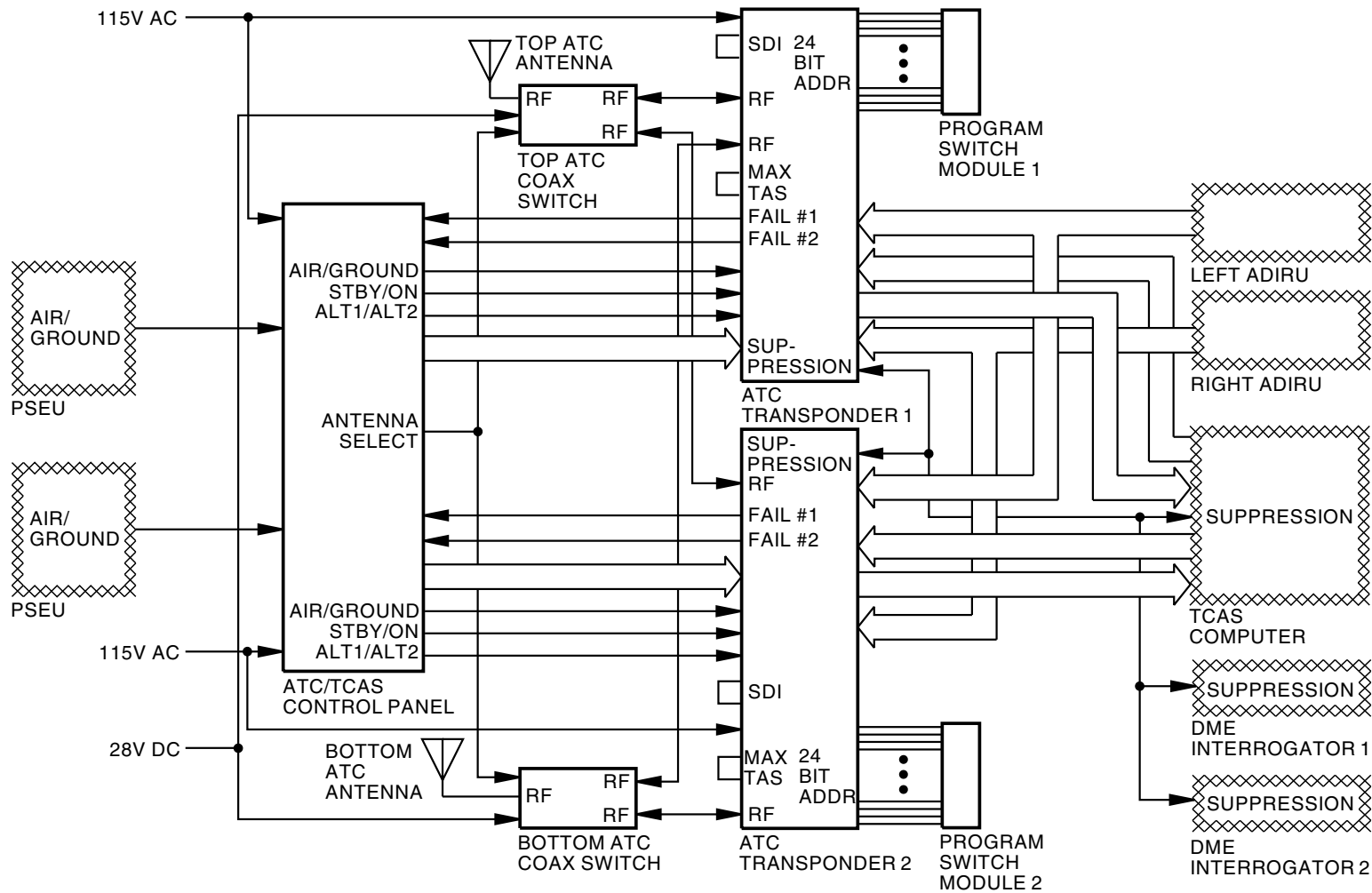
ATC SYSTEM - SYSTEM SUMMARY

General

This graphic is for reference purposes only.

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ATC SYSTEM - SYSTEM SUMMARY



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ATC SYSTEM - SYSTEM SUMMARY

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EFFECTIVITY

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**DISTANCE MEASURING EQUIPMENT - INTRODUCTION****Purpose**

The distance measuring equipment (DME) system supplies slant range (line of sight) distance measurement between the airplane and the ground station.

Abbreviations and Acronyms

- AC - alternating current
- ACP - audio control panel
- ADF - automatic direction finder
- alt - alternate
- altn - alternate
- app - approach
- ARINC - Aeronautical Radio, Inc.
- ATC - air traffic control
- ATE - automatic test equipment
- auto - automatic
- B - both
- BITE - built-in test equipment
- BL - buttock line
- CAPT - captain
- CDU - control display unit
- circ - circulator
- CPU - central (control) processing unit
- DC - direct current
- DPC - display processing computer
- DME - distance measurement equipment
- EFIS - electronic flight instrument system
- F/O - first officer
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FMC - flight management computer
- FMCS - flight management computer system
- freq - frequency
- fwd - forward
- grd - ground
- I/C - intercom
- ILS - instrument landing system
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- maint - maintenance
- MHz - megahertz
- MKR - marker beacon
- nav - navigation
- NCD - no computed data
- ND - navigation display
- NORM - normal
- PFD - primary flight display
- R - range
- rcvr - receiver
- REU - remote electronics unit
- RF - radio frequency
- rly - relay
- R/T - receive/transmit
- spkr - speaker
- sta - station
- TCAS - traffic alert and collision avoidance system
- TFR - transfer
- TX - transmitter
- V - voice

34-55-00**SIA ALL EFFECTIVITY**

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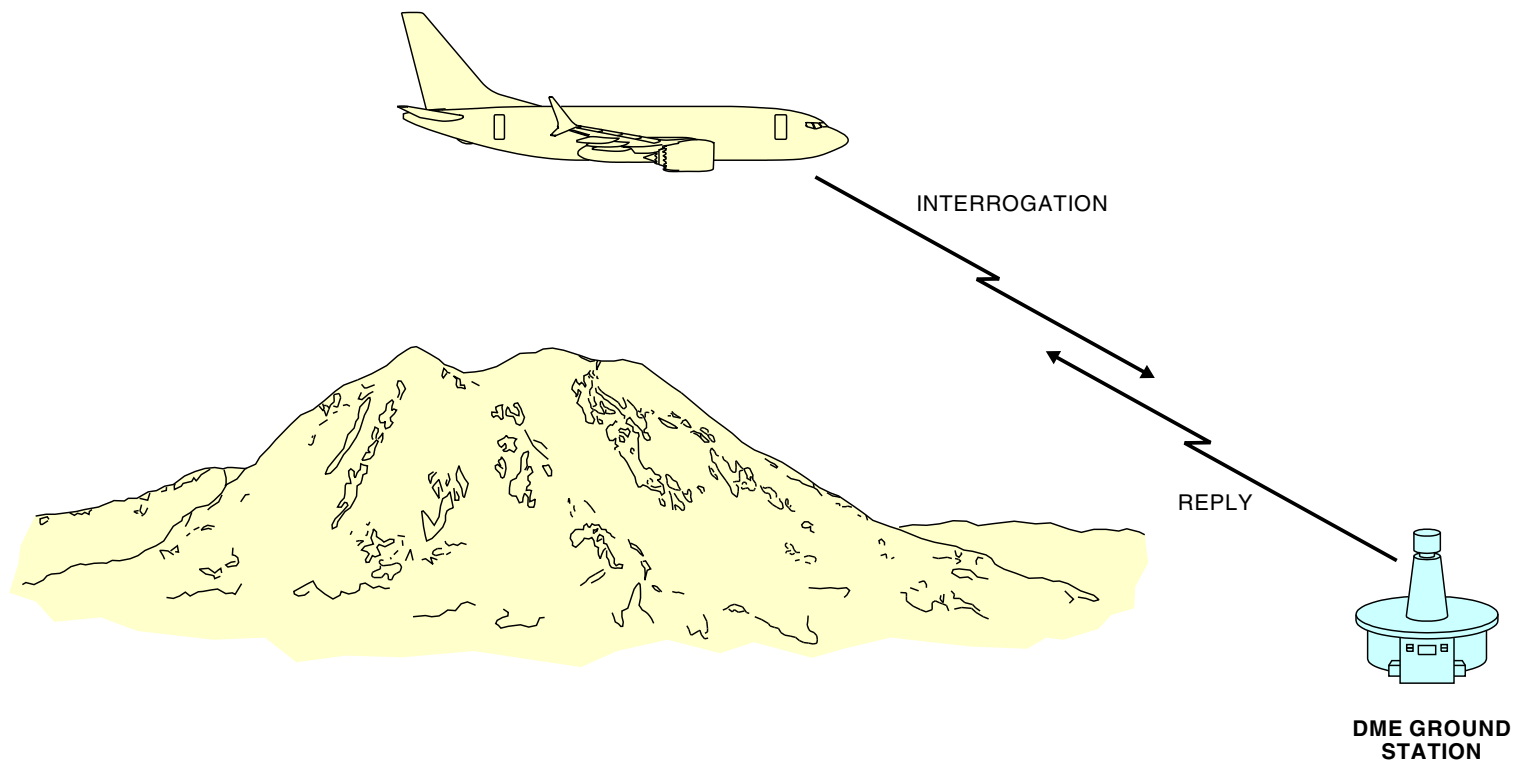
ECCN 9E991 BOEING PROPRIETARY - See title page for details



DISTANCE MEASURING EQUIPMENT - INTRODUCTION

- V - volts
- VHF - very high frequency
- xfr - transfer
- xmtr - transmitter
- xpndr - transponder

DISTANCE MEASURING EQUIPMENT - INTRODUCTION



2370066 S00061520910_V2

DISTANCE MEASURING EQUIPMENT - INTRODUCTION

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**DME SYSTEM - GENERAL DESCRIPTION****General**

The DME system has two DME interrogators and two antennas.

Description

The interrogators get manual tune inputs and flight management computer system (FMCS) autotune inputs from the navigation control panel. If the NAV control panel tune inputs fail, the interrogators get autotune inputs directly from the FMC.

The DME system sends data to the display processing computers to show on the primary flight displays (PFDs) and navigation displays (NDs).

The DME system sends data to these units:

- Flight control computers (FCC)
- Flight management computer System (FMCS)
- Flight data acquisition unit (FDAU)
- Remote Electronics Unit (REU).

The FCCs use DME data as an input to calculate the VOR capture point in the autopilot VOR mode. The DME data is also used in the VOR mode to find when over station is sensed (OSS) for the VOR ground station.

The FMCS uses DME data to calculate FMC position updates.

The flight data acquisition unit receives DME data, formats it, and sends it to the flight data recorder.

The REU receives audio from the DME station and sends it to the flight deck headsets and speakers.

The DME system sends and receives a suppression pulse between these units:

- DME
- ATCs
- TCAS.

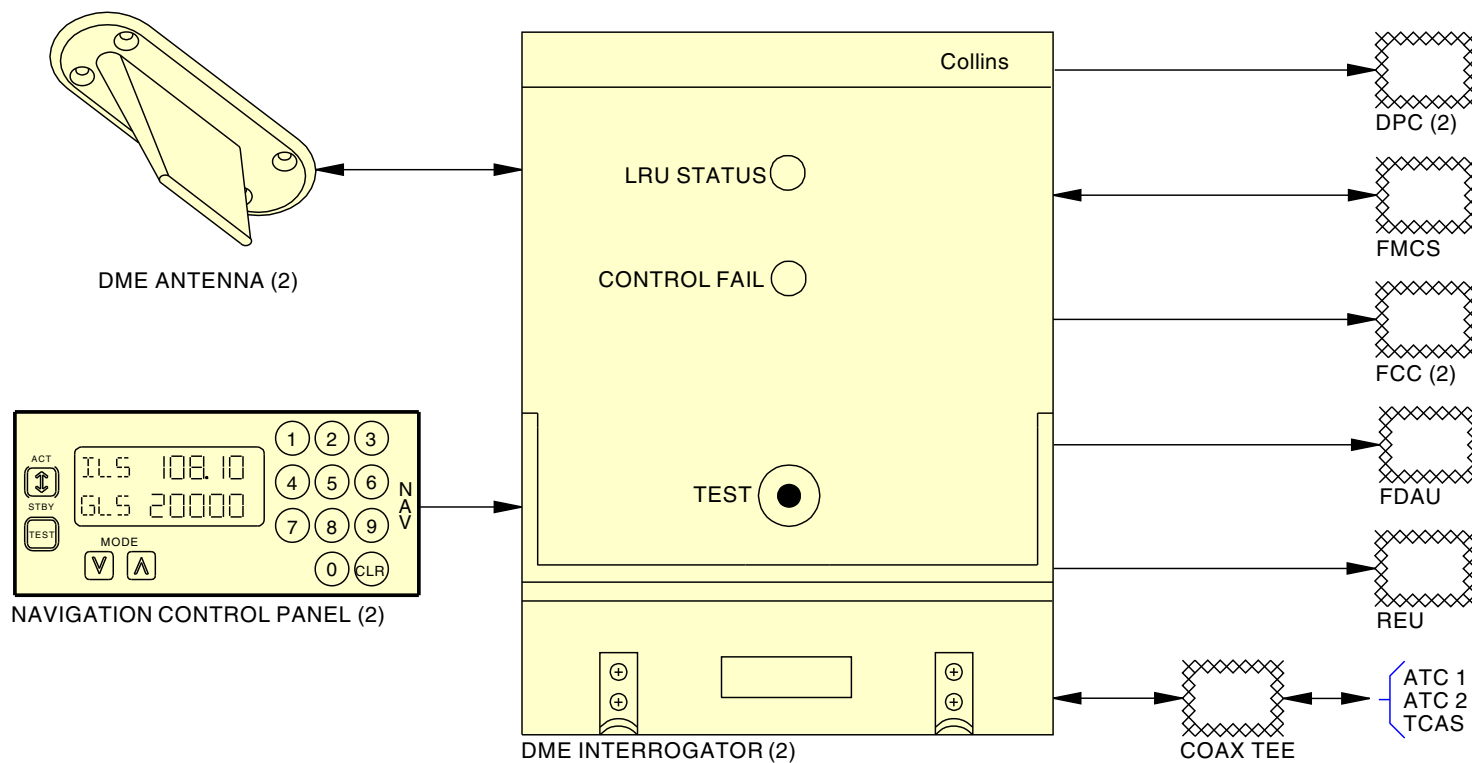
The DME interrogator receives the station audio identifiers and sends them to the remote electronics unit (REU).

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D633AM102-SIA

DME SYSTEM - GENERAL DESCRIPTION



2525175 S0000595928_V2

DME SYSTEM - GENERAL DESCRIPTION

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DME SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT

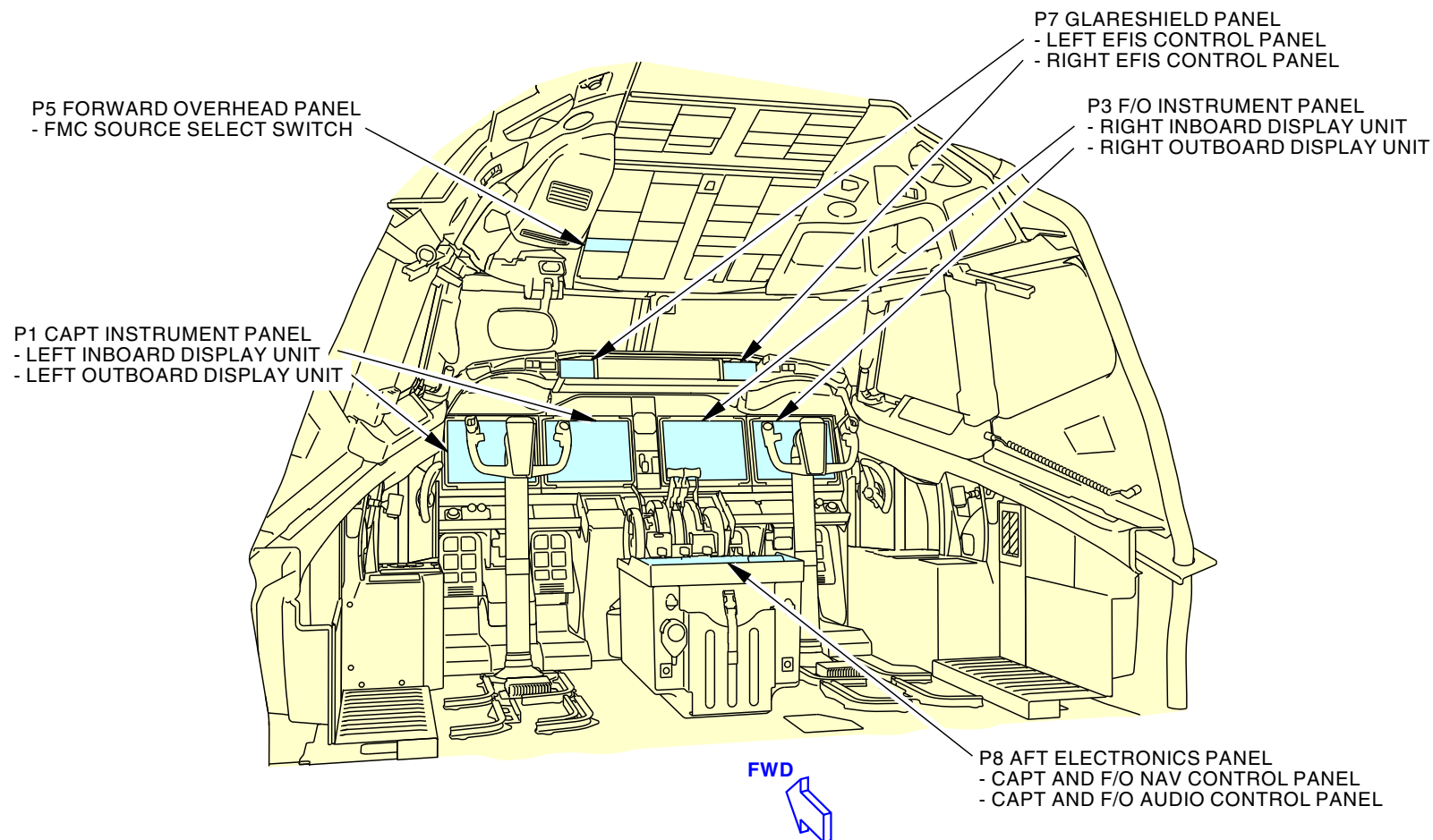
Flight Compartment Locations

These are the components in the flight compartment that have an interface with the DME system:

- FMC source select switch
- Max display system
- Captain's and first officer's EFIS control panels
- Captain's and first officer's NAV control panel
- Captain's and first officer's audio control panel.

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DME SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT



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DME SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT

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DME SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNAS

DME Component Locations

These components are in the electronics equipment compartment:

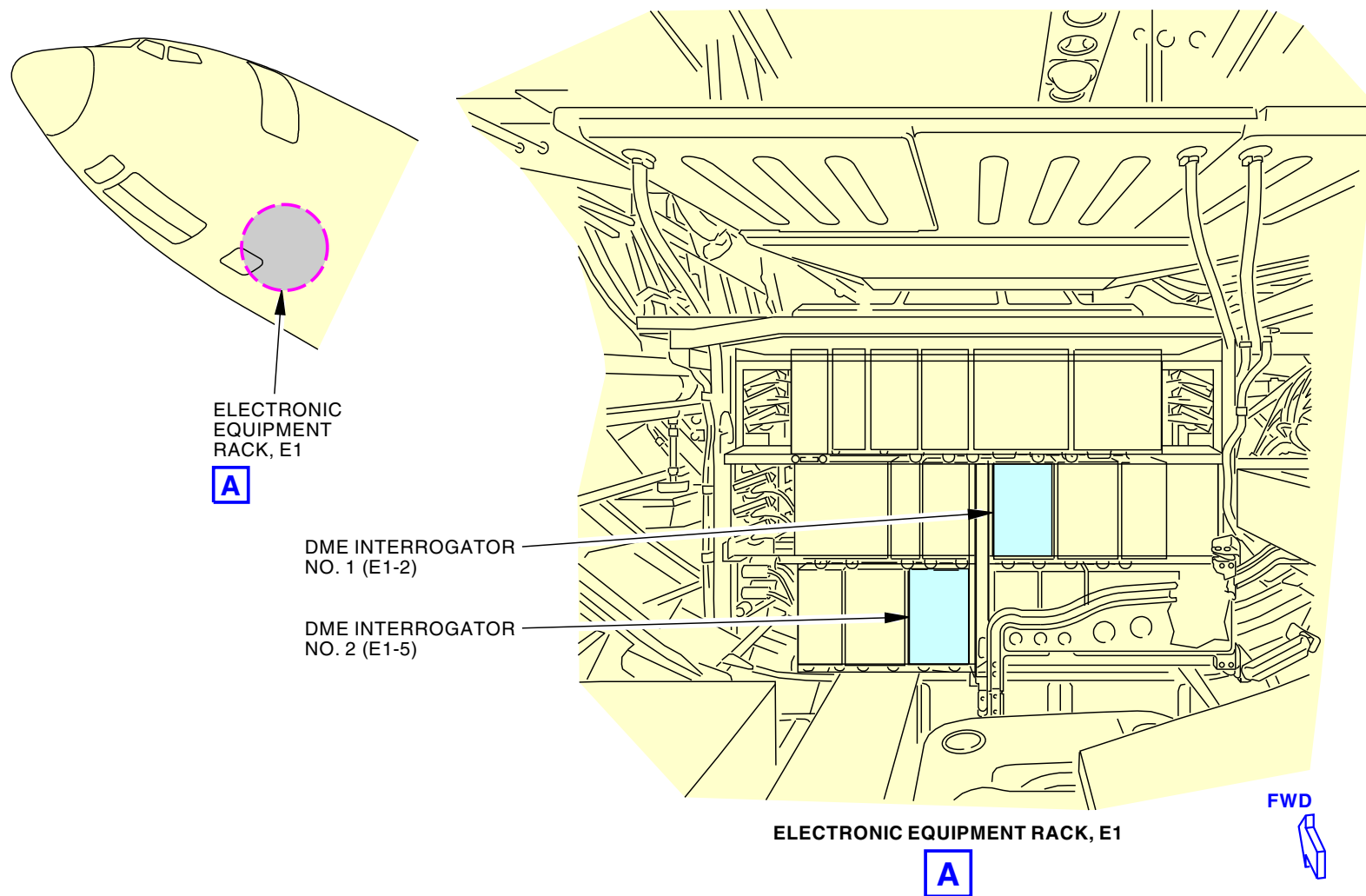
- DME 1 interrogator
- DME 2 interrogator.

These components are on the exterior of the airplane:

- DME 1 antenna
- DME 2 antenna.

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DME SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNAS



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DME SYSTEM - COMPONENT LOCATION - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNAS

34-55-00



DME SYSTEM - ARINC 429 INTERFACES

Navigation Control Panel

The navigation control panels supply a manual tune frequency input to the DME interrogator. They also send four auto tune frequency inputs from the Flight Management Computer (FMC).

The control panels send tune and test data on two output data buses. One output data bus goes to the MMR receiver and one output data bus goes to both the DME interrogator and VOR receiver.

DME Outputs

Each DME interrogator has two output buses. One output bus supplies data to the on-side flight control computer (FCC). DME 1 sends data to FCC A and DME 2 sends data to FCC B. the other Output bus supplies data to these units:

- Flight management computer system (FMCS)
- Display processing computer (DPC) 1 and 2
- Flight data acquisition unit (FDAU).

The FMCS uses DME distance to calculate position updates.

The DPCs use DME distance for displays.

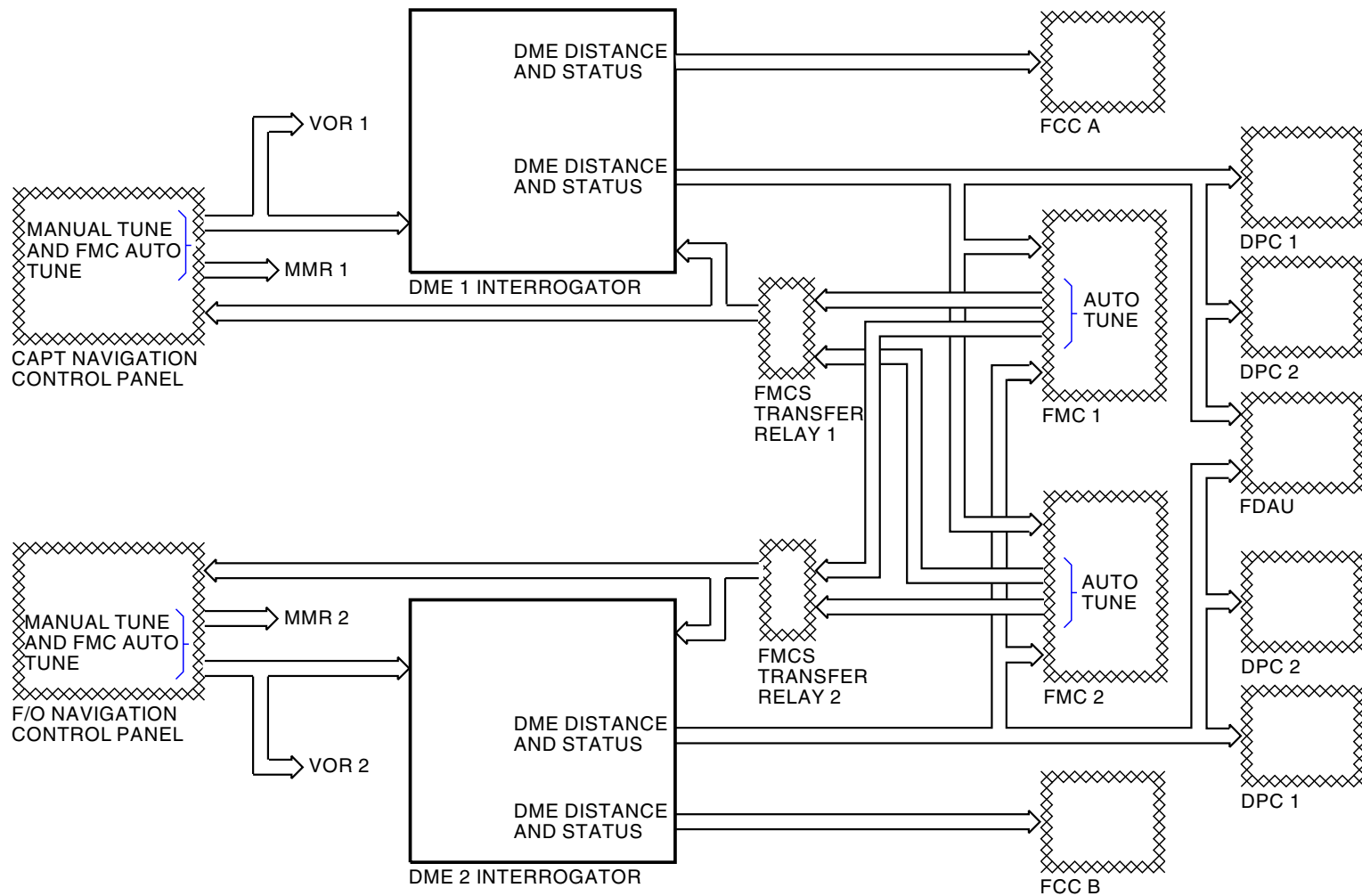
The FDAU receives DME distance and formats it for the flight data recorder.

Flight Management Computer

The FMC supplies auto tune commands through the navigation control panel to the DME interrogator. If the navigation control panel has a failure, the DME gets auto tune signals directly from the FMC.

EFFECTIVITY	
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DME SYSTEM - ARINC 429 INTERFACES



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DME SYSTEM - ARINC 429 INTERFACES

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34-55-00

**DME SYSTEM - POWER, ANTENNA, ANALOG, AND DISCRETE INTERFACE****Power Interface**

Each DME interrogator receives 115v ac from the DME circuit breakers.

DME Antenna Interface

The DME antennas transmit and receive DME signals. The antennas transmit signals to the ground stations. They then receive the reply signals from the DME ground station and send them to the interrogator.

Source Select Discrete

The source select discrete controls the ARINC 429 receive ports in the DME interrogator. With the source select open, the DME interrogator gets manual and auto tune commands from the navigation control panel. If the navigation control panel has a failure, the source select discrete goes to ground. The DME then gets auto tune signals directly from the FMC.

PSEU

The proximity switch electronics unit (PSEU), supplies an air/ground discrete inputs to the DME interrogators to set flight leg count. The air/ground discrete also goes to the navigation control panels to inhibit test commands in the air.

Default Scan Inhibit Discrete

The default scan inhibit discrete locks the DME interrogator so it can not make a scan of all the DME frequencies. It tunes to five channels controlled by the navigation control panel and the flight management computer.

DME/ATC/TCAS Suppression

These systems operate in the same frequency band:

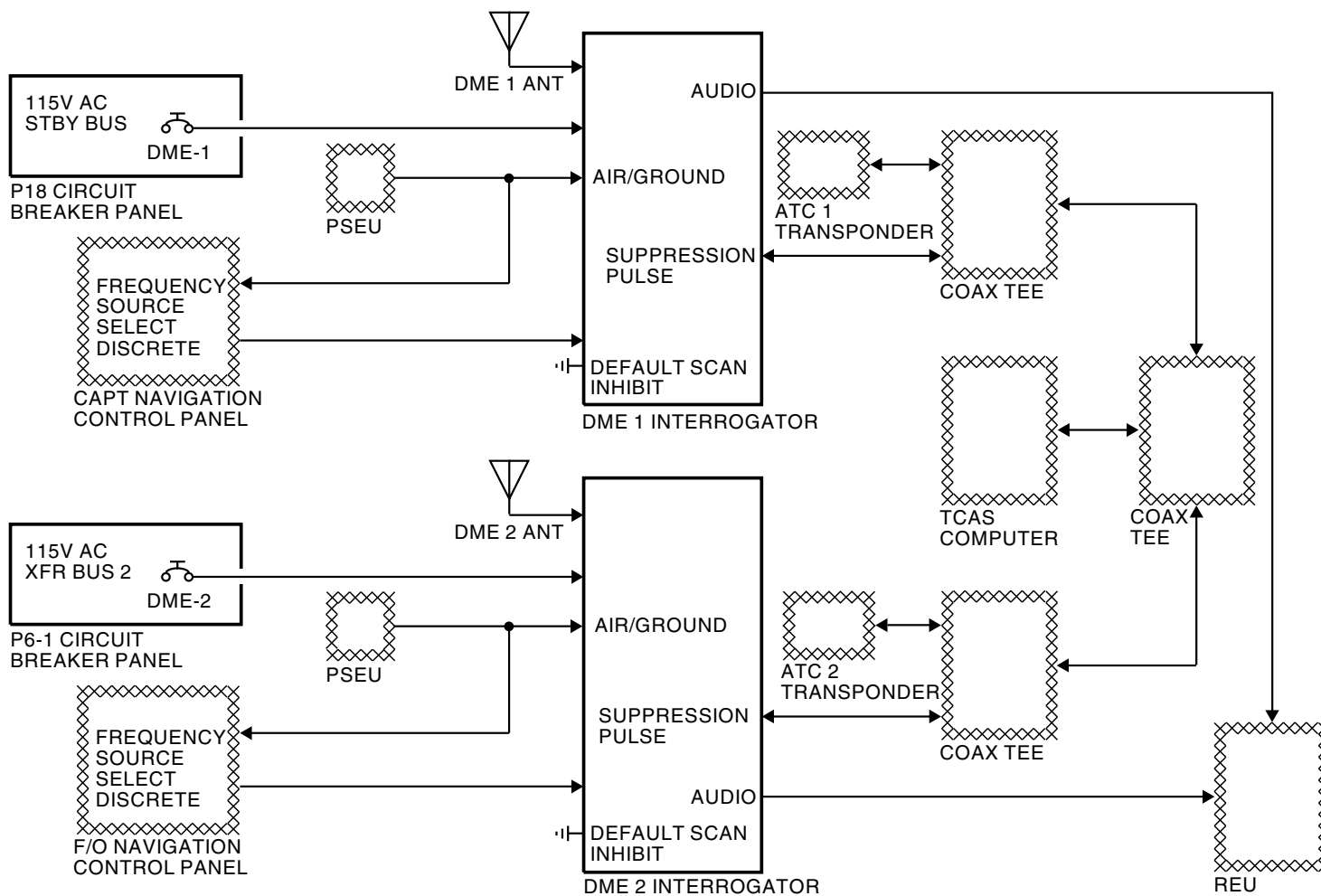
- DME
- Air traffic control (ATC)
- Traffic alert and collision avoidance system (TCAS).

When a DME interrogator, an ATC transponder, or the TCAS computer transmits, it sends a suppression pulse through the suppression lines. This pulse stops the reception of the other four units. This prevents damage to the receiver circuits of the other LRUs.

DME Audio

The DME interrogator sends the DME station audio identifier to the remote electronics unit (REU). The audio goes to the headsets and the flight interphone speakers.

DME SYSTEM - POWER, ANTENNA, ANALOG, AND DISCRETE INTERFACE



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DME SYSTEM - POWER, ANTENNA, ANALOG, AND DISCRETE INTERFACE

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SIA ALL

EFFECTIVITY

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D633AM102-SIA

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DME SYSTEM - INTERROGATOR

General

The DME interrogator tunes to 252 channels and calculates distance information for all the channels in the DME range. There are 200 DME channels for the VHF NAV frequencies. The other 52 channels are for military TACAN functions. The DME receive frequency is 63 MHz above or below the transmit frequency.

Purpose

These are the purposes of the DME interrogator:

- Interrogate DME stations
- Receive the station replies
- Receive audio identifiers
- Calculate slant range distances.

Frequencies

These DME tuning frequencies are in the VHF band:

- 108.00 to 117.95 MHz for DME stations with VOR or ILS
- 133.30 to 135.95 MHz for DME only stations.

Front Panel

The front panel of the DME interrogator has these features:

- LED status indicators
- A self test switch.

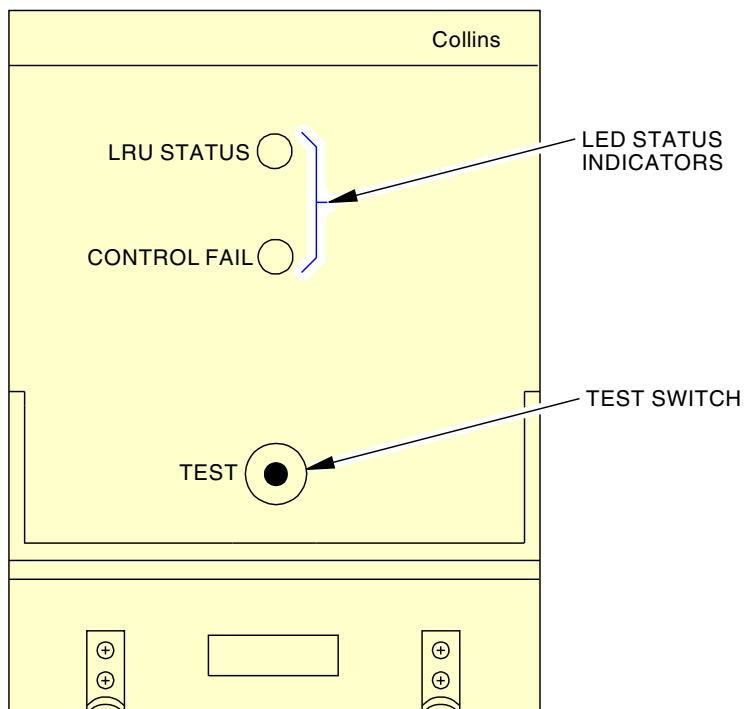
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DME SYSTEM - INTERROGATOR



2525249 S0000595885_V1

DME SYSTEM - INTERROGATOR

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DME SYSTEM - ANTENNA

General

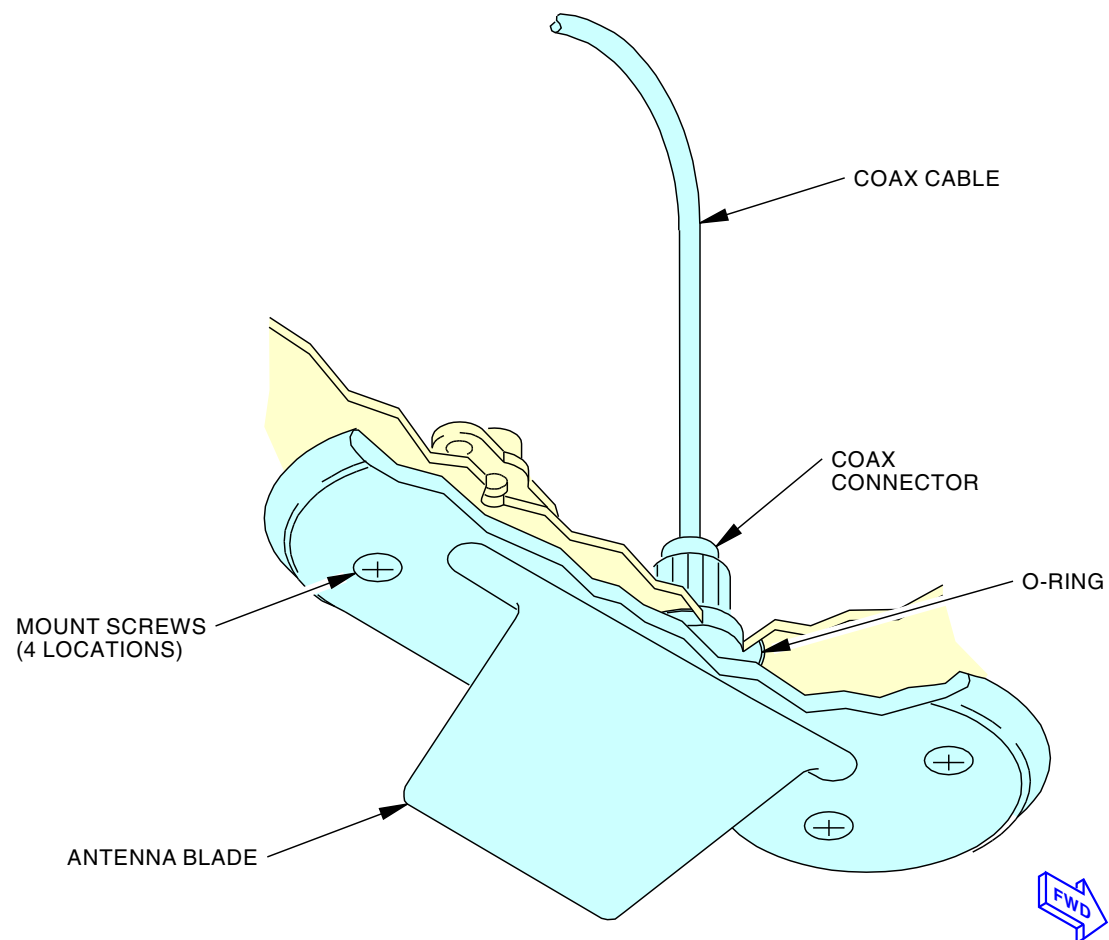
The L-band DME antenna transmits the interrogator output signal and receives the ground station reply and identification signals.

Physical Description

The antenna has an o-ring moisture seal and attaches to the airplane with four screws. The DME and the ATC antennas are the same and are interchangeable.

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DME SYSTEM - ANTENNA



2370073 S00061520924_V2

DME SYSTEM - ANTENNA

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SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



DME SYSTEM - NAVIGATION CONTROL PANEL

General

The navigation (NAV) control panels supply frequency inputs and test commands to these navigation radios:

- DME
- ILS
- VOR.

When you put a paired VOR or ILS frequency into the navigation control panel, it also goes to the DME interrogator. The DME tunes a DME frequency in the range of 108MHz to 117.95MHz.

Set the frequency on the navigation control panel for these audio outputs:

- VOR and DME station identification
- ILS and DME station identification.

Operation

The NAV control panels have an active mode frequency/channel indicator and a standby mode frequency/channel indicator. The mode frequency/channel that shows in the active frequency/channel indicator is the mode frequency/channel the navigation radios use for operation. The standby mode frequency/channel indicator shows the next frequency/channel you will use.

The mode frequency/channel transfer button is a momentary action button. It transfers the mode frequency/channel in the standby frequency/channel indicator to the active frequency/channel indicator. When you push the button, the frequency/channel in the active frequency/channel indicator transfers to the standby frequency/channel indicator.

The MODE Select buttons are used to select one of the modes available (ILS, VOR, MLS, or GLS).

The numeric key pad (keys 0 thru 9) is used to set the frequency/channel in the standby frequency/channel indicator.

The CLR button is used to erase one, several, or all digits of a frequency or channel value shown in the STBY display. If the CLR button is pushed for less than one second, only one digit is erased. If the CLR button is pushed for more than 1 second, the whole value shown in the STBY display is erased and replaced with underscores (_ _ _ _ _).

At power up, the frequency displays show the last frequency entry before power down.

The NAV control panel continuous BITE function monitors the operation. The NAV control panel shows PNL FAIL in the active and the standby frequency indicators when there is a control panel failure.

An internal monitor in the NAV control panel monitors the 28v dc input. If the monitor does not see the 28v dc, it shows the message BLANK in the active and the standby frequency indicators.

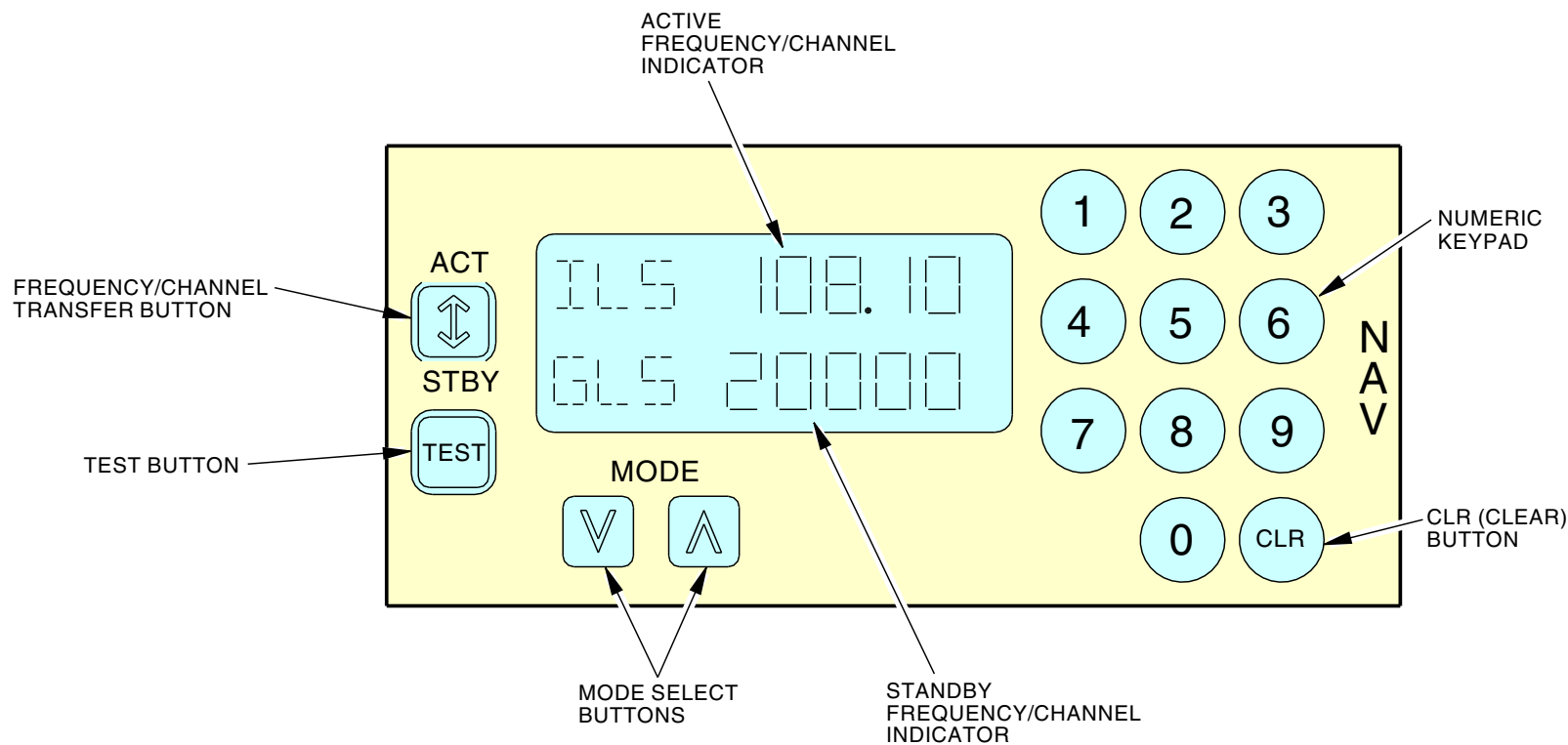
Test

When you push the NAV control panel test button, a test command goes out on the data bus. If a VOR frequency is active, the VOR receiver starts a self test. If an ILS frequency or a GLS channel is active, the MMR receiver starts a self test. If a DME frequency is paired with the VOR or ILS frequency, the DME interrogator starts a self test at the same time.

When you do a test of the master dim and test system, the NAV control panel shows 888.88. The display shows for two seconds on, then one second off until the test is complete.

EFFECTIVITY	
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DME SYSTEM - NAVIGATION CONTROL PANEL



2537379 S0000602217_V1

DME SYSTEM - NAVIGATION CONTROL PANEL

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**DME SYSTEM - OPERATION - CONTROLS****General**

The audio control panels (ACP) permit the crew to hear the DME station identification signals. The identification signals are 1350 Hz.

The EFIS control panel mode selector switch selects the NAV display modes that show DME distance.

Audio Controls

Set these controls on the audio control panel to listen to DME audio:

- Push ON the NAV receiver volume control (NAV 1 for DME 1 and NAV 2 for DME 2)
- Select B (both) or R (range) on the voice range filter switch
- Set the NAV receiver volume control.

The voice/range selector permits you to hear DME audio. You will hear the DME audio when the voice/range selector is in the R or B position.

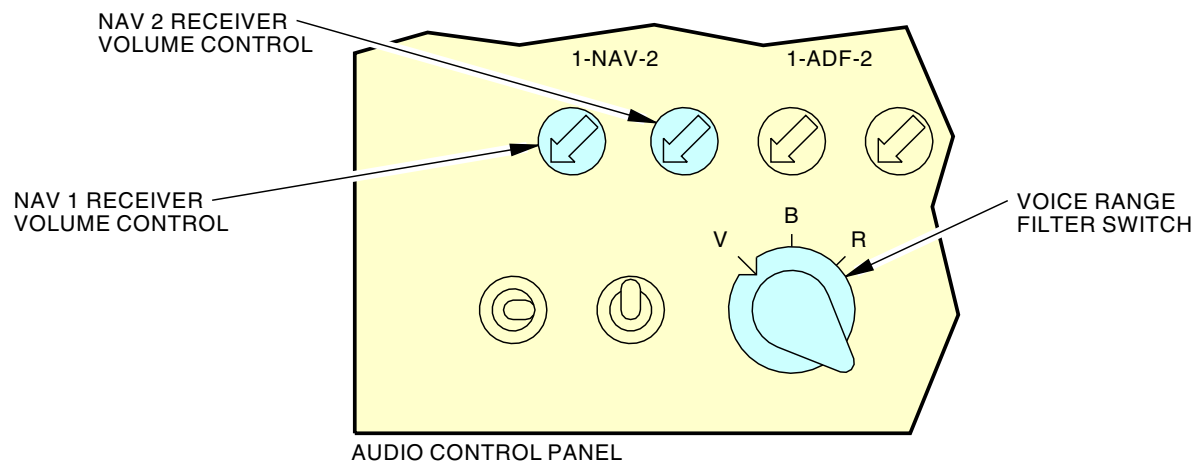
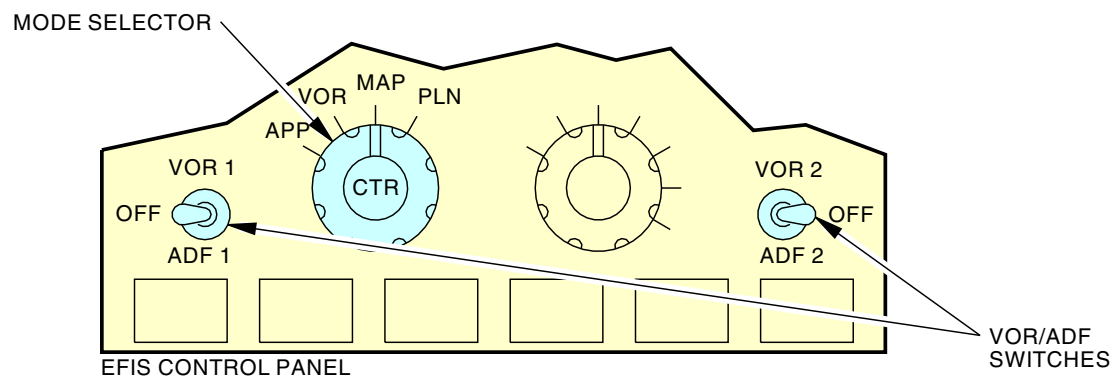
EFIS Controls

The EFIS control panel mode selector switch must be in the VOR/ILS position to show DME distance on the top right of the ND.

You put the VOR/ADF 1 switch to VOR 1 to show DME 1 in the lower left corner of the ND. DME 2 shows in the lower right corner of the ND when the VOR/ADF 2 switch is put to VOR 2.

EFFECTIVITY	
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DME SYSTEM - OPERATION - CONTROLS



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DME SYSTEM - OPERATION - CONTROLS

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DME SYSTEM - DISPLAY

Normal PFD Display

The left PFD shows DME 1 data. The right PFD shows the DME 2 data. The DME distance display shows in white letters and numbers.

Normal ND Display

DME distance shows on the top right corner of these ND displays:

- Expanded and centered VOR
- Expanded and centered ILS.

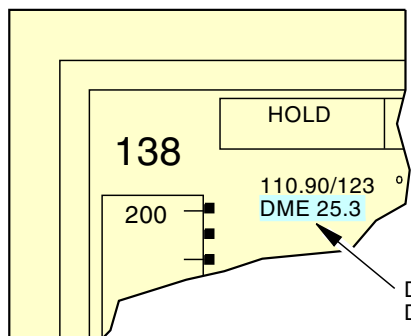
The DME also shows in the lower left (VOR 1) and the lower right (VOR 2) corner of the ND if you select VOR on the EFIS control panel.

DME NCD or Failed Displays

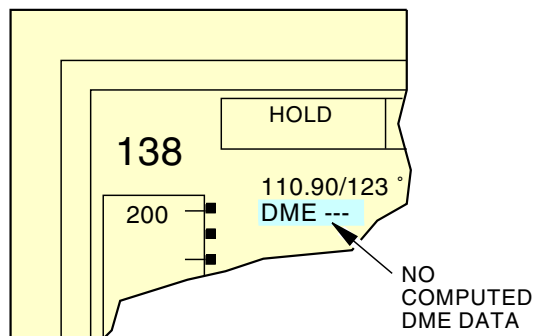
White dashes replace numbers when the DME distance is no computed data (NCD). If the DME has a failure, an amber DME flag replaces the DME distance. The NCD and fail flag show in amber.

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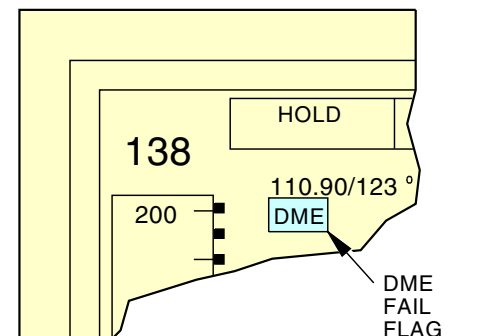
DME SYSTEM - DISPLAY



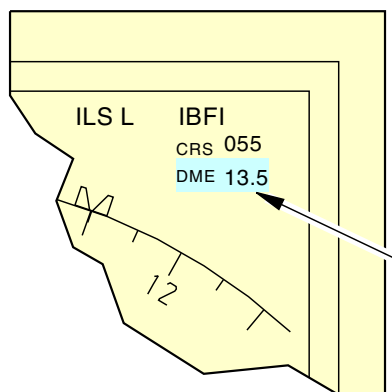
NORMAL PFD DISPLAY



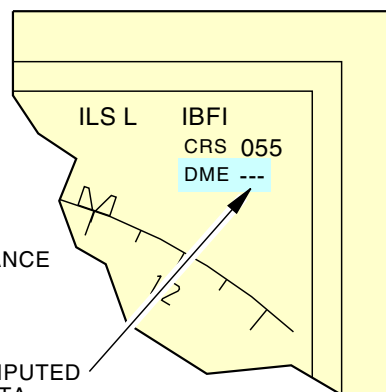
DME PFD NCD DISPLAY



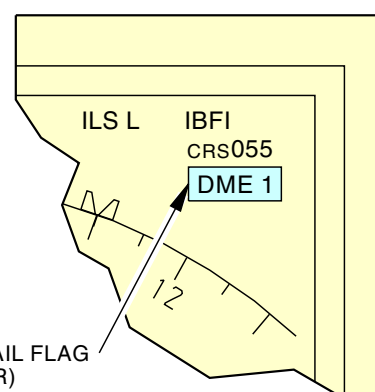
DME PFD FAIL DISPLAY



NORMAL ND DISPLAY



DME ND NCD DISPLAY



DME ND FAIL DISPLAY

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DME SYSTEM - DISPLAY

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SIA ALL

EFFECTIVITY

D633AM102-SIA

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34-55-00



DME SYSTEM - FUNCTIONAL DESCRIPTION

Normal Tune Input

The navigation control panel is the normal source for tune inputs. The flight management computer (FMC) sends up to four channels of auto tune signals to the navigation control panel. The navigation control panel adds one manual channel and sends five tune channels to the DME interrogator.

Alternate Tune Input

If the navigation control panel has a failure, the FMC sends auto signals directly to the DME interrogator.

Discrete Inputs

When the navigation control panel has a failure, it grounds a source select discrete to the DME central processing unit (CPU). The CPU changes the input from the navigation control panel to the FMC.

The proximity switch electronics unit (PSEU) supplies an air/ground discrete to prevent a DME test when the aircraft is in the air. The discrete also supplies flight leg data.

Operation

The CPU uses tune inputs to tune the frequency synthesizer. The CPU gives a signal to the transmitter to send interrogation pulses. The transmit pulses go through a circulator then to the DME antenna.

The transmitter sends a signal to the suppression circuits. During a transmission, the suppression circuit in the DME 1 interrogator sends a suppression pulse to these units:

- DME 2 interrogator
- ATC 1 and 2 transponders (XPNDR)
- TCAS computer.

The suppression pulse stops receiver operation in the other LRUs to prevent damage to internal circuits.

Receive

The circulator sends the RF pulse pairs it receives from the antenna to the receiver. The receiver sends the pulse pair to the CPU. The CPU calculates the slant range distance. It uses the time it takes to transmit pulse pairs and get a reply from the ground station. When another L-band system transmits, a suppression pulse stops the receiver operation.

Interrogator Output

After the CPU calculates slant range distance, the CPU sends it to two ARINC 429 transmitters. One ARINC 429 transmitter sends the range data to the DPCs for the flight deck displays and to other systems. A second ARINC 429 transmitter sends range data to the flight control computer. The CPU sends the pulse pairs to the pulse pair decoder. The decoder sends the DME audio to the REU.

Bite Module

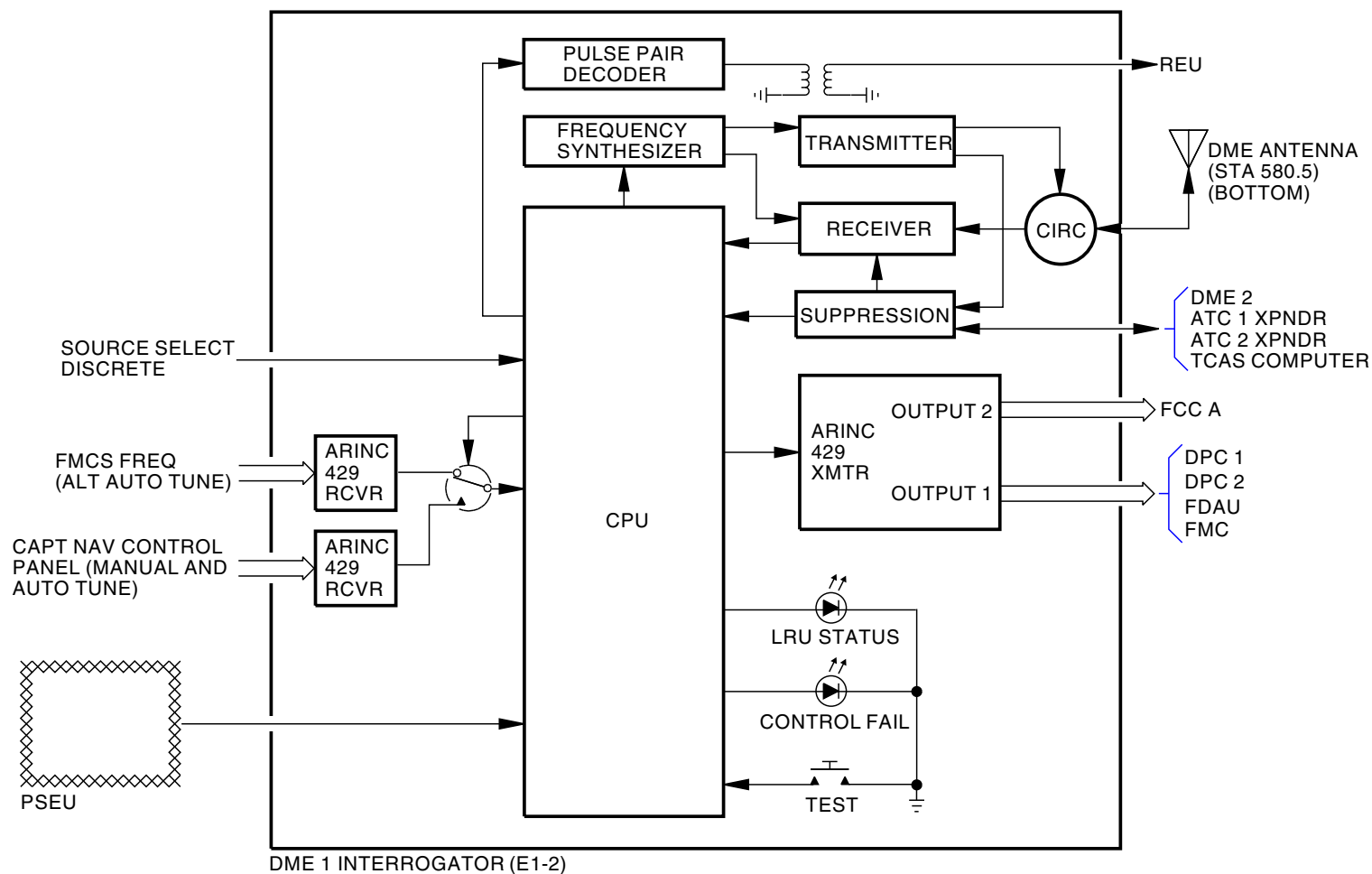
The built-in test equipment (BITE) in the CPU monitors the circuits in the DME interrogator for faults. The fault memory in the DME keeps the number of faults per flight. Shop personnel can read the fault memory contents.

Test

The CPU does a test of the interrogator when it receives a test command from the navigation control panel. You can also push the test switch on the front panel of the interrogator. The LEDs on the front panel of the interrogator do not show during the navigation control panel test.

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DME SYSTEM - FUNCTIONAL DESCRIPTION



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DME SYSTEM - FUNCTIONAL DESCRIPTION

**DME SYSTEM - SELF TEST****Self Test**

Push the test switch on the DME interrogator to start a DME self-test.

Front Panel Displays

The LED status indicators go through this sequence:

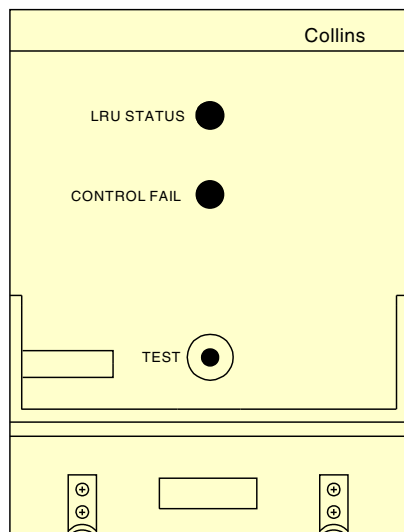
- The LRU status and control fail LEDs come on red for two seconds.
- The LRU status LED changes to green.
- All LEDs go off for two seconds.
- The applicable LEDs come on to show the LRU status.

The red CONTROL FAIL LED shows when the tuning source is invalid.

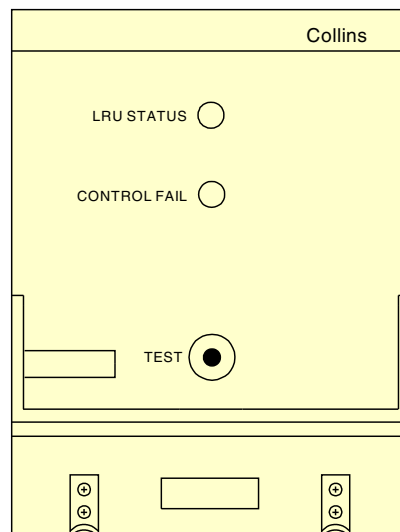
The LRU STATUS LED shows interrogator test results. The LRU STATUS LED shows green for a good test or it shows red for a test failure.

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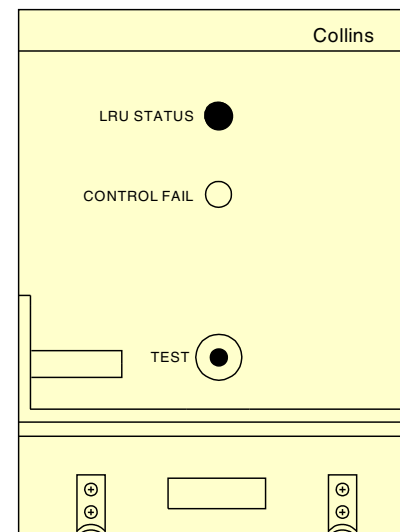
DME SYSTEM - SELF TEST



[1] CONTROL INPUT LED COMES ON RED, LRU STATUS LED FIRST COMES ON RED THEN CHANGES TO GREEN



[2] ALL LED(S) GO OUT FOR TWO SECONDS



[3] APPLICABLE LED(S) COME ON TO SHOW THE LRU STATUS

2525296 S0000595918_V2

DME SYSTEM - SELF TEST

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**DME SYSTEM - TEST DISPLAY****General**

During a ground test or a self test, the display units show these indications:

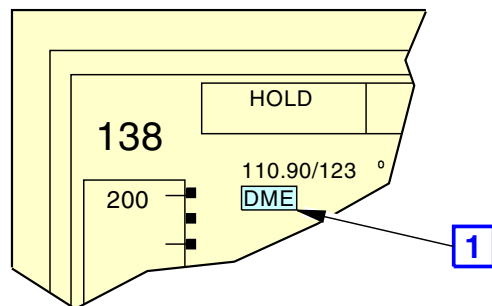
- The DME fail condition for two seconds
- The DME NCD condition for the next two seconds
- The DME normal condition to end the test.

The DME normal condition is the distance that shows before the test starts.

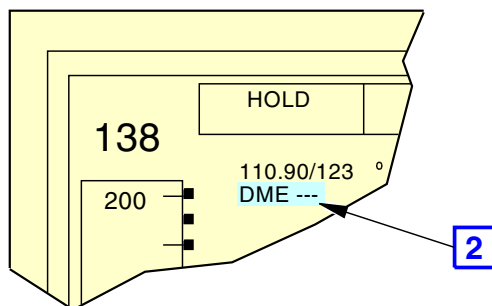
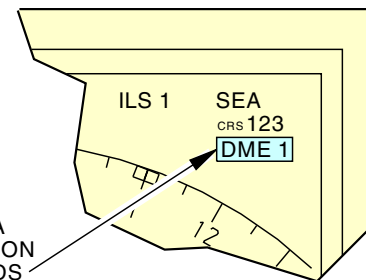
DME indications also show in the lower left (VOR 1) and lower right (VOR 2) corner of the ND when you select VOR on the VOR/ADF switches on the EFIS control panels.

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D633AM102-SIA	

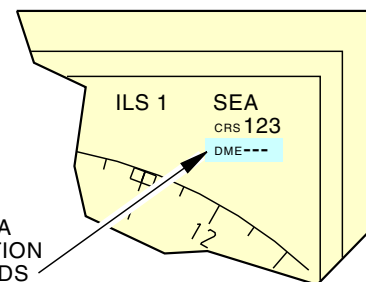
DME SYSTEM - TEST DISPLAY



DISPLAYS SHOW A DME FAIL CONDITION FOR TWO SECONDS



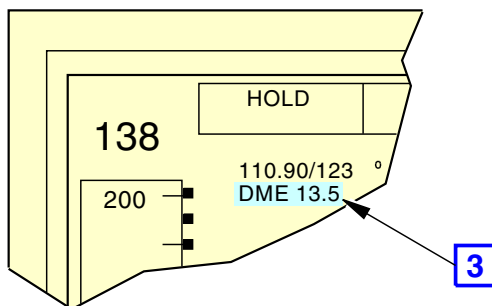
DISPLAYS SHOW A DME NCD CONDITION FOR TWO SECONDS



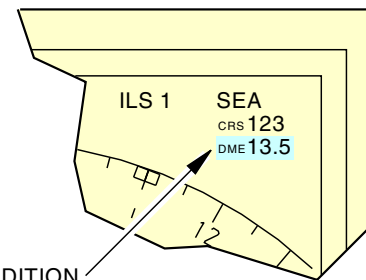
NOTE:

THE GRAPHIC SHOWS A TEST DISPLAY OF DME INTERROGATOR 1 ON THE CAPTAIN PFD AND ND WITH THE APP MODE SELECTED ON THE EFIS CONTROL PANEL. THE TEST IS THE SAME FOR DME INTERROGATOR 2 ON THE FIRST OFFICER DISPLAYS.

YOU CAN ALSO SEE THE DME TEST ON THE ND IN THE VOR DISPLAY MODE.



DISPLAYS SHOW A NORMAL DME CONDITION



ND - ILS MODE

2370079 S00061520936_V2

PFD

DME SYSTEM - TEST DISPLAY

EFFECTIVITY

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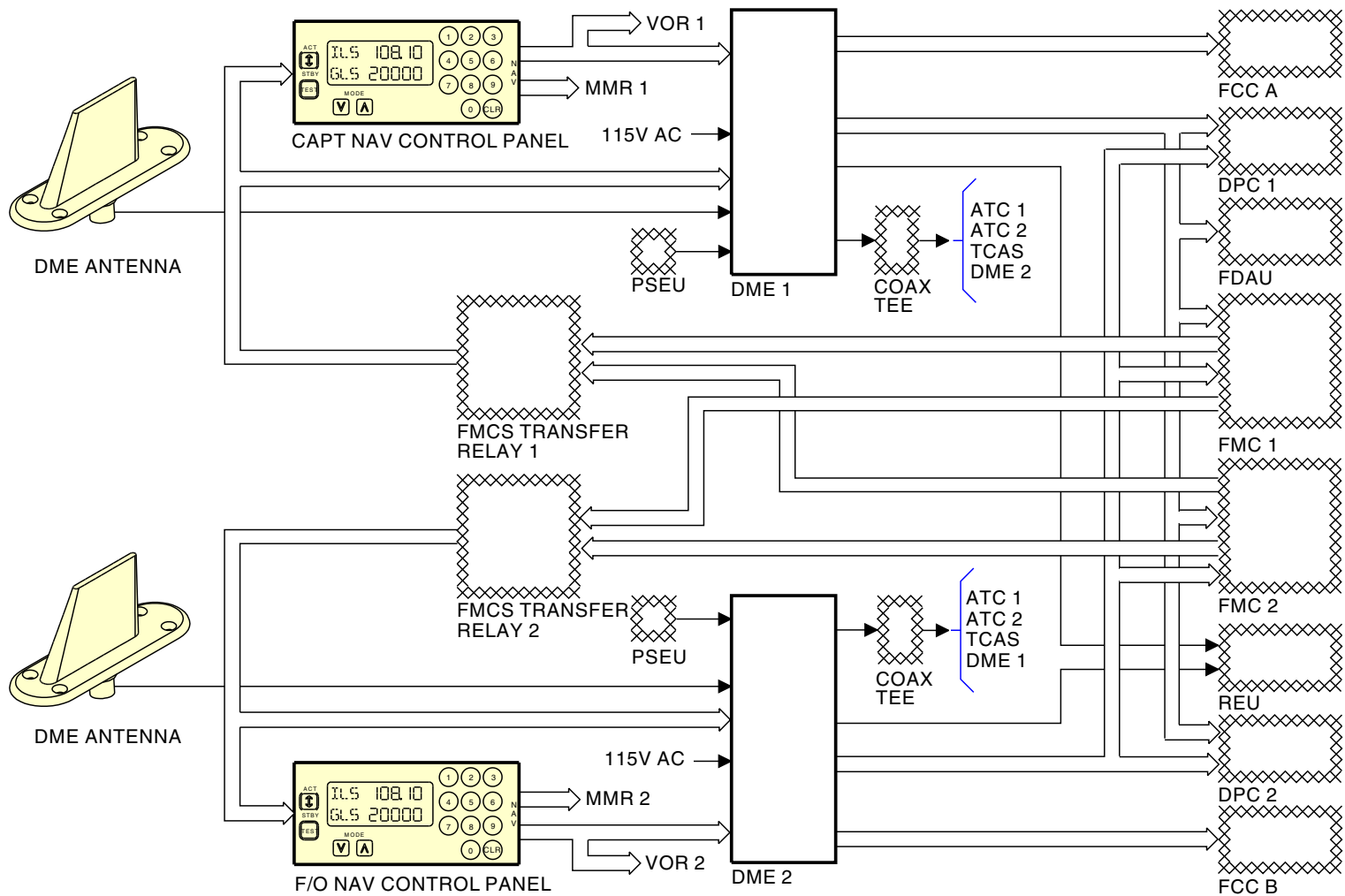
DME SYSTEM - SYSTEM SUMMARY

General

This page is for reference.

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DME SYSTEM - SYSTEM SUMMARY



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DME SYSTEM - SYSTEM SUMMARY

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**AUTOMATIC DIRECTION FINDER SYSTEM - INTRODUCTION****Purpose**

The automatic direction finder (ADF) system is a navigation aid. The ADF receiver uses amplitude modulated (AM) signals from ground stations to calculate the bearing to the ADF station from the airplane longitudinal axis. The ADF system also receives standard AM radio broadcasts.

- xmtr - transmitter

Abbreviations and Acronyms

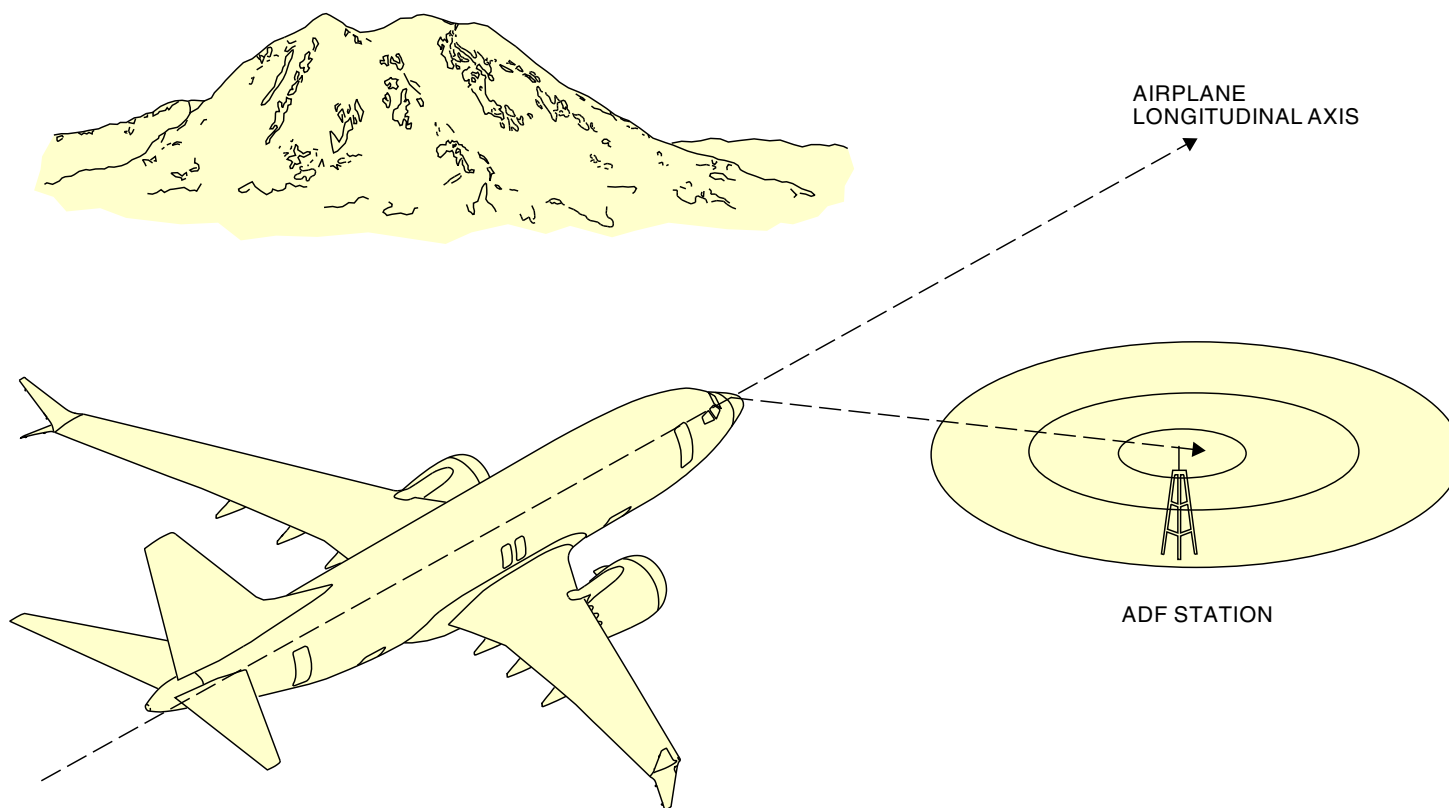
- AC - alternating current
- ACP - audio control panel
- ADF - automatic direction finder
- AM - amplitude modulation
- ant - antenna
- app - approach
- ARINC - Aeronautical Radio, Inc.
- BFO - beat frequency oscillator
- Capt - captain
- DC - direct current
- DPC - display processing computer
- EFIS - electronic flight instrument system
- F/O - first officer
- gnd - ground
- Hz - hertz
- LCD - liquid crystal display
- LRU - line replaceable unit
- nav - navigation
- NCD - no computed data
- QEC - quadrantal error correction
- RBL - right buttock line
- sta - station
- V - volts
- VOR - VHF omnidirectional ranging

34-57-00**SIA ALL EFFECTIVITY**

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AUTOMATIC DIRECTION FINDER SYSTEM - INTRODUCTION



2534689 S0000600500_V2

AUTOMATIC DIRECTION FINDER SYSTEM - INTRODUCTION

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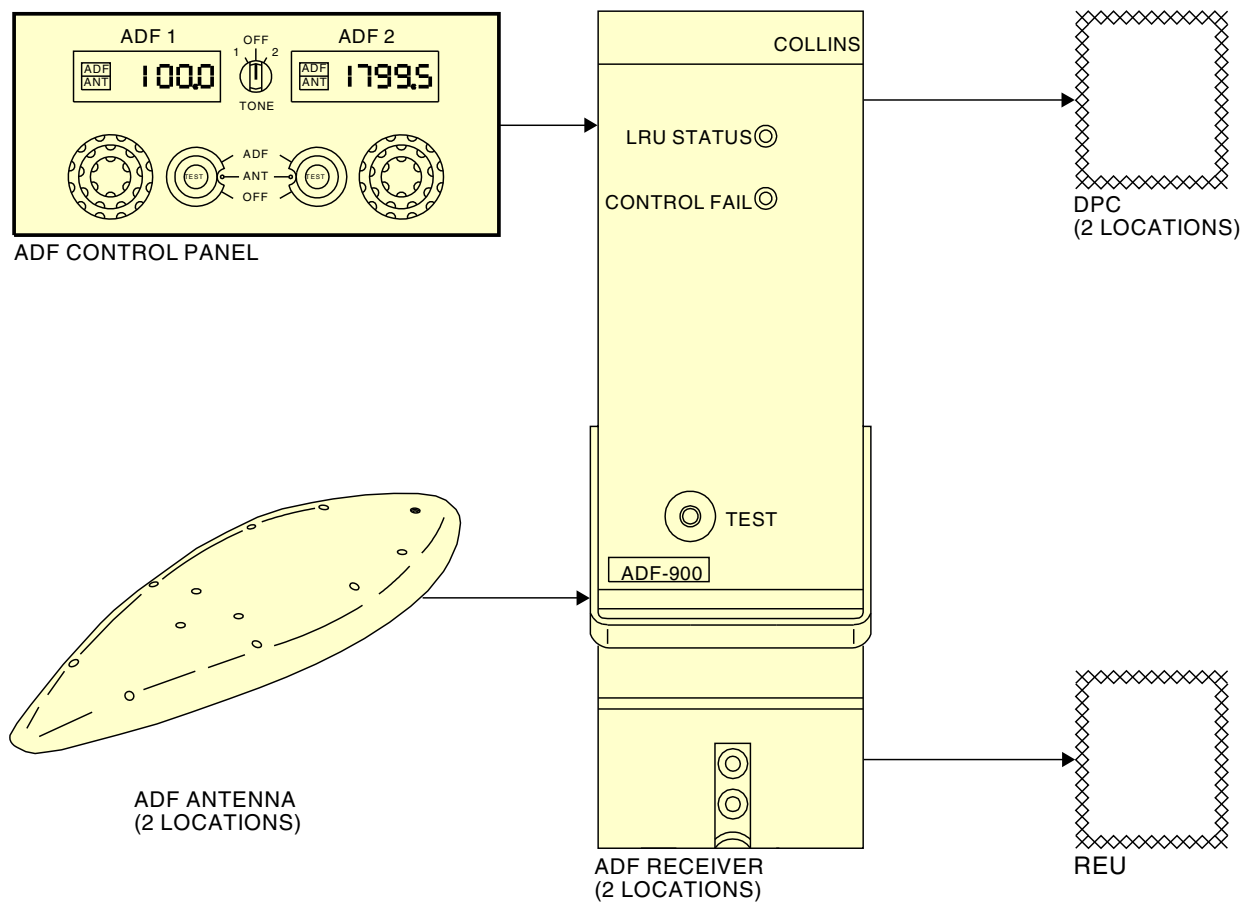
**ADF SYSTEM - GENERAL DESCRIPTION****Description**

The ADF control panel supplies manual tune inputs to the ADF receivers. The ADF antenna assemblies contain the loop antennas and the sense antennas. There are two ADF antennas, one for ADF receiver 1 and one for ADF receiver 2.

The ADF receiver calculates the bearing to the ADF ground stations and sends it to the DPCs for display. The ADF receiver processes audio from the ground stations and sends it to the remote electronics unit (REU).

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ADF SYSTEM - GENERAL DESCRIPTION



2534798 S0000600526_V2

ADF SYSTEM - GENERAL DESCRIPTION

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ADF SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

ADF System Components

The ADF control panel is on the P8 aft electronics panel.

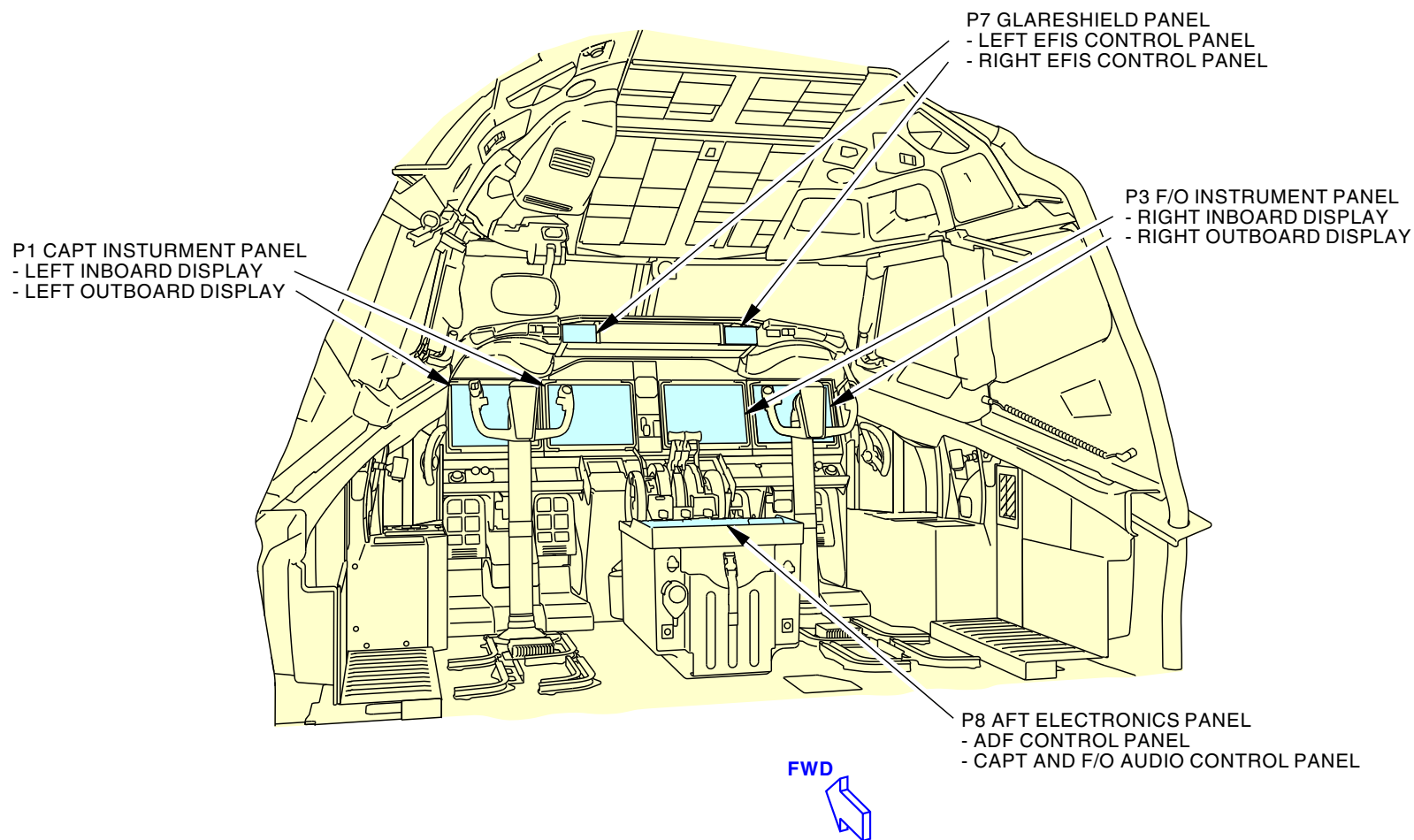
Interface Components

These flight compartment components have an interface with the ADF system.

- Left and right EFIS control panels
- Left inboard and outboard display units
- Right inboard and outboard display units
- Capt and F/O audio control panels.

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ADF SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION



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ADF SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

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ADF SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNA COMPONENT LOCATIONS

Electronic Equipment Compartment

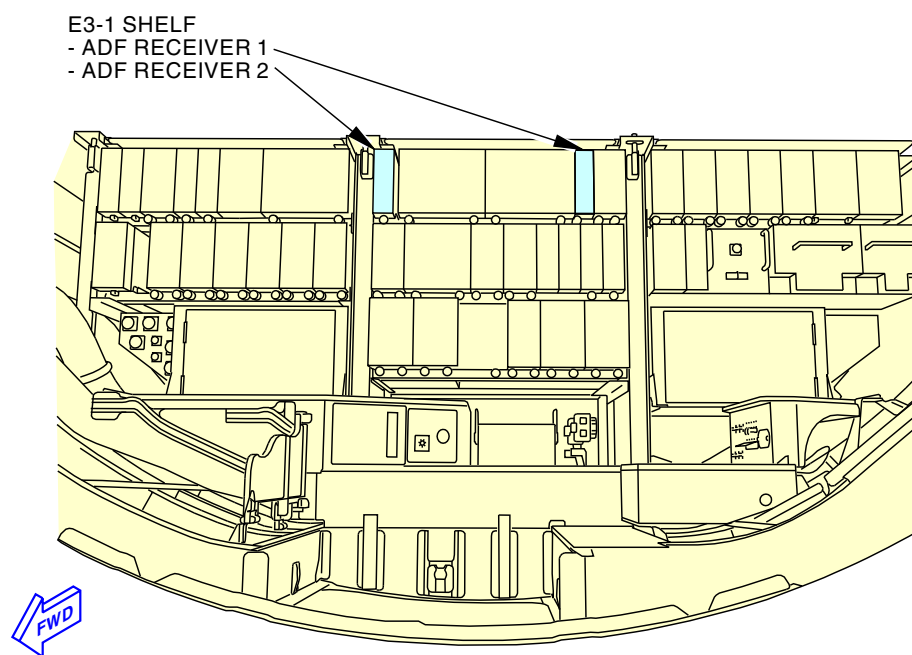
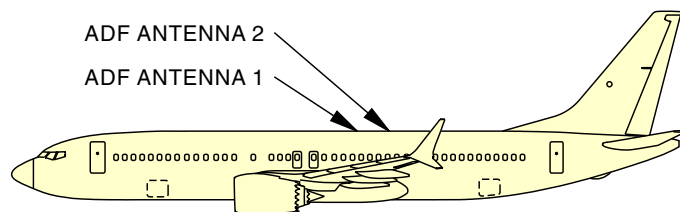
ADF receiver 1 and ADF receiver 2 are in the electronic equipment compartment on the E3-1 shelf.

ADF Antenna

The ADF antennas are on the top of the fuselage. ADF antenna 1 is at fuselage station 694, and ADF antenna 2 is at fuselage station 727.

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ADF SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNA COMPONENT LOCATIONS



ELECTRONIC EQUIPMENT COMPARTMENT

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ADF SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNA COMPONENT LOCATIONS

**ADF SYSTEM - POWER AND ANALOG INTERFACE****Power**

115v ac power from the ADF circuit breakers go to the ADF control panel. The ADF control panel uses the 115v ac power for operation. The ADF control panel sends 115v ac power to the ADF receivers for operation. The ADF receivers send 12v dc power to the ADF antennas for operation.

PSEU

The proximity switch electronics unit (PSEU) supplies an air/ground discrete input to the ADF receiver. The ADF receiver uses the air/ground input to calculate the flight leg count for the internal memory.

ADF Antenna

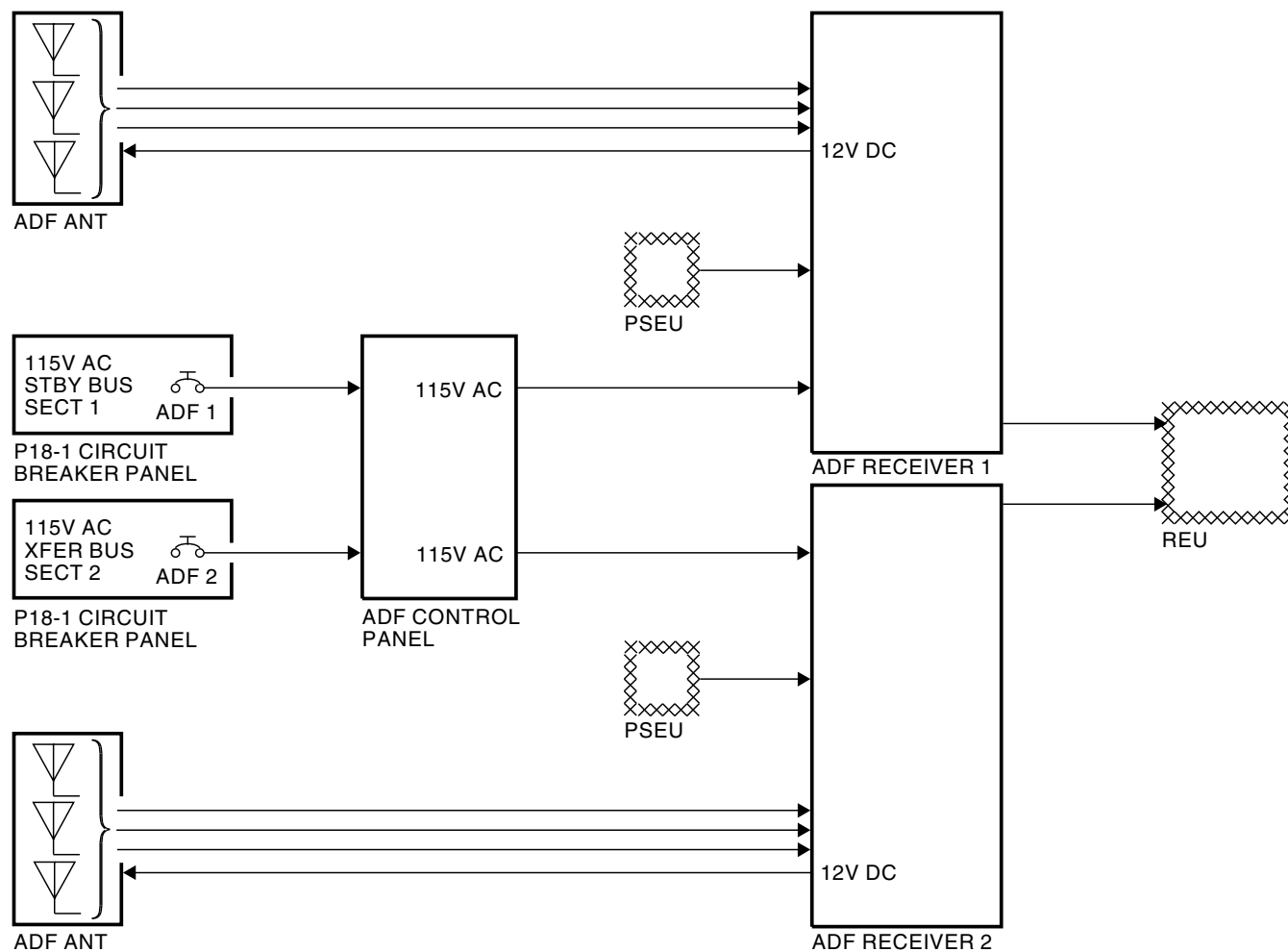
The ADF antenna assembly contains the loop antennas and the sense antenna. The antenna assembly also contains signal amplifiers for the loop and the sense antenna. The loop antennas supply direction data and the sense antenna supplies station audio.

REU

The ADF receiver sends station audio to the remote electronics unit (REU). The REU sends the station audio to the flight compartment headsets and speakers.

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ADF SYSTEM - POWER AND ANALOG INTERFACE



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ADF SYSTEM - POWER AND ANALOG INTERFACE

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ADF SYSTEM - DIGITAL INTERFACE

General

The ADF receivers have an interface with the processing computers (DPCs). The interface is on ARINC 429 data buses.

ADF Control Panel

The ADF control panel sends tune frequency inputs to the ADF receiver. The ADF control panel sends a data word that contains the ADF mode or ANT mode selection. The ADF control panel sets a bit that enables ADF receiver beat frequency oscillator (BFO) operation when you turn on the tone selector.

Digital Output

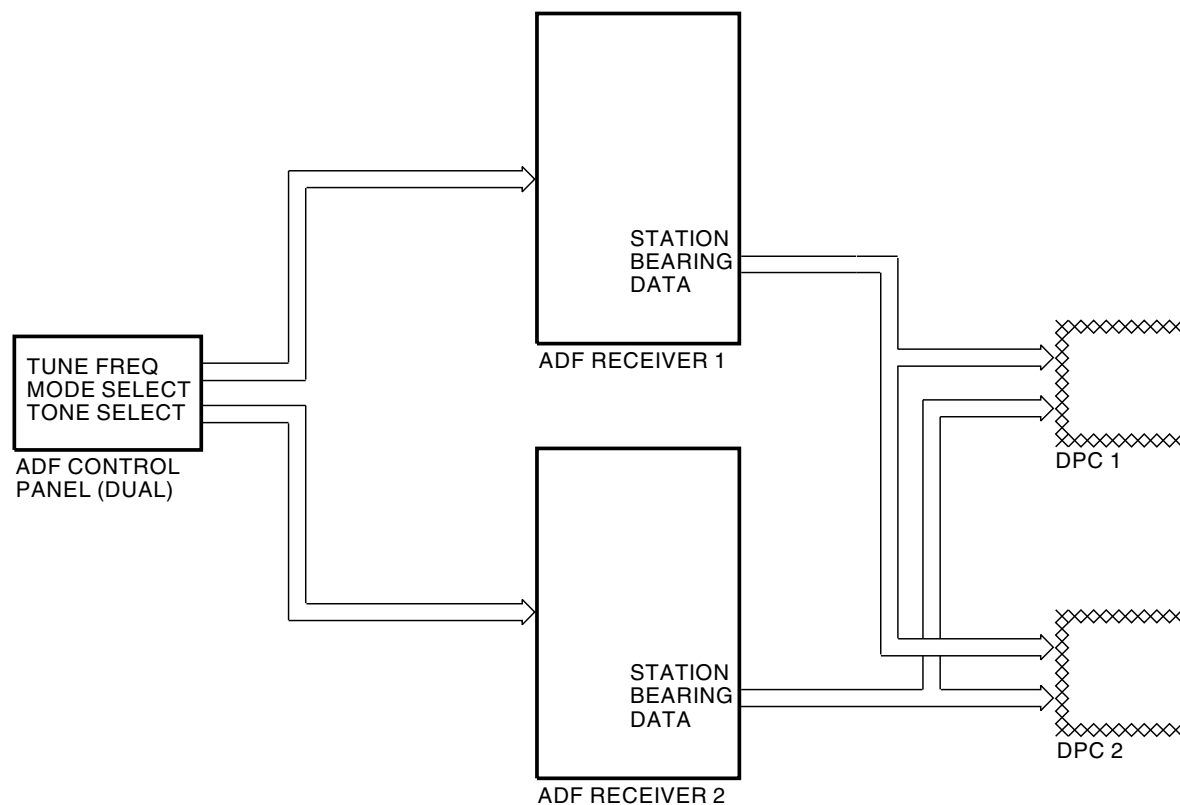
The ADF receiver sends this data on one output data bus:

- ADF station bearing
- Test signals
- Receiver condition.

The DPCs use this data for display.

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ADF SYSTEM - DIGITAL INTERFACE



2534953 S0000600608_V2

ADF SYSTEM - DIGITAL INTERFACE

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EFFECTIVITY

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**ADF SYSTEM - RECEIVER****Purpose**

The ADF receiver calculates bearing to a station that transmits in the frequency range of 190 Khz to 1750 Khz. The receiver also receives station identifiers and AM broadcasts.

Description

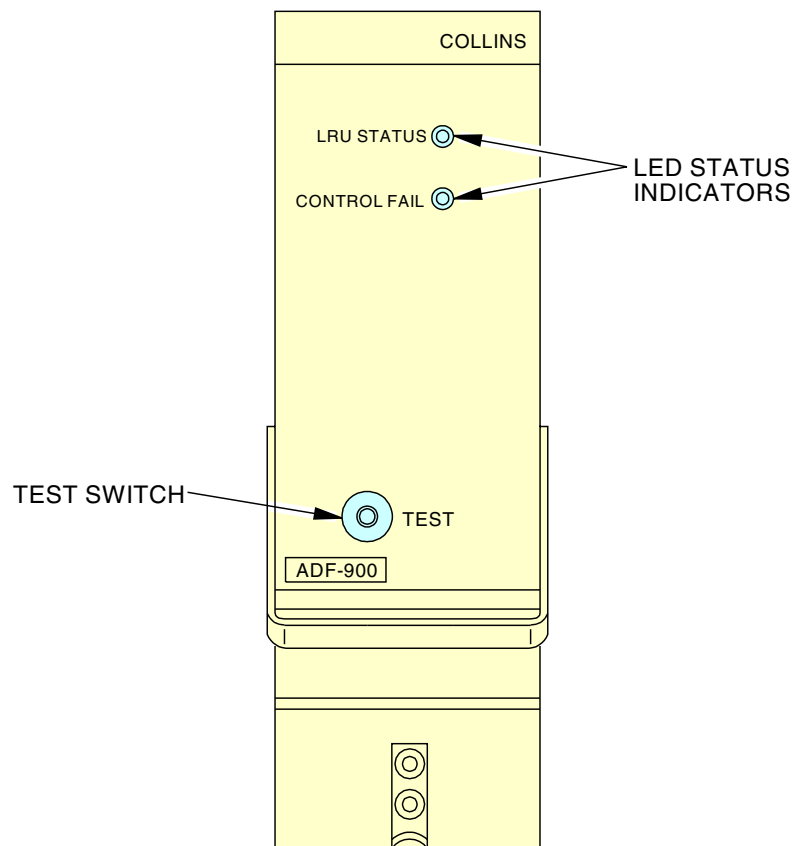
The ADF receiver is a standard ARINC 600 3 MCU unit with dimensions approximately 3.7 in. x 7.9 in. x 14.8 in. The receiver weighs approximately 9 pounds and uses 115V ac 400 Hz power for operation. The receiver has a non-volatile flight fault memory. Only shop personnel can use this feature.

Test and Indication

There is a test switch on the front panel of the receiver. When you push the test switch, a self test of the receiver starts. At the end of the test, the status of the receiver and the control panel inputs show on the front panel LED status indicators.

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ADF SYSTEM - RECEIVER



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ADF SYSTEM - RECEIVER

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

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**ADF SYSTEM - ANTENNA****Purpose**

The ADF antenna receives electromagnetic signals from ground stations. The sense antenna receives the electrical part of the signal. The loop antenna receives the magnetic part of the ground station signal.

Description

The antenna assembly is a one piece molded shell. The antenna attaches to the airplane with 12 bolts. The antenna assembly contains these components:

- Loop antenna elements (2)
- Sense antenna (1)
- Electronics assembly.

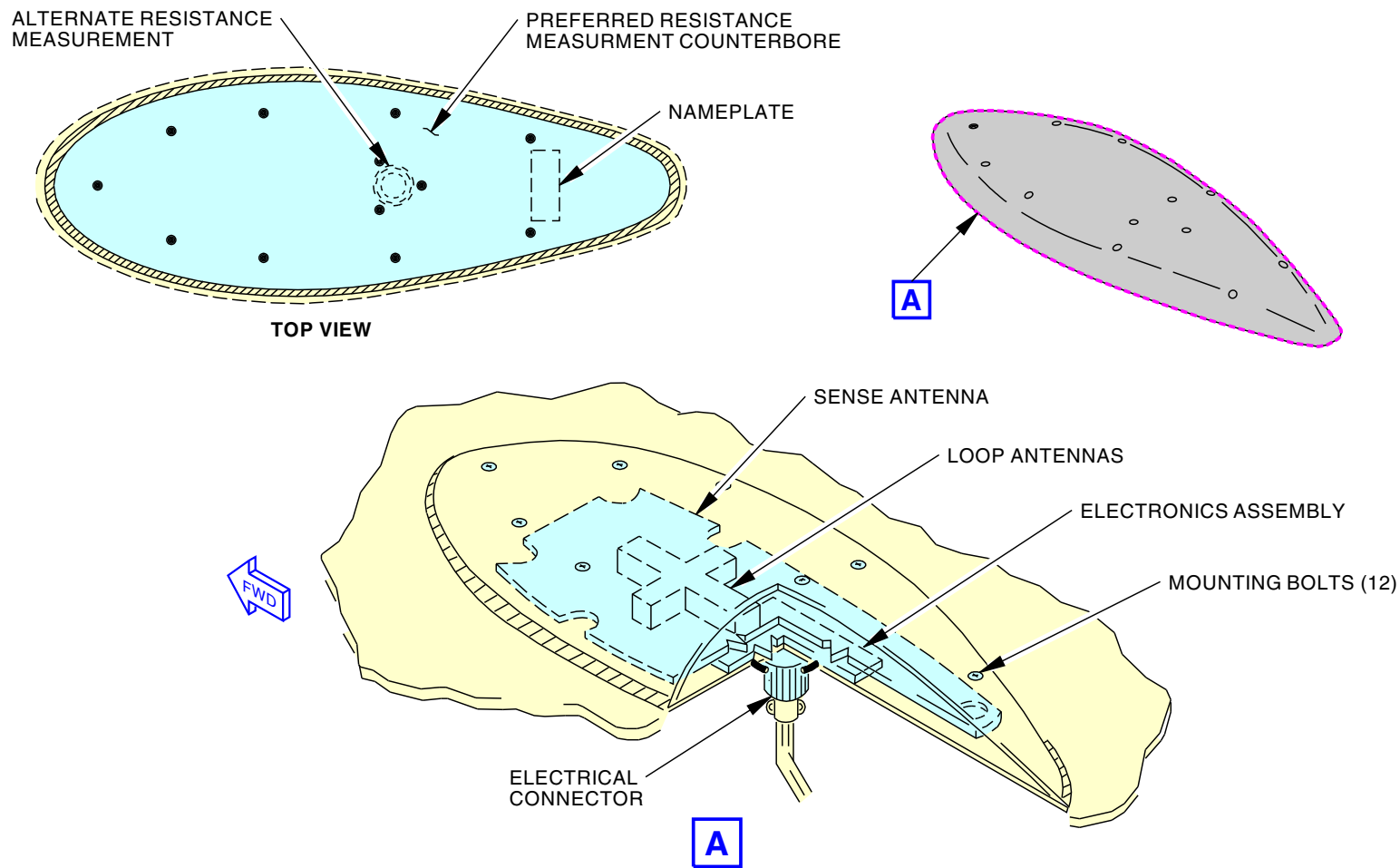
The ADF antenna electronics assembly contains amplifiers for each of the antenna elements. The amplifiers receive 12v dc power from the ADF receiver.

The electrical connectors connect the antenna assembly to the ADF receiver.

The preferred resistance measurement point uses one of the mounting bolt holes counterbore. There is also an alternate resistance measurement point. The alternate measurement is done from the inside of the airplane.

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ADF SYSTEM - ANTENNA



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ADF SYSTEM - ANTENNA

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ADF SYSTEM - CONTROL PANEL

Purpose

The ADF control panel supplies tune frequencies and system mode selection to the ADF receiver.

Description

There are two frequency display windows. the windows show the frequency that you set with the frequency selectors. There are indicators in the display windows that show if the system is in the ADF mode or the antenna (ANT) mode.

The tone selector turns on the beat frequency oscillator (BFO) in the ADF receiver. There are some ADF stations that turn their transmitters on and off to transmit their morse code station identifier. To process this type of signal, the receiver must be in the BFO mode. The selector has three positions, a position for receiver 1, receiver 2, and off.

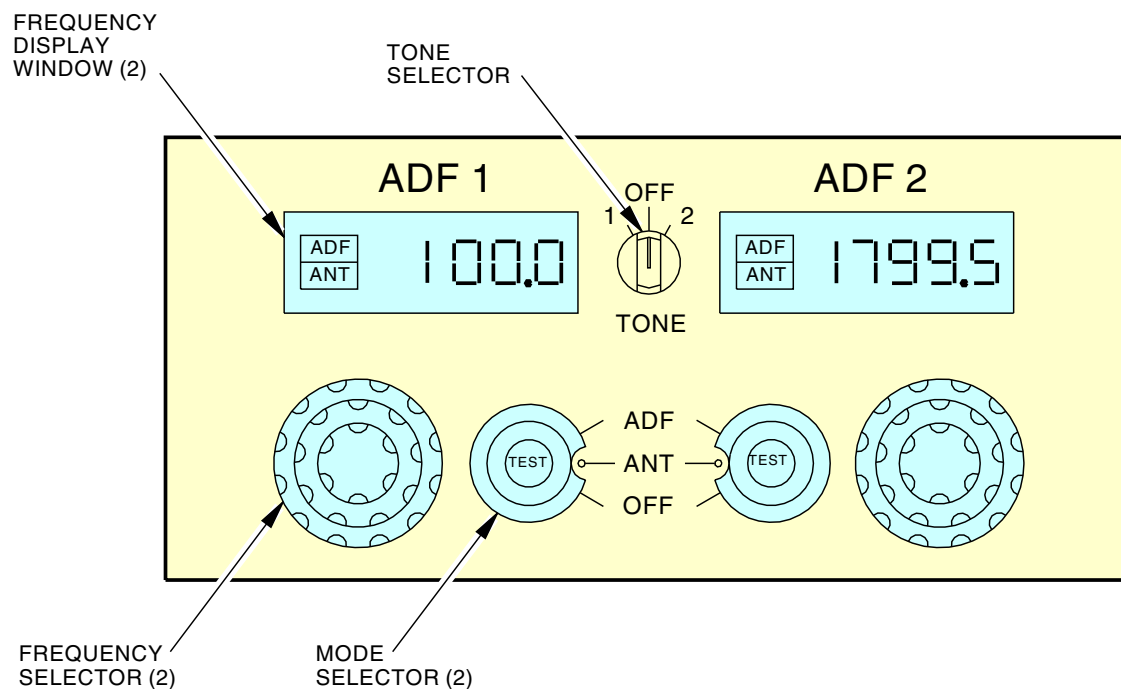
There are two frequency selectors. Each frequency selector sets the frequency for the display window that is directly above it. The selectors each have three controls. There is an outer, middle, and inner control. The inner control sets the tenths and ones numbers. The middle control sets the tens number. The outer control sets the hundreds number.

The mode selector selects the ADF or ANT modes. In the ADF position, the receiver sends bearing data and station audio. In the ANT mode, the receiver sends only station audio.

The test switches are on the top of the ADF mode selectors. Momentarily push the push button to start a system self test.

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ADF SYSTEM - CONTROL PANEL



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ADF SYSTEM - CONTROL PANEL

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ADF SYSTEM - FUNCTIONAL DESCRIPTION

Antenna Inputs

The loop antenna contains two identical antenna loops (sine and cosine) that are mechanically displaced ninety degrees from each other and share a common ferrite core. The sense antenna and loop antenna sine and cosine outputs are coupled through an L-band filter and static protection circuit. The signals then go to separate but identical low noise, wide dynamic range FET input amplifiers. The antenna outputs go to the antenna modulators in the ADF receiver.

ADF Control Panel Inputs

The ADF receiver system processor receives manual tune inputs and control panel mode selections from the ADF control panel on an ARINC 429 data bus.

PSEU

The proximity switch electronics unit (PSEU) sends an air ground discrete to the system processor. The discrete sets the flight leg count for the fault memory.

Program Pin Inputs

The ADF receivers get program pin discretes from a dip switch. The bearing computer circuit uses quadrantal error correction (QEC) program pin inputs to adjust for the signal distortion caused by the airplane structure.

A discrete identifies the antenna location as a top mounted antenna.

Receiver Operation

The ADF receiver contains two major assemblies, the A4 receiver assembly and the A2 instrument assembly.

The A4 receiver assembly contains the antenna modulators, tuner section, and synthesizer.

The modulator receives the input signals from the antenna assembly. The loop antenna inputs are modulated with a 95 Hz sine and cosine reference signal produced by the system processor. The modulated loop antenna signals are then summed with the sense antenna input. This composite signal then goes to a preselector filter in the tuner section.

The tuner section basically contains the receiver that processes the antenna inputs. The receiver tunes the frequency range of 190 to 1799 kHz. The tuner section receives the input signals from the antenna modulators and first sends it through a preselector filter. This preselector filter is made of six diode switched bandpass filters that are tuned to a specific portion of the ADF signal band. The filter is tuned by the system processor based on ADF control panel tune selections. From the preselector the signals are mixed with 15.19 through 16.75 MHz signal and an 18.6 MHz signal from the synthesizer. The signals are also filtered through a 15 MHz and 3.6 MHz to produce an intermediate frequency that can be processed by the ADF receiver.

The synthesizer uses binary tune data from the system processor to produce the injection frequencies to the mixers in the tuner section.

The A2 assembly contains the system processor, signal processor, and the maintenance processor. The system processor provides these functions:

- Format ADF bearing from the signal processor into an ARINC 429 bearing word
- Provide frequency tuning for the tuner section
- Perform functional test and power up tests
- Provide test results to the maintenance processor
- Transmit equipment identification and frequency data.
- Transmit station identification word and maintenance related words from the maintenance processor
- Store calibration constants in nonvolatile memory.

The signal processor provides these functions:

- Generate sine and cosine modulation to the ADF loop antenna modulators

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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ADF SYSTEM - FUNCTIONAL DESCRIPTION**

- Receive analog data from tuner section
- Compute relative bearing to the station
- Detect 1020 Hz and 400 Hz identifier tones
- Provide audio output.

The maintenance processor provides these functions:

- Receives data from the maintenance bus inputs, stores time, date, and aircraft configuration and processes the maintenance control word.
- Store data from system processor in NVM.
- Determines validity of input maintenance word
- Formats fault summary word and sends it to the system processor
- Transfers all CMC interactive and normal mode data to system processor
- Provide maintenance menus in the airplane when requested by the CMC
- Provide extended interactive mode support for troubleshooting data when LRU is removed from the airplane
- Monitor and decode the Morse code station identification data from the Signal processor
- Format the station ident word
- Format the LRU ident message.

The signal processor receives the conditioned analog data from the tuner section and compares the signal to a 95 Hz reference signal to compute the station bearing and station identification and sends it to the system processor. The signal processor also sends audio and station identifier tones to the audio amp in the A4 receiver assembly that sends it to the REU.

The system processor receives all data bus and discrete inputs that come into the ADF receiver. The processor uses ADF control panel tune data to tune the antenna modulators and synthesizer. It sends the QEC program pin configuration to the signal processor to compensate for QEC. It also processes the air/ground and antenna mount discrete for memory. The signal processor receives the bearing computation and detected ident codes from the signal processor, formats the bearing data word, and sends the data out on a data bus to the DPCs.

Power

The ADF receiver power supply receives 115v ac, 400 Hz power from the ADF control panel. The power supply provides -12v dc, +12v dc, and +5v dc for internal use. The modulators send the 12v dc power outputs to the ADF antenna for operation.

Test

When you push the test switch on the ADF receiver front panel, the system processor starts a test of internal functions and checks the ADF control panel data word input. The antenna modulator removes power to the antenna assembly amplifiers. This causes no RF signal inputs to the antenna modulators. A test RF signal replaces the antenna RF input and the receiver sends the signal through its internal circuits. Test results show on the front panel LED status indicators.

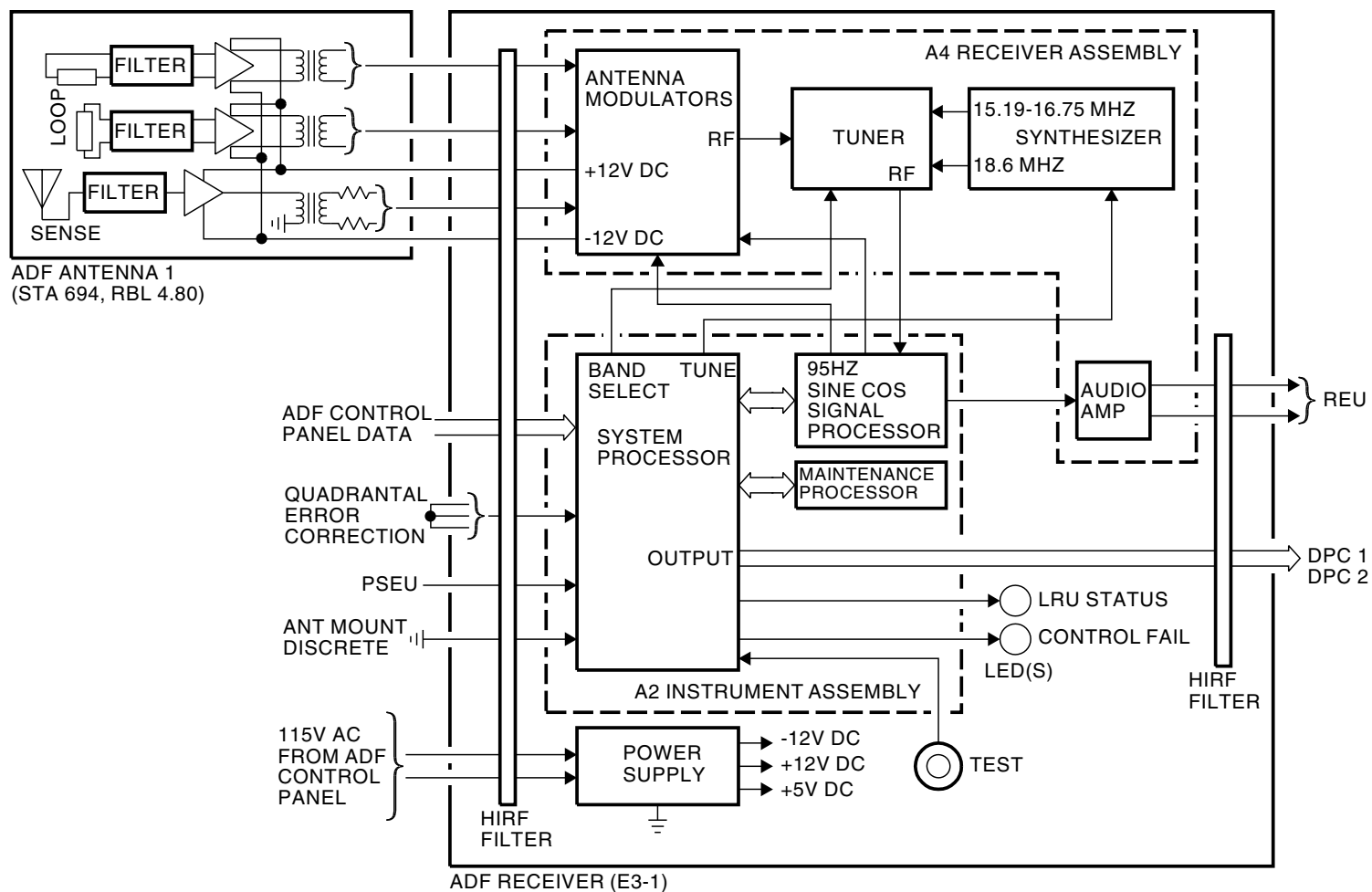
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ADF SYSTEM - FUNCTIONAL DESCRIPTION



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ADF SYSTEM - FUNCTIONAL DESCRIPTION

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ADF SYSTEM - CONTROLS

EFIS Control Panel

The ADF bearing data can show on the NAV display in the VOR, APP, and MAP modes. You use the mode selector on the EFIS control panel to select the display mode for the NAV display.

The VOR/ADF switches select the VOR system or the ADF system as the source of the bearing pointer data on the NAV display. To show ADF bearing, set the VOR/ADF switches on the EFIS control panels to the ADF position.

Audio Control Panel Controls

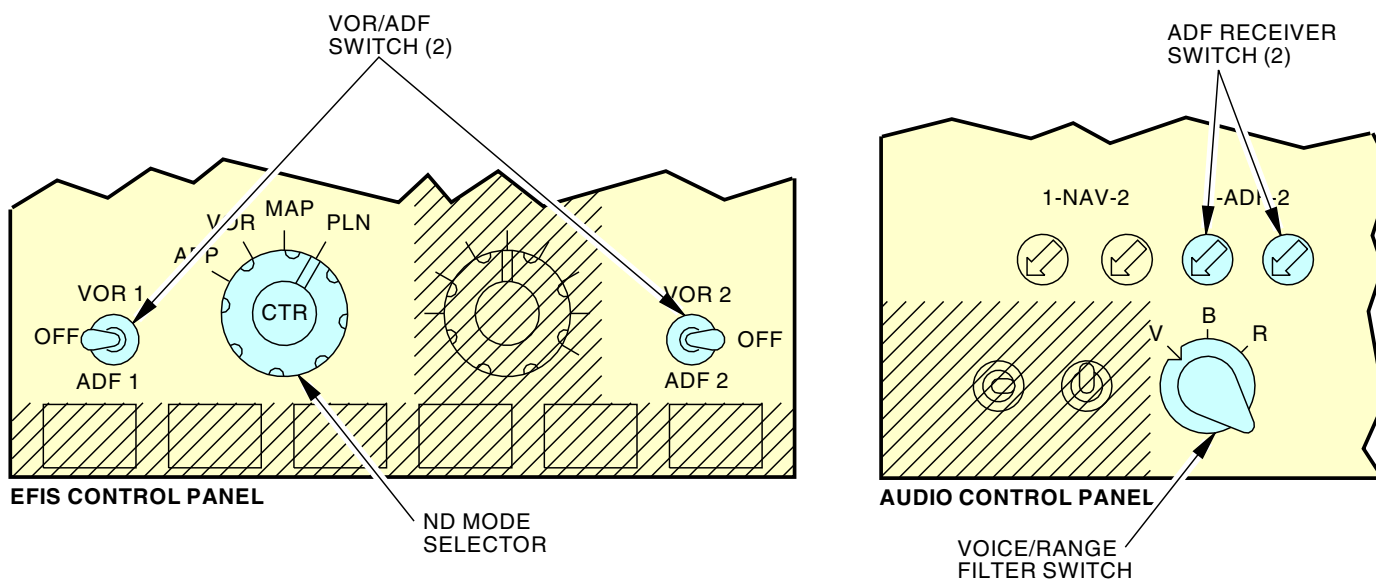
The audio control panels (ACP) let the crew listen to ADF station audio or the Morse code station identifier. You use the ACP ADF receiver switches to listen to ADF receiver audio.

The voice/range selector permits you to listen to only voice audio in the voice (V) position. The range (R) position permits you to listen to the station Morse code identifier. With the selector in the both (B) position, you can listen to both the voice audio and the Morse code station identifier.

Navigation aid stations transmit their Morse code identifier signals on a typical 1020 Hz signal. There are some ADF stations that transmit their Morse code identifier on a 400 Hz signal. The voice/range selector has no effect on these stations, the station Morse code identifier will always be present.

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ADF SYSTEM - CONTROLS



ADF SYSTEM - CONTROLS

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ADF SYSTEM - EFIS NAV DISPLAYS

General

The ADF data shows on the captain and first officer NAV displays in the VOR, APP, and MAP modes. The bearing pointers around the compass rose show VOR or ADF bearing data. To show ADF bearing, set the EFIS control panel VOR/ADF switches to ADF and set the EFIS mode selector to the VOR, APP, or MAP display modes. The bearing pointers are cyan when they show ADF data. The ADF source data and frequency or identifier shows in cyan at the bottom corners of the displays.

The bearing pointers show in the expanded and centered displays. The bearing pointers show on the expanded displays if the ADF bearing is in the compass rose display limit. This graphic shows the displays in the centered NAV display mode.

Bearing Pointers

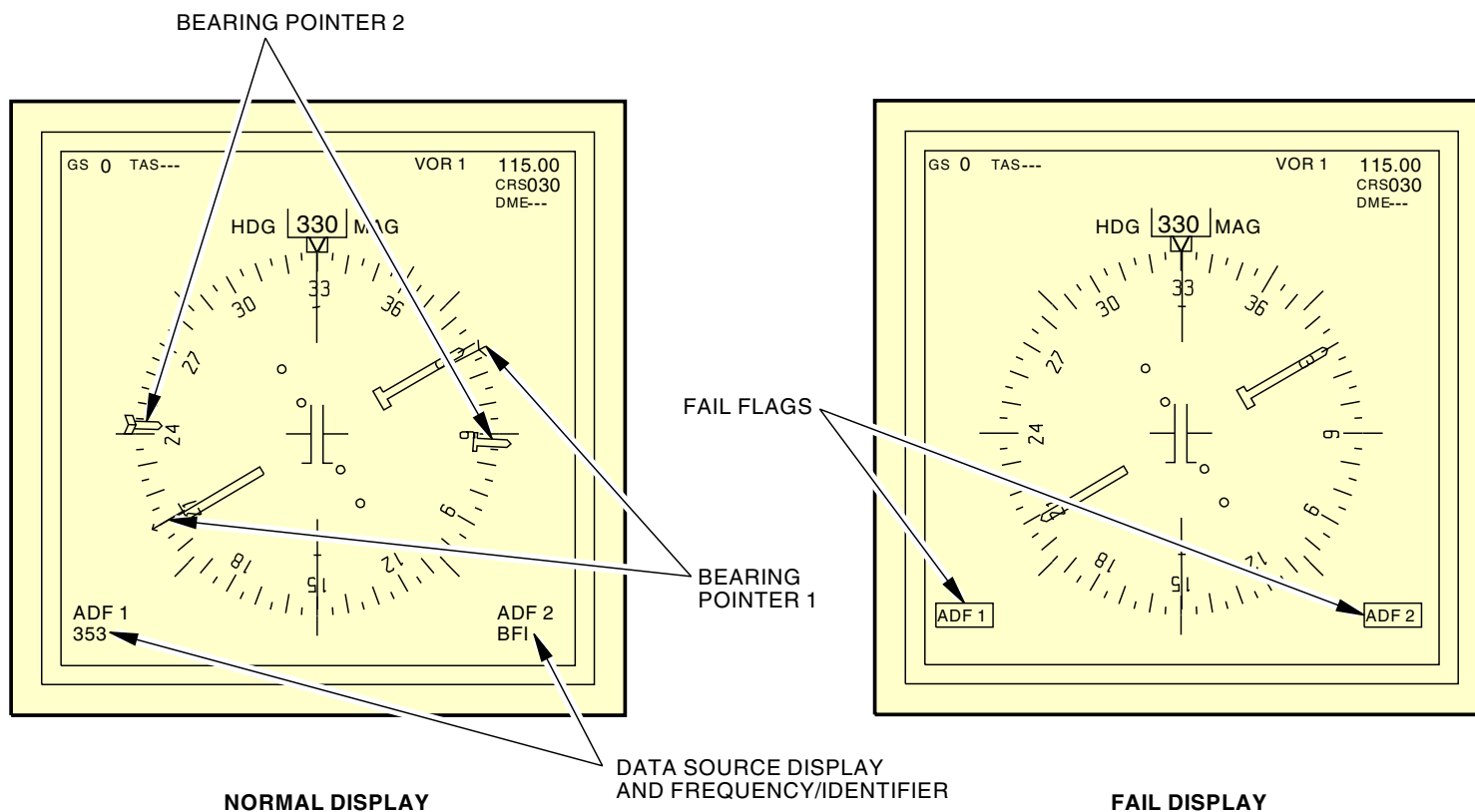
When you set the VOR/ADF switches to the ADF position, bearing pointers 1 and 2 show in cyan around the edge of the compass rose. There is a pointer head and tail for both bearing pointers. The DPCs move the bearing pointers when the receiver data goes to an NCD condition, or when you set the VOR/ADF switches to the off position.

Invalid Display

The amber ADF fail flags show in the lower corners of the display when there is a failure of the ADF receivers. The ADF flags show in the same location for the expanded display.

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ADF SYSTEM - EFIS NAV DISPLAYS



ADF SYSTEM - EFIS NAV DISPLAYS

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**ADF SYSTEM - FRONT PANEL BITE****Test**

Push the test switch on the front of the ADF receiver to start the test. The test results show on the LED status indicators on the front of the receiver.

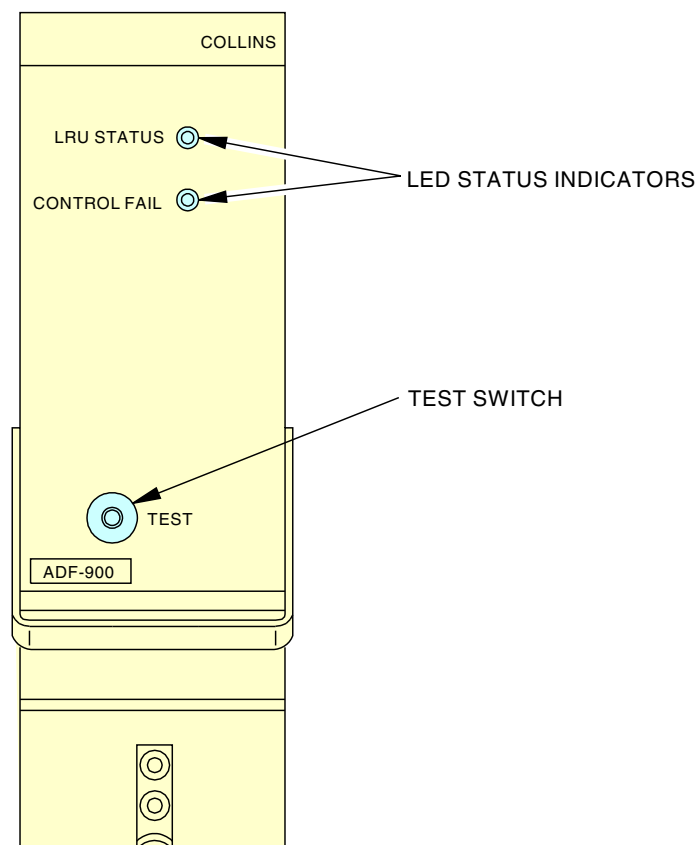
When you push the test switch, the receiver does a check of the internal receiver operation and the interface with the ADF control panel. The self test lasts 30 seconds. This is the test sequence that shows on the LED status indicators:

- 0 to 2 seconds - the LRU status and control fail LEDs come on red
- 2 to 4 seconds - the LRU status LED changes to green and the control fail LED remains red
- 4 to 12 seconds - the LRU status and control fail LEDs go off
- 12 to 42 seconds - the test results show on the LED status indicators.

For test results, the LRU status LED comes on green if there are no LRU faults or red if any faults occur. The control fail LED stays off if the ADF control panel input signal is valid or comes on red if there is no input from the ADF control panel or if the input signal is invalid.

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ADF SYSTEM - FRONT PANEL BITE



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ADF SYSTEM - FRONT PANEL BITE

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**ADF SYSTEM - SELF-TEST****Test**

To see the ADF test sequence, select VOR or APP on the EFIS control panel mode selector.

To start the test, push the test switch on the ADF control panel mode selector knob.

During the first two seconds of the test, the receiver output goes to a fail condition. The pointer goes out of view and the amber ADF flag shows momentarily.

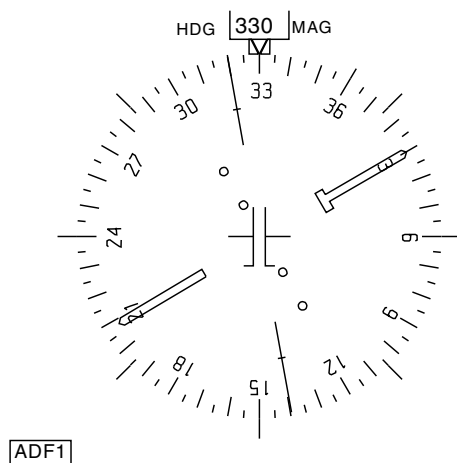
For the next two seconds, the receiver output goes to an NCD condition. During this time, the amber ADF flag goes out of view and the pointer stays out of view.

Next, the test display shows and the pointer goes to a test position of 135 degrees from the heading lubber line until the end of test.

NOTE: The graphic shows a test of ADF receiver 1. For a dual system, the test is the same for ADF receiver 2.

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ADF SYSTEM - SELF-TEST



0 TO 2 SECONDS:

THE RECEIVER OUTPUT GOES TO A FAIL CONDITION. THE ADF DATA GOES OUT OF VIEW. THE AMBER ADF FLAG SHOWS MOMENTARILY.



2 TO 4 SECONDS:

THE RECEIVER OUTPUT GOES TO NO COMPUTED DATA (NCD) AND THE FLAG GOES OUT OF VIEW. THE ADF POINTERS STAY OUT OF VIEW.



FROM 4 SECONDS TO END OF TEST:

THE POINTERS GO TO THE TEST POSITION (APPROX. 135 DEGREES FROM THE HEADING LUBBER LINE).

NOTE: THIS SHOWS A TEST OF ADF RECEIVER 1. FOR DUAL SYSTEMS, THE TEST IS THE SAME FOR ADF RECEIVER 2.

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ADF SYSTEM - SELF-TEST

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GLOBAL POSITIONING SYSTEM - INTRODUCTION

Purpose

The global positioning system (GPS) uses navigation satellites to supply airplane position to airplane systems and to the flight crew.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- AMP - amplifier
- APU - auxiliary power unit
- ARINC - Aeronautical Radio, Inc.
- ATT - attitude
- A/D - analog to digital
- BITE - built-in test equipment
- CDU - control display unit
- CONV - convertor
- dc - direct current
- DET - detection
- D/A - digital to analog
- ELEC - electrical
- flt - flight
- FMC - flight management computer
- GP - general purpose
- GPS - global positioning system
- HEX - hexadecimal
- IMMR - integrated multi mode receiver
- IRS - inertial reference system
- L - left
- LBL - left buttock line
- MMR - multi mode receiver
- nav - navigation
- NCD - no computed data
- NVM - non volatile memory
- ovht - overheat
- pos - position
- PPS - precision positioning service
- R - right
- RAIM - receiver autonomous integrity monitor
- RBL - right buttock line
- rcvr - receiver
- RF - radio frequency
- SAT - satellite
- SCR - silicon controlled rectifier
- SPS - standard positioning service
- SS - single shot
- sta - station
- UTC - universal time (coordinated)
- Δt BIAS - clock bias
- V - volts
- WL - water line

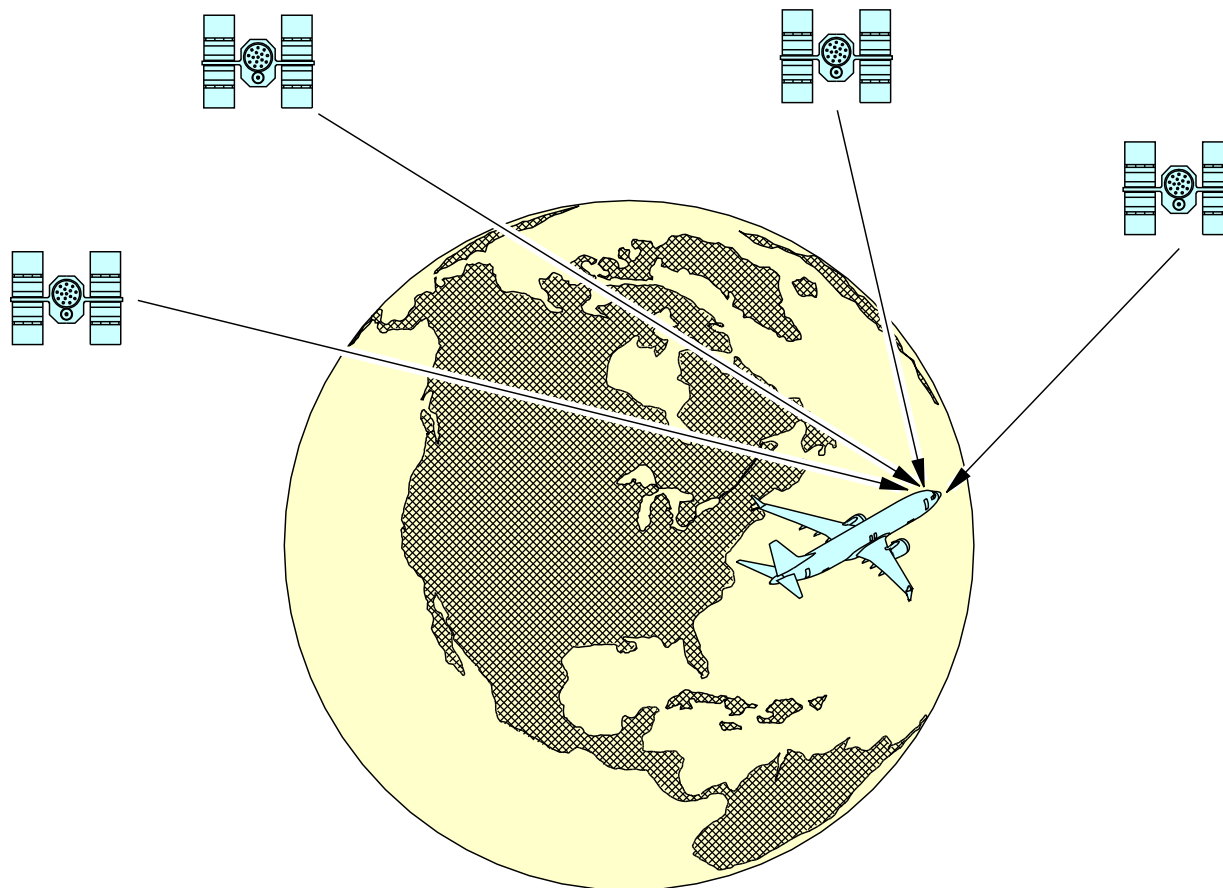
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GLOBAL POSITIONING SYSTEM - INTRODUCTION



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GLOBAL POSITIONING SYSTEM - INTRODUCTION

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	D633AM102-SIA



GPS - GENERAL DESCRIPTION

SIA 001-005

General

The global positioning system (GPS) calculates this data:

- Latitude
- Longitude
- Altitude
- Accurate time
- Ground speed.

There are two GPS systems. Antenna 1 receives satellite signals and sends them to multi mode receiver (MMR) 1. Antenna 2 connects to MMR 2. The MMRs calculate the airplane position and accurate time. This data goes to the flight management computer system (FMCS) and the IRS master caution unit. The FMCS uses GPS or navigation radio position with inertial reference data to calculate the airplane position.

SIA 005; SIA 001-004 POST SB 737-34-3141

For airplanes with hybrid GPS-inertial reference data activated, ADIRU use GPS data from the MMR to calculate hybrid GPS data.

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The IRS master caution unit gets GPS data from both MMRs. It causes the GPS fail light on the IRS mode select unit to come on when the two units have a failure or if one unit fails and the master caution annunciator is pushed.

The ground proximity warning computer gets GPS position and velocity data from the MMRs.

The display processing computers (DPCs) have the clock function and get GPS time and date from the MMRs.

SIA 006-999

General

The global positioning system (GPS) calculates this data:

- Latitude
- Longitude
- Altitude
- Accurate time
- Ground speed.

There are two GPS systems. Antenna 1 receives satellite signals and sends them to integrated multi mode receiver (IMMR) 1. Antenna 2 connects to IMMR 2. The IMMRs calculate the airplane position and accurate time. This data goes to the flight management computer system (FMCS) and the IRS master caution unit. The FMCS uses GPS or navigation radio position with inertial reference data to calculate the airplane position.

For airplanes with hybrid GPS-inertial reference data activated, ADIRU use GPS data from the IMMR to calculate hybrid GPS data.

The IRS master caution unit gets GPS data from both IMMRs. It causes the GPS fail light on the IRS mode select unit to come on when the two units have a failure or if one unit fails and the master caution annunciator is pushed.

The ground proximity warning computer gets GPS position and velocity data from the IMMRs.

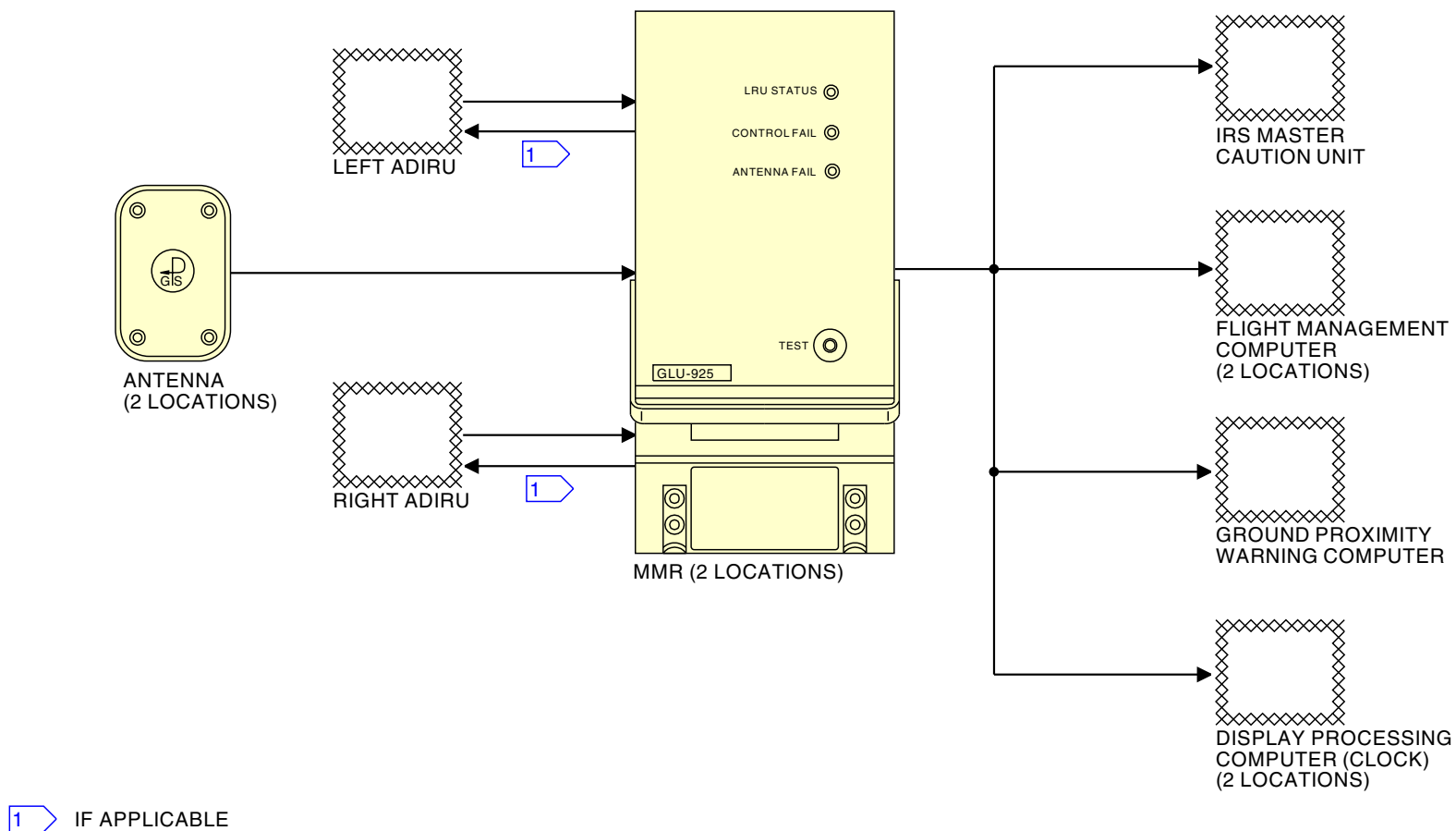
The display processing computers (DPCs) have the clock function and get GPS time and date from the IMMRs.

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPS - GENERAL DESCRIPTION

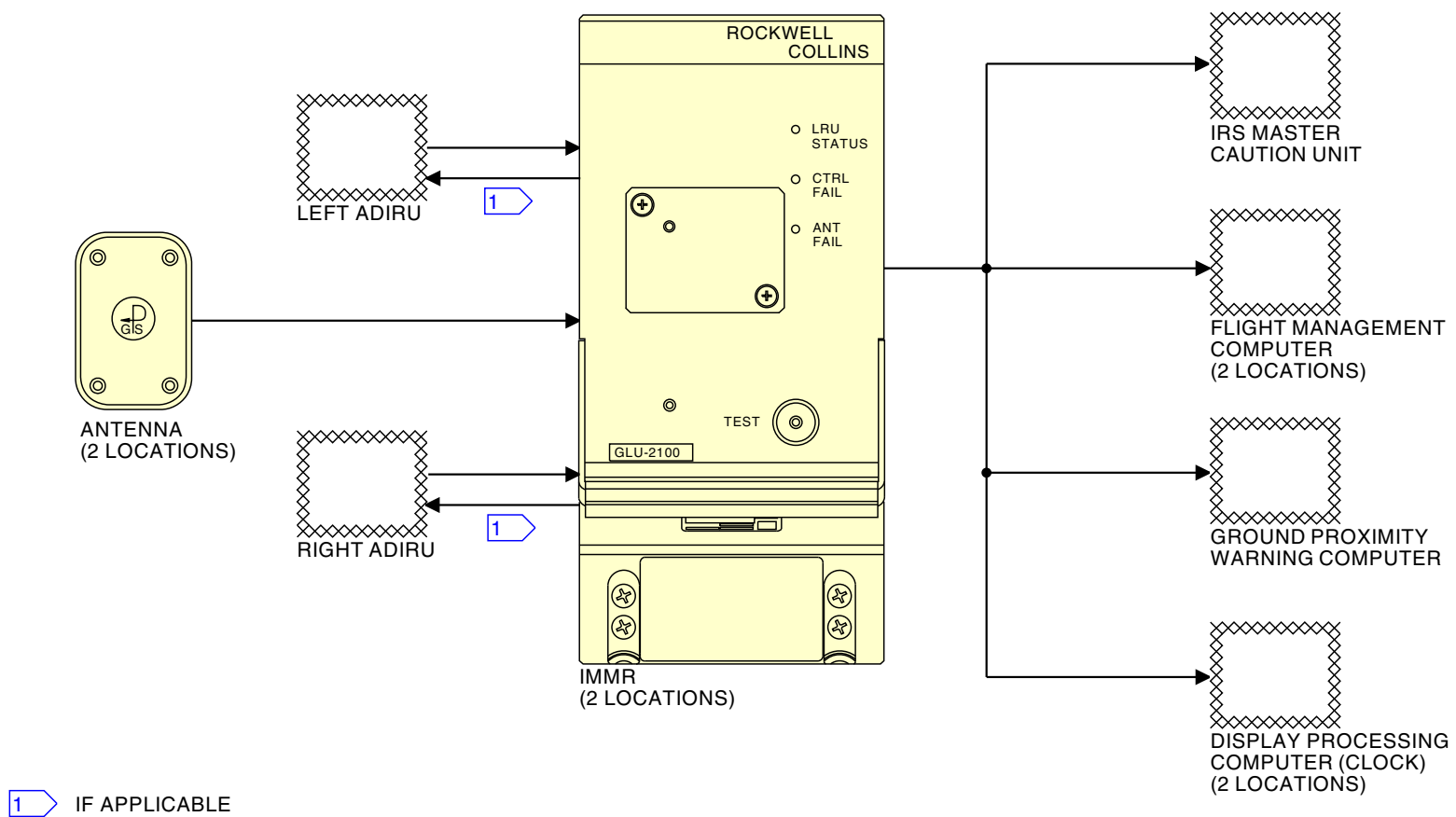


2532185 S0000599616_V4

GPS - GENERAL DESCRIPTION

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GPS - GENERAL DESCRIPTION



2804397 S0000643277_V2

GPS - GENERAL DESCRIPTION

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GPS - FLIGHT COMPARTMENT COMPONENT LOCATION

General

These are the components in the flight compartment that have a relation to the GPS:

- Control display units
- Master caution annunciator
- Master caution lights
- IRS master caution unit
- Annunciation and dimming module
- IRS mode select unit.

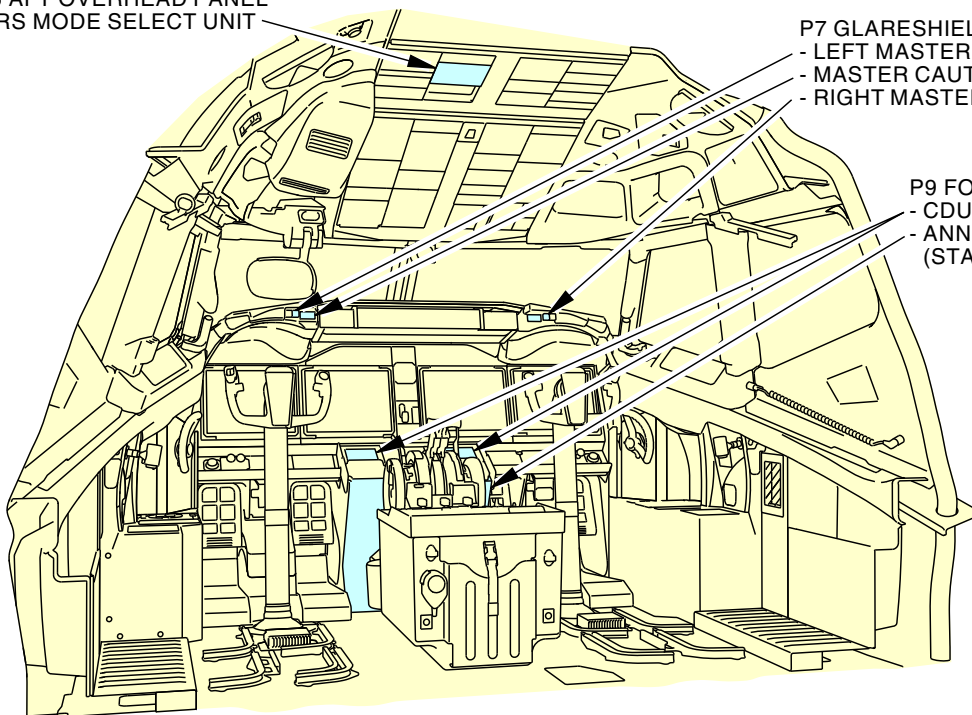
SIA ALL	EFFECTIVITY
	D633AM102-SIA

GPS - FLIGHT COMPARTMENT COMPONENT LOCATION

P5 AFT OVERHEAD PANEL
- IRS MODE SELECT UNIT

P7 GLARESHIELD PANEL
- LEFT MASTER CAUTION LIGHT
- MASTER CAUTION ANNUNCIATOR
- RIGHT MASTER CAUTION LIGHT

P9 FORWARD ELECTRONICS PANEL
- CDU (2)
- ANNUNCIATION AND DIMMING MODULE
(STA 190, WL 206, RBL 12)



IRS MASTER
CAUTION UNIT



P61 PANEL

2370083 S00061520946_V3

GPS - FLIGHT COMPARTMENT COMPONENT LOCATION



GPS - COMPONENT LOCATION

General**SIA 001-005**

GPS sensor units are in the multi mode receivers (MMR). The MMRs are in the electronic equipment compartment. MMR 1 is on the E1-2 shelf. MMR 2 is on the E1-4 shelf.

SIA 006-999

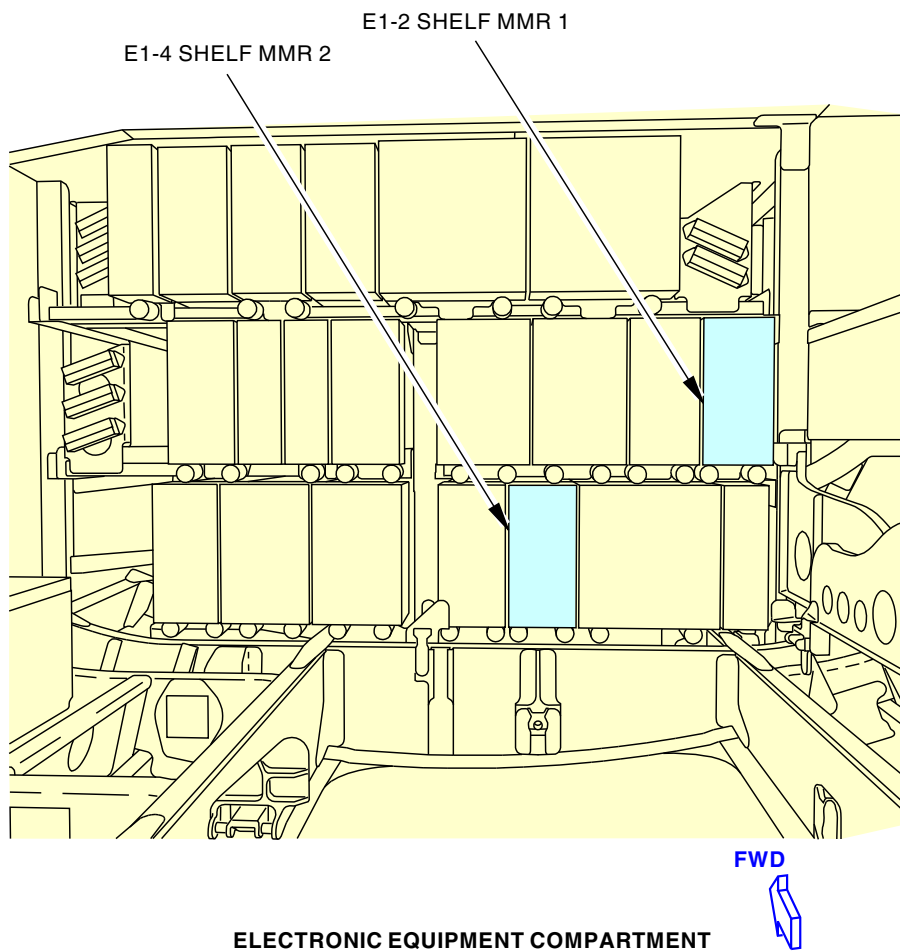
GPS sensor units are in the integrated multi mode receivers (IMMR). The IMMRs are in the electronic equipment compartment. IMMR 1 is on the E1-2 shelf. IMMR 2 is on the E1-4 shelf.

SIA ALL**34-58-00**

SIA ALL	EFFECTIVITY
	D633AM102-SIA

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GPS - COMPONENT LOCATION



2370084 S00061520948_V2

GPS - COMPONENT LOCATION

34-58-00

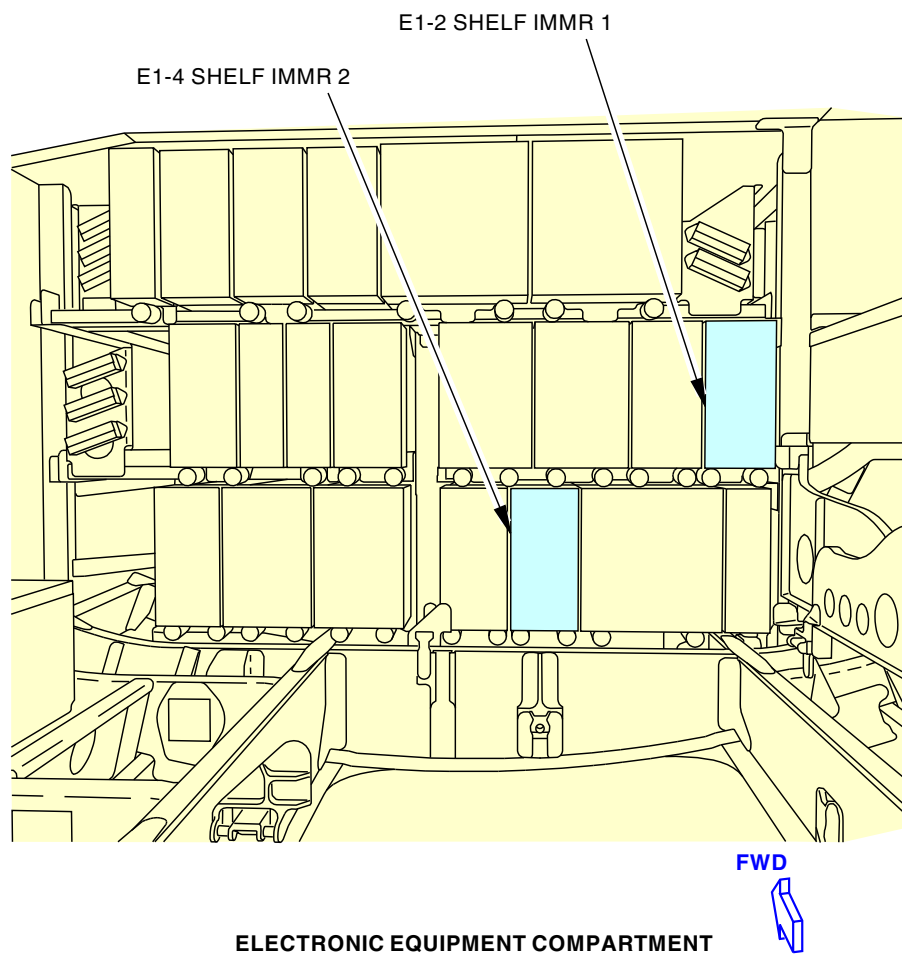
34-58-00-004

EFFECTIVITY
SIA 001-005

D633AM102-SIA

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GPS - COMPONENT LOCATION



2804399 S0000643289_V1

GPS - COMPONENT LOCATIONS

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



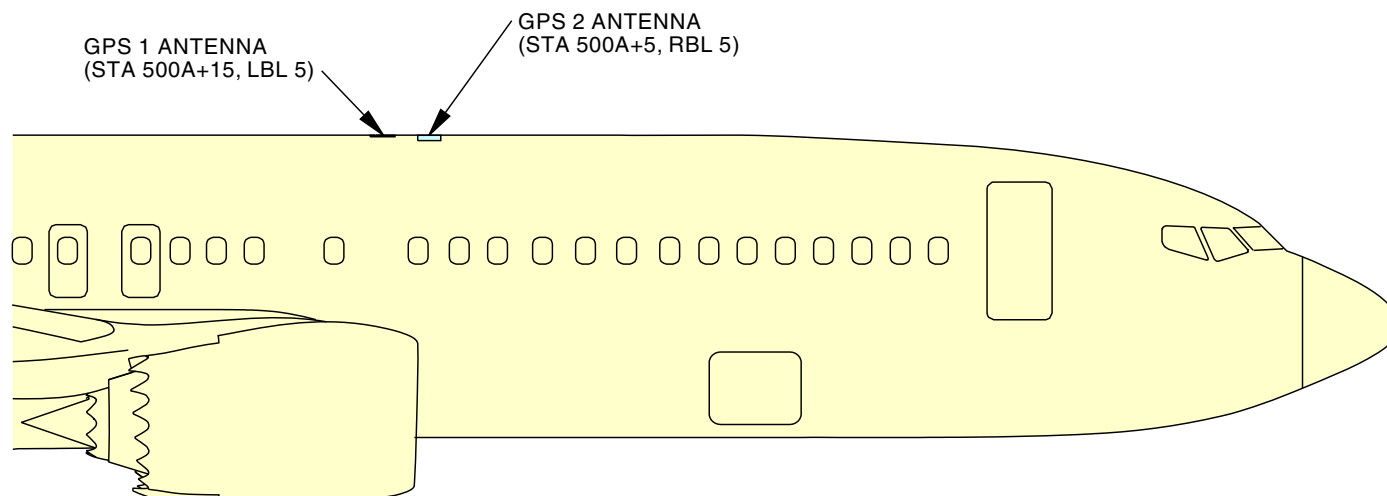
GPS - ANTENNA LOCATIONS

General

The GPS antennas are on the top of the fuselage.

SIA ALL	EFFECTIVITY
D633AM102-SIA	

GPS - ANTENNA LOCATIONS



2370085 S00061520950_V2

GPS - ANTENNA LOCATIONS

34-58-00



GPS - INTERFACES

Power and Antenna Interface

SIA 001-005

Each multi-mode receiver (MMR) has a circuit breaker. The 115v ac buses supply power to the MMRs.

SIA 006-999

Each integrated multi-mode receiver (IMMR) has a circuit breaker. The 115v ac buses supply power to the IMMRS.

SIA 001-005

Each MMR receives a radio frequency (RF) signal from a GPS antenna.

SIA 006-999

Each IMMRS receives a radio frequency (RF) signal from a GPS antenna.

SIA ALL

ADIRU IR Bus Input

SIA 001-005

The MMRs get inertial reference data from the ADIRUs. Each MMR receives IR data from its onside ADIRU and the offside ADIRU. During normal operation, MMR 1 uses L ADIRU data and MMR 2 uses R ADIRU data. If there is a loss of data from an ADIRU, the MMR will use the data from the offside ADIRU.

The MMRs use this data for system initialization and to help system operation during periods of low satellite coverage.

SIA 006-999

The IMMRS get inertial reference data from the ADIRUs. Each IMMRS receives IR data from its onside ADIRU and the offside ADIRU. During normal operation, IMMRS 1 uses L ADIRU data and IMMRS 2 uses R ADIRU data. If there is a loss of data from an ADIRU, the IMMRS will use the data from the offside ADIRU.

The IMMRS use this data for system initialization and to help system operation during periods of low satellite coverage.

SIA 001-005

MMR Data Output Bus

The MMR sends out this data:

- GPS latitude
- GPS latitude Fine
- GPS longitude
- GPS longitude fine
- Clock time and date
- GPS status
- Horizontal figure of merit
- Horizontal integrity limit.

The MMR sends the data to these units:

- FMC 1
- FMC 2
- Display processing computers (DPCs), Clock function
- Ground proximity warning computer (GPWC)
- IRS master caution unit.

SIA 005; SIA 001-004 POST SB 737-34-3141

- ADIRU-L
- ADIRU-R

SIA 006-999

IMMR Data Output Bus

The IMMRS sends out this data:

- GPS latitude

34-58-00

EFFECTIVITY
SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**GPS - INTERFACES****SIA 006-999 (Continued)**

- GPS latitude Fine
- GPS longitude
- GPS longitude fine
- Clock time and date
- GPS status
- Horizontal figure of merit
- Horizontal integrity limit.

The IMMR sends the data to these units:

- FMC 1
- FMC 2
- Display processing computers (DPCs), Clock function
- Ground proximity warning computer (GPWC)
- IRS master caution unit.
- ADIRU-L
- ADIRU-R

SIA ALL**Flight Management Computer (FMC)****SIA 001-005**

The MMRs send these GPS parameters to the FMC:

SIA 006-999

The IMMRs send these GPS parameters to the FMC:

SIA ALL

- Latitude
- Longitude
- Time
- Horizontal figure of merit

- Horizontal integrity limit.

The FMC uses the data for FMC position update and actual navigation performance (ANP) calculation.

Display Processing Computers (DPCs)

The DPCs use GPS time and date for the captain and first officer clock functions.

Ground Proximity Warning Computer**SIA 001-005**

The MMRs send these GPS parameters to the ground proximity warning computer:

SIA 006-999

The IMMRs send these GPS parameters to the ground proximity warning computer:

SIA ALL

- Latitude (coarse)
- Longitude (coarse)
- Latitude (fine)
- Longitude (fine)
- Ground speed
- True track
- Altitude
- Vertical velocity
- Horizontal dilution of precision (HDOP)
- Vertical dilution of precision (VDOP)
- Horizontal figure of merit (HFOM)
- Vertical figure of merit (VFOM)
- Date
- Time (UTC)

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SIA ALL EFFECTIVITY

D633AM102-SIA

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**GPS - INTERFACES**

- Horizontal integrity limit (HIL)
- Sensor status.

Latitude and longitude (coarse and fine) information gives airplane position for the TCF and terrain awareness functions.

Ground speed, true track, altitude, and vertical velocity are used in the terrain awareness function.

Horizontal dilution of precision, vertical dilution of precision, horizontal figure of merit and vertical figure of merit information are used for airplane position accuracy calculations.

Date and time information is used in the fault monitor process, which labels each fault with the date and time of occurrence.

The horizontal integrity limit is used to determine the current integrity limit and GPS non-isolatable satellite failures.

Sensor status lets the GPWC monitor the status of the GPS receiver.

IRS Master Caution Unit**SIA 001-005**

The IRS master caution unit monitors data from the MMRs.

SIA 006-999

The IRS master caution unit monitors data from the IMMRs.

SIA ALL**SDI Program Pins****SIA 001-005**

Three program pins tell the MMR if it is number 1 or 2.

SIA 006-999

Three program pins tell the IMMR if it is number 1 or 2.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

ADIRUs

SIA 005; SIA 001-004 POST SB 737-34-3141

The MMRs send GPS and time mark data to the ADIRUs for automatic ADIRS alignment.

SIA 006-999

The IMMRs send GPS and time mark data to the ADIRUs for automatic ADIRS alignment.

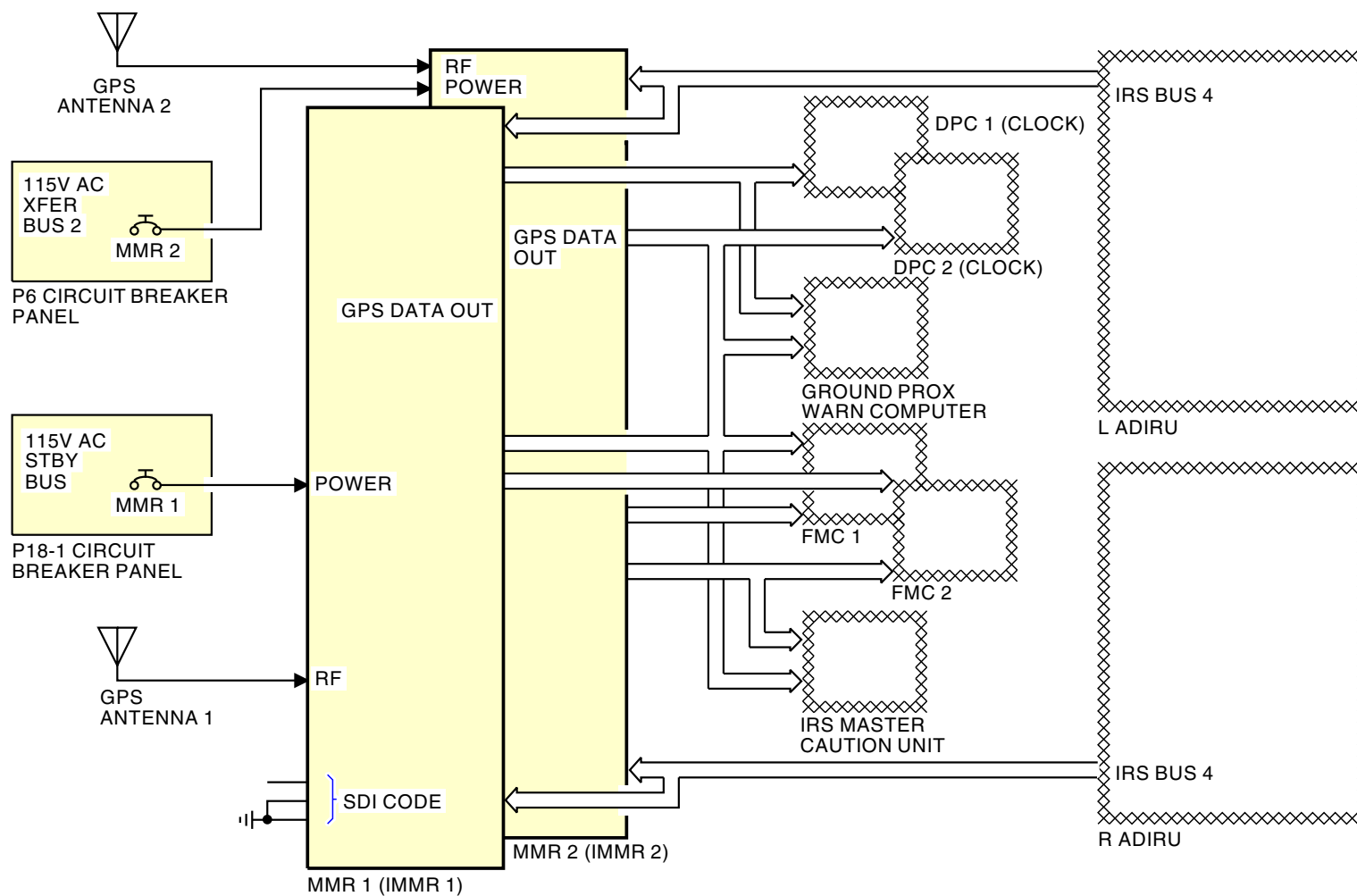
SIA ALL**34-58-00**

SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPS - INTERFACES



2370086 S00061520952_V3

GPS - INTERFACES

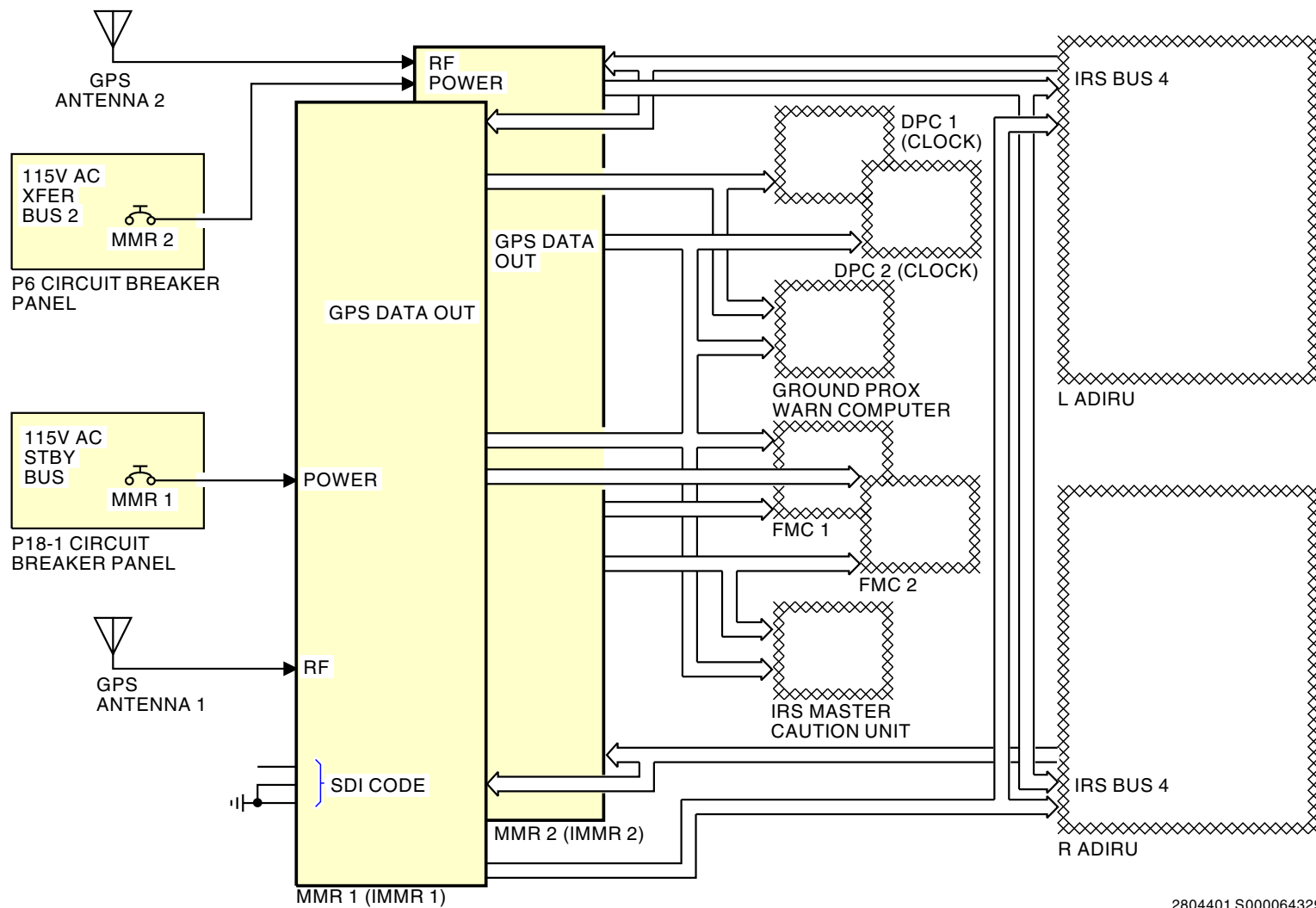
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EFFECTIVITY
SIA 001-004 PRE SB 737-34-3141

D633AM102-SIA

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GPS - INTERFACES



2804401 S0000643293_V2

GPS - INTERFACES

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EFFECTIVITY
SIA 005-999; SIA 001-004 POST SB 737-34-3141

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GPS - RECEIVER

Purpose

SIA 001-005

The multi-mode receiver (MMR) contains the GPS receiver. The GPS receiver receives navigation satellite signals to calculate GPS data.

SIA 006-999

The integrated multi-mode receiver (IMMR) contains the GPS receiver. The GPS receiver receives navigation satellite signals to calculate GPS data.

SIA ALL

Physical Description

SIA 001-005

The MMR is a standard ARINC 600 3 MCU unit with dimensions approximately 3.74 x 7.87 x 14.72 inches. It has forced air cooling per ARINC 600. The MMR weighs approximately 9 pounds and uses 115v ac, 400Hz power for operation.

SIA 006-999

The IMMR is a standard ARINC 600 3 MCU unit with dimensions approximately 3.74 x 7.87 x 14.72 inches. It has forced air cooling per ARINC 600. The IMMR weighs approximately 9 pounds and uses 115v ac, 400Hz power for operation.

SIA ALL

Test and Indications

SIA 006-999

There are status LED indicators and a test switch on the front of the IMMR. The test switch starts a functional test of the receiver. The LED status indicators show test results.

SIA 001-005

There are status LED indicators and a test switch on the front of the MMR. The test switch starts a functional test of the receiver. The LED status indicators show test results.

SIA ALL

Flight Fault Memory

SIA 001-005

The MMR has a nonvolatile flight fault memory. The faults are sent to the onboard network system (ONS) for use by line personnel.

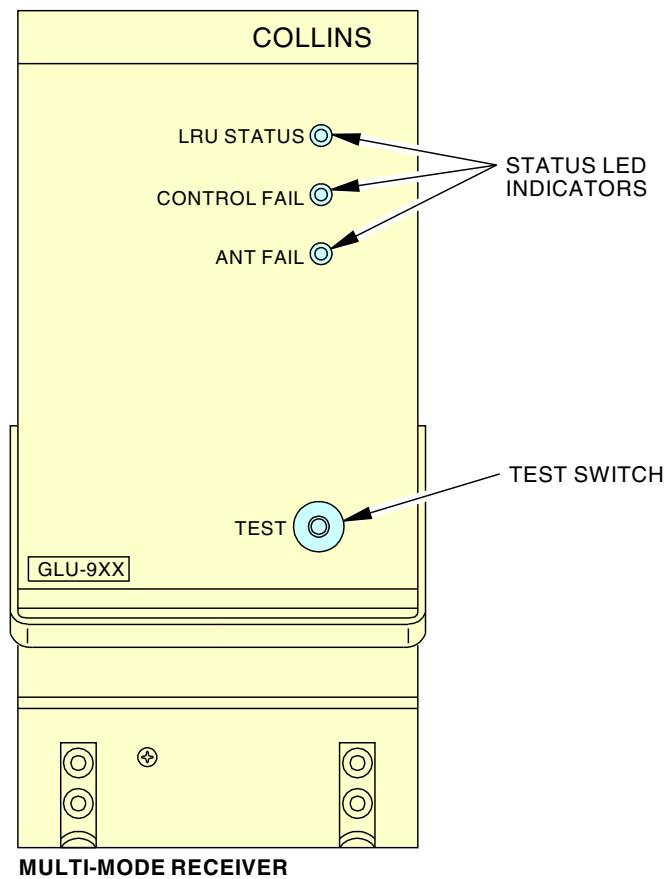
SIA 006-999

The IMMR has a nonvolatile flight fault memory. The faults are sent to the onboard network system (ONS) for use by line personnel.

SIA ALL

EFFECTIVITY	
SIA ALL	

GPS - RECEIVER



MULTI-MODE RECEIVER

GPS - RECEIVER

2369872 S00061520515_V1

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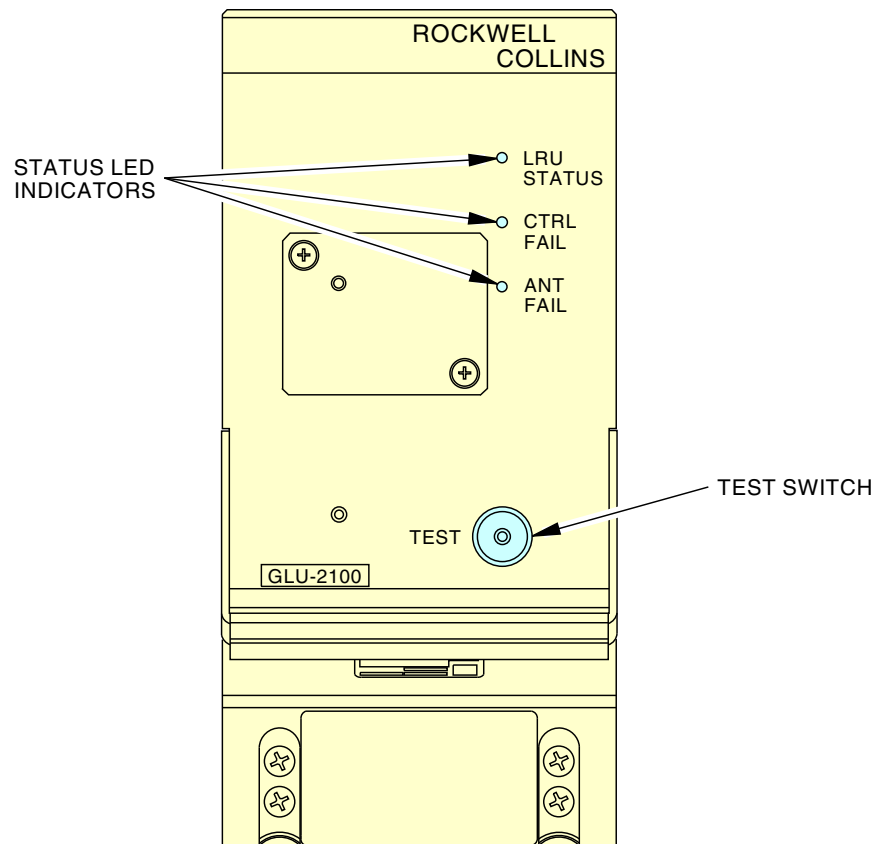
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SIA 001-005

34-58-00

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

GPS - RECEIVER



INTEGRATED MULTI-MODE RECEIVER

GPS - RECEIVER

2801318 S0000641920_V1

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34-58-00-007

EFFECTIVITY
SIA 006-999

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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**GPS - GPS ANTENNA****SIA 001-005****General**

The GPS antennas receive L-band frequency signals (1575.42 MHz) and sends them to the multi mode receivers (MMR).

Each antenna contains an integrated preamplifier to increase the signal level to the MMR. The antenna preamplifiers use 12v dc which comes from the power supply in the MMR.

SIA 006-999**General**

The GPS antennas receive L-band frequency signals (1575.42 MHz) and sends them to the integrated multi mode receivers (IMMR).

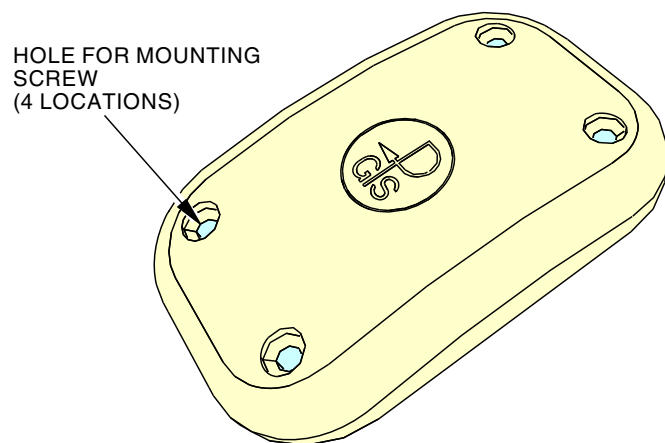
Each antenna contains an integrated preamplifier to increase the signal level to the IMMR. The antenna preamplifiers use 12v dc which comes from the power supply in the IMMR.

SIA ALL**34-58-00**

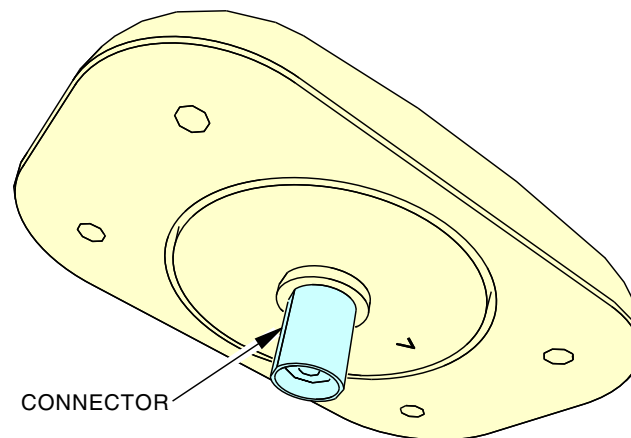
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SIA ALL	

D633AM102-SIA

GPS - GPS ANTENNA



TOP VIEW



BOTTOM VIEW

GPS - GPS ANTENNA

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SIA ALL

EFFECTIVITY

D633AM102-SIA

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34-58-00



GPS - THEORY OF OPERATION - 1

GPS Segments

The GPS has these three segments:

- Satellite
- User
- Control.

Satellite Segment

The satellite segment is a group of satellites that orbit 10,900 nautical miles above the earth. Each satellite makes an orbit once every 12 hours. There are 21 operational satellites and 3 spares.

The satellites continuously transmit radio signals with navigation data, range code, and the exact time.

User Segment

The user segment is the GPS receiver unit on the airplane. It receives the satellite signals. The GPS uses the satellite data to calculate the airplane position.

Control Segment

The control segment has control and monitor stations on earth that continuously monitor and track the satellites. The control segment does these things:

- Monitor and correct satellite orbits and clocks
- Calculate and format a satellite navigation message. This message has up-to-date descriptions of the satellites future positions, and a collection of the latest data on all GPS satellites
- Update the satellite navigation message regularly.

The control segment has one master control station and five monitor stations. Three of the monitor stations are also upload stations.

The master control station is in Colorado Springs, USA. The master control station is the operational center of the GPS. The master control station controls all operations in the control segment. The master control station has an atomic clock, this clock is the reference for the GPS.

The monitor stations track the satellites 24 hours a day. The master control station remotely controls the monitor stations through on-line connections. The monitor stations are in these locations:

- Ascension island
- Colorado Springs
- Diego Garcia island
- Hawaii
- Kwajalein island.

The monitor stations receive the same information from the satellites that the GPS receiver unit in the airplane receives. The monitor stations do these things:

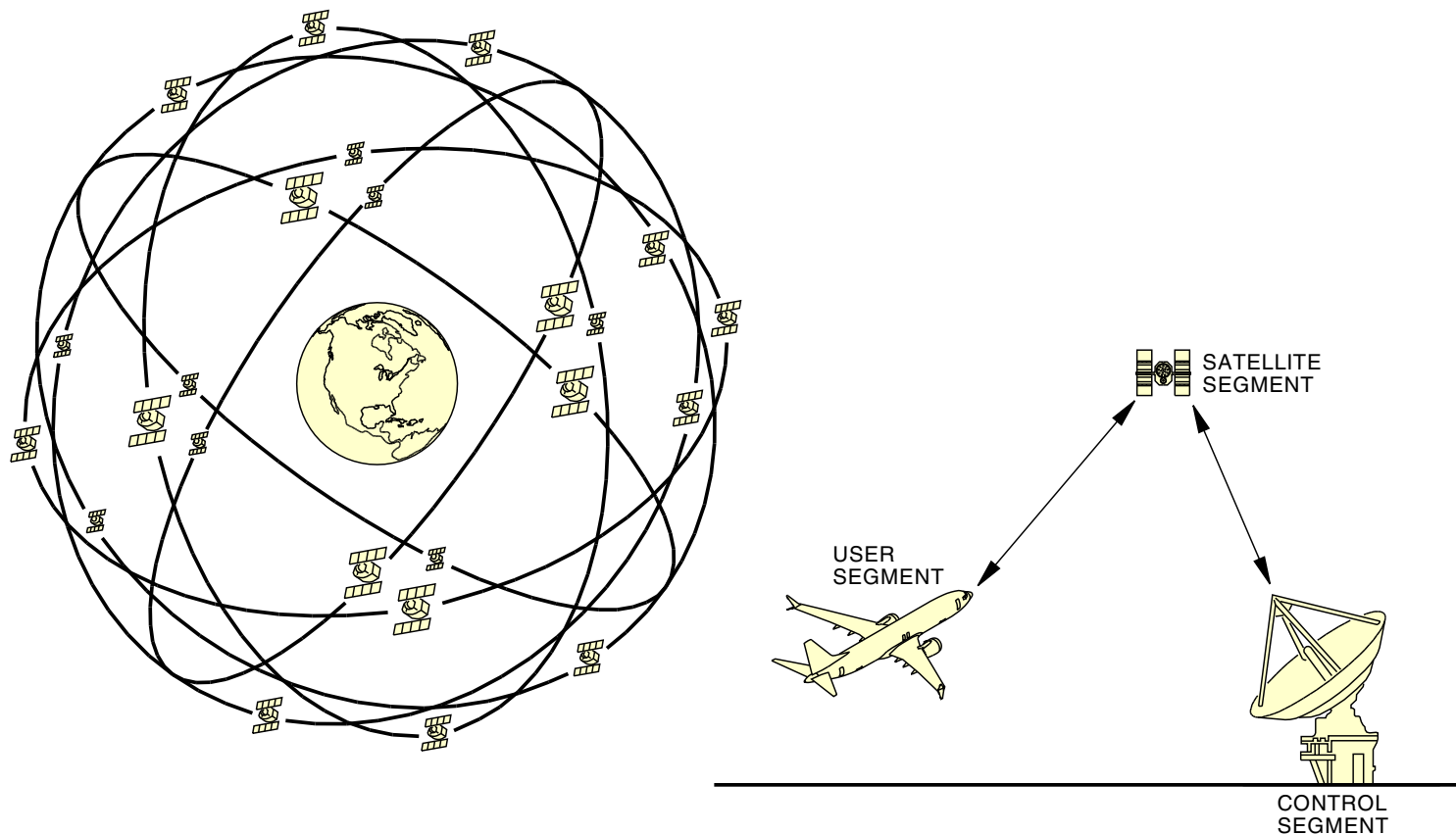
- Record the accuracy of the satellite clocks
- Collect and relay to the control station meteorologic data such as barometric pressure, temperature, and dew point. The master control station uses this data to calculate the tropospheric signal delay
- Continuously measure the ranges to all visible satellites. The master control station uses this data to calculate and predict the satellites orbits.

The master control station uses the upload stations to send this data:

- Orbit correction commands to the satellites. The satellites use control rockets to correct their orbits
- The navigation message to the satellites.

The upload stations are on Ascension island, Diego Garcia island, and Kwajalein island.

GPS - THEORY OF OPERATION - 1



2370089 S00061520958_V1

GPS - THEORY OF OPERATION - 1

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SIA ALL	EFFECTIVITY

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GPS - THEORY OF OPERATION - 2

Ranging

The GPS receivers use the principle of ranging to measure the distance between the receiver and the satellites. The receiver always has the location of the satellites in their orbits in memory.

The receiver measures the time it takes for a radio signal to go from a satellite to the airplane. Since the receiver knows the location of the satellite and that the radio signal travels at the speed of light, it can calculate the distance to the satellite.

The receiver uses one way ranging. The receiver must know exactly at what time the satellite sent the radio signal. The receiver compares the satellite signal to a signal that the receiver makes at the same time as the satellite. The difference between the two signals (Δt) is the time the satellite signal took to get to the receiver.

Each satellite has an atomic clock to keep accurate time. All the satellites have precisely the same time. The receiver in the airplane has an internal clock but it is not atomic. It is not as accurate. Thus, it is not possible for the receiver to have precisely the same time as the satellite.

The receiver assumes that its internal clock is off by some clock bias (Δt_{BIAS}). This Δt_{BIAS} is an unknown that the receiver must calculate. The Δt_{BIAS} is the difference between the receiver time and GPS time.

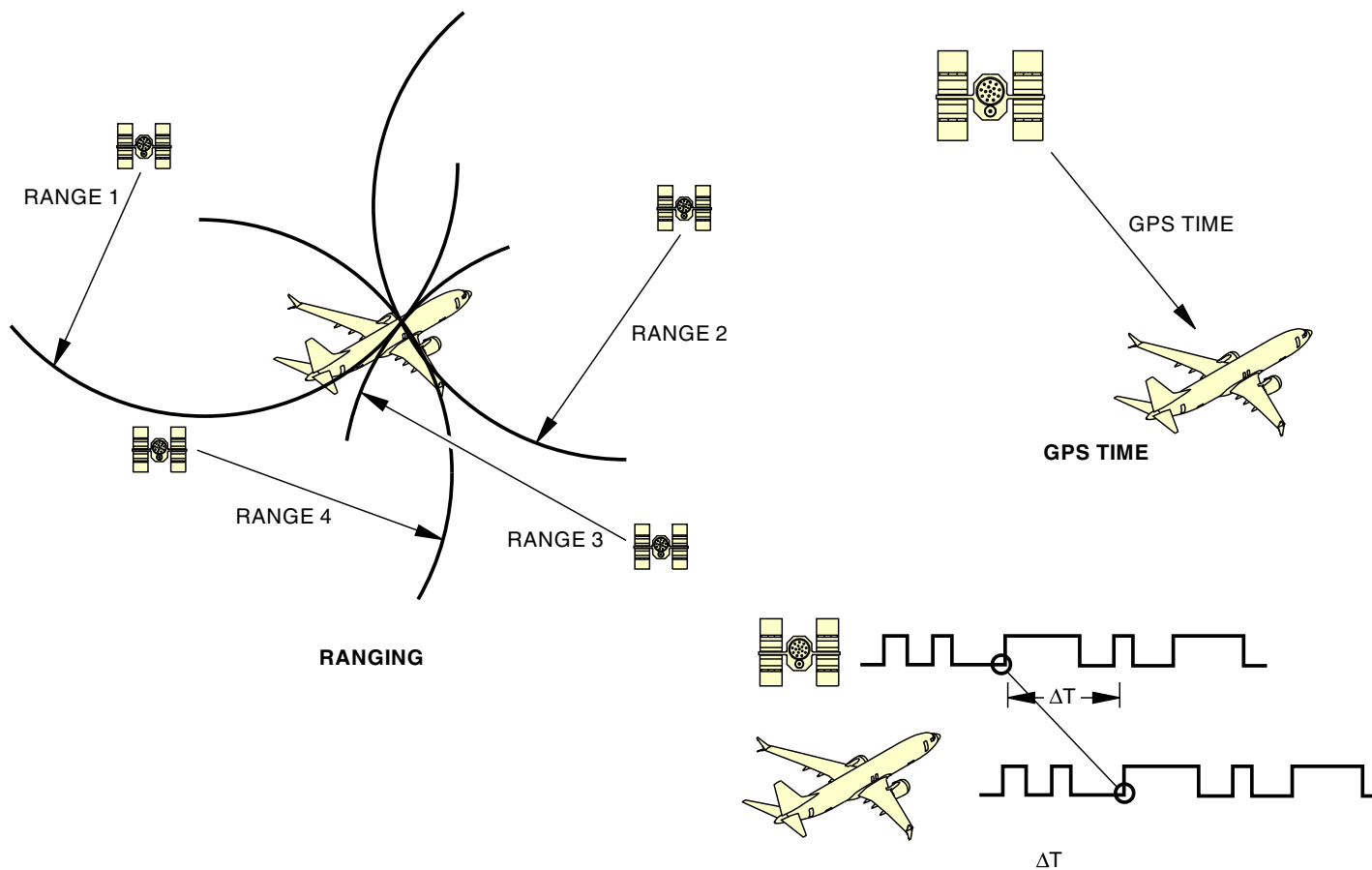
To calculate the airplane position (latitude, longitude, and altitude) and the Δt_{BIAS} , the receiver must know the position of at least four satellites. The receiver then measures the distances to all the satellites at the same time. It then solves for these four unknowns with four range equations:

- Latitude
- Longitude
- Altitude
- Δt_{BIAS} .

GPS Time

All the satellites synchronize to universal time (coordinated) (UTC). The satellites transmit this time to the receiver. The accuracy of the satellite UTC is approximately 100 nanoseconds. The receiver transmits UTC on an ARINC 429 format. The receiver also transmits a very accurate time mark once per second.

GPS - THEORY OF OPERATION - 2



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GPS - THEORY OF OPERATION - 2

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GPS - THEORY OF OPERATION - 3

GPS Modes of Operation

The GPS operates in these modes:

SIA 005-999; SIA 001-004 POST SB 737-34-3141

- Initialization mode

SIA ALL

- Acquisition mode
- Navigation mode
- Altitude aided mode
- Aided mode

SIA 005-999; SIA 001-004 POST SB 737-34-3141

- Fault mode.

Initialization Mode

The ADIRU transitions the hybrid GPS operational mode to Initialization when it completes the power-up sequence and transitions to normal mode. Both GPS sensor channels are validated during initialization mode and one is chosen as the selected GPS source. In Initialization mode, the ADIRU transmits hybrid GPS outputs with status set to No Computed Data (NCD).

SIA ALL

Acquisition Mode

The GPS looks for and locks on to the satellite signals. The GPS must find at least 4 satellites before it starts to calculate GPS data. The GPS gets data from the air data inertial reference system (ADIRS). The GPS uses this data from air data inertial reference unit (ADIRU) when it is in the acquisition mode:

- Present position
- Altitude.

The GPS uses this data and its internal database to calculate which satellites are available at the present airplane position. The GPS takes less time to get to the navigation mode with this data.

If the ADIRU data is not available, the GPS can still acquire satellites signals. It takes longer to acquire the satellite signals because it has to look for all the satellites. When the GPS finds the satellites, it calculates which ones it can use.

The GPS takes approximately 75 seconds to acquire the satellite signals when the ADIRU data is available. The GPS takes approximately 4 minutes (maximum of 10 minutes) to acquire the satellites when the ADIRU data is not available.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

Once GPS data inputs are valid, the hybrid GPS function transitions from Initialization to Acquisition mode. The hybrid GPS mode can also transition back to Acquisition from Navigation mode if the IR exits navigation mode or if valid GPS data is not received. In Acquisition mode, the ADIRU transmits hybrid GPS outputs with status set to NCD.

SIA ALL

Navigation Mode

The GPS enters the navigation mode after it acquires and locks on to at least 4 satellites. When the GPS is in the navigation mode, it calculates GPS data.

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EFFECTIVITY	
SIA ALL	

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



GPS - THEORY OF OPERATION - 3

SIA 005-999; SIA 001-004 POST SB 737-34-3141

The hybrid GPS function transitions from Acquisition to Navigation mode when IR is in navigation mode, the hybrid navigation has computed valid data, and the GPS and inertial positions agree within a reasonable tolerance. In Navigation mode, the ADIRU transmits valid hybrid GPS outputs. The accuracy of the hybrid GPS navigation data is dependent upon the accuracy of the inertial solution, errors in the GPS receiver measurements being used, and satellite geometry as measured by Horizontal and Vertical Dilution of Precision (HDOP/VDOP).

SIA ALL

Altitude Aided Mode

With four satellites available, the GPS stores the difference between the ADIRU inertial altitude and the GPS altitude.

The GPS stores the difference between inertial and GPS altitude so that it can estimate the GPS altitude when only three satellites are available.

In the altitude aided mode, the GPS sums the airplane altitude from the ADIRU and the length of the earth radius as the fourth range.

The GPS enters the altitude aided mode only after these three conditions are true:

- The GPS was in the navigation mode
- There are only 3 satellites available with good geometry for position fixes
- The GPS stored the difference between inertial and GPS altitude in memory.

The GPS starts normal operation again when a fourth satellite comes into view.

Aided Mode

The GPS enters the aided mode during short periods (less than 30 seconds) of bad satellite coverage. An example of bad satellite coverage is where at least four satellites are available but the airplane banks and loses satellite reception.

In the aided mode, the GPS receives inertial altitude, track angle, and groundspeed from the ADIRU. The GPS uses the ADIRU data to go back quickly to the navigation mode when there is good satellite coverage again. The GPS output is NCD in this mode.

If the GPS cannot track any satellites for 30 seconds or more, the GPS goes to the acquisition mode.

SIA 005-999; SIA 001-004 POST SB 737-34-3141

Fault Mode

The hybrid GPS function transitions to Fault mode whenever it detects a failure that affects the integrity of the hybrid outputs and the IR/hybrid GPS functional test function is not active. In Fault mode, the ADIRU transmits hybrid GPS outputs with their status set to Fail Warning (FW).

SIA ALL

GPS Frequencies

The satellites transmit to the GPS in the airplane on the L1 (1575.42 MHz) and L2 (1227.6 MHz) frequencies. The satellites downlink satellite status data to the monitor stations on 1783.74 MHz.

The upload stations send information to the satellites on 2227.5 MHz.

Autonomous Integrity Limit

The GPS has a receiver autonomous integrity monitor (RAIM) function. The RAIM monitors the status of the satellites that the GPS uses for calculations. The output of the RAIM function is an estimate of the GPS position error. The autonomous integrity monitor value goes to the FMC. The FMC uses the autonomous integrity monitor to determine if it can use GPS data for navigation.

Values Calculated by the GPS

These are some of the values that the GPS calculates:

- Latitude
- Longitude

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SIA ALL EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

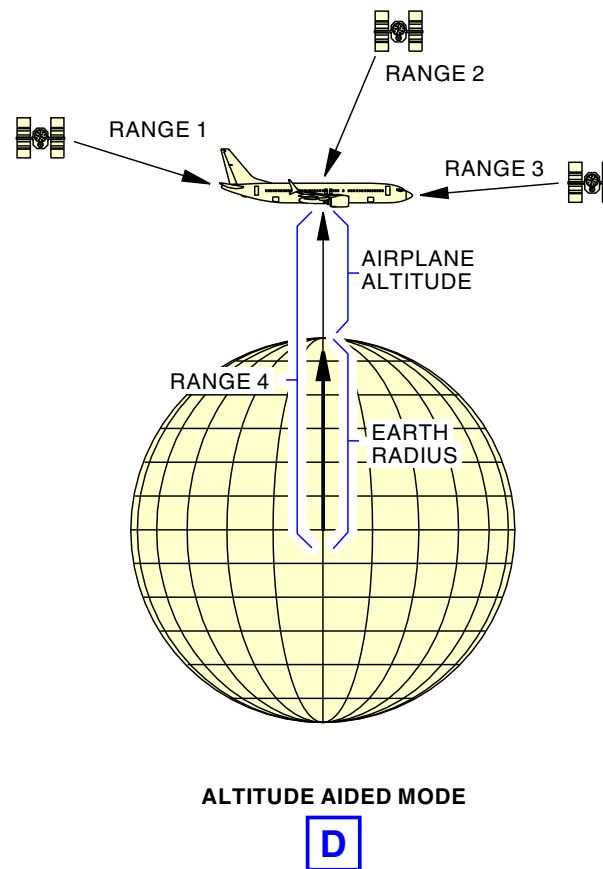


GPS - THEORY OF OPERATION - 3

- Altitude
- Universal time (coordinated) (UTC)
- Date
- North/south velocity
- East/west velocity
- Vertical velocity
- Track angle
- Autonomous integrity limit
- Satellite position
- GPS status

```

graph TD
    Start([POWER-UP]) --> Acquisition([ACQUISITION MODE])
    Acquisition --> Sat4_1{ARE 4 SATS AVAIL?}
    Sat4_1 -- NO --> Sat4_1
    Sat4_1 -- YES --> Nav([NAVIGATION MODE])
    Nav --> BadSat1{BAD SAT COVERAGE?}
    BadSat1 -- YES --> Sat4_1
    BadSat1 -- NO --> Sat3{ARE THERE ONLY 3 SATS?}
    Sat3 -- YES --> AltAid([ALTITUDE AIDED MODE])
    Sat3 -- NO --> Sat4_1
    AltAid --> BadSat2{BAD SAT COVERAGE?}
    BadSat2 -- YES --> Sat4_1
    BadSat2 -- NO --> Sat4_2{ARE 4 SATS AVAIL?}
    Sat4_2 -- YES --> Sat4_1
    Sat4_2 -- NO --> Sec30{30 SEC PASSED?}
    Sec30 -- YES --> Sat4_2
    Sec30 -- NO --> Sat4_1
    Sat4_1 --> Aided([AIDED MODE])
    Aided --> Sat4_1
    Aided --> Sat4_2
    Sat4_2 --> D([D])
    D --> AltAid
    
```



2370091 S00061520962_V2

GPS - THEORY OF OPERATION - 3



GPS - FUNCTIONAL DESCRIPTION

Power**SIA 001-005**

The power supply makes various dc voltages from the 115v ac input to the multi-mode receiver (MMR).

SIA 006-999

The power supply makes various dc voltages from the 115v ac input to the integrated multi-mode receiver (IMMR).

SIA ALL**Satellite Signal Processing****SIA 001-005**

The GPS antenna first amplifies the satellite signals and then sends them to the MMR. The low noise amplifier (LNA) in the MMR receives and amplifies the satellite signals from the GPS antenna. The receiver detects the satellite signal and sends it to an analog to digital converter (A/D). The A/D sends the digitized signal to the microprocessor. The microprocessor calculates the airplane position and other GPS data. The GPS data goes to these units:

SIA 006-999

The GPS antenna first amplifies the satellite signals and then sends them to the IMMR. The low noise amplifier (LNA) in the IMMR receives and amplifies the satellite signals from the GPS antenna. The receiver detects the satellite signal and sends it to an analog to digital converter (A/D). The A/D sends the digitized signal to the microprocessor. The microprocessor calculates the airplane position and other GPS data. The GPS data goes to these units:

SIA ALL

- Ground proximity warning computer (GPWC)
- Flight management computers (FMC 1 and 2).

The IRS master caution unit receives digital fault data from GPS systems 1 and 2.

Inputs**SIA 001-005**

The ADIRU sends inertial reference data on output bus 4 for initialization. The MMR uses this data in the aided and altitude aided modes.

The program pins tell position to the MMR. This is used for the source destination identifier (SDI) code in ARINC 429 data.

SIA 006-999

The ADIRU sends inertial reference data on output bus 4 for initialization. The IMMR uses this data in the aided and altitude aided modes.

The program pins tell position to the IMMR. This is used for the source destination identifier (SDI) code in ARINC 429 data.

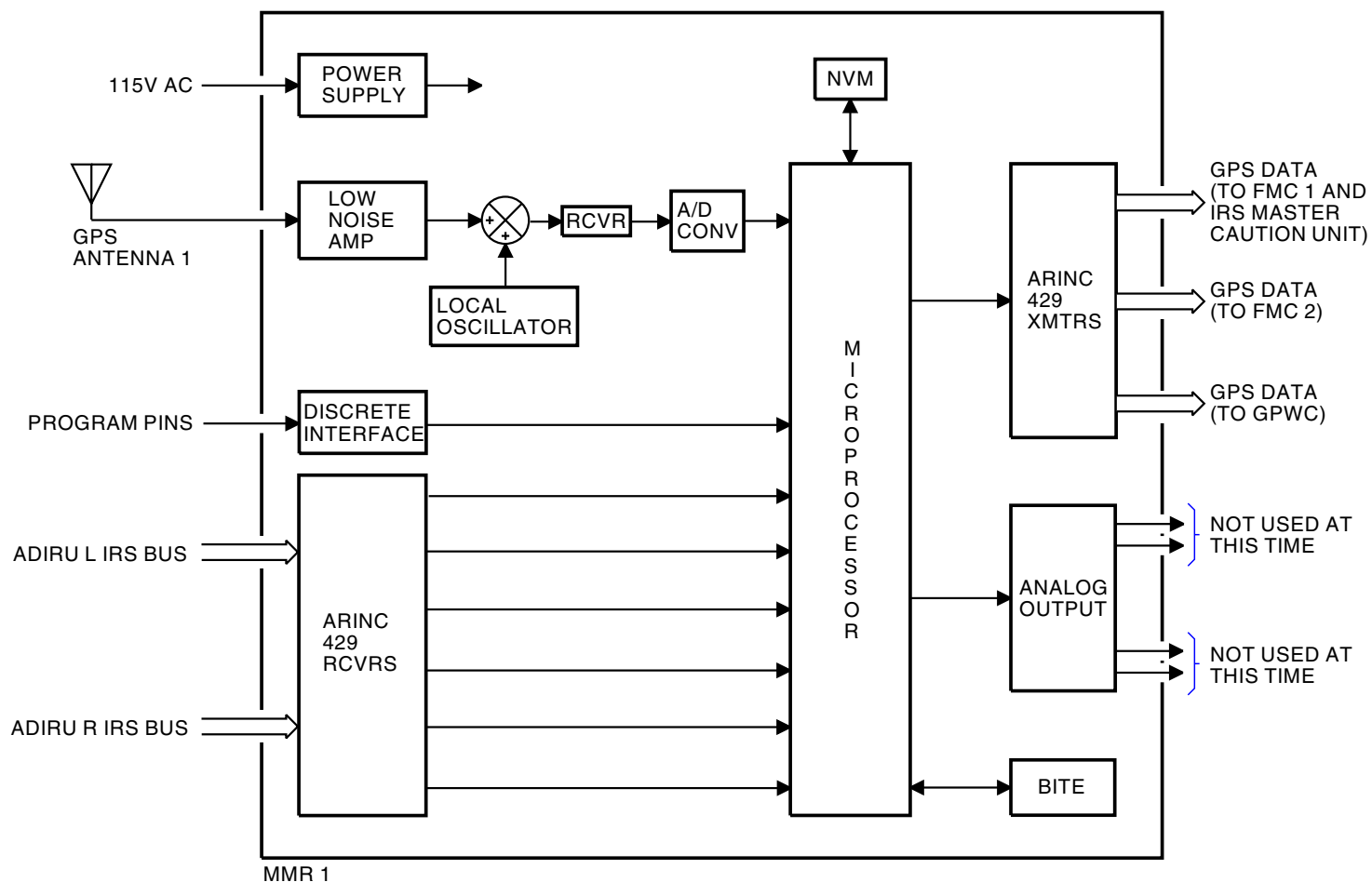
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GPS - FUNCTIONAL DESCRIPTION

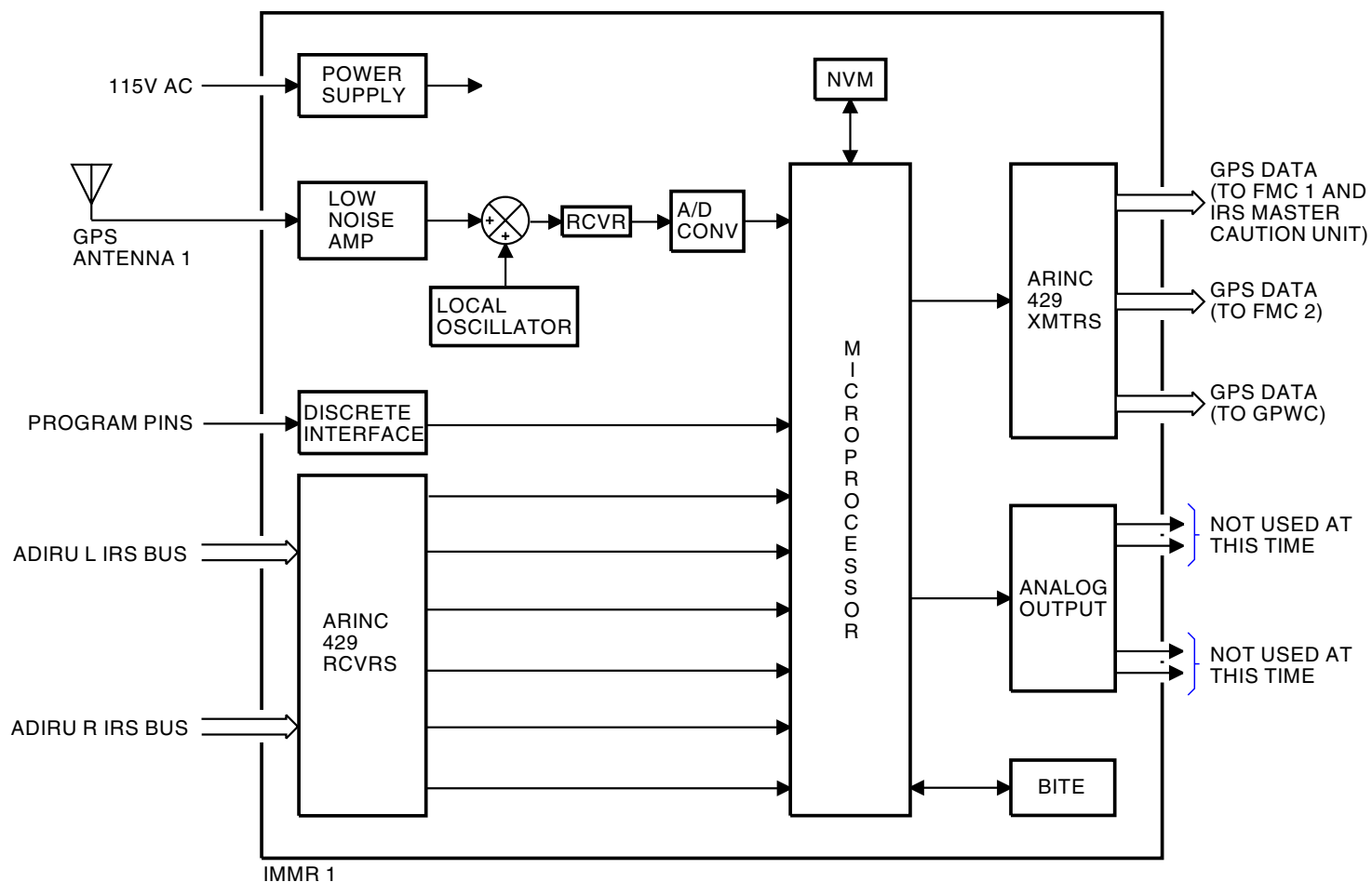


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GPS - FUNCTIONAL DESCRIPTION

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GPS - FUNCTIONAL DESCRIPTION



2804403 S0000643318_V1

GPS - FUNCTIONAL DESCRIPTION

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**GPS - GPS FAULT MONITORING - FUNCTIONAL DESCRIPTION****One GPS Failure**

If there is one GPS failure, there is no annunciation until you push the system status annunciator panel assembly (recall). When you push the annunciator panel, these annunciations show:

- GPS light on the IRS mode select unit
- IRS light on the system status annunciator
- Left and right master caution lights.

When you release the annunciator panel assembly, all the annunciations stay on until you reset by a push of either the left or right master caution light (reset).

Two GPS Failures

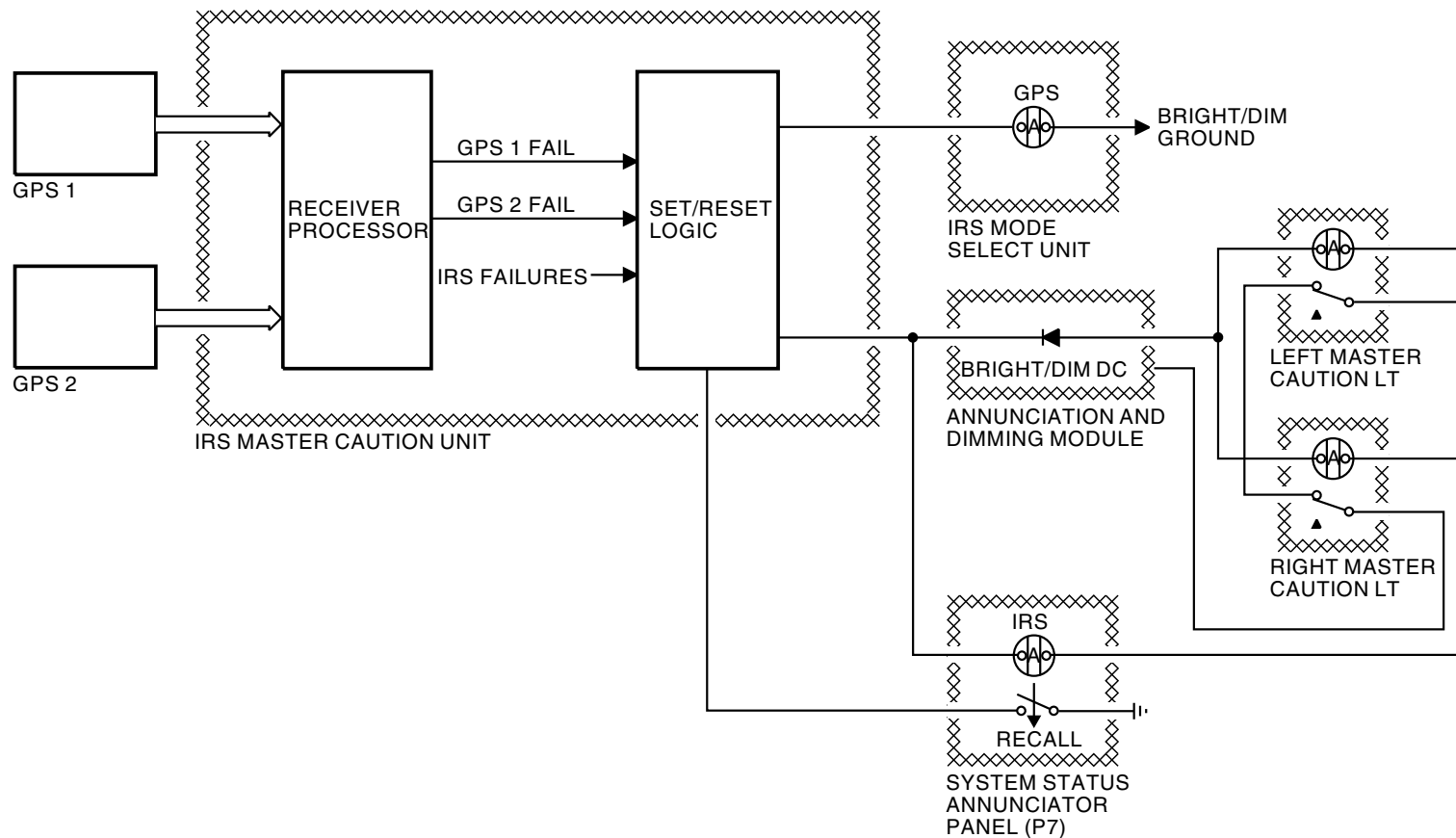
If both GPS systems have a failure, these annunciations show:

- GPS light on the IRS mode select unit
- IRS light on the system status annunciator
- Left and right master caution lights.

When you push and release either the left or right master caution light, the IRS light and master caution lights go out but the GPS light stays on.

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GPS - GPS FAULT MONITORING - FUNCTIONAL DESCRIPTION



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GPS - GPS FAULT MONITORING - FUNCTIONAL DESCRIPTION

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GPS - CDU DISPLAYS

General

GPS data shows on the Control Display Unit (CDU). The position pages show this data. These are the three position pages:

- Position initialization (1/3)
- Position reference (2/3)
- Position shift (3/3).

You use the next and previous key to see all three position pages. These are the pages that show GPS data:

- Position reference (POS REF)
- Position shift (POS SHIFT).

POS REF Page

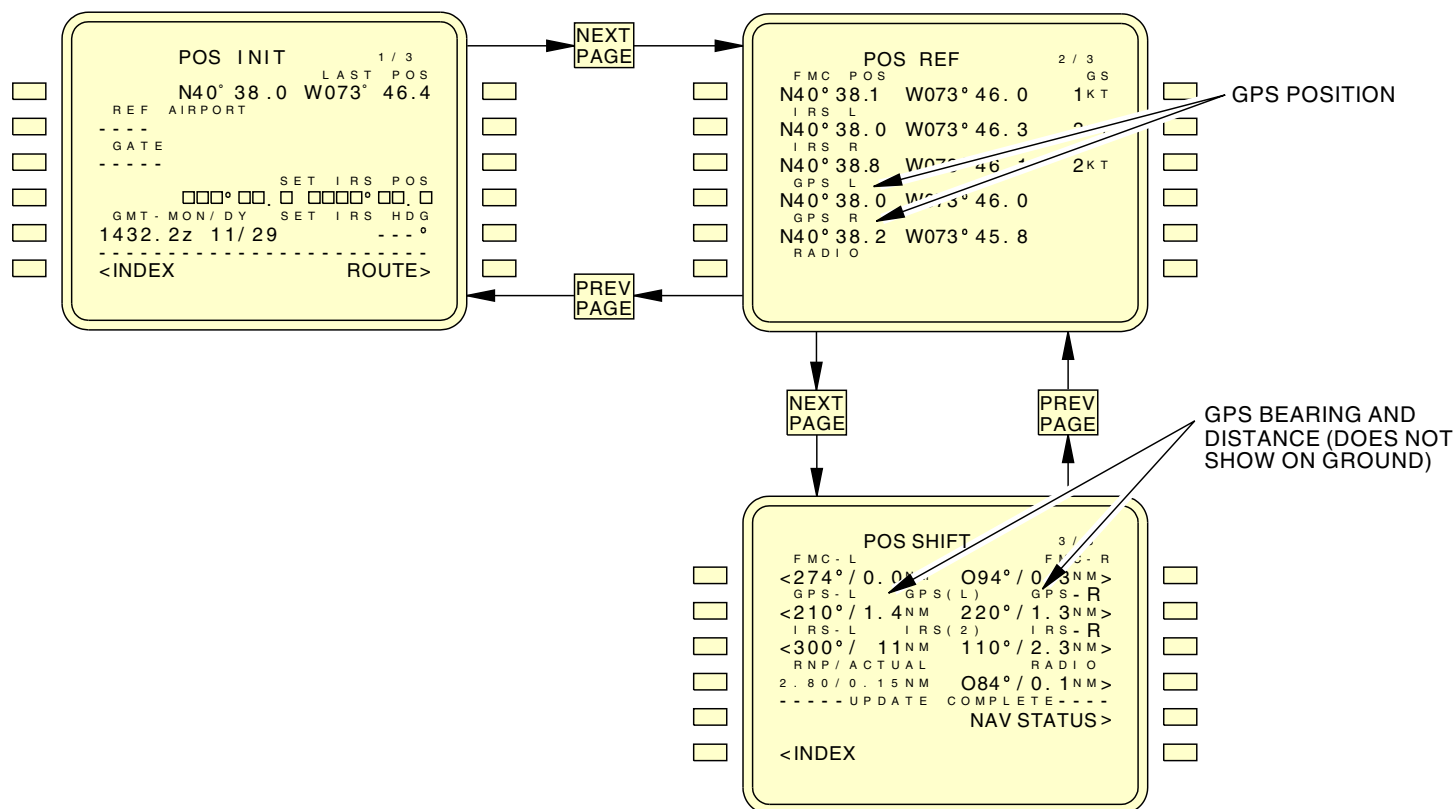
The POS REF page shows GPS L (1) and R (2) positions.

POS SHIFT Page

The POS SHIFT page shows the GPS position from the flight management computer (FMC) position. The GPS position shows in these two parts divided by a slash (/):

- Bearing of the GPS position from the FMC position
- Distance of the GPS position from the FMC position in nautical miles (NM).

GPS - CDU DISPLAYS



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GPS - CDU DISPLAYS

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GPS - MMR BITE

SIA 006-999

Front Panel Self-Test

When you push the test switch, the IMMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 44 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on red
- 2 to 4 seconds - the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 16 seconds - all LEDs go off
- 16 to 44 seconds - test status shows.

The LRU STATUS segment shows red when there is an internal failure in the IMMR. Green shows that the IMMR is operating normally.

The CONTROL FAIL segment shows red when an interface to the IMMR has a failure. Green shows that all the interfaces to the IMMR are normal.

SIA 001-005

Front Panel Self-Test

When you push the test switch, the MMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 44 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on red
- 2 to 4 seconds - the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 16 seconds - all LEDs go off
- 16 to 44 seconds - test status shows.

The LRU STATUS segment shows red when there is an internal failure in the MMR. Green shows that the MMR is operating normally.

The CONTROL FAIL segment shows red when an interface to the MMR has a failure. Green shows that all the interfaces to the MMR are normal.

SIA ALL

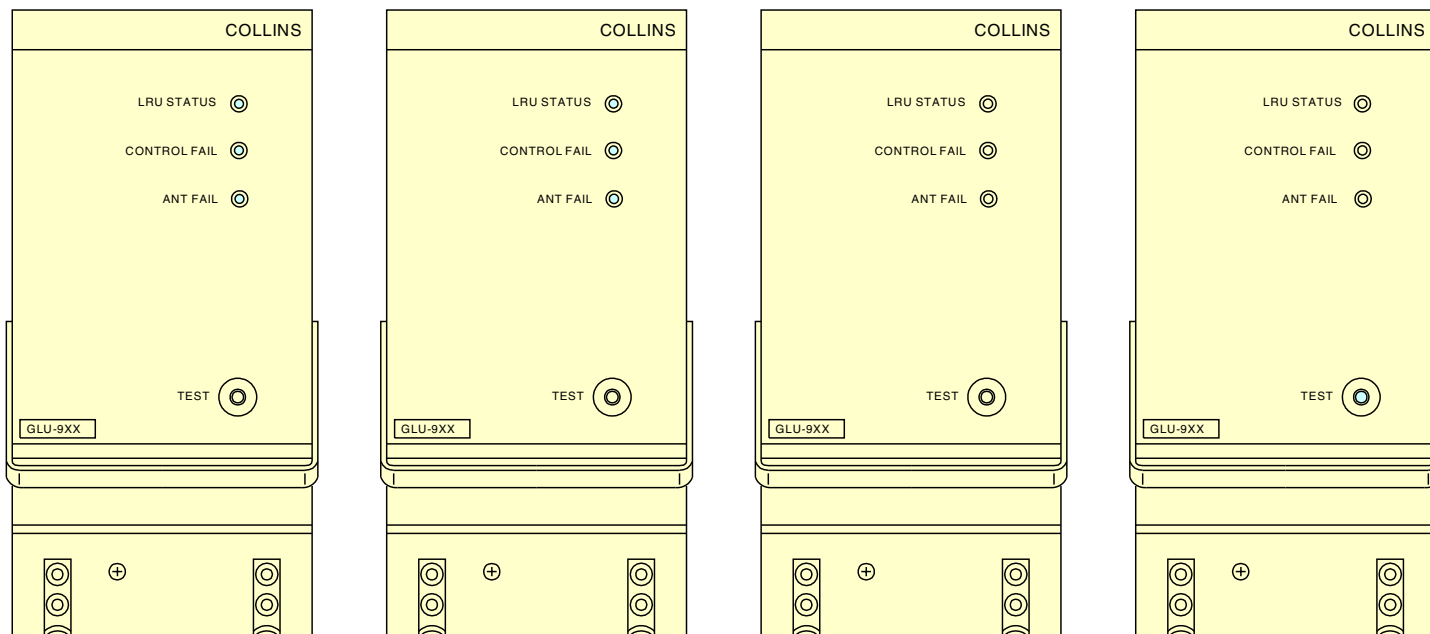
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GPS - MMR BITE



0-2 SECONDS

THE LRU STATUS, CONTROL FAIL AND ANT FAIL LEDS ON RED.

2-4 SECONDS

THE LRU STATUS IS GREEN, CONTROL FAIL AND ANT FAIL ARE RED.

4-16 SECONDS

ALL LEDS OFF.

16-44 SECONDS

THE TEST STATUS SHOWS.

2532089 S0000599623_V2

GPS - MMR BITE

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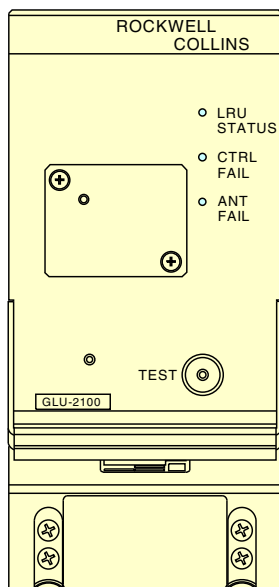
EFFECTIVITY

SIA 001-005

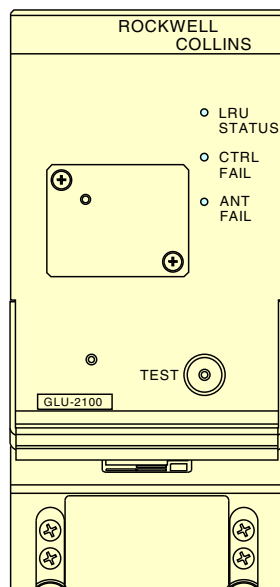
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

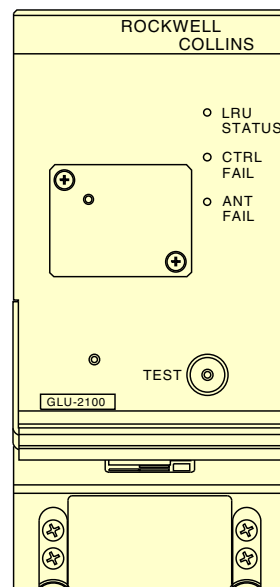
GPS - MMR BITE



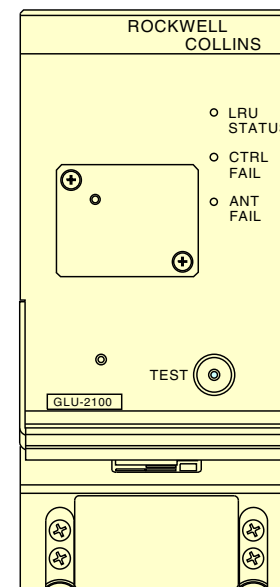
0-2 SECONDS
THE LRU STATUS, CONTROL
FAIL AND ANT FAIL LEDS ON
RED.



2-4 SECONDS
THE LRU STATUS IS GREEN,
CONTROL FAIL AND ANT FAIL
ARE RED.



4-16 SECONDS
ALL LEDS OFF.



16-44 SECONDS
THE TEST STATUS SHOWS.

2801320 S0000641918_V1

GPS - IMMR BITE

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GPS - MMR BITE

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FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

General

The flight management computer (FMC) is the main component of the flight management computer system (FMCS). The flight crew uses the Control Display Unit (CDU) to enter the route and performance data for the flight into the FMC. With this flight plan data and inputs from the airplane sensors, the FMC performs these functions:

- Navigation
- Performance
- Guidance

An optional connection to the airplane communication and reporting system (ACARS) is also available. The ACARS lets the FMC receive flight plan data from a ground station and to send flight status to the ground station.

Navigation

The navigation data base in the FMC memory includes all the navigation data for the area of operation. This data base is updated every 28 days. The pilot can preselect the entire flight plan from the navigation data base. Also, the flight crew can have the FMC fly an offset from the route. The required time of arrival (RTA) function is also available.

The FMC calculates the airplane position as the flight continues. It uses the inertial reference function and navigation aids, if available, to calculate the position. Any deviation shows on the MAX display system.

The FMC also uses the global positioning system (GPS) to calculate the airplane position.

The FMC compares the calculated position with the flight plan for LNAV control. The FMC displays the calculated position and the flight plan on the navigation display panel.

Performance

A performance data base in the FMC contains a performance model of the airplane and the engines. The flight crew enters gross weight, cruise altitude and cost index for the flight. The FMC uses this data to calculate the speeds, flight attitude and top of descent point. The CDU and flight displays show the target speeds and altitudes.

The FMC uses this data to calculate these functions:

- Economy speeds
- Best flight altitude
- Top of descent point

The MAX display system (MDS) shows target speeds and altitudes.

Guidance

The FMC sends commands to the digital flight control system (DFCS) and the autothrottle (A/T) function. The DFCS and the A/T use these signals to control the airplane in the lateral (LNAV) and vertical (VNAV) parts of the flight plan.

Built-In Test equipment

Use the FMCS CDU to select and control BITE for these systems:

- FMCS
- Digital flight control system (DFCS)
- Autothrottle (A/T)
- Air data inertial reference unit (ADIRU)
- MAX display system (MDS)
- Electronic engine controller (EEC)
- APU engine control unit (ECU)
- Fuel quantity indication system (FQIS)



FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

Abbreviations and Acronyms

- AA - autoflight status annunciator
- AADD - ACARS adaptable datalink database
- act - active
- AC - alternating current
- ACARS - aircraft communications addressing and reporting system
- ACMS - airplane conditioning monitoring system
- ADIRU - air data inertial reference unit
- ADIRS - air data inertial reference system
- ADL - airborne data loader
- ADS - automatic dependent surveillance
- AFN - ATS facilities notification function
- alt - altitude
- appr - approach
- APU - auxiliary power unit
- ARINC - aeronautical radio incorporated
- arr - arrival
- ASA - autoflight status annunciator
- ASIC - application specific integrated circuit
- A/S - airspeed
- A/T - autothrottle
- ATA - actual time of arrival
- ATC - air traffic control
- ATN - aeronautical telecommunications network
- ATS - air traffic services
- BIT - built in test
- BITE - built in test equipment
- brg - bearing
- C - celsius
- calc - calculate
- CAPT - captain
- CAS - computed airspeed
- CDU - control display unit
- chng - change
- clb - climb
- clr - clear
- cmd - command
- CO - company
- comp - complete
- CON - continuous
- CPDLC - controller pilot datalink communication
- crs - course
- crz - cruise
- ctr - center
- DC - direct current
- del - delete
- dep - departure
- des - descent
- dest - destination
- DPC - display processing computer
- dev - deviation
- DFDAU - digital flight data acquisition unit
- DFCS - digital flight control system
- DIR - direct
- dist - distance
- dspl - display
- DTG - distance-to-go
- DME - distance measuring equipment
- E - east
- E/O - engine out

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FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

- econ - economy
- ECU - engine control unit
- E/D - end of descent
- EEC - electronic engine control
- EEPROM - electrically erasable programmable read only memory
- ELEX - electronics
- ELT - emergency locator transmitter
- eng - engine
- ENG - engaged
- ETA - estimated time of arrival
- EXEC - execute
- F - fahrenheit
- FANS - future air navigation system
- FF - fuel flow
- FL - flight level
- FDAU - flight data acquisition unit
- F/O - first officer
- flt - flight
- FMA - flight mode annunciation
- FMC - flight management computer
- FMCS - flight management computer system
- FPA - flight path angle
- FQIS - fuel quantity indicating system
- FQPU - fuel quantity processor unit
- fwd - forward
- G - ground
- G/A - go-around
- GMT - Greenwich mean time
- GPS - global positioning system
- GPWC - ground proximity warning computer

- GRWT - gross weight
- GS - ground speed
- HF - high frequency
- hdg - heading
- hrwd - hardware
- IAN - integrated approach navigation
- ident - identification
- IFSAU - integrated flight system accessory unit
- ILS - instrument landing system
- inbd - inboard
- info - information
- INIT/REF - initialization/reference
- INTC - intercept

SIA 006-999

- IMMR - integrated multi-mode receiver

SIA ALL

- ISA - international standard atmosphere
- ISB - intersystem bus
- KTS - nautical miles per hour (knots)
- L - left
- lat - latitude
- LED - light emitting diode
- lim - limit
- LNAV - lateral navigation
- long - longitude
- LVL CHG - level change
- MAINT - maintenance
- MASI - mach airspeed indicator
- max - maximum
- MCP - mode control panel

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FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

- MDS - MAX display system
- MEDB - model/engine data base

SIA 001-005

- MMR - multi mode receiver

SIA ALL

- mod - modification
- msg - message
- M - meters
- N - north
- nav - navigation
- NAV RAD - navigation radio
- NDB - navigation database
- NM - nautical miles
- NV - non volatile
- OAT - outside air temperature
- OFP - operational flight program
- OFST - offset
- OFP - operational flight program
- OPS - operational program software
- PDB - performance data base
- PDDDB - performance default data base
- PDL - portable data loader
- perf - performance
- pln - plan
- pos - position
- PPOS - present position
- pred - predicted
- preflit - preflight
- proc - procedure
- prof - profile

- PROG - progress
- PSEU - proximity switch electronics unit
- PTH - path
- QFE - altimeter setting to show altitude above reference airfield
- QNH - altimeter setting to show altitude above mean sea level
- QUAD - quadrant
- qty - quantity
- R - right
- rad - radio
- RAM - random access memory
- RDY - ready
- REC - recorder
- ref - reference
- RTA - required time of arrival
- rte - route
- R/W - read/write
- rwy - runway
- S - south
- S/C - step climb
- SAT - static air temperature
- sel - selector
- SID - standard instrument departure
- SMYD - stall management yaw damper
- SPD - speed
- SRAM - scratch random access memory
- STAR - standard terminal arrival route
- SW - software
- TACAN - tactical air navigation
- TAS - true airspeed
- TAT - total air temperature

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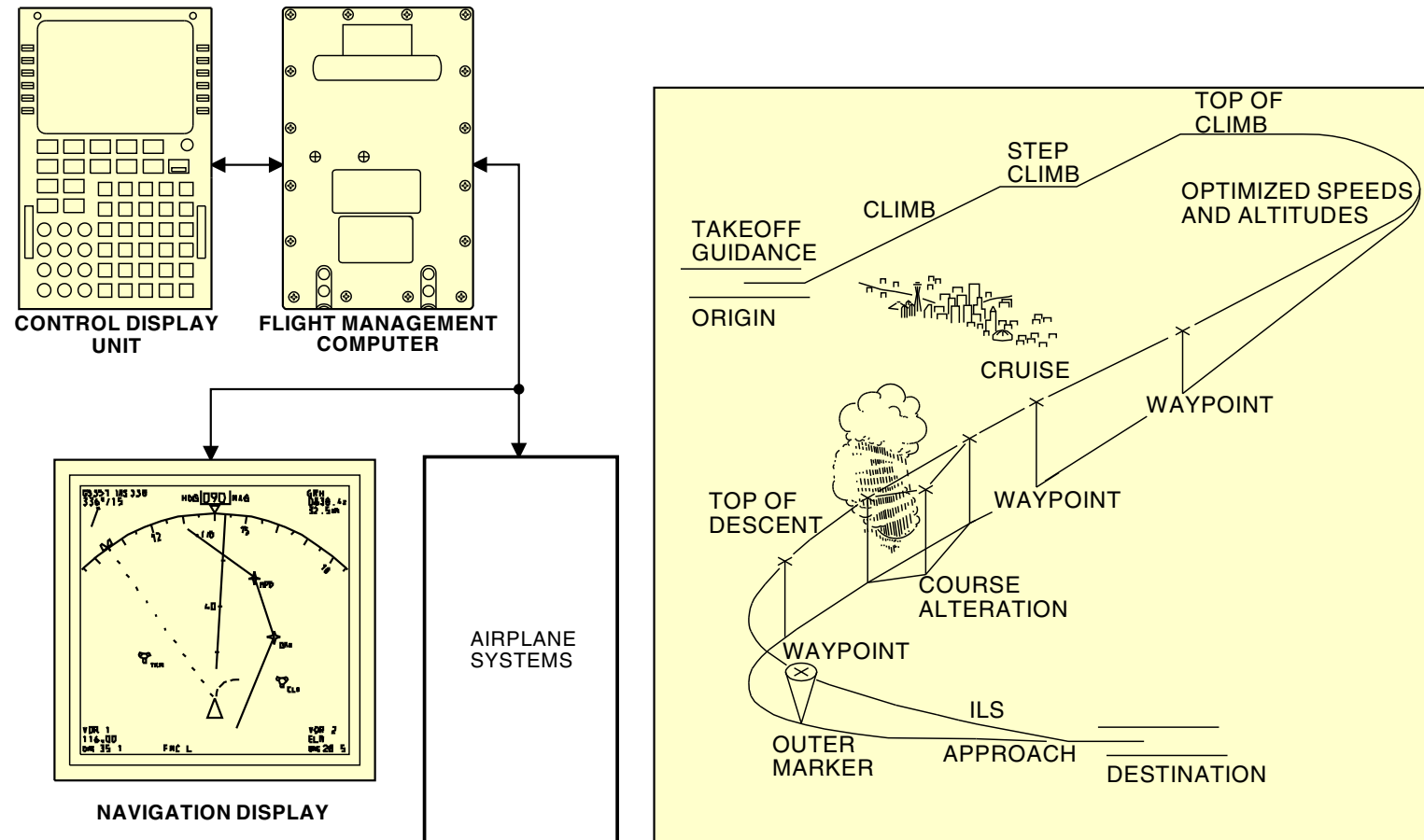
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FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

- T/C - top of climb
- T/D - top of descent
- tgt - target
- thr - thrust
- thr ref - thrust reference
- TO/GA - takeoff/go-around
- trans - transition
- trk - track
- UTC - universal time (coordinated)
- V1 - takeoff decision speed
- V2 - climbout speed
- v - volt
- V - volt
- VNAV - vertical navigation
- VR - rotation speed
- VREF - reference speed
- V/S - vertical speed
- VTK - vertical track
- W - west
- wpt - waypoint
- wt - weight
- XFR - transfer
- XTK - cross track
- Z - zulu
- ZFW - zero fuel weight

FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION



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FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

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**FMCS - GENERAL DESCRIPTION****General**

The flight management computer system (FMCS) reduces the flight crew workload with an automatic control of the airplane navigation, performance, and guidance functions. It also gives access to the BITE functions of other systems.

The FMCS receives data from airplane systems to calculate the navigation and performance data. This data shows on the MDS for use by the flight crew.

The navigation and performance functions also go to the digital flight control system (DFCS) and the autothrottle (A/T) to provide automatic control of the airplane flight path in both the vertical (VNAV) and lateral (LNAV) modes. This is the guidance function of the FMC.

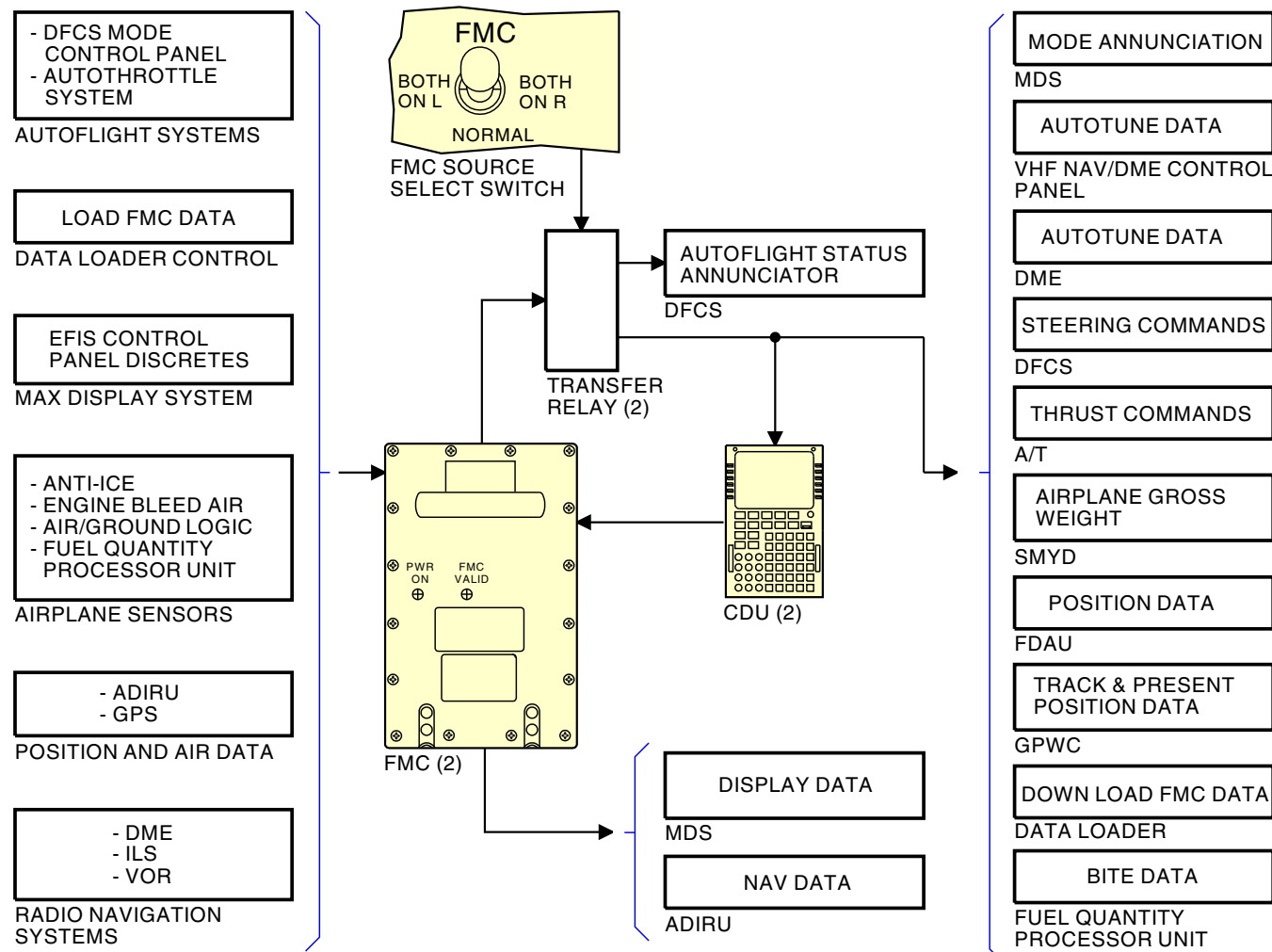
FMC display data goes directly to MDS and present position data goes directly to the air data inertial reference units (ADIRU). The ADIRUs use present position during the alignment.

All other data goes through two transfer relays to the user systems.

The FMC input and output data format is ARINC-429 digital data and analog discretes.

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FMCS - GENERAL DESCRIPTION



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FMCS - GENERAL DESCRIPTION

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**FMCS - FUTURE AIR NAVIGATION SYSTEM - GENERAL DESCRIPTION****General**

The Future Air Navigation System (FANS) is part of the Flight Management Computer System (FMCS) and provides direct datalink communication between the aircraft and ground, both for Air Traffic Control (ATC) and Airline Operational Communications (AOC) ground operations.

FANS requires the aircraft to be equipped with the following:

- Flight Management Computer (FMC)
- FANS Control Display Unit (CDU) with ATC keyboard
- Aircraft Communications Addressing And Reporting System (ACARS) or Communications Management Unit (CMU)
- Multi-Input Printer
- MDS
- Very High Frequency (VHF) Radio
- High Frequency (HF) Radio

Satellite Communication (SATCOM) is required for FANS if flying over oceanic regions or for remote communications where terrestrial contact is unavailable.

The Air Traffic Services (ATS) DATALINK option needs to be enabled in the FMCS to allow operation in a FANS environment. ATS DATALINK option enables Controller Pilot Datalink Communication (CPDLC) and Automatic Dependent Surveillance - Contract (ADS-C) which provides periodic position data reporting, and ATS Facility Notification (AFN) which notifies the ATC facility of an aircraft address.

FANS-1 System

The FANS-1 is mandated in the North American and oceanic ATC airspace. The ATS DATALINK application include the following functions:

- Controller/Pilot Data Link Communications (CPDLC) allows the pilot to communicate with the ATC ground systems using digital transmission of text messages over ACARS. CPDLC increases the effective capacity and improves the availability of the communications channel.

- ADS-C is automatic surveillance used for position reporting. ADS-C also allows an automatic handshake by contract between the aircraft and the enroute ATC ground station for CPDLC.

SIA 001-006 POST SB 737-34-3065**FANS-2 System**

FANS-2 is the next generation of FANS, developed for operations in high-density continental airspace. FANS-2 meets mandates for airplanes flying between North American and European ATC airspace. FANS-2 integrates FANS-1 with the addition of Protected Mode - CPDLC (PM-CPDLC). PM-CPDLC allows a higher speed data link service under the Aeronautical Telecommunications Network (ATN) protocol using VDL (VHF Datalink) Mode 2.

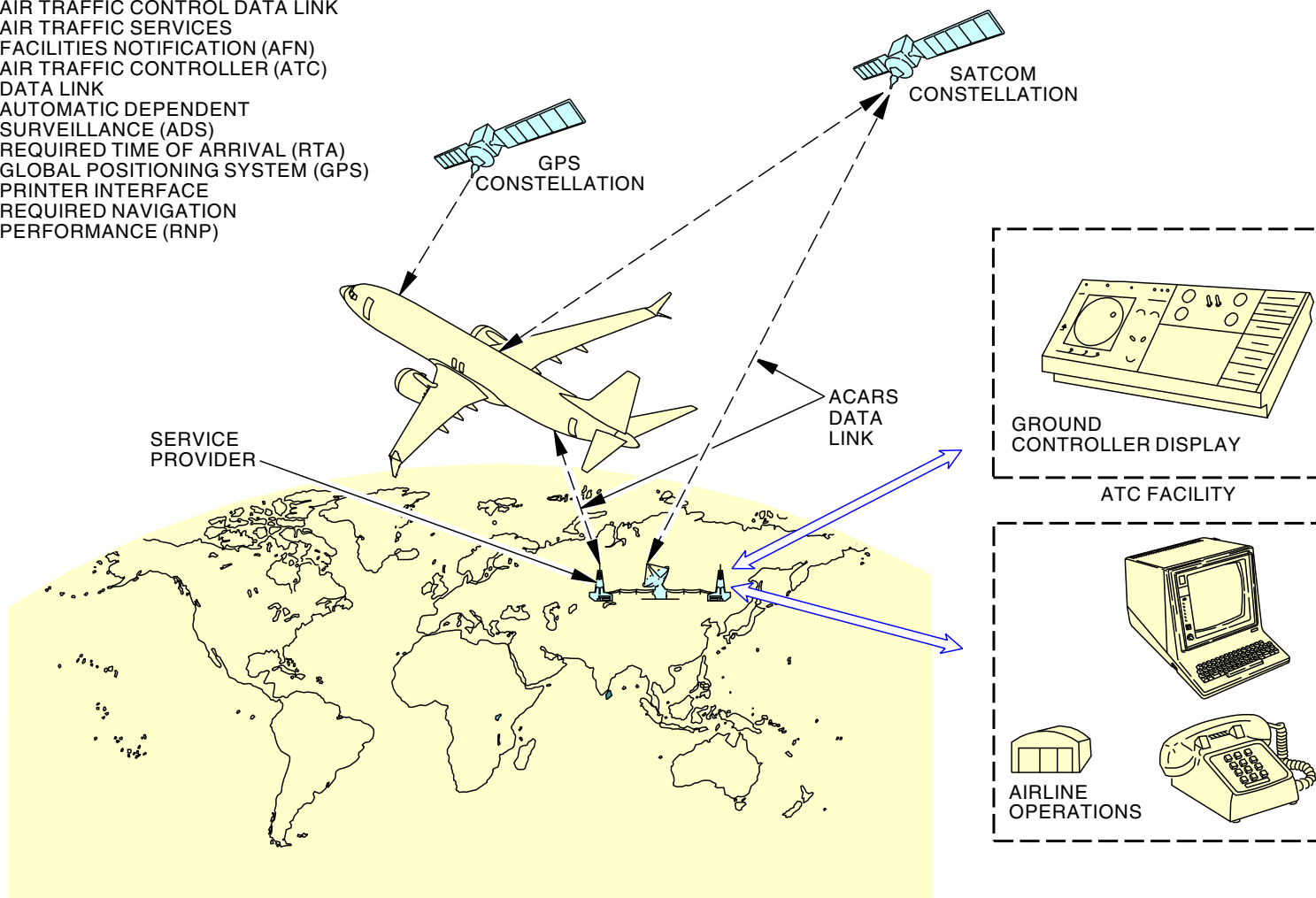
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

FMCS - FUTURE AIR NAVIGATION SYSTEM - GENERAL DESCRIPTION

- AIR TRAFFIC CONTROL DATA LINK
- AIR TRAFFIC SERVICES FACILITIES NOTIFICATION (AFN)
- AIR TRAFFIC CONTROLLER (ATC) DATA LINK
- AUTOMATIC DEPENDENT SURVEILLANCE (ADS)
- REQUIRED TIME OF ARRIVAL (RTA)
- GLOBAL POSITIONING SYSTEM (GPS)
- PRINTER INTERFACE
- REQUIRED NAVIGATION PERFORMANCE (RNP)



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FUTURE AIR NAVIGATION SYSTEM - GENERAL DESCRIPTION



FMCS - FLIGHT COMPARTMENT COMPONENT LOCATION

P9 Forward Electronics Panel

These are the FMCS components on the P9 forward electronics panel:

- CDU 1
- CDU 2.

P5 FWD Overhead Panel

The FMC source select switch is on the P5-28 forward overhead panel.

P61 Panel

These are the FMCS components on the P61 panel:

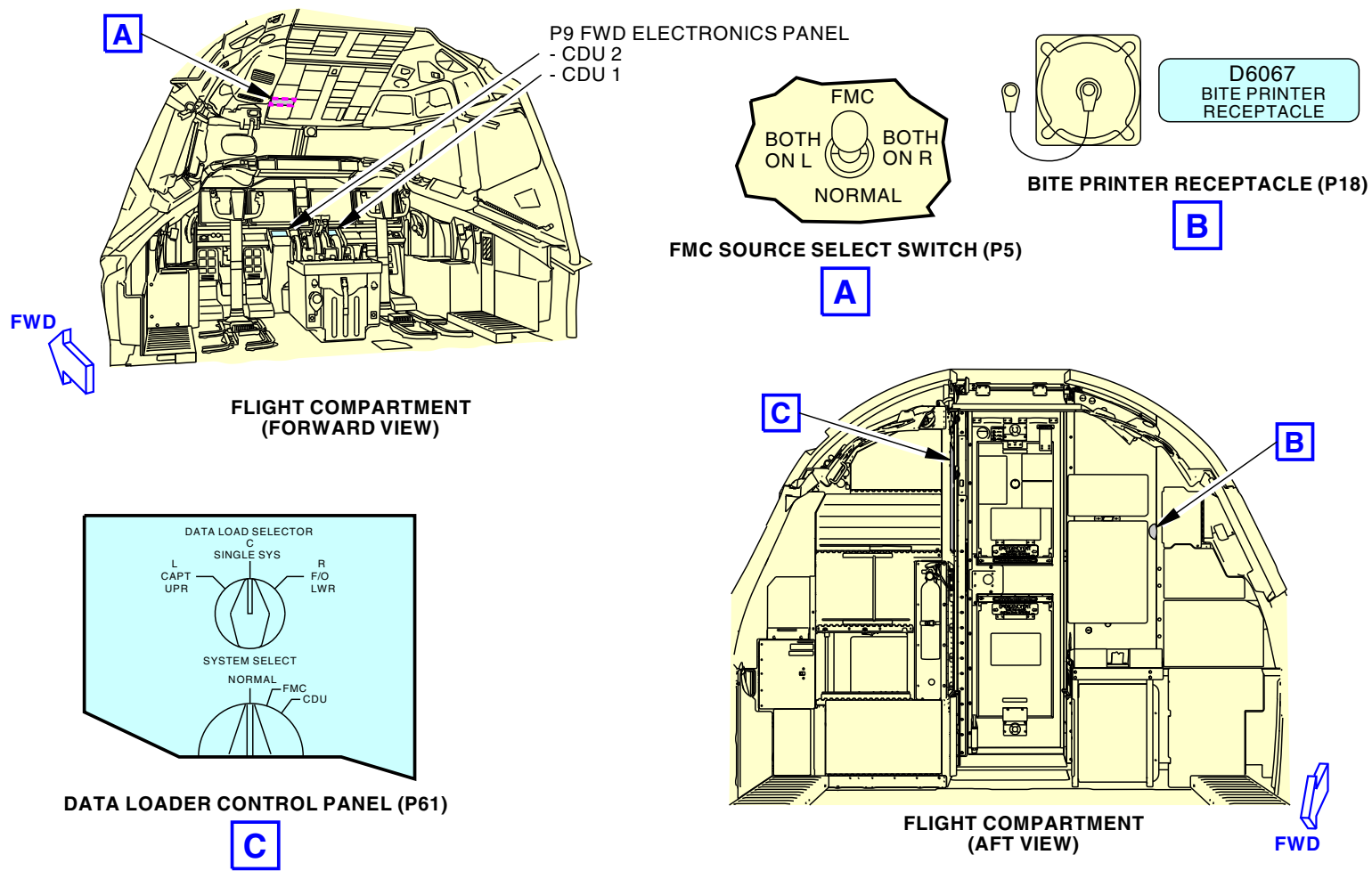
- Data loader control panel.

P18 Panel

The BITE printer receptacle is on the P18-02 panel. When a portable printer is connected to this receptacle, you can print CDU and FMC data.

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FMCS - FLIGHT COMPARTMENT COMPONENT LOCATION



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FMCS - FLIGHT COMPARTMENT COMPONENT LOCATION

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FMCS - ELECTRONIC EQUIPMENT COMPARTMENT LOCATIONS

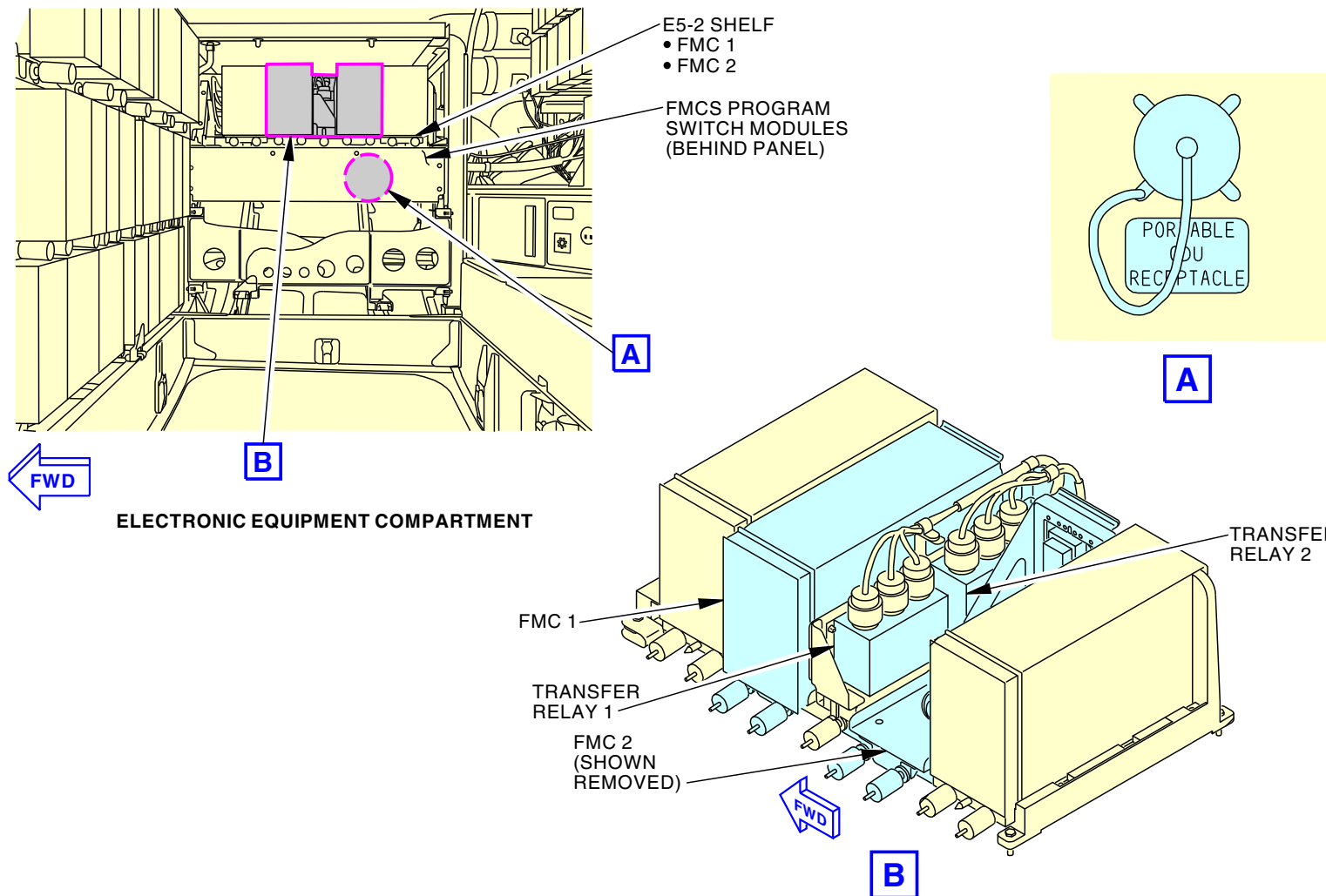
FMCS - Component Location - Electronic Equipment Shelf

The FMCS components installed on the E5-2 shelf are as follows:

- FMC 1
- FMC 2
- Portable CDU receptacle
- FMCS program switch modules
- FMCS transfer relay 1
- FMCS transfer relay 2.

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FMCS - ELECTRONIC EQUIPMENT COMPARTMENT LOCATIONS



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FMCS - ELECTRONIC EQUIPMENT COMPARTMENT LOCATIONS

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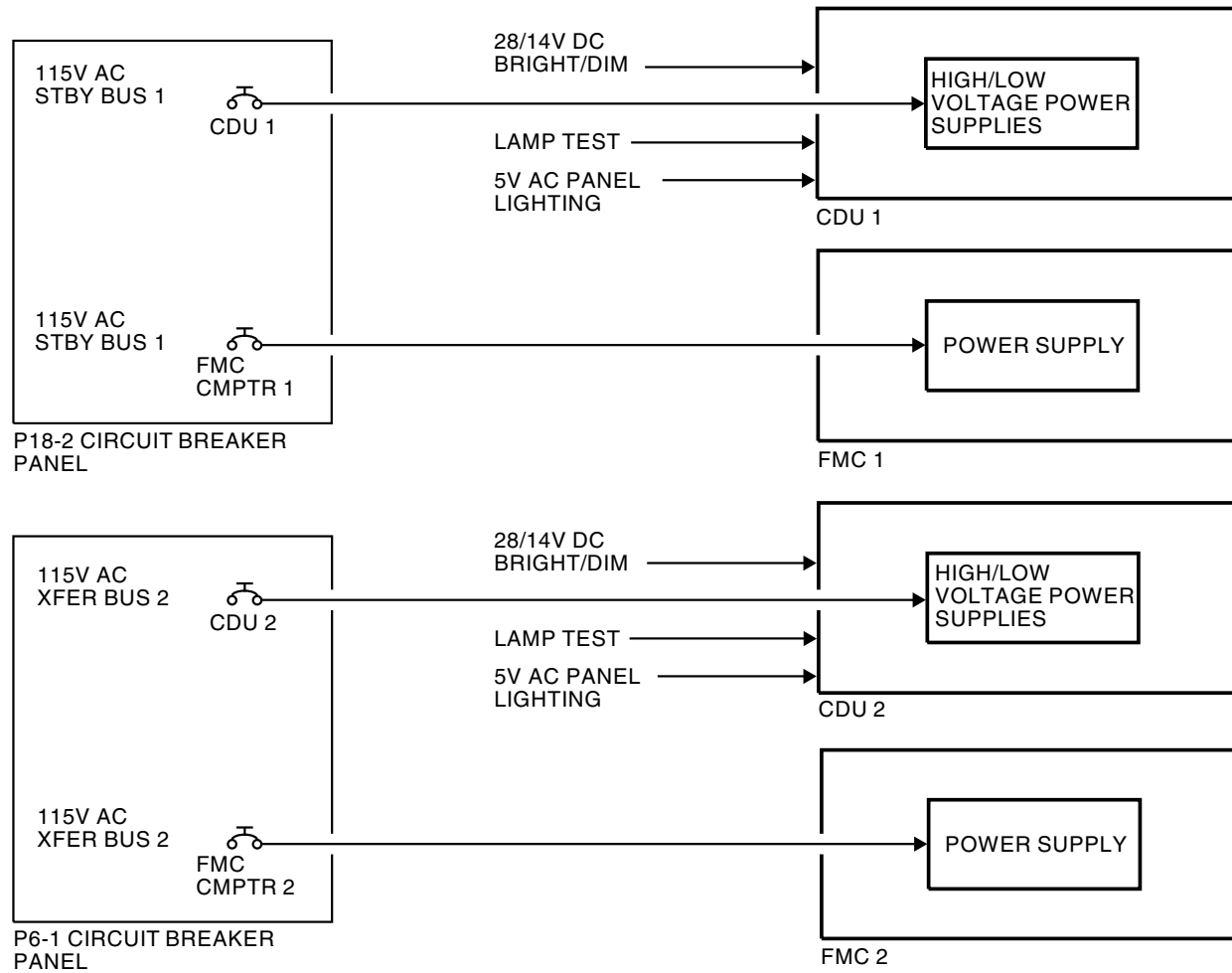
FMCS - FMC AND CDU POWER INTERFACE

General

The FMC and CDU primary power is 115 VAC from the AC standby bus and AC transfer bus 2.

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FMCS - FMC AND CDU POWER INTERFACE



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FMCS - FMC AND CDU POWER INTERFACE

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FMCS - TRANSFER RELAY POWER INTERFACE

General

The transfer relays are Ledex type relays. They mechanically latch to the position you select.

The FMCS source select switch controls the FMCS transfer relays. These are the switch positions:

- NORMAL
- BOTH ON L (both on left FMC)
- BOTH ON R (both on right FMC).

Operation

The transfer relay power is 28v dc from electronics bus 2. The FMC source select switch controls the dc power to the transfer relays.

With the FMC source select switch in the NORMAL position, both transfer relays go to the normal position and mechanically latch in that position.

When the FMC source select switch is set to the BOTH ON R position, 28v dc goes from the source select switch, through a contact on transfer relay 2, to relay 1 coil winding. Relay 1 moves to the BOTH ON R position and mechanically latches to that position. Relay 2 does not change because the BOTH ON R and NORMAL positions are the same.

When the FMC source select switch is set to the BOTH ON L position, 28v dc goes from the source select switch, to the coil on relay 1. Relay one latches in the BOTH ON L/NORMAL position. The FMC source select switch then sends 28v dc through a contact on transfer relay 1 to the relay 2 coil winding. Relay 2 moves to the BOTH ON L position and mechanically latches to that position.

Other contacts on the transfer relays supply the necessary logic to tell these LRUs the position of the transfer relays:

- DPC (1&2)
- FDAU
- FMC (1&2).

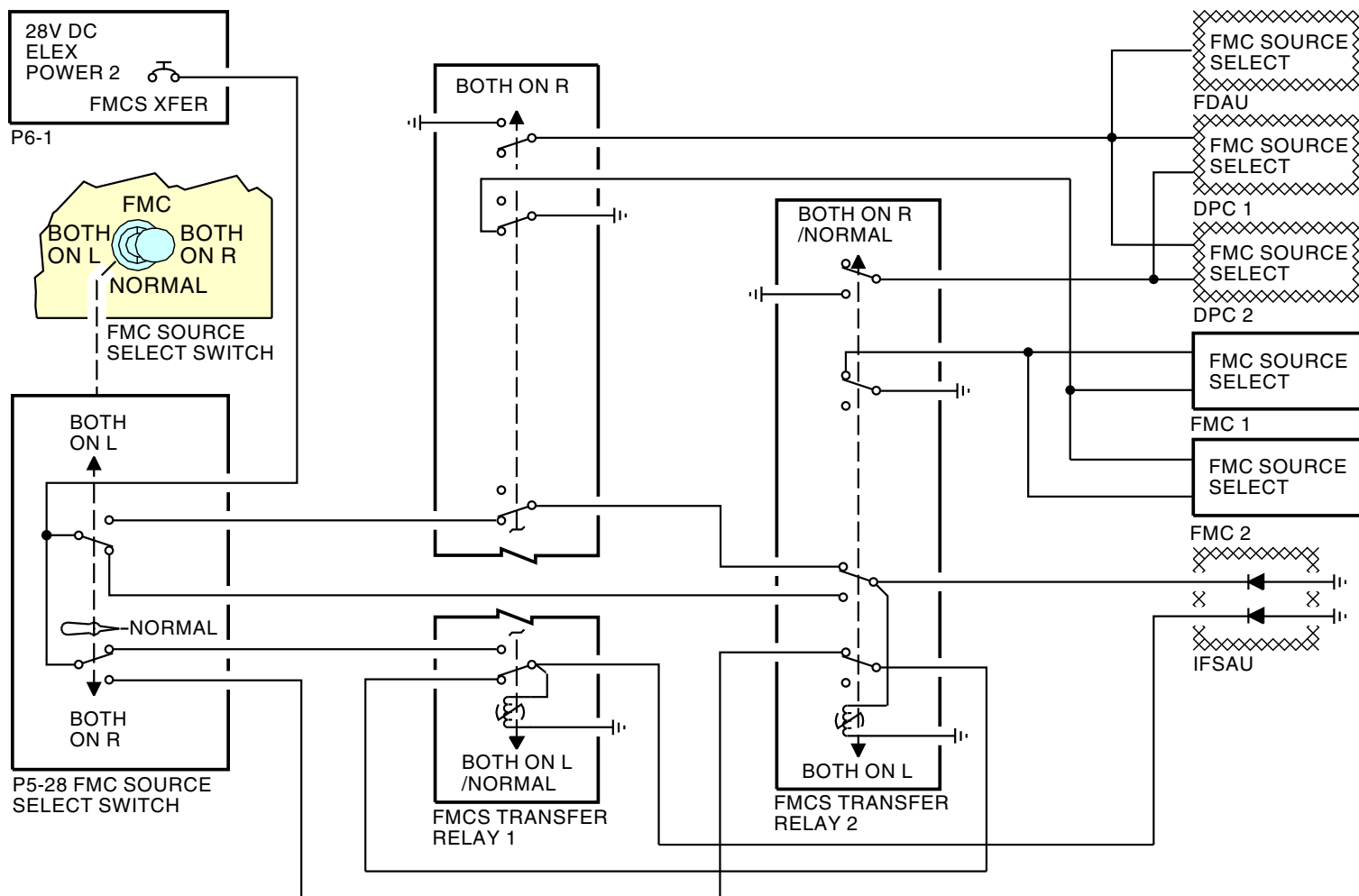
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FMCS - TRANSFER RELAY POWER INTERFACE



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FMCS - TRANSFER RELAY POWER INTERFACE

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**FMCS - DIGITAL INPUT INTERFACE - 1****General**

These LRUs supply data to the FMCS:

- VOR/MB

SIA 001-005

- MMR

SIA 006-999

- IMMR

SIA ALL

- DME.

VOR/MB

VOR 1 and VOR 2 receivers give the bearing and the frequency data of the VOR stations that are manually tuned by the flight crew.

The FMC uses this data for FMC position updating in the VOR/DME mode. The effective range for this mode is up to a maximum of 25NM.

SIA 001-005**ILS/GPS/MMR**

MMR 1 and MMR 2 give localizer deviation and the station frequency data of the ILS transmitters that are manually tuned by the flight crew.

The FMC uses this data for FMC position updating during a final approach. The airplane must be within 20NM of the tuned ILS transmitter and below 6000 feet.

The GPS receivers in the MMRs give this data to the FMC:

- Latitude
- Longitude
- Time
- Horizontal Figure of Merit
- Horizontal Integrity Limit

The FMC uses this data for FMC position updating and actual navigation performance (ANP) calculation.

SIA 006-999**ILS/GPS/IMMR**

IMMR 1 and IMMR 2 give localizer deviation and the station frequency data of the ILS transmitters that are manually tuned by the flight crew.

The FMC uses this data for FMC position updating during a final approach. The airplane must be within 20NM of the tuned ILS transmitter and below 6000 feet.

The GPS receivers in the IMMRs give this data to the FMC:

- Latitude
- Longitude
- Time
- Horizontal Figure of Merit
- Horizontal Integrity Limit

The FMC uses this data for FMC position updating and actual navigation performance (ANP) calculation.

SIA ALL**DME**

DME 1 and DME 2 interrogators give the slant range distance and the station frequency data that are automatically tuned by the FMC.

The FMC corrects this slant range for airplane altitude and uses the data for FMC position updating in the DME/DME or VOR/DME modes.

Clock

The clock input to both FMCs is from the selected GPS. If the GPS is not valid, you can set the time with the CDU and the FMCs calculate time.

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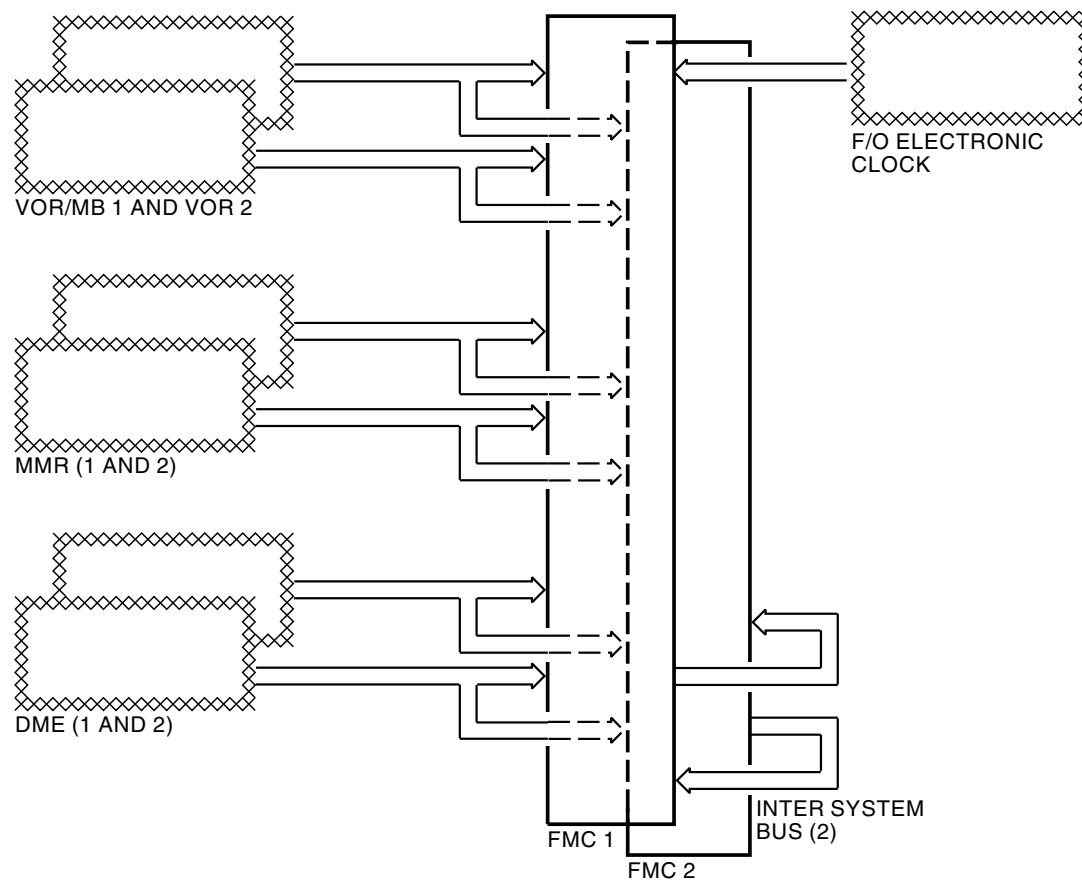
FMCS - DIGITAL INPUT INTERFACE - 1

Intersystem Bus

The intersystem bus is used to compare data between the primary and secondary FMCs.

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FMCS - DIGITAL INPUT INTERFACE - 1



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FMCS - DIGITAL INPUT INTERFACE - 1

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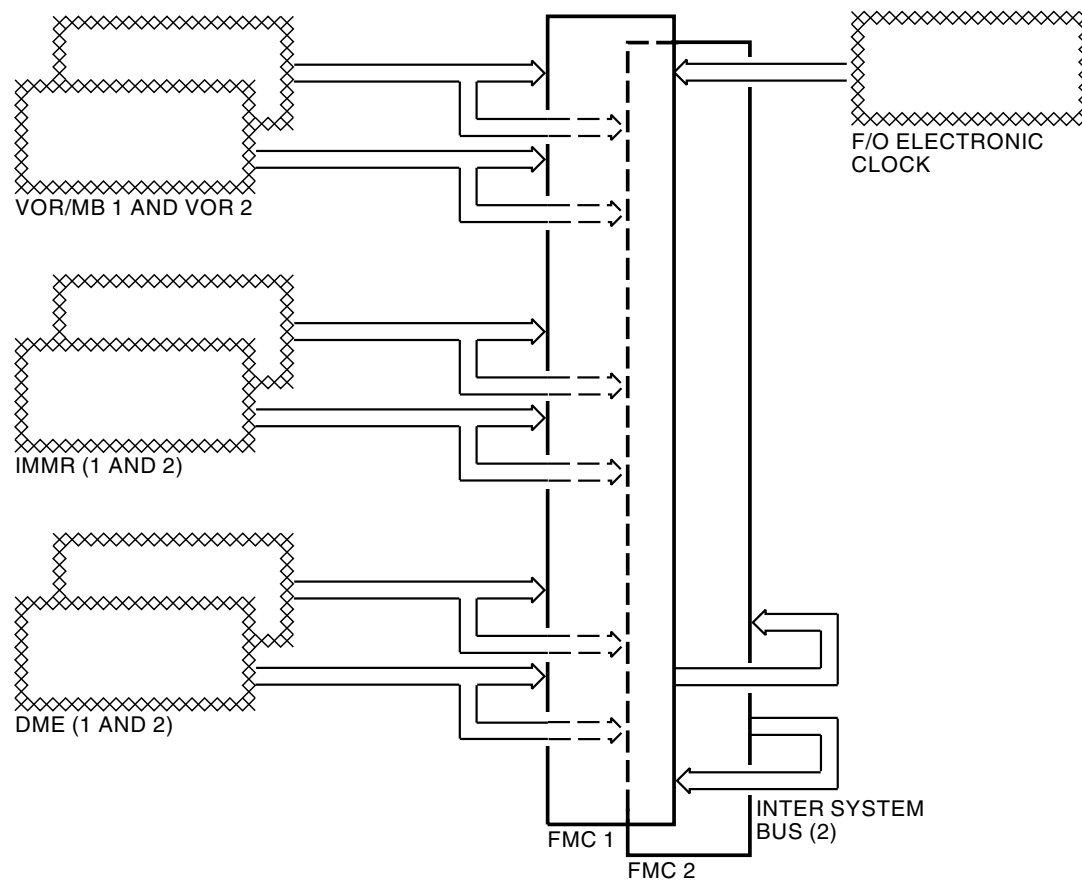
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FMCS - DIGITAL INPUT INTERFACE - 1



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FMCS - DIGITAL INPUT INTERFACE - 1

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FMCS - DIGITAL INPUT INTERFACE - 2

General

These components send data to the FMCS:

- DFCS MCP
- A/T
- ADIRU
- DPC
- Engine electronic control (EEC)
- APU engine control unit (ECU)
- FQPU.

DFCS

The flight control computers (FCC) send data to the DFCS mode control panel (MCP).

The MCP sends this data to the FMCS:

- Local selected course
- Foreign selected course
- Selected altitude
- Trailing edge flap position
- DFCS mode discretes
- DFCS BITE response
- Selected airspeed
- Selected mach.

The FMCS uses the selected course data in the navigation subfunction. The selected altitude and trailing edge flap position are used in the performance and guidance sub-functions. The mode discretes show VNAV/LNAV switch position, TO/GA switch position, and system status.

The selected airspeed and selected mach number are used in the speed intervention mode. The selected altitude is also used in the altitude intervention mode.

The FCC also sends A/T BITE response to the FMCS.

ADIRU

The ADIRUs send this inertial reference (IR) data to the FMCS:

- Present position latitude
- Present position longitude
- Ground speed
- True heading
- Magnetic heading
- Pitch angle
- Roll angle
- Inertial altitude
- Inertial vertical speed
- N-S velocity
- E-W velocity.

The ADIRUs send this air data reference (ADR) data to the FMCS:

- Uncorrected barometric altitude
- Baro corrected altitude
- Mach
- Computed airspeed
- True airspeed
- Total air temperature
- Static air temperature.

The FMCS uses this data to calculate these functions:

- Aircraft position (latitude, longitude and altitude)
- Groundspeed
- Flight path angle
- Drift angle
- Track angle
- Wind velocity and direction

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**FMCS - DIGITAL INPUT INTERFACE - 2**

- Horizontal position accuracy (actual navigation performance).

ADIRU Selection

The FMC sees the inertial reference (IR) data and the air data reference (ADR) data as two different sensors.

Usually, the FMCs receive inertial data from their on-side ADIRU (left ADIRU to FMC 1 and right ADIRU to FMC 2). If the on-side ADIRU malfunctions or it is in the ATT or ALIGN mode, the FMC uses the data from the other ADIRU.

The FMCs use the same air data source as the DFCS. Flight control computer (FCC) A gets ADR data from the left ADIRU and FCC B gets ADR data from the right ADIRU. If FCC A is engaged, the FMCs use ADR data from the left ADIRU. If FCC B is engaged, the FMCs use ADR data from the right ADIRU.

DPC

The display processor computers (DPCs) send MDS BITE response data and EFIS control panel mode discretes to the FMCS.

The DPCs send these EFIS control panel discretes to the FMC:

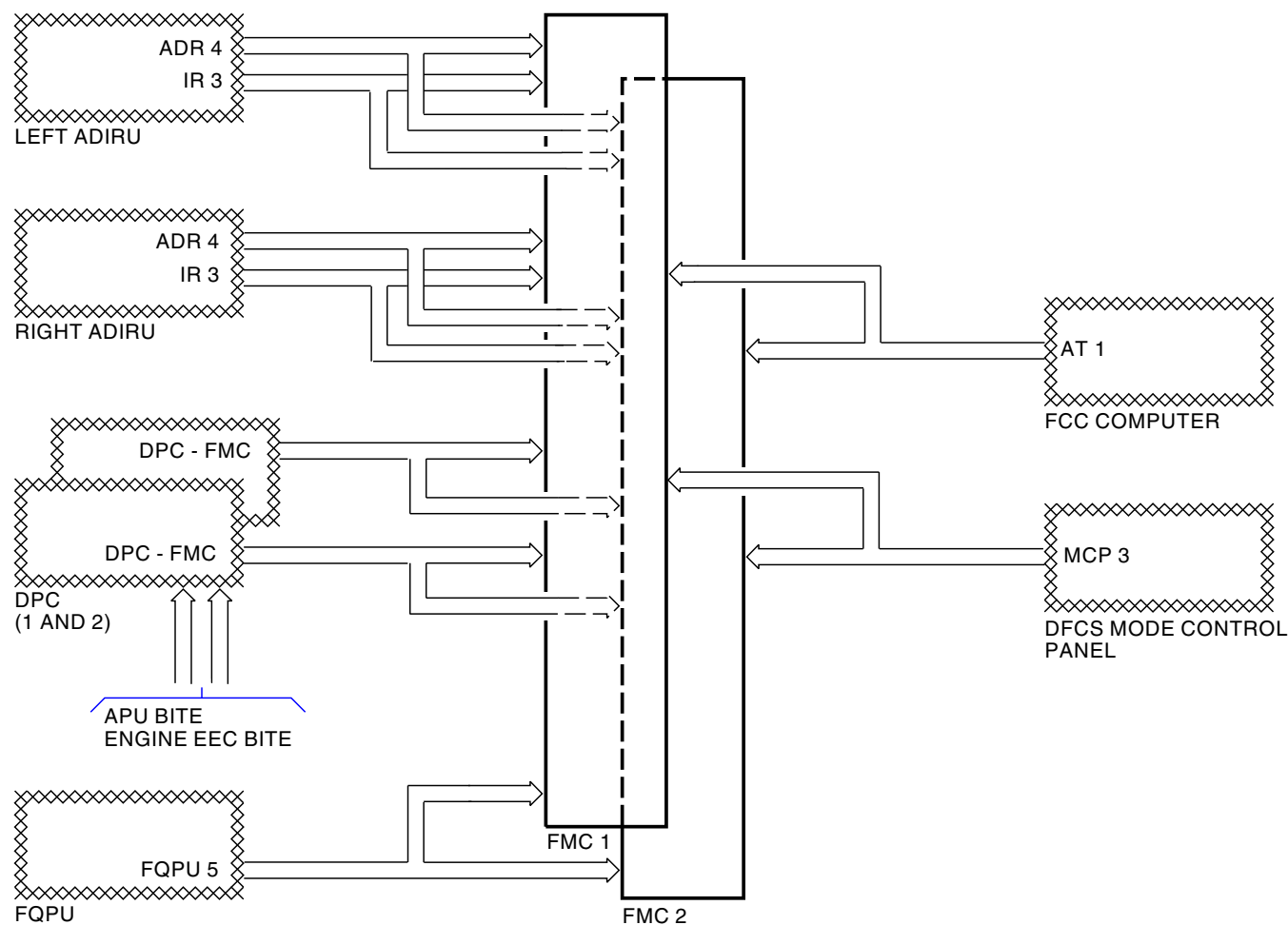
- Center display format
- Airports selected
- Route data selected
- Waypoint selected
- Ground station data selected
- Position data selected
- PFD/ND display format
- Plan mode selected
- Map mode selected
- VOR mode selected
- Approach mode selected
- Range selected.

The DPCs also send APU and main engine EEC BITE response data on the same bus. There is no direct BITE interface between the FMCS and the APU and EEC. The DPCs are a buffer between the APU, EEC, and the FMCS.

FQPU

The fuel quantity processor unit (FQPU) calculates total fuel weight and sends it to the FMCS. Fuel quantity BITE response data also comes from the FQPU.

FMCS - DIGITAL INPUT INTERFACE - 2



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FMCS - DIGITAL INPUT INTERFACE - 2

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FMCS - DIGITAL OUTPUT INTERFACE - 1

General

The FMC data on bus 01 and 02 goes directly to the ADIRUs. The other user systems get this FMC data through the transfer relays.

Data Output

Bus 01 and 02 have this data:

- Distance-to-go (waypoint)
- Groundspeed
- VOR/DME frequencies
- Set latitude
- Set longitude
- Set magnetic heading
- Origin/destination
- Destination runway
- Destination estimated time of arrival (ETA)
- Gross weight
- Total fuel
- FMC target altitude
- FMC target airspeed
- FMC target mach number
- Horizontal command
- Vertical speed command
- Desired track
- Waypoint bearing
- Cross-track deviation
- Vertical deviation
- Magnetic track angle
- Drift angle
- GMT
- Date

- Static air temperature (SAT)
- Selected temperature
- Flight number
- Minimum airspeed
- Minimum buffet airspeed
- Maximum buffet airspeed
- Continuous N1 limit
- Go-around N1 limit
- Cruise N1 limit
- Climb N1 limit
- Target N1
- NDB effectivity
- BITE test word
- FMC discrete word 1
- FMC discrete word 2
- FMC discrete word 3.
- ATC data interface

FMC discrete word 1 has this data:

- Isolation valve open
- Wing antice on
- Cowl-R antice on
- Cowl-L antice on
- ECS pack-R H/L
- ECS pack-L H/L
- ECS pack-R
- ECS pack-L
- Engine bleed 2 on
- Engine bleed 1 on

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**FMCS - DIGITAL OUTPUT INTERFACE - 1**

FMC discrete word 2 has this data:

- Lateral alert
- Computer master/slave
- Annunciator test
- FMC valid
- Offset
- Dead reckoning
- Vertical alert.

FMC discrete word 3 has this data:

- IAS/mach
- Engine out engaged
- Landing flaps selected
- Manual N1 select
- Level decel
- Autothrottle to idle arm
- Autothrottle to arm
- FMC vertical speed
- N1 limit mode
- Speed on elevator
- Reduced thrust (derate)
- LNAV takeoff enabled
- Level change request
- VNAV valid
- Thrust cutback enable
- Initiate thrust cutback.

ADIRU

The ADIRUs use this data from the selected FMC:

- Set latitude

- Set longitude
- Set heading
- BITE test word.

The ADIRUs use the latitude and longitude data during alignment. Magnetic heading is used when the ADIRU is in the attitude mode (ATT) and the BITE test word is used to start BITE through the CDUs.

DPC

The DPCs use this data from the selected FMC:

- N1 limit mode
- Target N1
- Gross weight
- GMT and date
- BITE test words.

The DPCs use this data to show the thrust modes on the center upper display unit (DU). Target N1 shows on the engine display. Gross weight is used by the MDS to calculate the flap maneuver speeds that show on the PFD speed tape. GMT and date are used in BITE for fault data storage.

Target N1, GMT, and date also go from the DPCs to the engine electronic controls (EEC). The EECs use the N1 target to calculate an equivalent TRA for engine control. GMT and date are used in EEC BITE.

The BITE test words are for the DPCs and these systems:

- Engines (EEC)
- APU (ECU).

There is no direct BITE interface between the FMCs and the electronic engine controls (EECs) and APU ECU. The DPCs are the interface between the EEC, APU ECU, and the selected FMC.

**FMCS - DIGITAL OUTPUT INTERFACE - 1****FCC**

The autothrottle function of the FCC uses this data from the selected FMC:

- Target N1
- FMC gross weight
- Minimum airspeed
- N1 limit mode
- FMC altitude
- GMT and date
- Static air temperature
- N1 thrust limits (CLB, CRZ, CONT & GA)
- BITE test words.

The autothrottle function uses this data to maintain specific engine N1 targets or airspeeds from takeoff to touchdown.

The autothrottle function changes the target N1 values to an equivalent thrust resolver angle (TRA) target. The target N1 rating is dependent on the FMC engaged mode.

Gross weight is used in the A/T go-around control logic and approach control logic.

Minimum airspeed is the lowest airspeed that is acceptable by the A/T during VNAV operations.

The N1 limit mode discretes are used to determine control law gains and limits.

FMC altitude is used by the autothrottle computer for anticipation of altitude acquire during VNAV operation.

GMT and date are used in A/T BITE for fault data storage.

SAT is used by the autothrottle function to calculate a backup TRA limit value.

N1 thrust limits are used to limit A/T authority and prevent possible engine overboost.

The flight profile function of the FCCs use this data from the selected FMC:

- FMC target altitude
- FMC target airspeed
- FMC target mach number
- Horizontal command
- Vertical speed command
- GMT and date
- Flight number
- FMC discrete words
- BITE test word.

The FCCs use the altitude, airspeed, mach number, horizontal commands, vertical commands, and FMC discretes to control the airplane lateral and vertical flight profile.

GMT and date, flight number, and the BITE test word are used by the FCC in the BITE function.

You select the source of FMC data with the FMC source select switch.

FMC SOURCE SELECT SWITCH POSITION	FCC A	FCC B
NORMAL	FMC 1	FMC 2
BOTH ON LEFT	FMC 1	FMC 1
BOTH ON RIGHT	FMC 2	FMC 2

SMYD

The SMYDs use this data from the selected FMC:

- Gross weight
- Lower buffet margin speeds
- Upper buffet margin speeds
- Landing flap position.

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FMCS - DIGITAL OUTPUT INTERFACE - 1

The SMYDs use gross weight to adjust the gain in the yaw damper command signal. They use all the FMC inputs to calculate the upper and lower amber bands on the airspeed indication for MDS. The flap input enables the pitch limit indication on MDS.

DME

The DMEs use four autotune frequencies (channels 2 - 5) from the selected FMC.

In normal operation, the FMCs autotune the DME interrogators through their onside NAV control panels. If a NAV control panel fails, its on-side DME interrogator is autotuned directly from the selected FMC.

Fuel Quantity Processor Unit

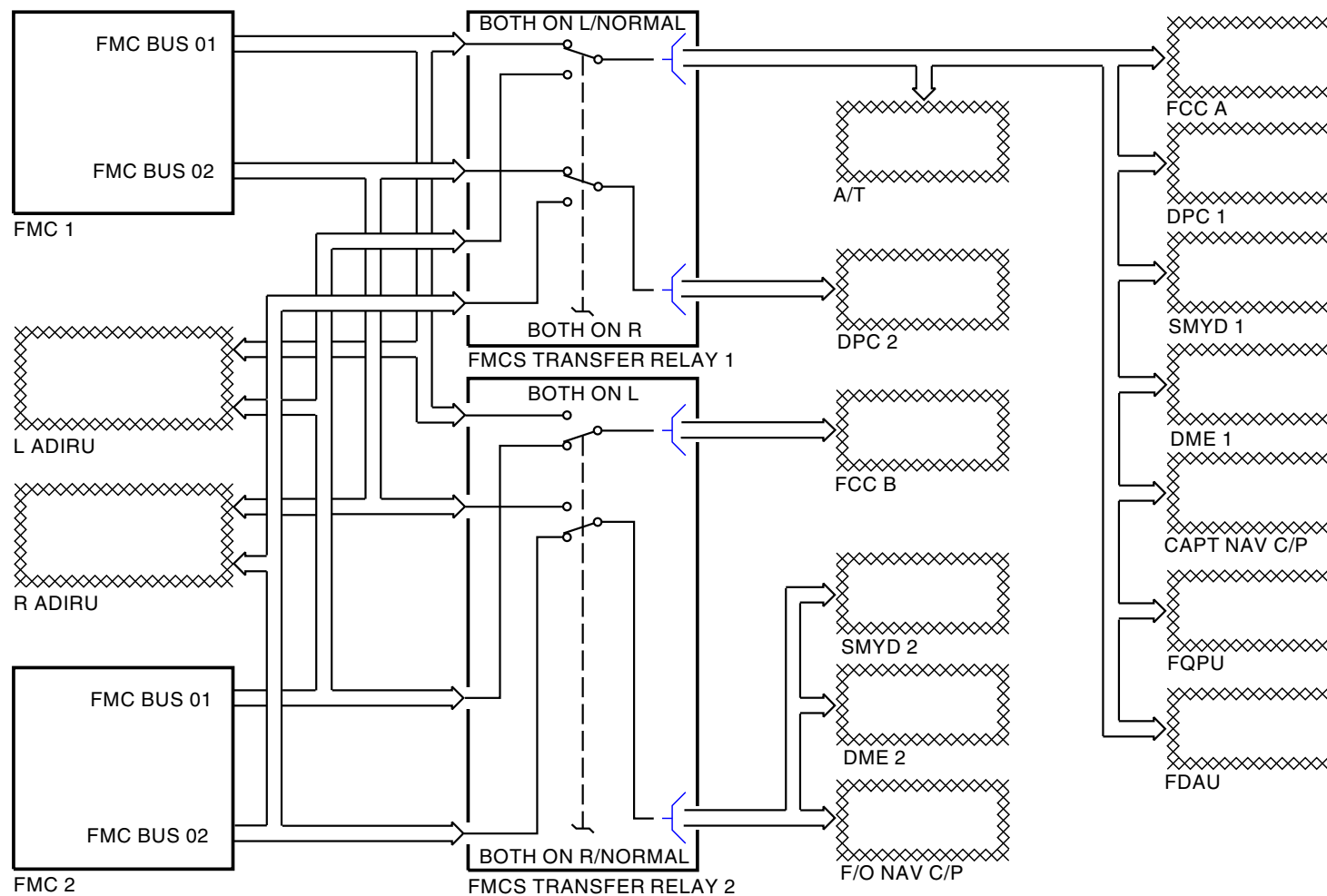
The fuel quantity processor unit uses a BITE word from the selected FMC to start the BITE program.

FDAU

Navigation data from the selected FMC goes to the FDAU where it is stored in the solid state memory.

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FMCS - DIGITAL OUTPUT INTERFACE - 1



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FMCS - DIGITAL OUTPUT INTERFACE - 1

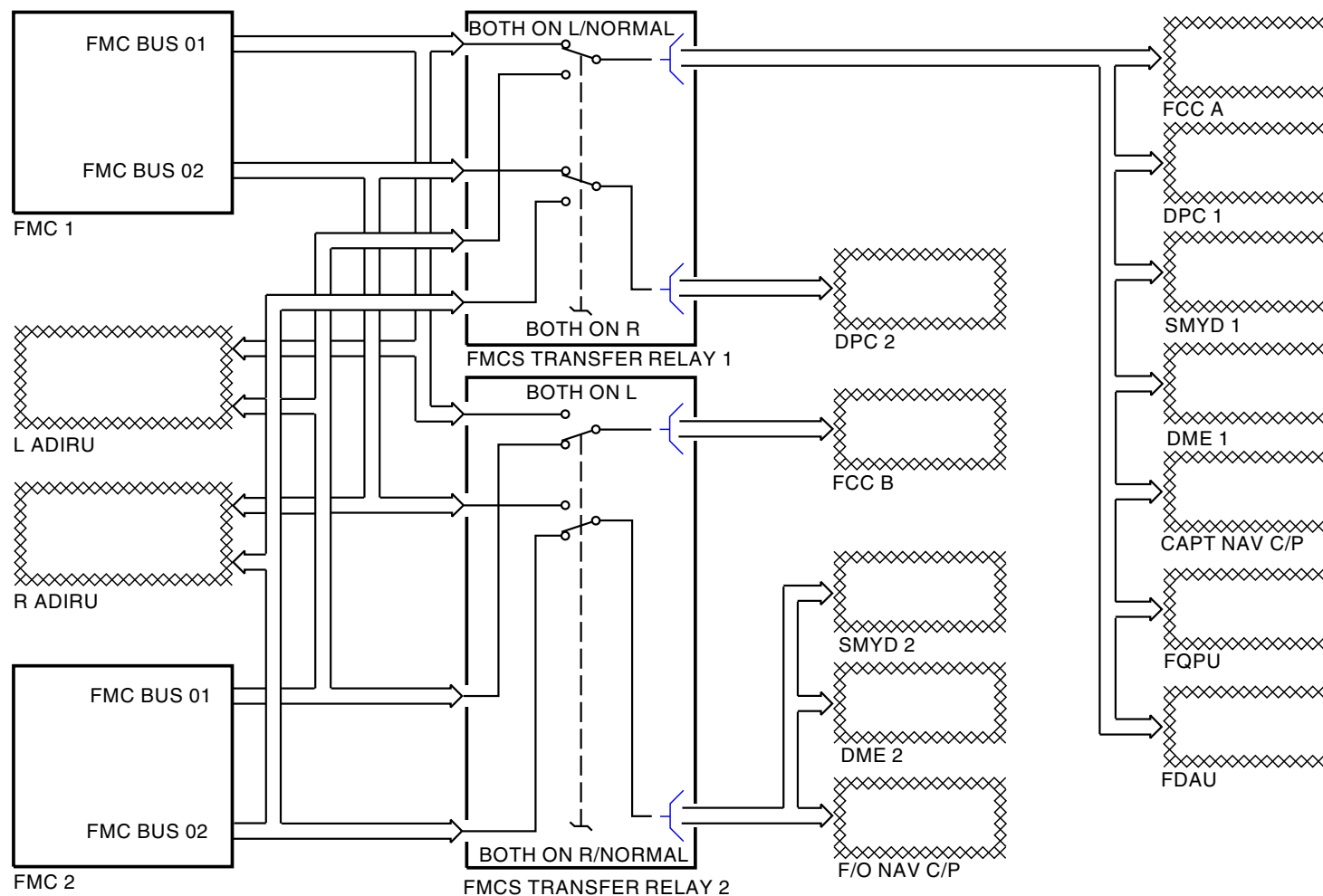
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FMCS - DIGITAL OUTPUT INTERFACE - 1



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FMCS - DIGITAL OUTPUT INTERFACE - 2

General

The FMC data on bus 08 and 09 feeds directly to the DPCs. The other user systems get this data through the transfer relays.

Data Output

The buses 08 and 09 have this data:

- Distance to go (waypoint)
- Groundspeed
- Estimated time of arrival (ETA)
- V speeds
- GPS position data
- Desired track
- Waypoint bearing
- Cross-track deviation
- Range to altitude
- Vertical deviation
- Set landing altitude
- DME elevation
- Transition altitude
- Clean
- Speedbrakes
- FMC navigation source (GPS, VOR, LOC, ADIRU)
- Map background word/block count
- Dynamic data start word
- FMC position
- Track angle (magnetic and true)
- Wind speed and direction
- Drift angle
- Flight path angle
- Alphanumeric display data (WPT, NAVAIDS etc.)

- Flight number
- FMC discrete word 2
- FMC discrete word 3.

The FMC discrete word 2 has this data:

- ADIRU position difference
- Alerts (lateral and vertical)
- FMC source select annunciation
- Annunciator test
- FMC valid
- Offset
- Dead reckoning.

The FMC discrete word 3 has this data:

- IAS/Mach
- Engine out engaged
- Man N1 select
- Level decel
- A/T to idle arm
- A/T to arm
- FMC vertical speed
- Speed on elevator
- Reduced thrust derate
- Level change request
- VNAV valid
- Thrust cutback enable
- Initiate thrust cutback
- Landing flaps selected
- N1 limit mode.

**FMCS - DIGITAL OUTPUT INTERFACE - 2****DPC**

The DPCs get navigation and flight display data from both FMCs. There are two types of data, dynamic data and background data. Dynamic data changes as a function of time while background data does not change as a function of time.

Dynamic data has the following information:

- Distance-to-go
- Groundspeed
- Estimated time of arrival
- V speeds
- GPS position data
- Desired track
- Waypoint bearing
- Cross-track deviation
- Range to altitude
- Vertical deviation
- Set landing altitude
- DME elevation
- Transition altitude
- FMC discrete word 2
- FMC discrete word 3
- FMC position
- Track angle (magnetic and true)
- Wind speed and direction
- Drift angle
- Flight path angle
- Alpha numeric display data
- Flight number.

Background data has this type of information:

- Vector lines
- Special symbols
- Standard character text messages
- Discrete words defining map/plan mode and range data.

This data is formatted and sent by the DPCs to the display units (DUs) to show the airplane position with respect to the flight plan path and navigation facilities (navaids, waypoints, airports etc.).

GPWC

The GPWC uses magnetic track and present position (latitude and longitude) from the selected FMC for its envelope modulation calculations.

FDAU

Display data from the selected FMC goes to the FDAU where it is stored in the solid state memory.

ELT Program and Position Interface Unit

The emergency locator transmitter (ELT) uses FMC position from the selected FMC. It goes through the ELT program and position interface unit.

HGS Computer

The HGS computer uses this data from the FMC:

- Distance to go
- Desired track
- Waypoint bearing
- Vertical deviation
- Groundspeed
- Wind speed and direction
- Track angle (Mag & Tru)
- Status data.

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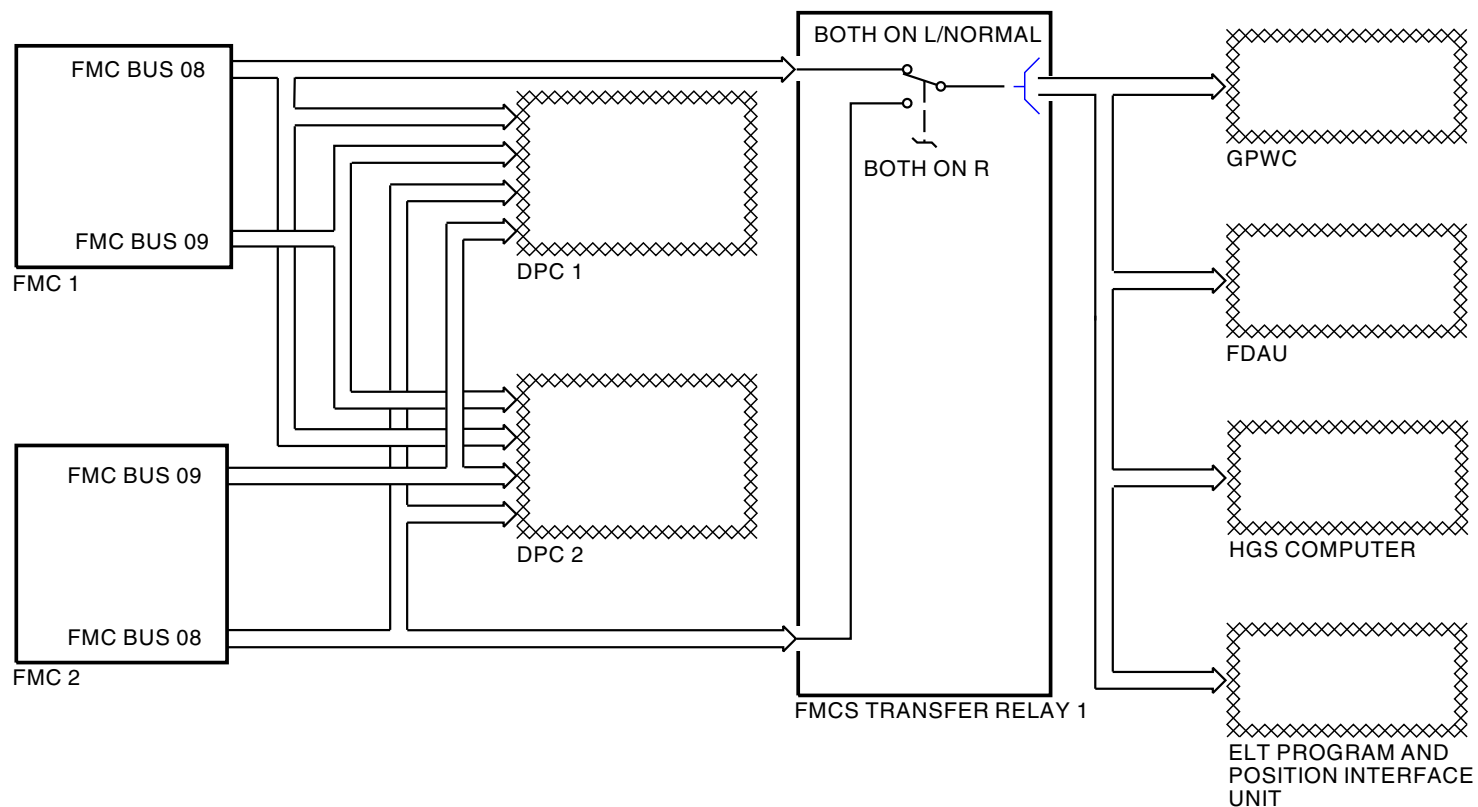
FMCS - DIGITAL OUTPUT INTERFACE - 2

The data from the selected FMC is formatted and shows on the HGS combiner.

The data from FMC 1 is formatted and shows on the HGS combiner.

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FMCS - DIGITAL OUTPUT INTERFACE - 2



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FMCS - DIGITAL OUTPUT INTERFACE - 2

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**FMCS - CDU INTERFACE****FMC Digital Output**

When the FMC source select switch is set to the BOTH ON L or the NORMAL position, CDU 1 and CDU 2 get data from FMC 1. When the source select switch is set to the BOTH ON R position, both CDUs get data from FMC 2.

FMC Digital Input

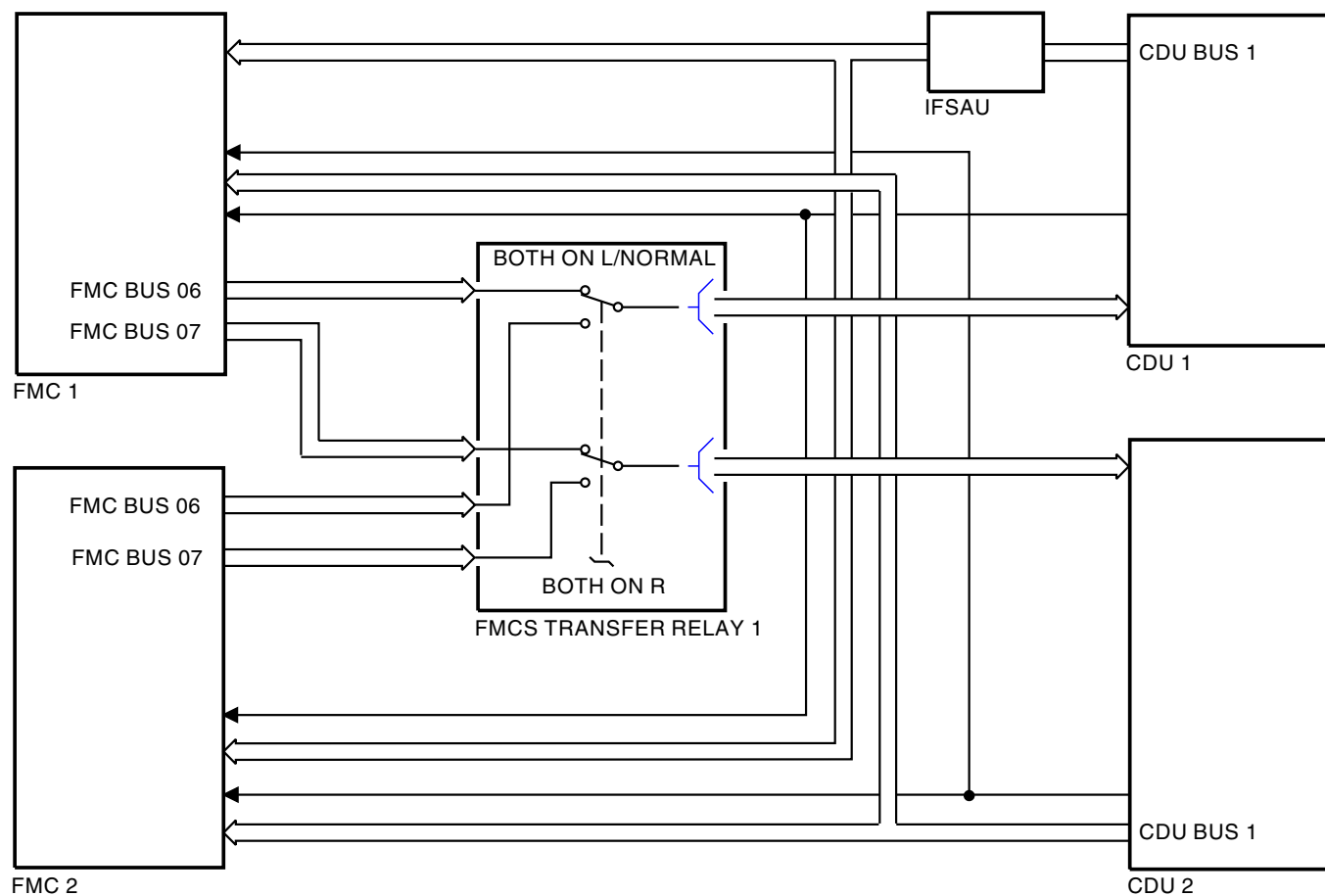
CDU 1 sends data through the integrated flight system accessory unit (IFSAU) to FMC 1 and FMC 2. This allows a portable CDU to be connected in the electronic equipment compartment in place of CDU 1. CDU 2 sends data directly to both FMCs.

CDU Analog Output

Each CDU sends an analog discrete to both FMCs to show a failure of the CDU.

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FMCS - CDU INTERFACE



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FMCS - CDU INTERFACE

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**FMCS - FMC DATA LOADER INTERFACE****General**

You move data to or from the FMCS with the ONS and the data loader control panel.

The data loader gets 115v ac power from the P18 circuit breaker panel.

The data loader digital inputs and output connect to FMC 1 and FMC 2 through the data loader control panel. The control panel must be set to the FMC position to transfer data to and from the FMCS.

When the data loader 3-position switch is set to the L position, the data is loaded into FMC 1. When the data loader 3-position switch is set to the R position, the data is loaded into FMC 2. The new data base(s) may then be crossloaded between the FMCS.

NOTE: The FMC source select switch on the P5-28 panel must be set in the BOTH ON L or NORMAL positions to see the load progress on the CDUs if FMC 1 is being loaded. If the 3-position switch is in the R position, the FMC source select switch must be set to BOTH ON R to see the load progress on the CDUs.

A function discrete from the data loader goes through the data loader control panel to the FMC. This is the load enable signal to the FMC.

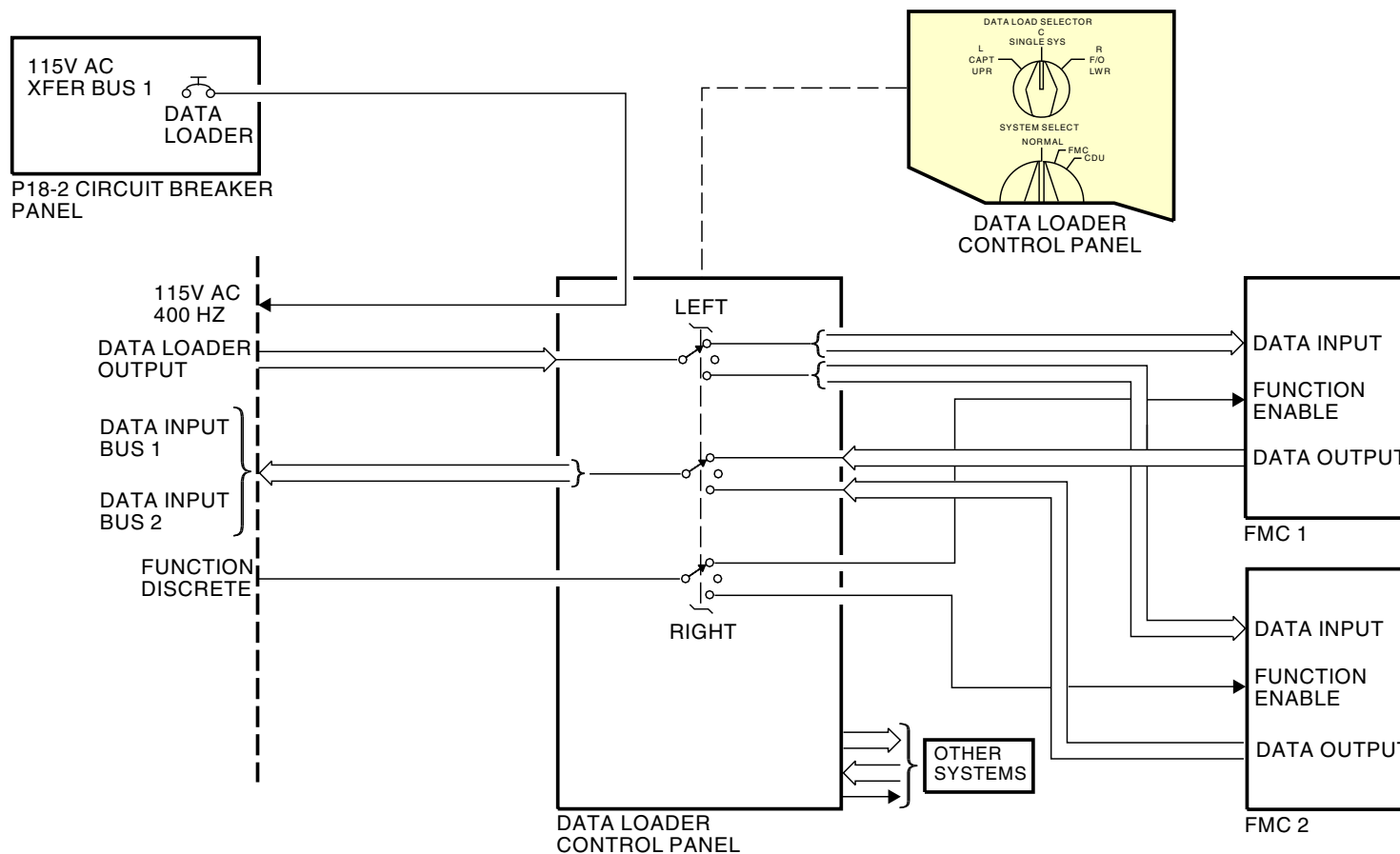
The data loader control panel also has other digital inputs and outputs to other airplane systems. In this way, these other systems can be updated through the data loader.

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FMCS - FMC DATA LOADER INTERFACE



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FMCS - FMC DATA LOADER INTERFACE

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**FMCS - CDU DATA LOADER INTERFACE****General**

You move data to or from the CDUs with the ONS and the data loader control panel.

The data loader gets 115v ac power from the P18 circuit breaker panel.

The data loader digital inputs and output connect to CDU 1 and CDU 2 through the data loader control panel. The control panel must be set to the CDU position to transfer data to the CDUs.

When the data loader 3-position switch is set to the L position, the data is loaded into CDU 1. When the data loader 3-position switch is set to the R position, the data is loaded into CDU 2.

A function discrete from the data loader goes through the data loader control panel to the CDU. This is the load enable signal to the CDU.

A system 1 air/ground relay provides a ground to the CDU to enable the loader function when the airplane is on the ground.

The data loader control panel also has other digital inputs and outputs to other airplane systems. In this way, these other systems can be updated through the data loader.

SIA ALL	EFFECTIVITY



The diagram illustrates the wiring for the Data Loader Control Panel (DLCP) and its connections to the 115V AC Xfer Bus 1, the P18-2 Circuit Breaker Panel, and two CDU units.

DLCP Components and Connections:

- DLCP Left Section:**
 - DATA LOADER OUTPUT (connected to 115V AC XFER BUS 1)
 - DATA INPUT BUS 1
 - FUNCTION DISCRETE
- DLCP Right Section:**
 - DATA LOADER OUTPUT (connected to 115V AC XFER BUS 1)
 - DATA INPUT BUS 1
 - FUNCTION DISCRETE
- DLCP Control Panel:**
 - DATA LOADER CONTROL PANEL (containing switches for LEFT and RIGHT sections)
 - OTHER SYSTEMS (connected via a 3-wire interface)

CDU Connections:

- CDU 1:**
 - DATA INPUT (connected to DLCP Left DATA INPUT BUS 1)
 - FUNCTION ENABLE (connected to DLCP Left FUNCTION DISCRETE)
 - AIR/GRD (connected to DLCP Left DATA LOADER OUTPUT)
- CDU 2:**
 - DATA INPUT (connected to DLCP Right DATA INPUT BUS 1)
 - FUNCTION ENABLE (connected to DLCP Right FUNCTION DISCRETE)
 - AIR/GRD (connected to DLCP Right DATA LOADER OUTPUT)

Other Components:

- 115V AC XFER BUS 1:** Provides power to the DLCP and the P18-2 Circuit Breaker Panel.
- P18-2 CIRCUIT BREAKER PANEL:** Controls the power to the DLCP.
- AIR/GRD RELAY:** Controls the AIR/GRD line for the CDUs.

FMCS - CDU DATA LOADER INTERFACE

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**FMCS - ACARS INTERFACE****General**

ACARS data for the CDUs is direct and does not go through the transfer relays. Uplink and downlink data is sent through the transfer relay 1.

Data Output

The bus 02 has this data:

- Distance to go (waypoint)
- Groundspeed
- VOR/DME frequencies
- Set latitude
- Set longitude
- Set magnetic heading
- Origin/destination
- Destination runway
- Destination estimated time of arrival (ETA)
- Gross weight
- Total fuel
- FMC target altitude
- FMC target airspeed
- FMC target mach number
- Horizontal command
- Vertical speed command
- Desired track
- Waypoint bearing
- Cross-track deviation
- Vertical deviation
- Magnetic track angle
- Drift angle
- GMT
- Date

- Static air temperature (SAT)
- Selected temperature
- Flight number
- Minimum airspeed
- Minimum buffet airspeed
- Maximum buffet airspeed
- Continuous N1 limit
- Go-around N1 limit
- Cruise N1 limit
- Climb N1 limit
- Target N1
- NDB effectivity
- BITE test word
- FMC discretes.

The FMC discretes have this data:

- IAS/mach
- Engine out engaged
- Landing flaps selected
- Manual N1 select
- Level decel
- Autothrottle to idle arm
- Autothrottle to arm
- FMC vertical speed
- N1 limit mode
- Speed on elevator
- Reduced thrust (derate)
- Level change request
- VNAV valid
- Thrust cutback enable
- Initiate thrust cutback.

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FMCS - ACARS INTERFACE

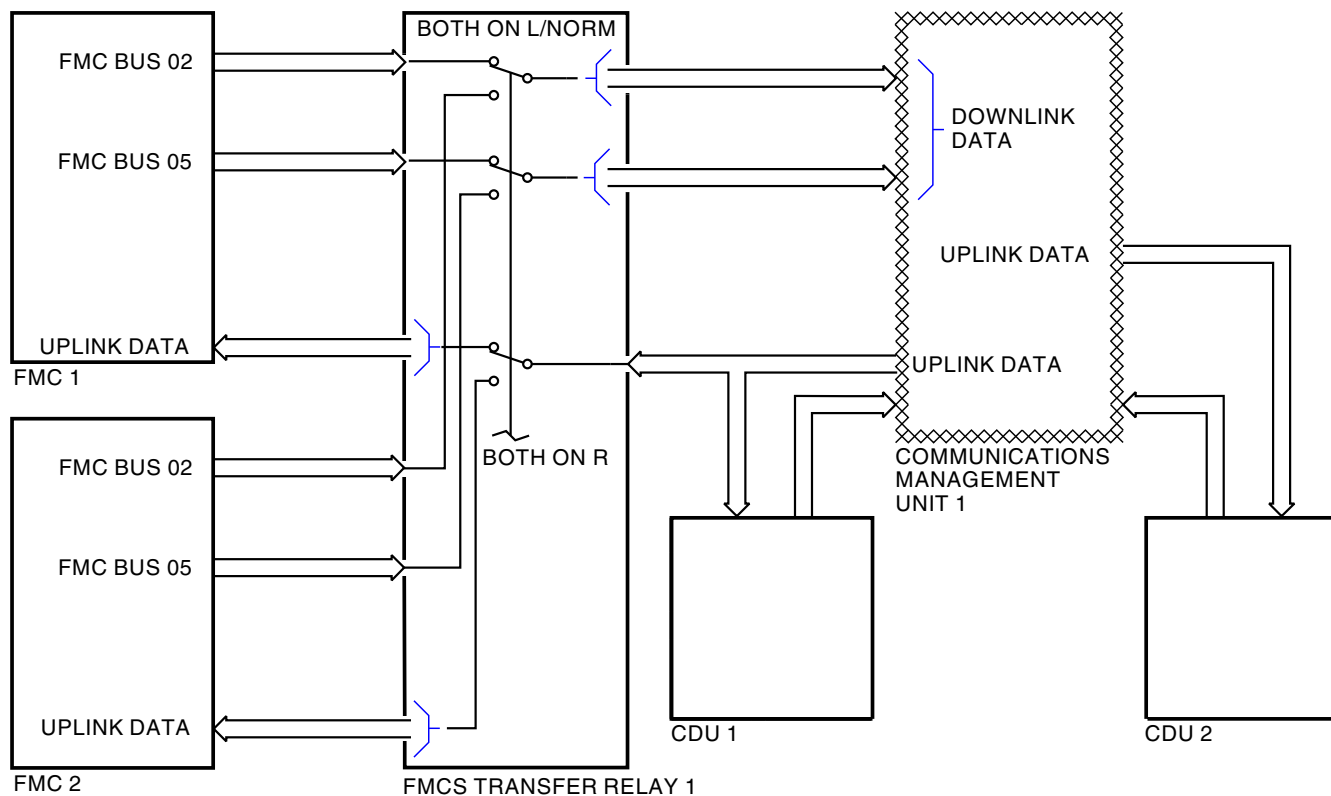
The bus 05 has FMC system status.

ACARS

The FMC/ACARS interface allows the receipt (uplink) and transmission (downlink) of FMC data from or to the customers ground computers via the communications management unit.

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FMCS - ACARS INTERFACE



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FMCS - ACARS INTERFACE

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**FMCS - ANALOG DISCRETES****General**

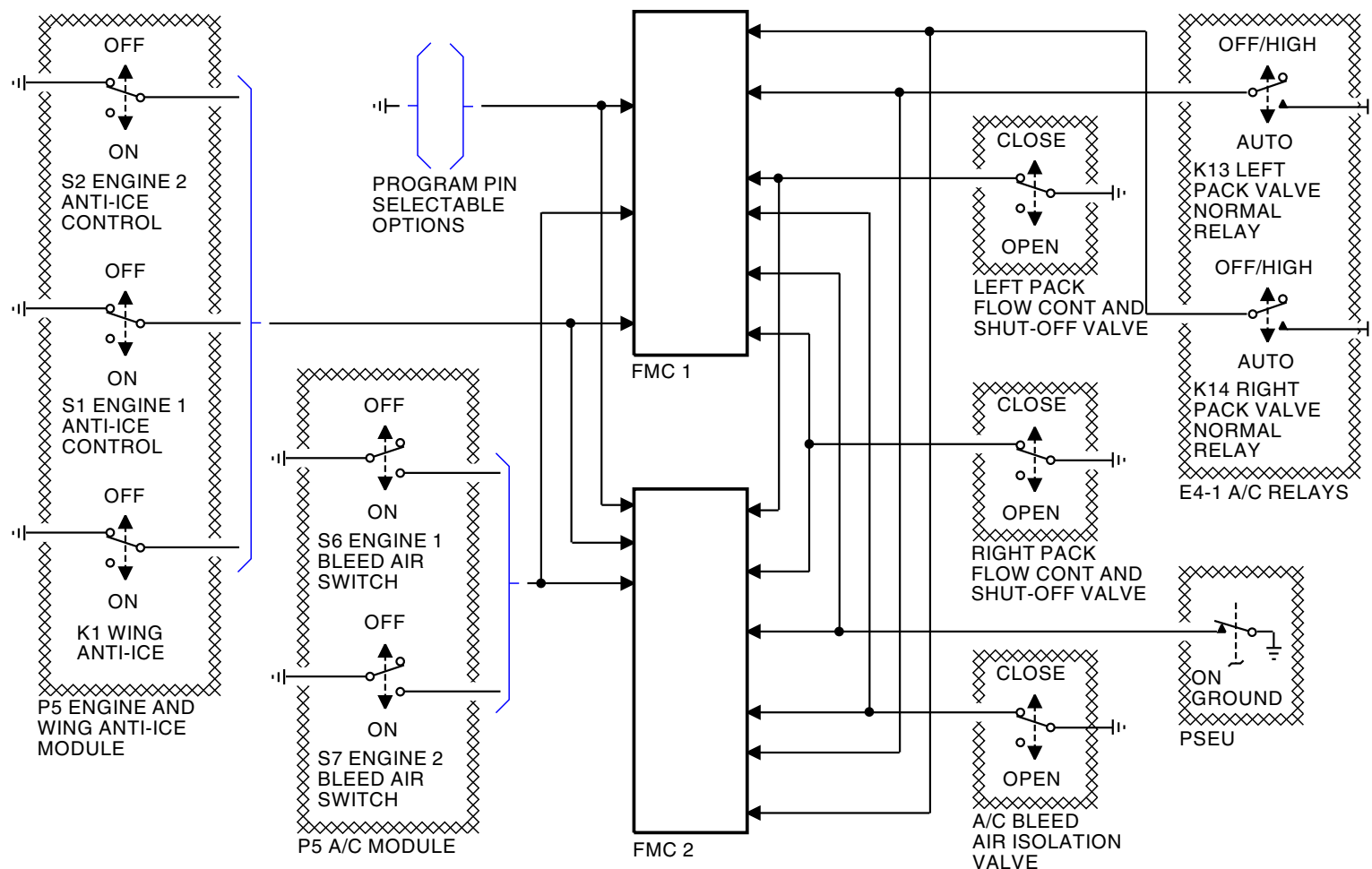
Inputs from switches and valves give engine bleed air data to the FMCS. The FMCS uses these signals to calculate the N1 limits for the engines.

The program pin selectable options customize the FMCS to the airline configuration.

The proximity switch electronics unit (PSEU), supplies an air/ground discrete input to the FMCS to set flight leg count. The air/ground discrete also goes to the FMC to inhibit data load in the air.

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FMCS - ANALOG DISCRETES



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FMCS - ANALOG DISCRETES

**FMCS - STATUS ANNUNCIATOR INTERFACE****General**

The autoflight status annunciators (ASAs), have three warning lights. The warning lights are push to reset. The ASA also has a TEST switch.

The ASAs show a change of condition for these systems:

- Autopilot
- Autothrottle
- Flight management computer system (FMCS).

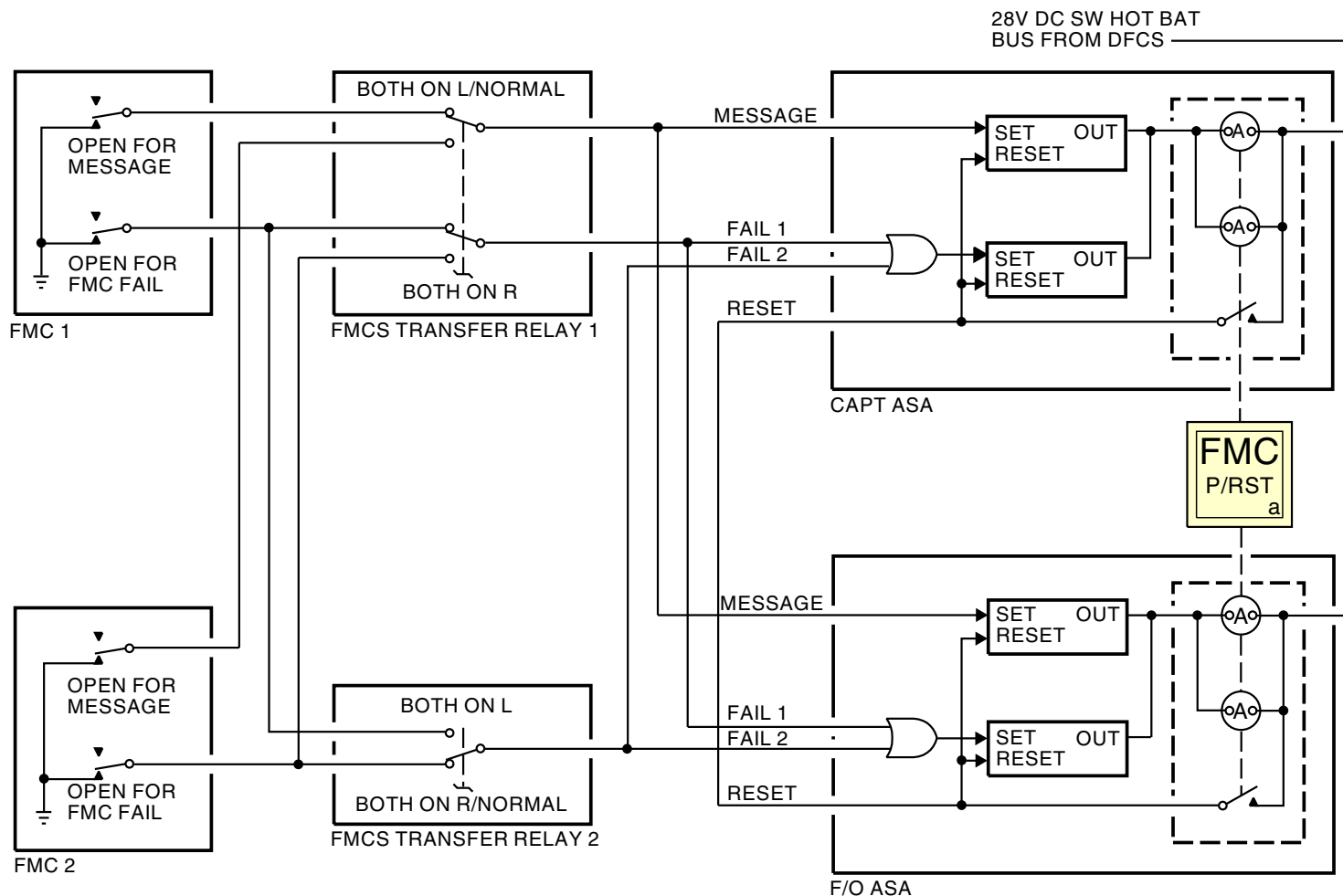
FMCS

The FMC warning light is amber when an FMC has an alert message or when an FMC fails. The light also comes on when you put the TEST switch in position 1 or 2.

Push the FMC warning light to reset the latch and turn the light off.

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FMCS - STATUS ANNUNCIATOR INTERFACE



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FMCS - STATUS ANNUNCIATOR INTERFACE

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FMCS - PROGRAM PIN INTERFACE

General

FMCS hardware program pin options are set with the FMC program switch modules. The program pins customize the FMCS to your airline configuration.

NOTE: Program pin status can be verified on the FMCS BITE analog discretes pages and model engine configuration pages on the CDU.

Options

These are your FMCS options:

- Airplane model 737-8
- Engine rating 27k
- Cat_B brakes
- Fixed tail skid
- Aspirated TAT probe
- Performance option 1
- ACARS installed
- Selected course radial shown on the navigation display
- Degrees C default
- Flight number entry
- Autotune navaid suppression on EFIS
- Runway position update on TO/GA
- Takeoff profile
- Weight in kilograms
- Source/Destination Identifier
- Dual FMC
- FAA flight rules
- integrated approach navigation
- Single NFS

Configuration Options

The airframe/engine configuration is found by a combination of eight program pins. This combination sets these conditions:

- Airplane model
- Engine thrust
- Brake type
- Tailskid type.

The airframe/engine parity pin determines that the airframe/engine configuration is valid. Odd parity is used.

The performance option code defines levels of reduced climb thrust so that climb thrust can not be more than take off thrust.

The source/destination identifier identifies the FMC as left or right. It is always set to left.

Computation Options

The runway position update on TOGA option enables the FMC to update the FMC position to the present runway position when the TOGA switch is pushed.

The takeoff profile option lets the FMC control the altitude at which thrust is decreased from T/O thrust to climb thrust.

The FAA flight rules option sets the default values for cruise center of gravity (CG) and maneuver margin.

Display Options

The selected course option displays the selected course radials for manually tuned nav aids on the navigation display.

The degrees C default option sets the temperature default for CDU entries.

The autotune navaid suppression option inhibits the display of autotuned nav aids on the MDS map display.

The kilogram weight option sets the weight default for CDU entries.

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**FMCS - PROGRAM PIN INTERFACE****Interface Options**

The aspirated TAT probe option lets the FMC use the temperature from the TAT probe on the ground to calculate V1, VR, and V2 speeds.

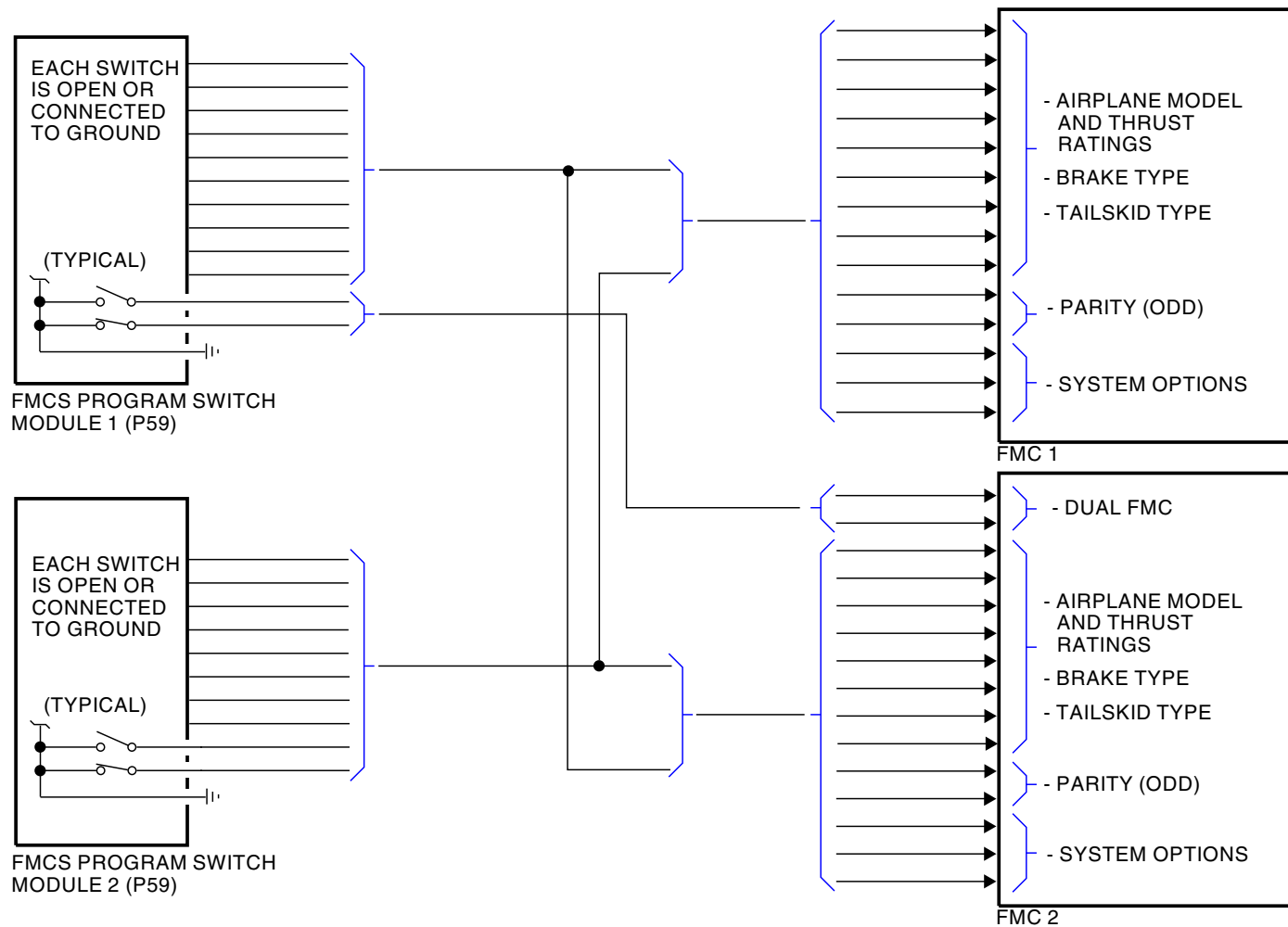
The ACARS installed option enables the interface between the CDU and the ACARS management unit.

The flight number entry option lets the crew enter flight number which shows on the PROGRESS pages.

The SEL CONFIG mode option is used to see the configuration data for the loadable software of a non FMC system.

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FMCS - PROGRAM PIN INTERFACE



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FMCS - PROGRAM PIN INTERFACE

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**FMCS - BITE PRINTER AND PORTABLE CDU RECEPTACLES****Printer Receptacle**

The portable printer can be connected to the BITE printer receptable connector on the P-18 panel. When the printer is connected, CDU and FMC data can be printed.

The printer is supplied by the customer.

Portable CDU Receptacle

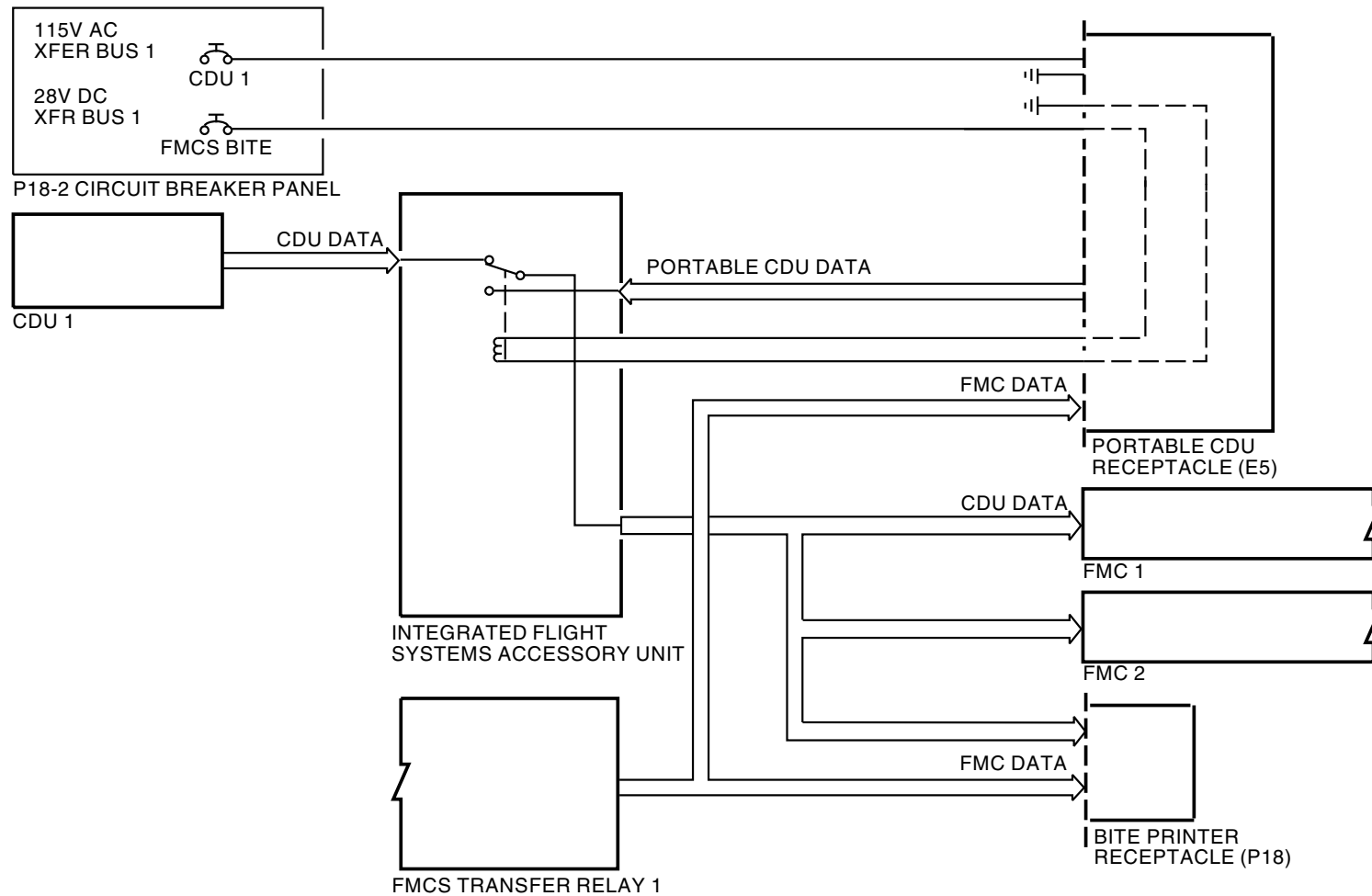
A portable CDU can be connected to the portable CDU receptable connector in the main electronic equipment compartment. With the CDU connected, maintenance BITE can be performed in the electronic equipment compartment.

The portable CDU is supplied by the customer.

NOTE: Data still shows on CDU 1 when the portable CDU is connected.

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FMCS - BITE PRINTER AND PORTABLE CDU RECEPTACLES



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FMCS - BITE PRINTER AND PORTABLE CDU RECEPTACLES

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FMCS - FLIGHT MANAGEMENT COMPUTER

Purpose

The FMC uses data from the airplane sensors and data stored in the FMC to do the calculations for navigation, performance, and guidance of the airplane.

Physical Description

The FMC is a rack-mounted chassis assembly in an ARINC 600, 4 MCU box. It weighs less than 22 pounds (10 kilograms). It uses 115V AC, 400 Hz single phase electrical power.

The FMCs are cooled with air from the equipment cooling supply and exhaust systems. Cooling air for FMC 1 is blow-through. Cooling air for FMC 2 is draw-through.

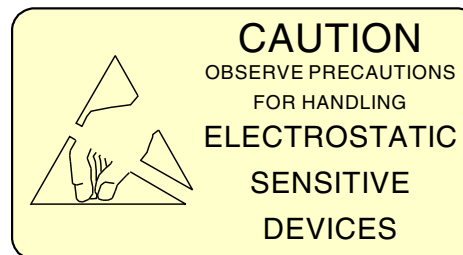
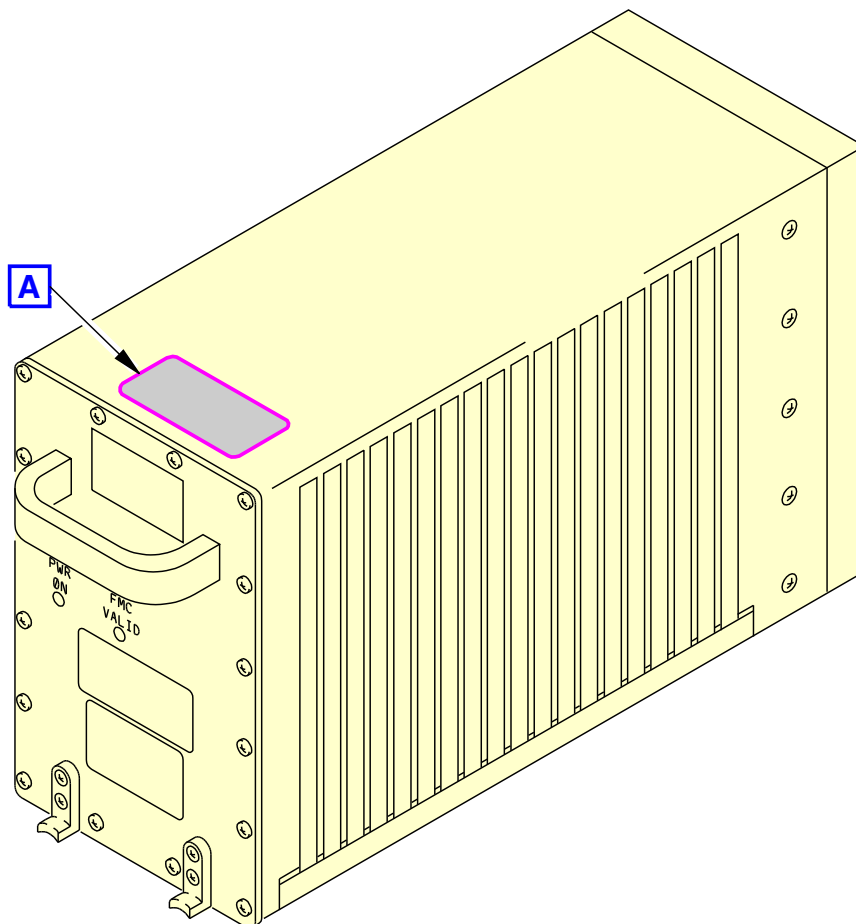
Two green light emitting diodes (LEDs) show through openings in the front of the unit. The PWR ON LED comes on when the FMC has power. The FMC VALID LED comes on after power is on and the unit passes internal tests.



THIS EQUIPMENT CONTAINS ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) DEVICES. EQUIPMENT, MODULES, AND ESDS DEVICES MUST BE HANDLED IN ACCORDANCE WITH PROCEDURES OUTLINED IN 'REPAIR' SECTION 600 OF I.B. 1104C.

You must observe electrostatic discharge precautionary procedures when touching, removing, or inserting parts of assemblies. Failure to follow these precautions can degrade or cause failure of the FMC.

FMCS - FLIGHT MANAGEMENT COMPUTER



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FMCS - FLIGHT MANAGEMENT COMPUTER

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**FMCS - FLIGHT MANAGEMENT COMPUTER - FUNCTIONAL DESCRIPTION****General**

The the primary components of the FMC are as follows:

- Processor card
- Memory card
- ARINC I/O module
- Power supply

Processor Card

The primary components of the processor card are the processor and the application specific integrated circuit (ASIC).

The processor card has the following functions:

- Flight plan management
- Navigation and navaid tuning function
- Performance management function
- Guidance function
- Control and display functions.

The processor card also has the memory for the FMC boot and maintenance programs. The random access memory (RAM) is used for the scratchpad memory.

The ASIC controls the intersystem bus (ISB) between the two FMCs and the MAINT BITE processing. It also controls the real time clock and the system reset and power down logic.

Memory Card

The memory card contains the memory used for the storage of the operational flight program (OFP). It also contains these data bases:

- Navigation data base (NDB)
- Model/Engine data base (MEDB)
- ACARS datalink data base
- Software options data base.

- Loadable Default data base

All memory on the memory card is electrically erasable programmable read only memory (EEPROM).

ARINC I/O Card

The I/O card does all the functions necessary for communication between the FMC and external systems. The card is divided into a discrete I/O function and an ARINC 429 I/O function.

The I/O card also includes an ASIC which acts as the primary controller for the I/O function. There are 16 ARINC 429 output drivers, 32 ARINC input translators, 6 discrete outputs and 6 discrete inputs.

An LED on the I/O card comes on when there is a BIT failure.

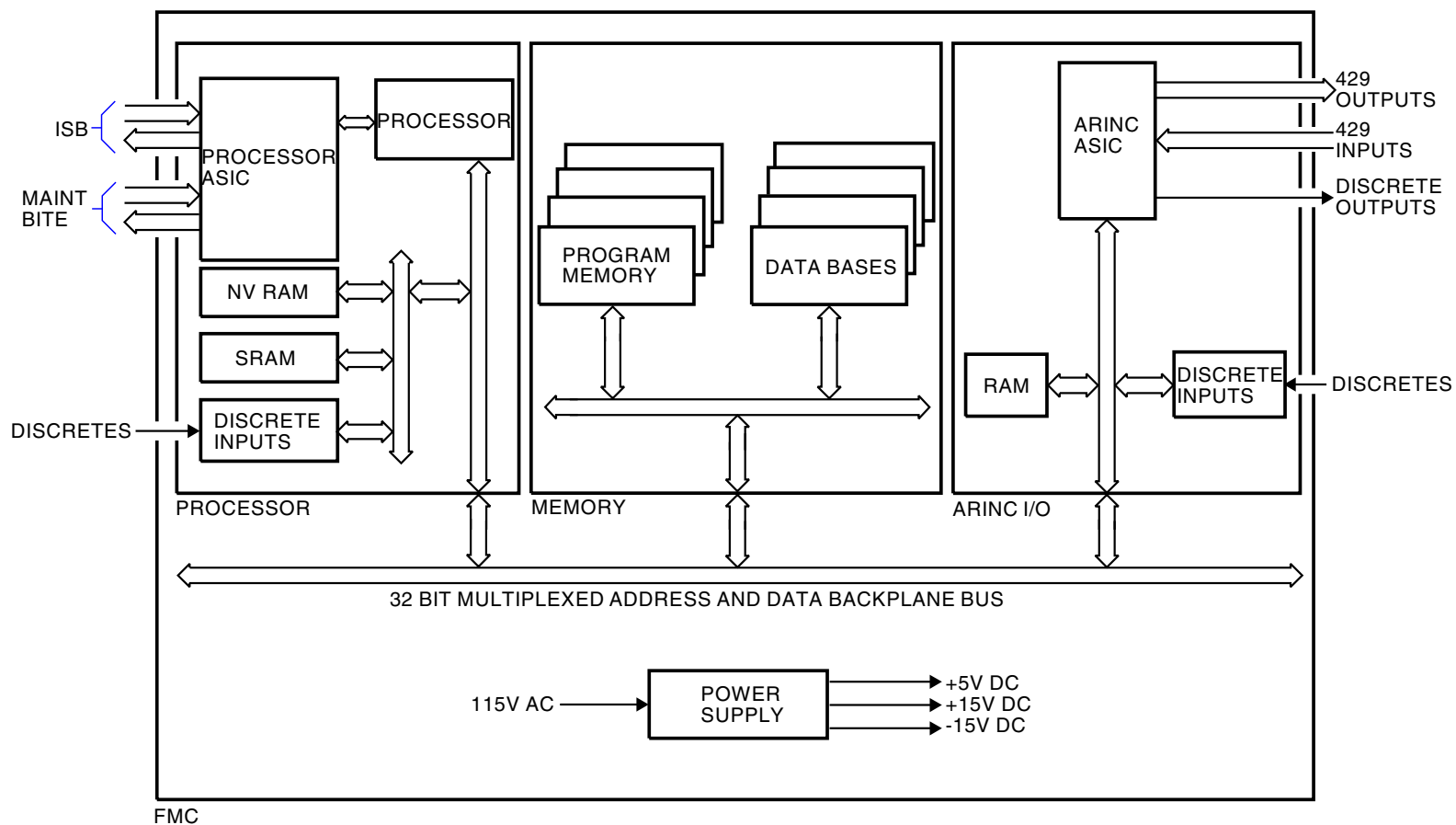
Power Supply

The power supply uses 115v ac, single phase from the aircraft electrical system. It supplies + 5v dc, +15v dc and -15v dc to internal components of the FMC. Total output power is 40 watts. There is a 50 microsecond hold up feature for short term power interrupts.

An LED on the power supply card comes on when the power supply is valid.

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FMCS - FLIGHT MANAGEMENT COMPUTER - FUNCTIONAL DESCRIPTION



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FMCS - FLIGHT MANAGEMENT COMPUTER - FUNCTIONAL DESCRIPTION

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FMCS - CONTROL DISPLAY UNIT**Purpose**

The flight crew uses the control display unit (CDU) to put in flight data and to select displays and modes of operation. They also use the CDU to start ADIRU alignment. You use the CDU to do tests of the FMCS and other systems.

There are two CDUs in the airplane. They are functionally and physically interchangeable.

Physical Description

The CDU weighs 9 pounds (4.1 kg).

There are holes in the chassis for cooling air. The equipment cooling system supplies cooling for the CDUs. Keep dust and dirt build-up from the vent and surfaces. The procedures to clean the CDU are in the maintenance practices section.

The CDU has these annunciators:

- Fail
- CALL
- MSG (message)
- OFST (offset).

The annunciators each use a two-lamp circuit board assembly. Each board assembly is line replaceable.

The execute (EXEC) key is on the right of the CDU. This key has a lamp assembly with two lamps. The lamp assembly is line replaceable.

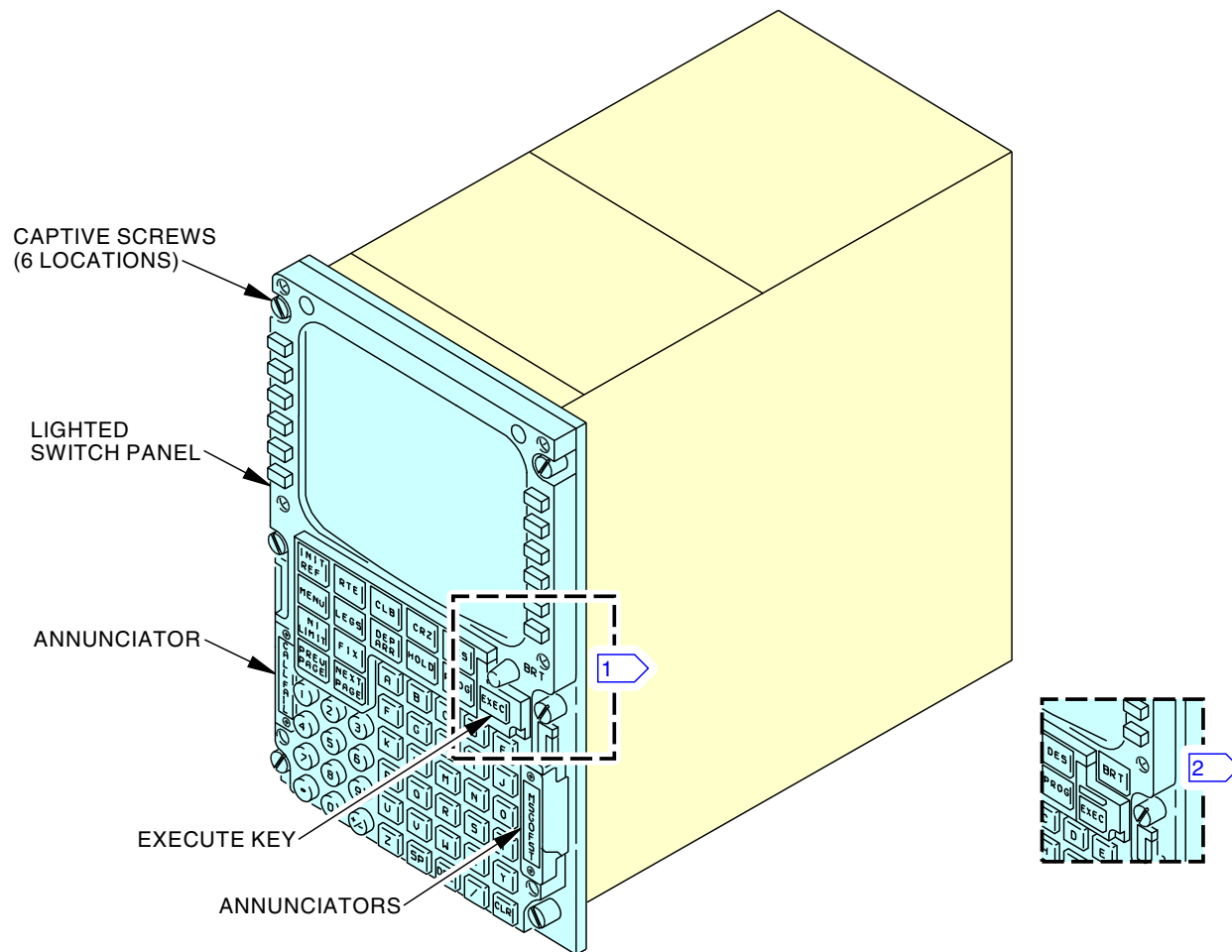
The lighted switch panel is line replaceable. Six screws hold the panel in place.

**CAUTION**

THIS EQUIPMENT CONTAINS ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) DEVICES. EQUIPMENT, MODULES, AND ESDS DEVICES MUST BE HANDLED IN ACCORDANCE WITH PROCEDURES OUTLINED IN 'REPAIR' SECTION 600 OF I.B. 1104C.

You must observe electrostatic discharge precautionary procedures when touching, removing, or inserting parts of assemblies. Failure to follow these precautions can degrade or cause failure of the FMC.

FMCS - CONTROL DISPLAY UNIT


NOTE:

REMOVAL/INSTALLATION HANDLE IS NOT SHOWN.

- 1 WITH BRIGHTNESS KNOB
- 2 WITH BRIGHTNESS CONTROL SWITCH

FMCS - CONTROL DISPLAY UNIT

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**FMCS - CONTROL DISPLAY UNIT - FUNCTIONAL DESCRIPTION****General**

The LCD CDU has these sub-assemblies:

- Low voltage power supply
- Rear connector filter assembly
- Processor and interface circuit card assembly
- LCD module
- Backlight assembly
- Lighted switch panel.

Power Supplies

The low voltage power supply module in the CDU receives 115v ac, 400Hz, single phase power from the airplane electrical system. It provides the following operating voltages within the LCD CDU:

- +5v dc
- +12.7v dc
- -12.7v dc
- +26v dc
- +28v dc
- Switched +28v dc (used for the backlight and LCD heaters).

The airplane master dim and test circuits supply 28v dc to the CDU for annunciator power and lamp test. Also, 5v ac power is used for the lighted switch panel lighting.

Rear Connector Filter Assembly

The CDU receives data on up to seven ARINC data buses and four discrete inputs. Output data is sent over two ARINC data buses and one discrete output. All input and output data goes through the rear connector filter assembly (RCFA) which provides electromagnetic interference (EMI) protection.

Processor/Interface Circuit Card

The processor and interface circuit card (P&I CCA) provides all of the control and external interface circuitry for the CDU. It provides the following functions:

- Read lighted switch panel inputs to determine CDU modes/inputs
- Receive ARINC inputs from other airplane systems
- Read and interpret airplane discrete inputs
- Generate CDU fail output discrete
- Control CDU annunciator operation
- Send ARINC outputs to FMCS
- Communicate with other airplane sub-systems
- Generate data for LCD and backlight assembly
- Perform BITE.

LCD Module

The LCD module provides the display of 24 columns and 14 rows. It is a non-light emitting device that requires a separate light source (backlight assembly) to make the display viewable.

During power-up, the LCD provides a display within 10 seconds at normal operating temperatures (0-55 degrees C, 32-131 degrees F). At or below freezing temperatures, the LCD can take up to 2 minutes to provide a normal display. The LCD contains a temperature regulating function which improves operation over a wide range of temperatures.

Backlight Assembly

The backlight assembly has a lamp and control circuitry to provide the required illumination for the LCD. It is controlled by the P&I CCA.

The backlight assembly also sends ambient light level information to the P&I CCA so that it can adjust the luminance level for the LCD. The backlight assembly also sends temperature information to the P&I CCA so that, when necessary, it can turn on the LCD heater.

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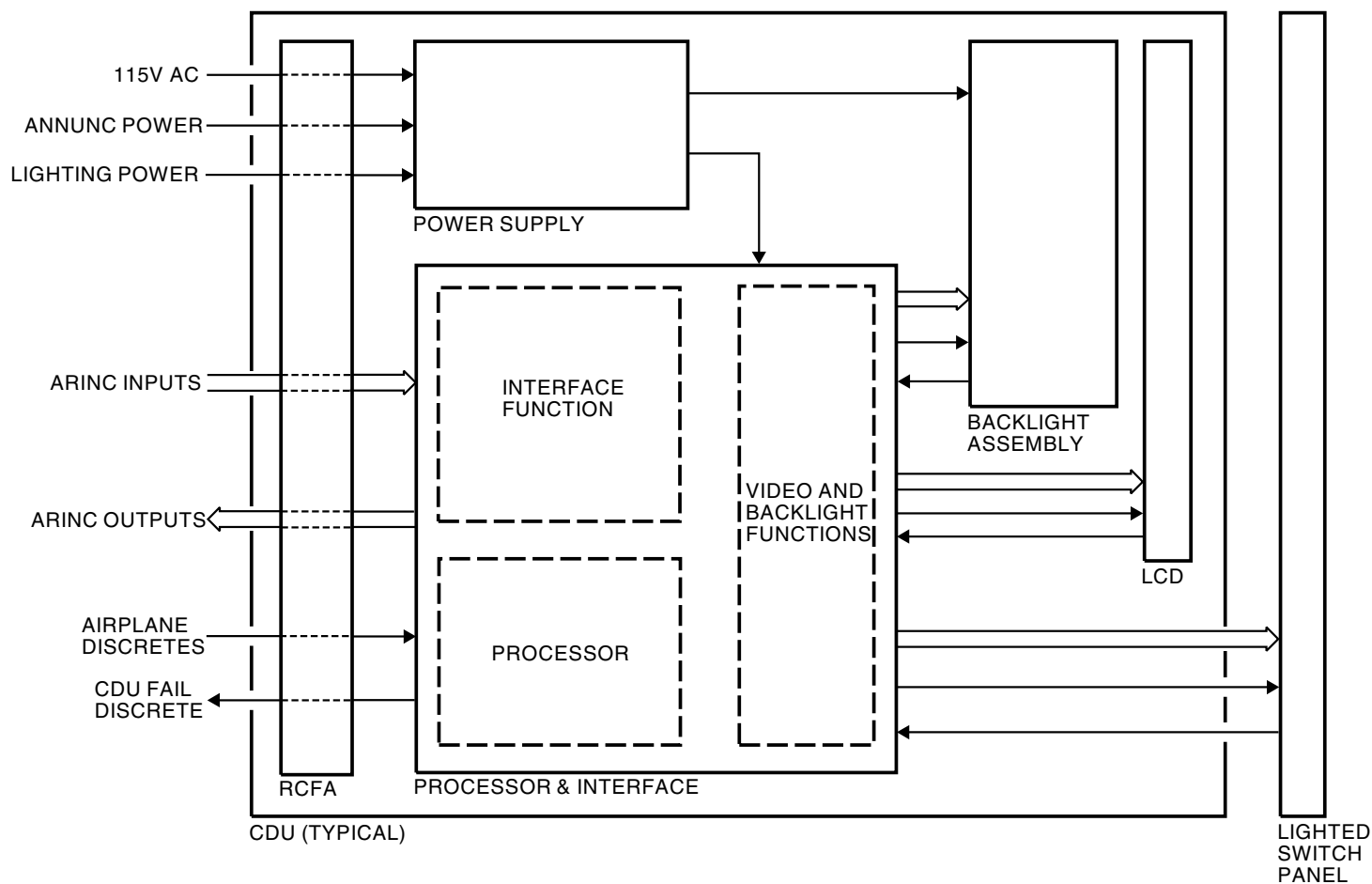
FMCS - CONTROL DISPLAY UNIT - FUNCTIONAL DESCRIPTION

Lighted Switch Panel

The lighted switch panel provides the interface between the operator and the FMCS through the CDU. The panel contains two ambient light sensors which are used to adjust the display brightness and contrast.

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FMCS - CONTROL DISPLAY UNIT - FUNCTIONAL DESCRIPTION



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FMCS - CONTROL DISPLAY UNIT - FUNCTIONAL DESCRIPTION

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**FMCS - CONTROL DISPLAY UNIT - CONTROLS AND DISPLAYS****Display Format**

The Control Display Unit (CDU) data shows on the five-inch liquid crystal display (LCD). The basic display is a set of fourteen lines. Each line can show 24 characters. Each line can show alphanumeric characters and symbols.

Color

The FANS CDU contains a liquid crystal display (LCD). It shows white text on a black background.

The LCD uses different colors to show flight activity and modes. Data shows in these colors:

- Black - background
- White - default color for text
- Magenta - active waypoint, active speed target and active altitude target in flight plan
- Green - actively tuned VOR, ILS and DME data (frequency, station ID and course). Also, green will be used for data fields that can be toggled on and off in which case the active state is green
- Amber - FMC mismatch indications on maintenance BITE pages
- Cyan - Inactive route page titles
- Shaded white - data that modifies the flight plan until the EXEC key is pushed.

The CDU shows this data in white:

- Text
- Scratchpad messages
- Header line titles
- Box prompts
- Dashes, except when the dash is an integral part of the data field (i.e. negative temperature) in which case it will be the same color as the data

- Slashes, except when the slash has data on both sides in which case it will be the same color as the data.

Display Layout

The first line shows these data blocks:

- Status
- Title
- Page number.

Status shows that the information on the display is the active executed plan (ACT) or a modified plan (MOD). When the data on the display is not active or not a part of the flight plan, the status block is blank.

The next block is the title for the display. An example of a title is POS INIT.

The last character spaces in the first line show the page number for each display. This tells the operator the active page and the total number of pages.

Data on lines two through thirteen (data field) applies to operation of the airplane.

Line fourteen is a scratch pad to enter data from the keyboard. Also, this line shows this data:

- Failure messages
- Alerts during operation
- Advisory prompts.

Alphanumeric Key Board

You use the key board to enter data into the FMCS and to make changes to a flight plan.

Each time you push an alphanumeric key, the entry shows in the scratch pad (line 14). In the scratch pad, you can edit the entry or clear it.

**FMCS - CONTROL DISPLAY UNIT - CONTROLS AND DISPLAYS****Function and Mode Keys**

These are the function and mode keys:

- INIT REF
- RTE
- DEP ARR
- ATC
- VNAV
- FIX
- LEGS
- HOLD
- FMC COMM
- PROG
- MENU
- N1 LIMIT
- EXEC.

The INIT REF key supplies access to a selection of data pages necessary to start the FMCS and ADIRU. Also, the operator can access navigation data and maintenance pages.

The RTE key selects the page you use to enter route data. This includes the flight origin and destination plus the takeoff runway number.

The CLB key shows the climb modes. Top-of-climb (T/C) altitude and speed/altitude restrictions show here. Information about time and distance to the next waypoint is also shown here.

The CRZ key shows the cruise modes. Information about optimum altitude, maximum altitude, step climb savings and turbulence N1 targets also show.

The DES key shows the descent modes. The end-of-descent altitude and speed/altitude restrictions show here. Information about flight path angle, airplane vertical speed and vertical bearing also show.

The MENU key gives access to other airplane data communication systems.

The LEGS key shows and accepts input of data about each leg of the flight plan. Information about heading between the waypoints, speed and altitude is also shown.

The DEP/ARR key supplies access to a selection of departure and arrival runways and procedures for the origin and destination airports.

The HOLD key lets you plan or start a hold at a waypoint or present position.

The PROG key shows this current flight status information.

The N1 LIMIT key shows the FMC calculated N1 thrust limits for specific flight phases.

This page also shows the reduced climb thrust limits CLB-1 (Climb 1) and CLB-2 (Climb 2). The flight crew can set N1 limit data from this page.

The FIX key shows range and bearing data from the present position to a selected reference position (SRP).

The ATC key shows the ATC index page. This page provides access to pages used for ATC datalink functions. When the .ATC crew alert is shown on the Engine Display and the Hi-Low chime sounds, press the ATC key to display the ATC uplink message on the FANS CDU.

The VNAV key shows the climb, cruise, and descent performance pages. When the VNAV key is pushed in flight, the page shown will be the active flight phase. On the ground, the CLB page shows. The other flight phase pages may be shown with the PREV PAGE and NEXT PAGE keys.

The FMC COMM key shows FMC communications page. This page has the airline operational communications (AOC) datalink functions.

The EXEC key is used to make active or to modify a page with data entry when the EXEC light comes on.

Page Select Keys

You push the NEXT PAGE key to advance the display to the next higher number page. You push the PREV PAGE key to back-up the display to the next lower number page.

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**FMCS - CONTROL DISPLAY UNIT - CONTROLS AND DISPLAYS**

The page strings are continuous. If the first page of a string is shown (1/9) and you push the PREV PAGE key, the display shows the last page in the string (9/9). If you go past the last page in a string (past 9/9 for example), this takes the display back to the first page in the string (1/9).

Line Select Keys

You use the line select keys for these operations:

- Move data from the scratch pad to a data field
- Copy data from a data field to the scratch pad
- Remove data from a data field
- Select a BITE operation from the maintenance bite index.

Lighted Annunciators

These are the active annunciators:

- CALL
- MSG (Message)
- OFST (Offset).
- FAIL

The CALL light is on when there is a call from another system other than the FMCS.

The MSG light is on to show there is an alert or advisory message. The MSG light stays on until you clear the message.

The OFST light is on when a parallel offset is active.

The FAIL light is on if there is a system failure found by BITE.

Special Keys

The keyboard has special keys in addition to the alpha-numeric keys. These are the special keys:

- Change sign (+/-)
- Space (SP)

- Delete (DEL).
- Slash (/)
- Clear (CLR).

The change sign (+/-) and slash (/) keys are standard keys on a keyboard.

The space key (SP) puts a space into the scratchpad. This will allow the flight crew to write messages into the scratchpad.

A push of the DEL key puts the word DELETE in the CDU scratch pad. This lets the operator delete a data field with the line select key next to the data field. The DEL key does not work when the scratchpad contains data. Some data fields do not permit the DEL key function. In this case, the INVALID DELETE message shows in the CDU scratchpad.

Push the CLR key once to remove one alphanumeric character in the scratch pad or an alert or advisory message from the scratch pad. Hold the CLR key down for one second to remove all scratch pad data.

BITE

The FMCS BITE function does a check of all key functions.

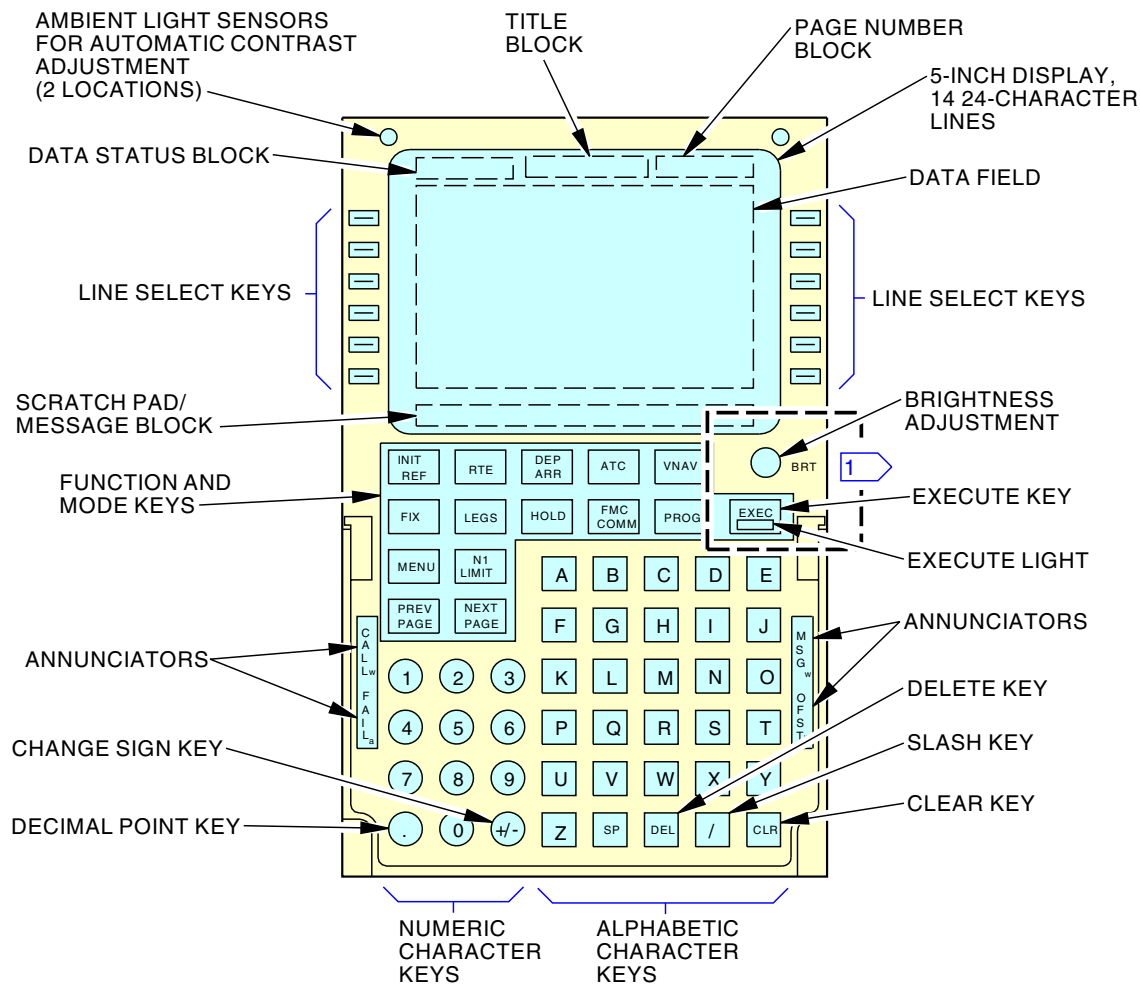
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FMCS - CONTROL DISPLAY UNIT - CONTROLS AND DISPLAYS



- 1 WITH BRIGHTNESS KNOB
- 2 WITH BRIGHTNESS CONTROL SWITCH

FMCS - CONTROL DISPLAY UNIT - CONTROLS AND DISPLAYS

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**FMCS - TRANSFER RELAYS****Purpose**

There are two FMCS transfer relays. The relays select the FMC to send data to the systems that interface with the FMCS. The FMC SOURCE SELECT SWITCH controls the relays. The source select switch is in the flight deck.

Location

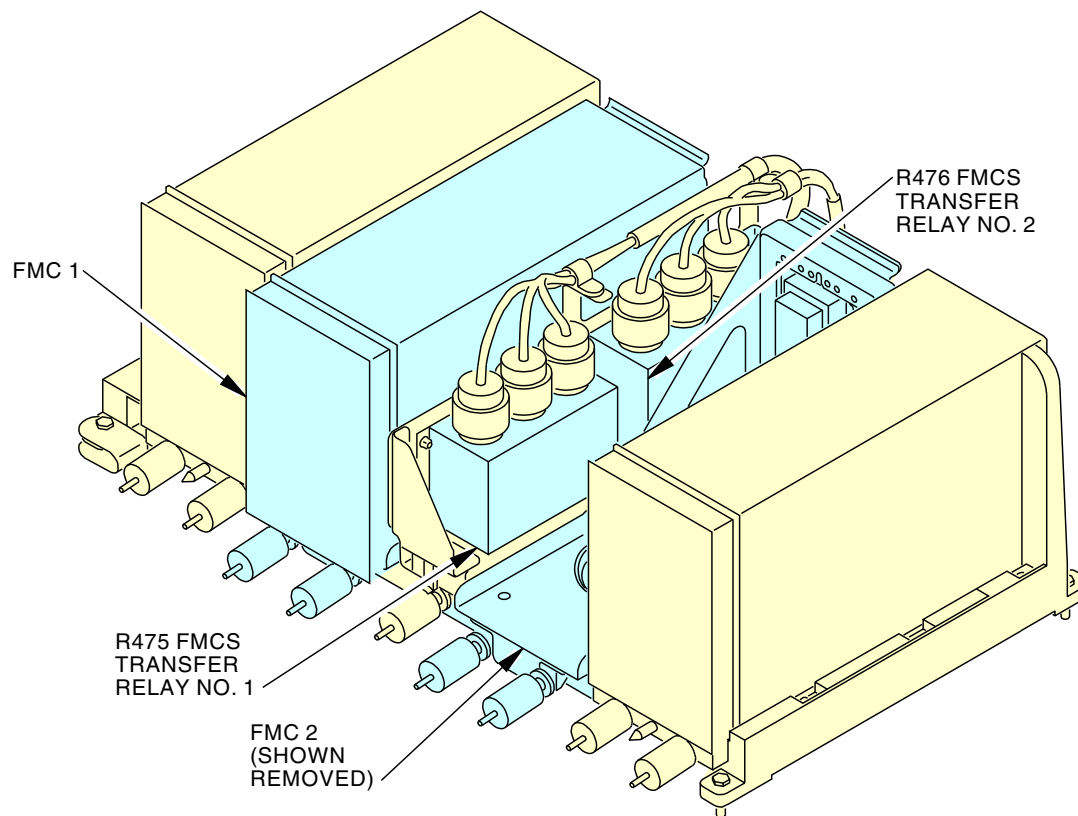
The relays are on the E5-2 shelf in the electronic equipment compartment.

Physical Description

The relays are Ledex type relays. They mechanically latch and are hermetically sealed.

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FMCS - TRANSFER RELAYS



ELECTRONIC EQUIPMENT SHELF E5-2

FMCS - TRANSFER RELAYS

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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

General

These are the primary FMC functions:

- Navigation
- Performance
- Guidance.

The FMC does the primary functions with data input from these sources:

- Flight crew
- Airplane system sensors
- Data stored in the FMC memory.

This is the data in memory:

- Operational flight program (OFP)
- Navigation data base (NDB)
- Performance default data base (PDDB)
- Airplane model/engine performance data base (MEDB)
- ACARS adaptable datalink data base (AADD)
- Software options data base.

NOTE: Operational flight program (OFP) is also referred to as operational program software (OPS).

FMC Data Bases

The operational flight program is the computer software that the FMCS uses to do the navigation, performance, and guidance functions.

The navigation data base contains all the data necessary for the airplane operation over a defined route network. This type of information is available:

- Waypoints
- Nav aids
- Airport data
- Airway data

- Standard instrument departures (SIDs)
- Standard terminal arrival routes (STARs).

There are two navigation data bases, the current and a set of update revisions, stored in the FMC.

The performance default data base (PDDB) and the model/engine performance data base (MEDB) contain the same type of data and carry out the same functions.

The PDDB is part of the operational flight program. It has an aerodynamic model for the 737-600/700/800/900 series airplanes and a fuel flow/N1 thrust model for the specific engine on the airplane. This data is used to predict the performance characteristics that give the optimum vertical profile for the airplane.

The MEDB has the aerodynamic model for the 737-7/8/9 series airplanes and a fuel flow/N1 thrust model for the specific engine on the airplane. The MEDB is loadable through the network file server (NFS) and is not part of the operational flight program.

The aerodynamic model includes this data:

- Optimum altitudes
- Speed schedules
- Operating limits
- Drag data for dual and single engine operation.

This data is used to calculate the performance characteristics that give the optimum vertical profile for the airplane.

The fuel flow/N1 thrust model is used to calculate fuel flows and thrust limits corrected for the effects of air conditioning and airframe anti-ice bleed air demands.

The software options data base has the software options that have been selected. These are some of the software options:

- Runway position update (runway remaining in meters)
- Manual T/O speeds
- VNAV ALT enable

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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

- GPS navigation
- Manual RNP entry
- ATS datalink
- ATC message on displays

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- ATN DB

SIA ALL

- Abeam waypoints
- AOC datalink
- Altitude/speed intervention
- Plan fuel
- QFE (altimeter setting to show altitude above reference airfield) landing reference
- CDU color
- Geometric path descent
- Pilot defined company routes
- Engine out SIDS
- Common instrument approach procedures (CIAP/IAN)
- Missed approach color
- Integrated approach navigation
- GPS landing system approach
- Gross weight inhibit
- Takeoff derate inhibit
- Common VNAV
- Speed propagation
- Default DME off
- Default RNP
- NDB size.
- Variable takeoff (T/O) rating

The ACARS datalink data base has the software that permits the uplink and downlink of data between the FMC and a ground network.

All these data bases are loadable with a data base loader.

Navigation

The navigation function gives airplane position (FMC position) and autotuning capability for the navigation radios.

The FMCS uses these sensors to calculate the FMC position:

- Global positioning system
- NAV radio data
- ADIRS.

The flight crew can manually build the route or select it from the company navigation data base. When the route has been activated, it shows on the navigation display of the MDS.

Performance

The performance function gives flight profile information and target engine N1 speeds. This lets the airplane fly at the most economical altitudes and speeds for the conditions.

The FMC uses this information to calculate performance data:

- CDU data (cost index, CRZ altitude, etc.)
- Air data and inertial reference information
- Fuel weight
- Engine bleed air data
- Airplane and engine information from the model/engine performance database.

The economy mode is the primary performance mode for the climb, cruise, and descent phase of flight. The flight crew can select other operating modes at any time.

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**FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION****Guidance**

The guidance function sends flight path and steering commands to the digital flight control system (DFCS) and the autothrottle (A/T).

For lateral navigation (LNAV), the FMC calculates the route and compares it to the FMC position. If they are different, the FMC calculates a roll steering command and sends it to the DFCS.

For vertical navigation (VNAV), the FMC calculates speed and vertical speed targets and sends them to the DFCS. The FMC also calculates N1 thrust and speed targets and sends them to the A/T. The autothrottle and autopilot follow the targets and commands to keep the airplane on the calculated flight path.

During climb or descent, the FMCS sends speed and altitude targets to the DFCS. During level flight, the FMCS sends speed commands to the A/T.

Other Functions

The aircraft communications and reporting system (ACARS) lets the FMC receive (uplink) and send (downlink) messages to the operators ground network. The uplink can be used to send flight plan data, weather or other pertinent information. The downlink can be used by the flight crew to request flight planning or performance data.

The ACARS function controls the messages sent to and from the ground with ACARS. Some messages show when the crew selects the correct command on the CDU. Other messages are automatic. The ACARS configuration data base controls the automatic messages.

The display function sends display data to the MDS and the CDUs. The data includes route and position data and N1 data.

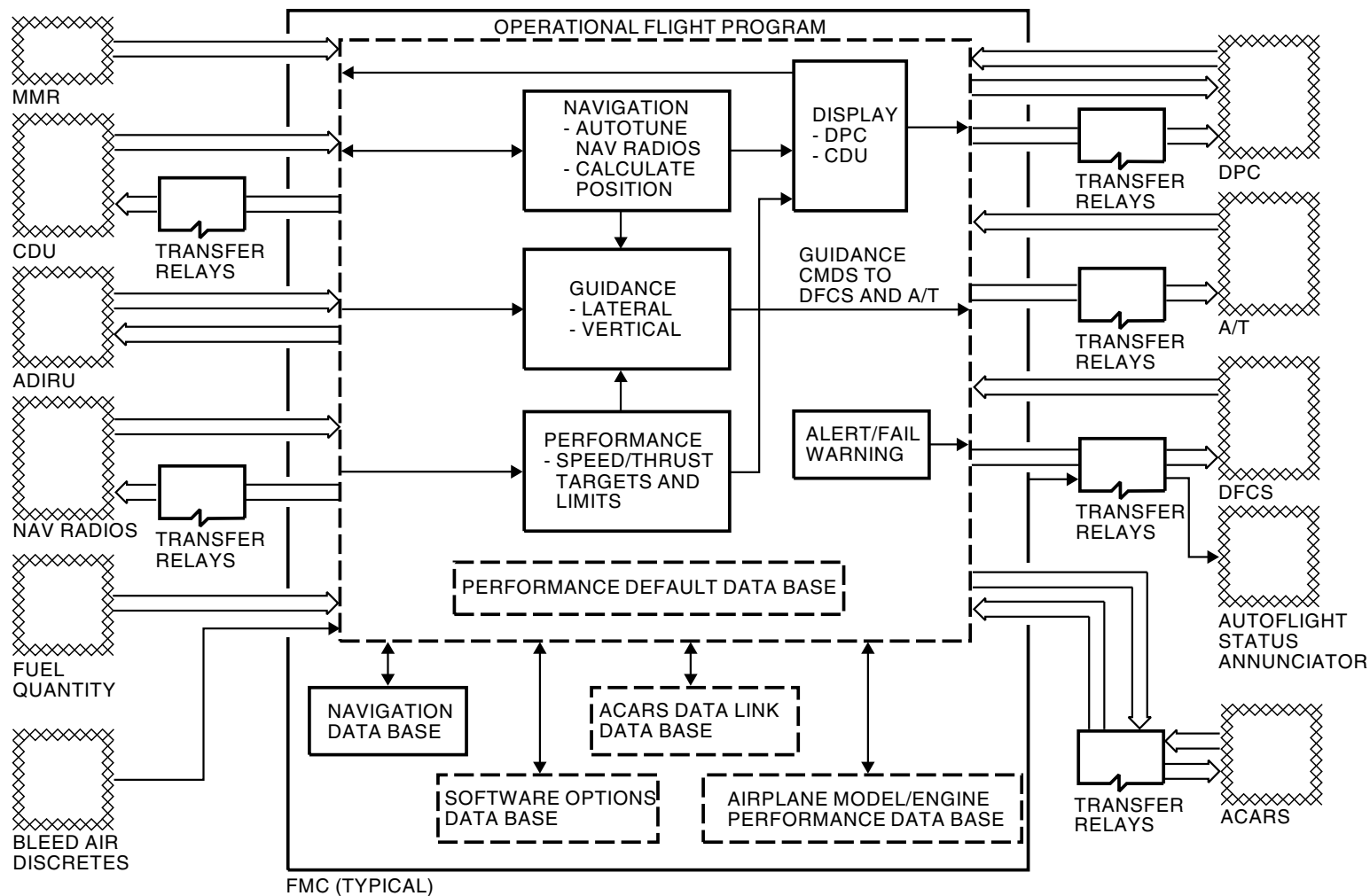
The ALERT function does a check of the FMC status. It turns on the FMC light on the autoflight status annunciators when the FMC fails or when there is a message that makes flight crew awareness and subsequent action necessary.

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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION



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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

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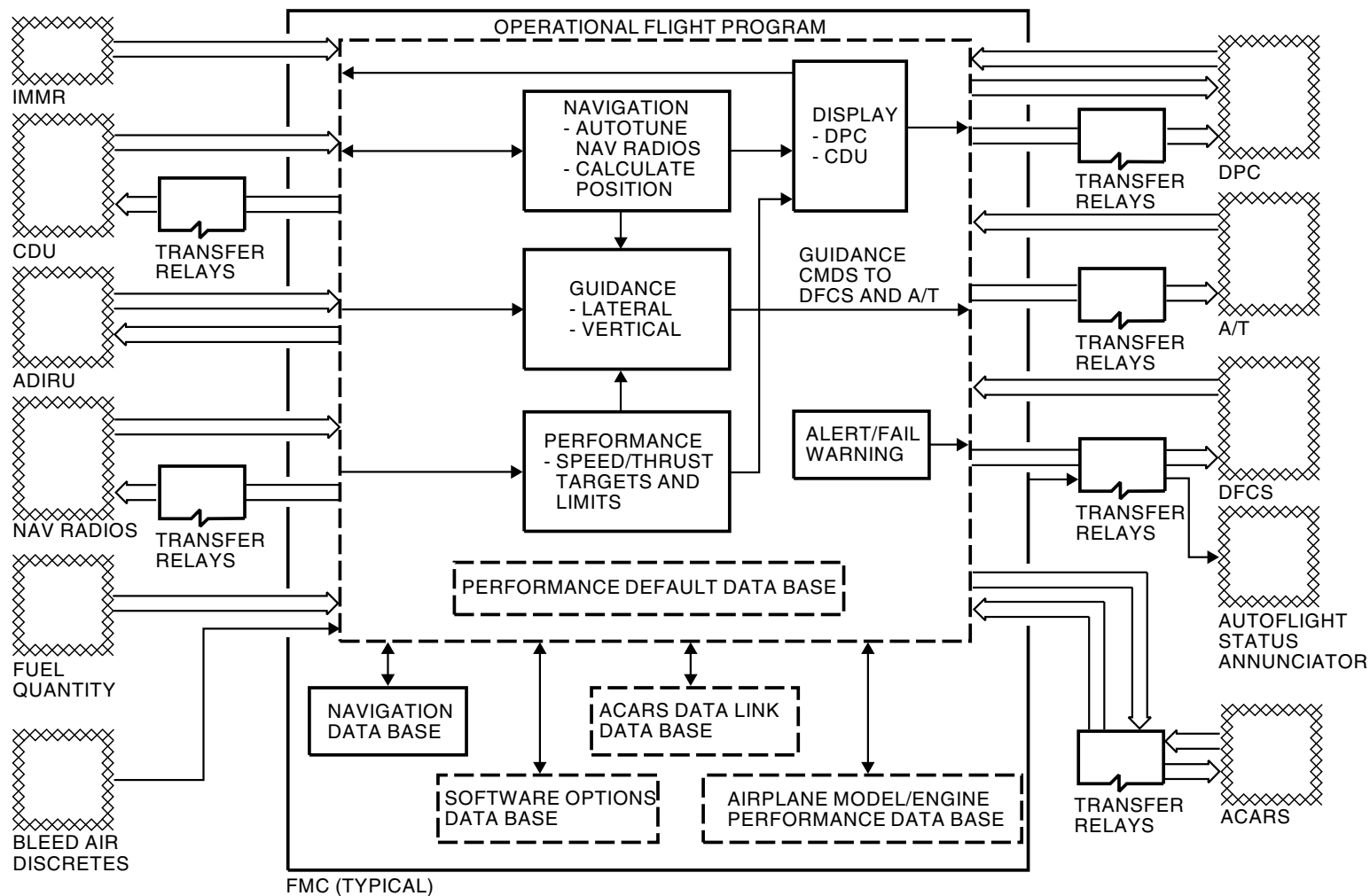
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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION



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FMCS - FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

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FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION

General

The FMCS navigation sub-function calculates this data:

- Lateral position
- Vertical position
- Actual navigation performance (ANP).

The FMCS navigation function also tunes the DME interrogators and supplies radio tuning data for display on the CDU NAV STATUS page.

The primary data source for the lateral and vertical position calculations is the ADIRU. Because the ADIRU data drifts over time, the FMC navigation function uses data from other sensors to correct the ADIRU data that it receives.

The FMC uses independent measurements from the navigation sensors filtered with ADIRU position, heading and velocity data to produce an accurate calculation of the airplane's position in the horizontal plane.

NOTE: The ADIRU must be in the NAV mode to provide valid data to the FMC.

The FMC will select only one navigation update mode at a time. The navigation update mode with the least amount of position uncertainty will be used.

These are the sensors used to calculate/update the FMC position and their selection priority:

- ADIRU/GPS
- ADIRU/DME/DME
- ADIRU/DME/VOR
- ADIRU/DME/LOC
- ADIRU ONLY.

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The first priority for FMC position updating is GPS data from the GPS receiver in the MMRs.

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The first priority for FMC position updating is GPS data from the GPS receiver in the IMMRs.

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The next priority is a pair of DME stations that have the best range and geometry. The maximum range for DME/DME updating is nominally 200 nautical miles (NM) but the FMC will always use those stations that are nearest the airplane position. The FMC will also always tune two DMEs that are not within 30 degrees of each other or not greater than 150 degrees apart (90 degrees being the optimum angle).

If there are not two DME stations within range or that do not have the necessary geometry, the FMC uses DME distance and VOR bearing from a co-located VOR/DME station. The maximum range for VOR/DME update is 25 nautical miles.

NOTE: The FMC will autotune the DME interrogators but VOR must be manually tuned by the flight crew.

In an airport terminal area when the airplane is on a localizer approach, the FMC uses localizer deviation and DME distance to update the FMC position. The maximum range for LOC/DME update is 20 nautical miles and the airplane altitude must not be greater than 6000 feet above the localizer station elevation. Also, the airplane track must be within 45 degrees of the localizer inbound course and localizer deviation must be less than 1.25 dots for at least 5 seconds.

With all VHF NAV radio updates, the FMC will correct the DME slant range distance for airplane altitude.

If GPS data and NAV radio data are not available or become invalid, the FMC uses ADIRU data only corrected by a fixed error bias calculated by the FMC.

The FMCS can use GPS data on the ground to update the FMC position if the GPS data is valid. VHF NAV radio update is not enabled on the ground.

The navigation sub-function also calculates the following nav data:

- Airplane position (latitude, longitude and altitude)

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FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION

- Groundspeed
- Flight path angle
- Drift angle
- Track angle
- Wind velocity and direction
- Horizontal position accuracy (actual navigation performance).

The FMC uses the following inputs to calculate these parameters:

- Inertial position (latitude, longitude and inertially smoothed altitude)
- Vertical speed (inertially smoothed)
- Groundspeed components (N-S, E-W velocity vectors)
- Heading (magnetic and true)
- Pressure altitude (uncorrected and baro-corrected)
- True airspeed
- GPS data
- DME slant range
- VOR bearing
- ILS LOC deviation.

Lateral Position

This function calculates latitude and longitude.

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The FMCs use the position calculated from the GPS data and the ADIRU inputs to correct their ADIRU based inertial lateral positions. These are the FMC positions and are calculated in terms of latitude and longitude. The FMCs will use their onside GPS input from the multi mode receivers (MMR) if the data is valid. The offside GPS data will be used if the onside data is invalid.

SIA 006-999

The FMCs use the position calculated from the GPS data and the ADIRU inputs to correct their ADIRU based inertial lateral positions. These are the FMC positions and are calculated in terms of latitude and longitude. The FMCs will use their onside GPS input from the integrated multi mode receivers (IMMR) if the data is valid. The offside GPS data will be used if the onside data is invalid.

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Vertical Position

This function calculates altitude and flight path angle (FPA).

Altitude is calculated from ADIRU inertial altitude corrected by barometric pressure altitude. Flight path angle is calculated from inertial vertical speed and FMC calculated ground speed. The FPA is zero when the airplane is on the ground.

FMCS Composite Position

Each FMC sends its FMC position to the other FMC with a confidence factor. The confidence factors are based on the estimated accuracy of each FMC and the navigation sensors that are being used in the position calculations.

In each FMC, FMC 1 position and FMC 2 position are used to give a final FMC position. This final position calculation from each FMC is a combination of the two positions weighted from their respective confidence factors. This final FMCS position and navigation data is continually compared between the two FMCs.

Actual Navigation Performance (ANP)

The ANP is the accuracy of the FMC calculated position. It is calculated in nautical miles by the FMCS during all parts of the flight. It is measured in nautical miles and it shows the radius of a circle around the calculated FMC position where the probability of the airplane being inside the circle is 95%.

**FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION**

The ANP calculation uses this data:

- The NAV stations in use
- GPS availability and accuracy
- Accuracy of DME range data
- Accuracy of VOR bearing data
- ADIRU drift.

The required navigation performance (RNP) is the accuracy requirement of the FMC navigation performance within a defined airspace. It is calculated in nautical miles and represents the radius of a circle where the probability of the airplane being within that circle is more than 95%. The default values for RNP are contained in the navigation data base.

The default values for RNP are as follows:

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- Oceanic - 12.0 NM
- Enroute - 2.0 NM
- Terminal - 1.0 NM
- Approach - 0.3 NM.

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RNP can also be set manually on the LEGS or POS SHIFT pages on the CDU by the flight crew. The manually set value of RNP can not be more than the default RNP value.

ANP is compared with RNP and both show on the CDU LEGS and POS SHIFT pages. When the ANP exceeds the RNP, the message UNABLE REQD NAV PERF-RNP will show in the scratchpad on the CDUs.

NAVAID Selection and Tuning

The primary FMC selects the navaids that both FMCs use. It selects the navaids that give the most accurate estimate of position and have the best range and geometry.

Each FMC sends four navaid frequencies to its on-side navigation control panel. The frequencies then go to the DME interrogators. If there is a fault with a control panel, the DME interrogators get the data directly from the FMC.

Each FMC is allocated two navaid pairs for position updating. These pairs will be dissimilar with at most one navaid in common between the two FMCs. The primary FMC will use the best and third best pairs and the secondary will use the second and fourth best pairs.

If there is only one navaid pair available, the primary FMC will use that data for position updating while the secondary FMC will propagate its position using ADIRU data only corrected by a fixed error bias. This enables some independence in the individual FMC position calculations.

Navigation Data Base

The navigation data base is stored in the flash EEPROM memory of the FMC in two parts. There is the main body of active data which is effective until a specified expiration date and also a set of data revisions for the next period of effectivity.

This information is in the navigation data base:

- VOR, DME, VORTAC, and TACAN navigation aids
- Waypoints
- Airports and runways
- Standard instrument departures (SIDs)
- Standard terminal arrival routes (STARs)
- Procedure turns and holds
- Holding patterns
- Missed approaches
- Approach Procedures
- Approach and departures transitions
- Company route structure
- Terminal gates.

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**FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION****FMC Selection**

You use the FMC source select switch to select the primary FMC.

FMC Source Select Switch Position	Primary FMC	Secondary FMC
NORMAL	FMC 1	FMC 2
BOTH ON L	FMC 1	FMC 2
BOTH ON R	FMC 2	FMC 1

The primary FMC does these functions:

- Selects the nav aids for tuning for both FMCs
- Determine the navigation update mode (ADIRU/DME/DME etc.)
- Transmit the initial alignment position to the ADIRUs.

Dual FMC Operation

When the source select switch is in the NORMAL position, dual mode operation is enabled. The secondary FMC is synchronized with the primary FMC at all times. The FMCs compare this data:

- Current aircraft state data
- Static data.

Current aircraft state data consists of the following output data from the FMC navigation sub-function:

- Airplane position (latitude and longitude)
- Magnetic heading
- Magnetic track
- Magnetic variation
- Roll angle
- Drift angle
- Airplane altitude
- Flight path angle

- Wind components (headwind and crosswind components, wind speed and direction).

Static data consists of the following data:

- Power up data
- Flight plan data
- Fix page data
- Supp/temp navigation data
- Navigation option page data.

In the dual mode, if the current aircraft state data and static data do not compare within tolerance, the data is automatically crossloaded from the primary FMC to the secondary FMC (synchronization). The data is then compared again and if it is satisfactory, dual FMC operation is maintained.

If the data still miscompares after this synchronization, the failure is logged into BITE against the secondary FMC and the system reverts to single FMC operation. The message SINGLE FMC OPERATION shows in the CDU scratchpads. In this configuration, the calculations from the primary FMC are used and the secondary FMC is set to a conditional fail state.

If the secondary FMC is set to a conditional fail state, the intersystem bus between the FMCs will remain active and both FMCs will continue to process data. All outputs from the secondary FMC will be set to no computed data (NCD).

After one FMC has become conditionally failed and the FMC source select switch is set to the BOTH ON L or BOTH ON R positions, synchronization will be attempted again between the FMCs using data from the primary FMC as the source for the synchronization. If the synchronization is successful, the message DUAL FMC OP RESTORED shows on the CDU and the system goes to dual operation.

Following a failure to restore dual operation by movement of the FMC source select switch, an additional attempt at synchronization will be made 5 minutes after the failure. This attempt will only be made if the FMC source select switch is in the BOTH ON L or BOTH ON R positions.

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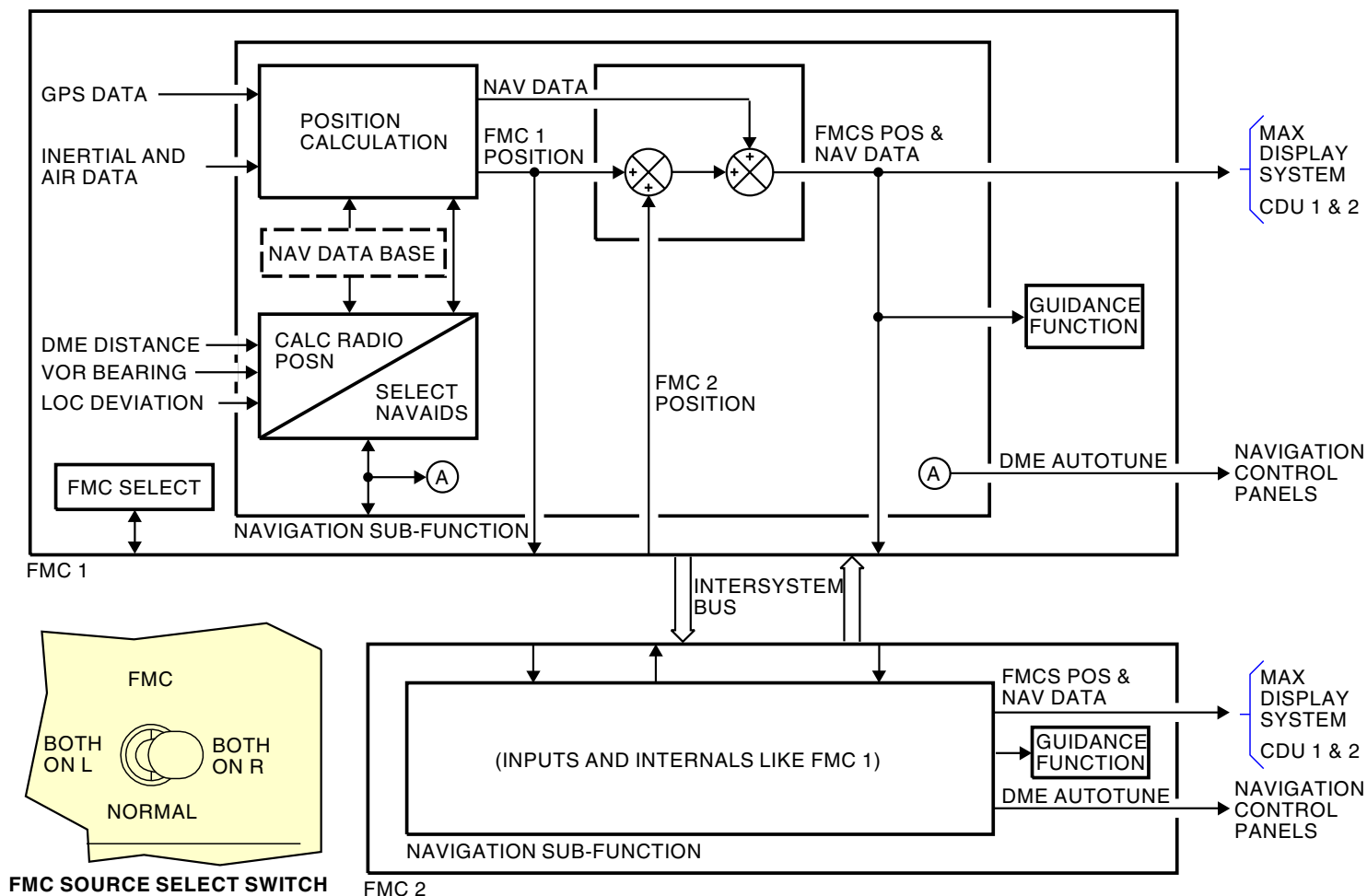
**FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION**

When one FMC has conditionally failed and the FMC source select switch is in the BOTH ON L or the BOTH ON R position, the calculations from the selected FMC are used. The output systems receive data from the selected FMC.

The primary FMC processes all CDU operations and sends them to the secondary FMC via the intersystem bus. This ensures that the secondary FMC is synchronized to the primary FMC with regard to CDU keypush events.

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FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION



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FMCS - FMC FUNCTIONAL DESCRIPTION - NAVIGATION SUB-FUNCTION

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**FMCS - FMC FUNCTIONAL DESCRIPTION - PERFORMANCE SUB-FUNCTION****General**

The performance sub-function provides optimum values for airspeed and engine thrusts to provide the most economical vertical path profile. It uses aerodynamic and engine models to do these calculations. It calculates this data:

- Speed targets
- Speed limits
- N1 targets
- N1 limits
- Airplane gross weight.

Speed and Thrust Targets

The performance sub-function calculates the optimum speed and thrust targets. These calculations occur during climb, cruise and the descent phases of flight. The economy mode (ECON) is the default mode for each flight phase.

In the economy mode of operation, the FMC uses the data input from the flight crew (cruise altitude, cost index etc.) to calculate the most cost efficient flight profile. Other modes (maximum rate climb, long range cruise, speed descent etc.) are also available and can be selected by the flight crew through the CDU.

When the VNAV mode is engaged, the speed and thrust targets go to the FMC guidance function. The guidance function then sends out commands to the DFCS and the autothrottle computer to control the vertical flight path of the airplane.

Speed targets do not go to the DFCS during takeoff or approach/go-around operation. Only target N1 (limit value or reduced value if engine derate has been selected) is used.

Speed and Thrust Limits

The performance sub-function also calculates minimum and maximum speed and thrust limits for the climb, cruise and descent phases of the flight. These make sure that the airplane operates within its flight envelope and the engines are protected against possible overboost.

Gross Weight

The FMCS calculates airplane gross weight or the flight crew manually enters the data. Total fuel weight from the fuel quantity processor unit goes to the FMC. The flight crew can enter either gross weight or zero fuel weight through the CDUs.

If the flight crew enter gross weight, the FMC subtracts total fuel weight from gross weight to calculate zero fuel weight. If the flight crew enter zero fuel weight, the FMC adds total fuel weight and zero fuel weight to calculate gross weight.

Performance Data

The FMC uses this data for the performance calculations:

- Air data
- Cruise altitude
- Cost index
- Fuel weight
- Engine bleed air sensors
- Model/engine data base.

Air Data

The FMC uses this air data from the ADIRUs:

- Air temperature is used to calculate thrust limits.
- Altitude is used to calculate speed and thrust targets and limits.
- Airspeed is used to calculate DFCS/Autothrottle commands.

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**FMCS - FMC FUNCTIONAL DESCRIPTION - PERFORMANCE SUB-FUNCTION****Cruise Altitude**

Cruise altitude is entered by the flight crew through the CDUs. It is used to establish the altitude for the top of climb (T/C) point.

Cost Index

The cost index is a number which is a ratio of the operator time costs (such as labor) to the fuel cost.

A low value for cost index means that fuel costs are more important than time costs. A high cost index means that time costs are more important than fuel costs. For flights where fuel costs are high, the performance economy speed schedules are slower. For flights where time costs are high, the economy speed schedules are faster.

The flight crew enters the cost index in the CDU and changes the data as necessary. The range is from 000 (most economical) to 200 (time critical). This lets the operator adjust the economy speed schedules (climb, cruise and descent) for the conditions and routes they operate.

Fuel Weight

Fuel weight data is sent by the fuel quantity processor unit to the FMC. It is used by the FMC in the gross weight calculations.

If the total fuel weight data from the fuel quantity processor unit is invalid, the flight crew can manually input the fuel weight to the FMC on the CDUs. Every 30 minutes, the FMC prompts the flight crew to enter a new fuel weight with the message VERIFY GW AND FUEL. After the airplane is past the T/D (top of descent) and a Vref value is entered, the FMC will not show this message.

Engine Bleed Air Sensors

The FMC receives analog discretes from the air conditioning system and the thermal antice (TAI) systems for both the engines and wings. The FMC uses this data to correct calculated thrust values.

Model/Engine Data Base (MEDB)

The MEDB contains this data:

- An aerodynamic model of the airplane. This consists of recommended speed schedules, optimum operating altitudes, buffet limit envelope and the certified operating limits for the airplane. Engine out operating conditions including speed and drag data are also contained in this data base.
- Fuel flow and N1 thrust models for the engine thrust rating selected on the airplane. These are used to calculate fuel flow, thrust limits, engine limits and to compensate for engine air bleed loads.

Flight Envelope Protection

The operational flight program (OFP) continually monitors computed performance targets against the airplane operation limits. If any performance target is more than the limit, the FMC will restrict the performance target to the correct value and maintain both airplane and engine optimal performance.

Dual FMC Operation

When the source select switch is in the NORMAL position, dual mode operation is enabled. The secondary FMC is synchronized with the primary FMC at all times. The FMCs compare this static performance data.

Static data consists of the following data:

- Flight plan data
- Performance data
- Takeoff reference page data
- Approach reference page data
- N1 limit page data
- Switchable discrete data.

**FMCS - FMC FUNCTIONAL DESCRIPTION - PERFORMANCE SUB-FUNCTION**

In the dual mode, if the static data does not compare within tolerance, the data is automatically crossloaded from the primary FMC to the secondary FMC (synchronization). The data is then compared again and if it is satisfactory, dual FMC operation is maintained.

If the data still miscompares after this synchronization, the failure is logged into BITE against the secondary FMC and the system reverts to single FMC operation. The message SINGLE FMC OPERATION shows in the CDU scratchpads. In this configuration, the calculations from the primary FMC are used and the secondary FMC is set to a conditional fail state.

If the secondary FMC is set to a conditional fail state, the intersystem bus between the FMCs will remain active and both FMCs will continue to process data. All outputs from the secondary FMC will be set to no computed data (NCD).

After one FMC has become conditionally failed and the FMC source select switch is set to the BOTH ON L or BOTH ON R positions, synchronization will be attempted again between the FMCs using data from the primary FMC as the source for the synchronization. If the synchronization is successful, the message DUAL FMC OP RESTORED shows on the CDU and the system goes to dual operation.

Following a failure to restore dual operation by movement of the FMC source select switch, an additional attempt at synchronization will be made 5 minutes after the failure. This attempt will only be made if the FMC source select switch is in the BOTH ON L or BOTH ON R positions.

When one FMC has conditionally failed and the FMC source select switch is in the BOTH ON L or the BOTH ON R position, the calculations from the selected FMC are used. The output systems receive data from the selected FMC.

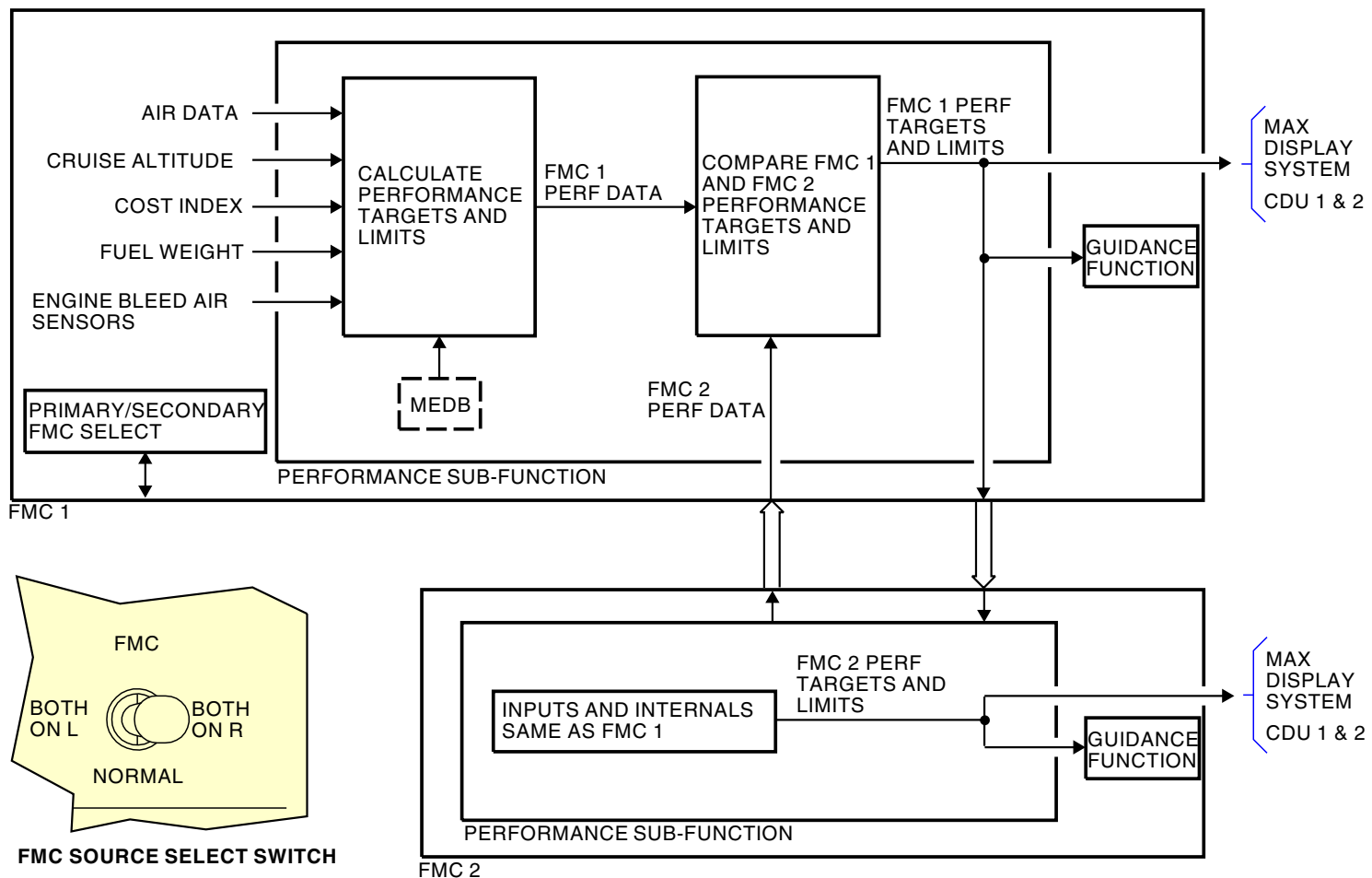
The primary FMC processes all CDU operations and sends them to the secondary FMC via the intersystem bus. This ensures that the secondary FMC is synchronized to the primary FMC with regard to CDU keypad events.

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FMCS - FMC FUNCTIONAL DESCRIPTION - PERFORMANCE SUB-FUNCTION



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FMCS - FMC FUNCTIONAL DESCRIPTION - PERFORMANCE SUB-FUNCTION

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**FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION****General**

The guidance sub-function calculates data for the lateral and vertical guidance functions and supplies guidance commands to the digital flight control system (DFCS) and autothrottle (A/T) system. The calculations start when the guidance sub-function receives an active route (lateral flight plan) and an active performance plan (vertical flight plan).

The DFCS and A/T use the commands to automatically guide the airplane along a lateral path and to control airspeeds, vertical speeds and N1 targets/limits. The LNAV mode must be active to enable the lateral guidance function and the VNAV mode must be active to enable the vertical guidance function.

NOTE: In path descents, LNAV must be valid and a valid end of descent point must be defined in order to engage the VNAV mode.

These are the major parts of the guidance sub-function:

- Flight plan management
- Lateral guidance commands
- Vertical guidance commands.

Flight Plan Management

The lateral route is a set of navigation legs. A navigation leg is a path between two waypoints. The flight plan management process calculates the great circle and turn segments for each path. Navigation legs are great circle tracks between the flight plan waypoints or constant heading legs.

A waypoint shows as latitude, longitude and altitude. The waypoints come from the navigation data base or are put in by the flight crew.

This data is calculated for each way point:

- Predicted altitude
- Time-of-arrival
- Speed
- Fuel remaining
- Distance between the waypoints

- Flight path course between the waypoints.

The performance plan (ZFW, cost index, cruise altitude, performance modes) determines the performance speed schedules and thrust that will be calculated by the FMC. The path calculations then use the performance data to calculate altitude, time, airspeed and fuel for each waypoint. If there are any speed or altitude restrictions attached to the lateral waypoints in the flight plan, these will be incorporated into the vertical flight profile calculated by the FMC.

Initially the flight plan management calculates the parameters for the waypoints in the climb and cruise phases but the top of descent (T/D) waypoint will be unknown.

The T/D is calculated using the last waypoint in the flight plan and working backwards. The approximate T/D is estimated to get a descent speed schedule and descent path gradient together with fuel remaining. Range in descent is first calculated from the altitude change in descent and an assumed flight path angle. The T/D will be calculated by subtracting range in descent from the total flight plan range.

Next the estimated fuel remaining at T/D and wind profile are used to calculate descent range, speed schedules, path gradient and final fuel remaining. Then the full descent leg is calculated using the last set of data backward from the terminal waypoint. This gives the T/D and a predicted fuel remaining value. The descent phase of the flight plan is now combined with the climb and cruise phases to complete the flight plan predictions.

Lateral Guidance Commands

When a complete route has been activated in the FMCS and the LNAV mode is valid, the lateral guidance function sends lateral steering commands to the DFCS.

If the LNAV function is not valid and lateral guidance outputs are not calculated, the FMCS sets the lateral guidance outputs to no computed data (NCD). The DFCS disconnects the LNAV mode and reverts to control wheel steering (CWS).

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**FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION****Vertical Guidance Commands**

The vertical guidance function calculates and sends airspeed or vertical speed targets to the DFCS. Airspeed, N1 limit and mode commands are also calculated and sent to the A/T system.

These are the two basic modes for vertical guidance:

- Airspeed (VNAV SPD)
- Path (VNAV PATH).

In the airspeed mode, the DFCS controls the airplane to a target FMCS airspeed while thrust is set to an N1 climb limit rating or idle. Both the speed target and the thrust limit values are provided by the FMCS. VNAV SPD will show on the flight mode annunciators (FMA). Speeds set on the MCP (speed intervention) can also be used.

In the path sub-mode, the DFCS controls the airplane to a target FMCS vertical speed. This path will be calculated for a specified speed/thrust profile. In descents, the default will be idle thrust and economy speeds. VNAV PATH will show on the FMAs.

If the VNAV function is not valid and vertical guidance outputs are not calculated, the FMCS sets the vertical steering command to no computed data (NCD). The DFCS disconnects the VNAV mode and reverts to CWS mode. The FMC lights on the ASAs will illuminate to alert the flight crew to this condition together with the VNAV DISCONNECT message in the CDU scratchpads.

For descent, a vertical path deviation display is sent to the MDS. The deviation shows the difference between the reference altitude on the vertical reference path and the current airplane altitude.

MDS Function

This function provides the MDS with display/background data to accurately show the airplane's position with respect to the flight plan path.

The following data is sent to the MDS:

- FMC present position (Lat & Long)
- Distance to go to a waypoint

- Groundspeed
- Estimated time of arrival
- Desired track
- Cross track distance
- Vertical deviation
- Range to altitude
- Navigation sensor position (IRS, GPS, radio)
- V1 speed
- VR speed
- Speed targets
- Waypoint bearing
- True track angle
- Magnetic track angle
- Wind speed and direction
- Drift angle
- Flight path angle
- Waypoint, navaid, airport symbology
- Discrete word.

The discrete word contains the following data:

- To/from
- IRS source
- IRS position difference
- N1 limit mode
- Reduced thrust derate
- FMC source select annunciation.

Dual FMC Operation

When the FMC source select switch is in the NORMAL position, dual mode operation is enabled. The secondary FMC is synchronized with the primary FMC at all times.

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**FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION**

FMC 1 supplies the guidance commands and N1 thrust targets to flight control computer (FCC) A and the autothrottle computer while FMC 2 supplies FCC B.

The MDS will use onside FMC dynamic/background data for the captain's and F/O's navigation displays.

With regard to the guidance sub-function, the FMCs compare dynamic data:

Dynamic data consists of the following output data:

- DFCS data
- Autothrottle data
- MDS data.

In the dual mode, if the dynamic data does not compare within tolerance, the guidance data is automatically crossloaded from the primary FMC to the secondary FMC (synchronization). The data is then compared again and if it is satisfactory, dual FMC operation is maintained.

If the data still miscompares after this synchronization, the guidance data calculations are initiated again in each FMC and compared again.

If the data still miscompares after this recalculation, all primary FMC RAM data is crossloaded to the secondary FMC and a "soft" software restart is initiated (FMC outputs are smoothed and the autopilot does not disconnect). If the data still miscompares, the system reverts to single FMC operation. The message SINGLE FMC OPERATION shows in the CDU scratchpads. In this configuration, the calculations from the primary FMC are used and the secondary FMC is set to a conditional fail state.

If the secondary FMC is set to a conditional fail state, the intersystem bus between the FMCs will remain active and both FMCs will continue to process data. All outputs from the secondary FMC will be set to no computed data (NCD).

After one FMC has become conditionally failed and the FMC source select switch is set to the BOTH ON L or BOTH ON R positions, synchronization will be attempted again between the FMCs using data from the primary FMC as the source for the synchronization. If the synchronization is successful, the message DUAL FMC OP RESTORED shows on the CDU and the system goes to dual operation.

After a failure to restore dual operation by movement of the FMC source select switch, an additional attempt at synchronization is made 5 minutes after the failure. This attempt is only made if the FMC source select switch is in the BOTH ON L or BOTH ON R positions.

When one FMC has conditionally failed and the FMC source select switch is in the BOTH ON L or the BOTH ON R position, the calculations from the selected FMC are used. The output systems receive data from the selected FMC.

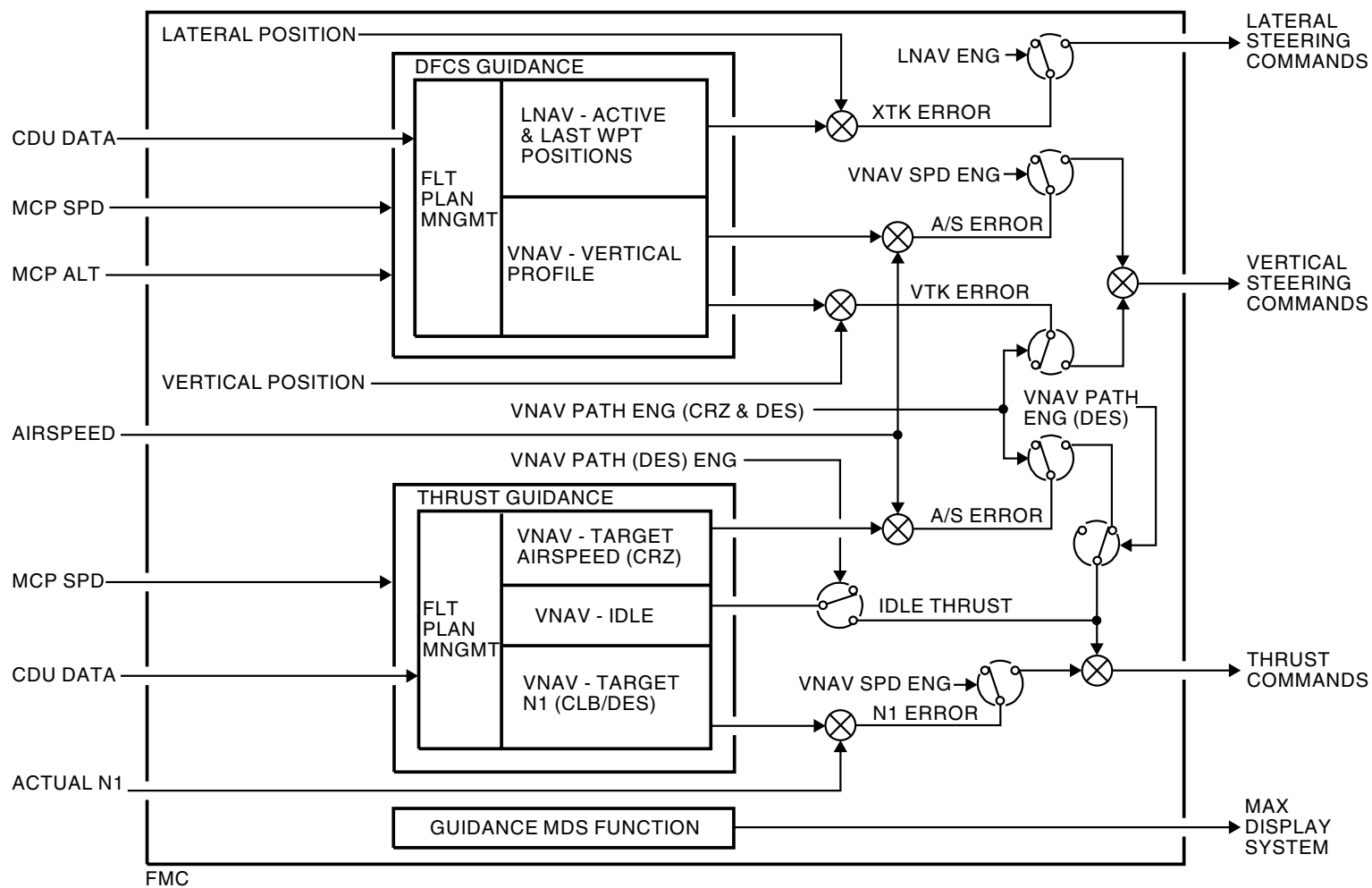
The primary FMC processes all CDU operations and sends them to the secondary FMC on the intersystem bus. This makes sure the secondary FMC is synchronized to the primary FMC for CDU keypush events.

34-61-00**EFFECTIVITY****SIA ALL**

D633AM102-SIA

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FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION



2370129 S00061521035_V3

FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION

**FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION - LNAV AND VNAV MODE LOGIC****General**

LNAV and VNAV logic uses inputs from several sources to engage the LNAV and VNAV modes.

The FMCS guidance sub-function needs these logic inputs to complete its guidance command output path to the DFCS and the A/T system.

LNAV/VNAV Mode Activation

To engage LNAV or VNAV, push the LNAV or VNAV switch on the mode control panel (MCP). The MCP then sends the mode requests by way of the flight control computers (FCCs) to the guidance sub-function in the FMC.

FMC LNAV Logic

These are the inputs to the FMCS necessary to engage the LNAV mode:

- ADIRU in the Nav mode and the data is valid
- LNAV capture criteria is satisfied (The present airplane track will intercept the active flight leg at an angle of 90 degrees or less and the crosstrack deviation is less than 3 nautical miles)
- Active route (no discontinuity to the next waypoint)
- Localizer mode is not active
- Go-around mode is not active
- LNAV arm/operate (MCP).

FMC VNAV Logic

These inputs to the FMCS are necessary to engage the VNAV mode:

- Airplane in the air
- ADIRU in the Nav mode and the data is valid
- Performance data (ZFW or GW, fuel reserves, cost index and cruise altitude) is valid
- Glideslope mode is not active
- Go-around mode is not active
- VNAV arm/operate.

VNAV will engage in VNAV SPEED mode when:

- A climb or a speed descent flight phase is active
- The airplane is not in level flight
- VNAV mode is active.

VNAV will engage in VNAV PATH mode when:

- The airplane is holding altitude or a path descent is active
- Active lateral route (LNAV engaged)
- VNAV mode is active.

The climb flight phase is active when the flight crew sets a new altitude on the CDU cruise (CRZ) page or selects altitude intervention, and the airplane climbs to a new altitude.

The speed descent flight phase is active when the flight crew selects the SPEED prompt on the CDU descent (DES) page.

The path descent flight phase is active when the flight crew selects PATH on the CDU descent (DES) page.

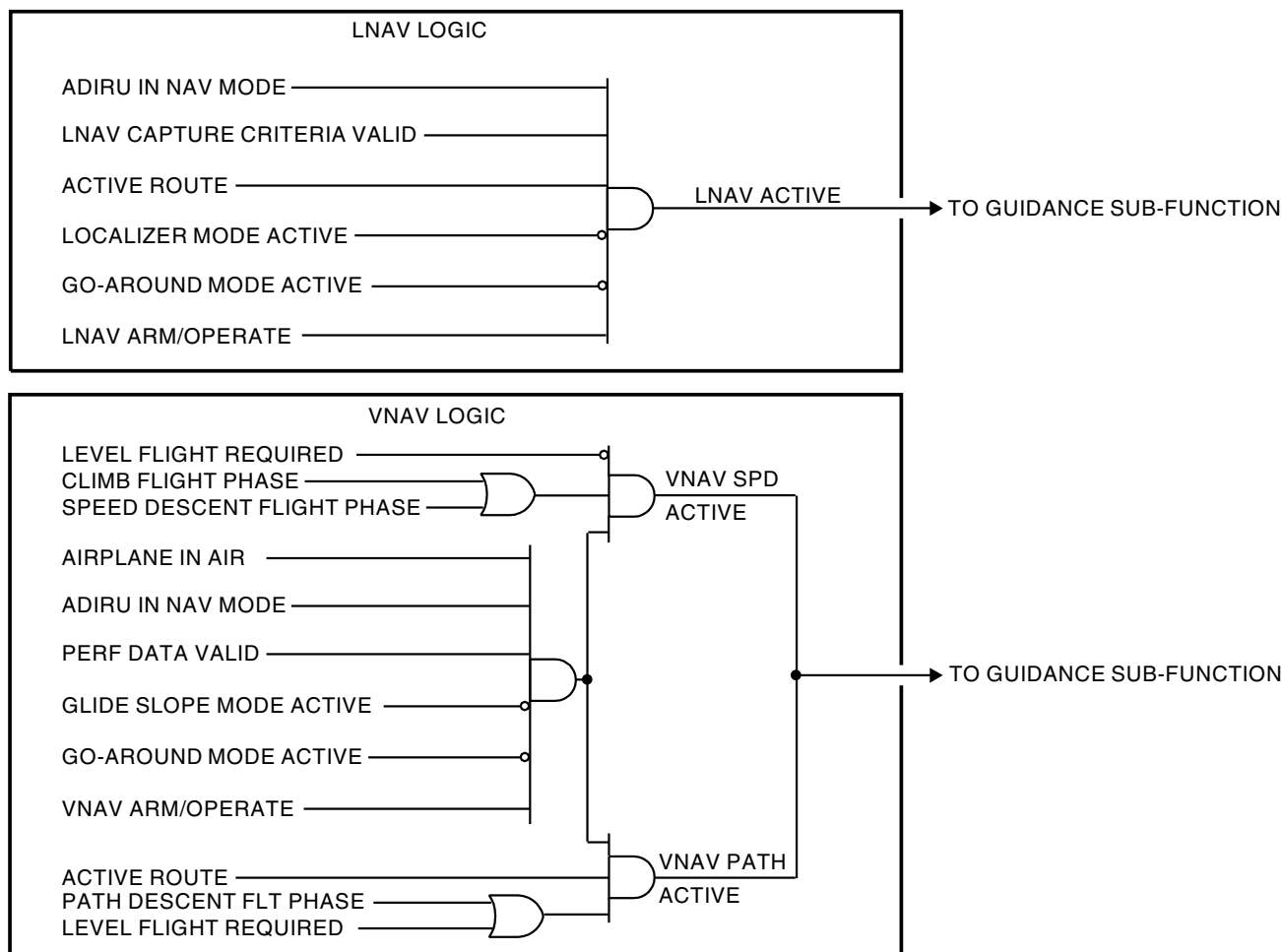
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EFFECTIVITY
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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION - LNAV AND VNAV MODE LOGIC



2370130 S00061521037_V2

FMCS - FMC FUNCTIONAL DESCRIPTION - GUIDANCE SUB-FUNCTION - LNAV AND VNAV MODE LOGIC

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D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**FMCS - DISPLAYS - CDU - GROUND POWER UP - 1****General**

The CDU and FMCS both do internal BITE tests at power up. If the power up test is normal, the CDUs show the MENU page.

The MENU page always shows the FMC prompt at line select key 1L. The other available sub-systems show below the FMC prompt.

Selection of the FMC prompt or any FMCS mode key on the CDU makes the FMCS the active user and the IDENT page shows.

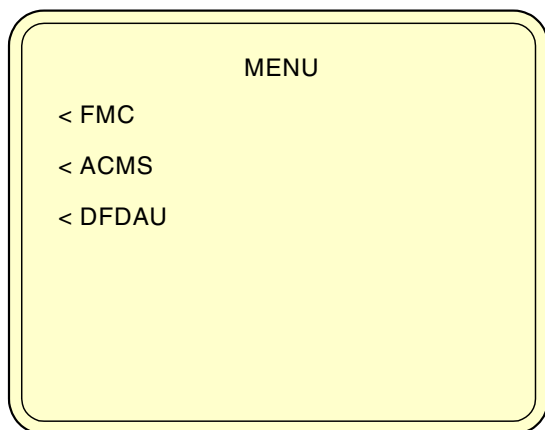
The status of the sub-systems shows on the MENU page by the label <ACT> to the right of the active sub-system. The label <REQ> shows to the right of a sub-system if it is not active but has sent a request to the CDU to request operator attention.

The MENU page automatically shows if the primary FMC fails but the FMC prompt will not show.

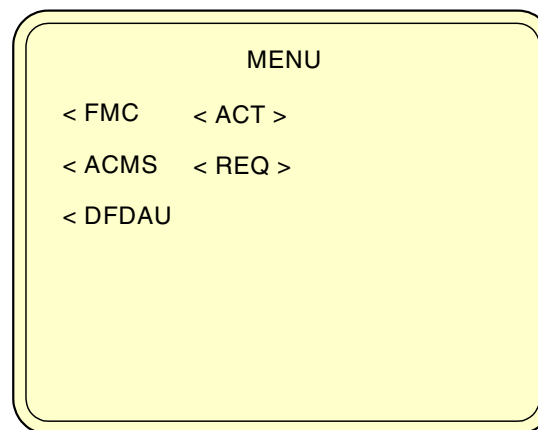
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FMCS - DISPLAYS - CDU - GROUND POWER UP - 1



INITIAL PAGE



MENU PAGE

FMCS - DISPLAYS - CDU - GROUND POWER UP - 1

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**FMCS - DISPLAYS - CDU - GROUND POWER UP - 2****FMC**

At power-up, each FMC does a check of the status of the other FMC. During power-up, the CDU annunciators come on momentarily. If the primary FMC fails at power-up, the FMC prompt does not show on the MENU page. The FMC warning light on the autoflight status annunciators also comes on. If the secondary FMC fails, the primary FMC shows the SINGLE FMC OPERATION message in the scratch pad on the IDENT page. If the transfer switch is in normal, the FMC warning light comes on.

CDU

A CDU display is blank if the CDU fails at power-up.

Other Tests

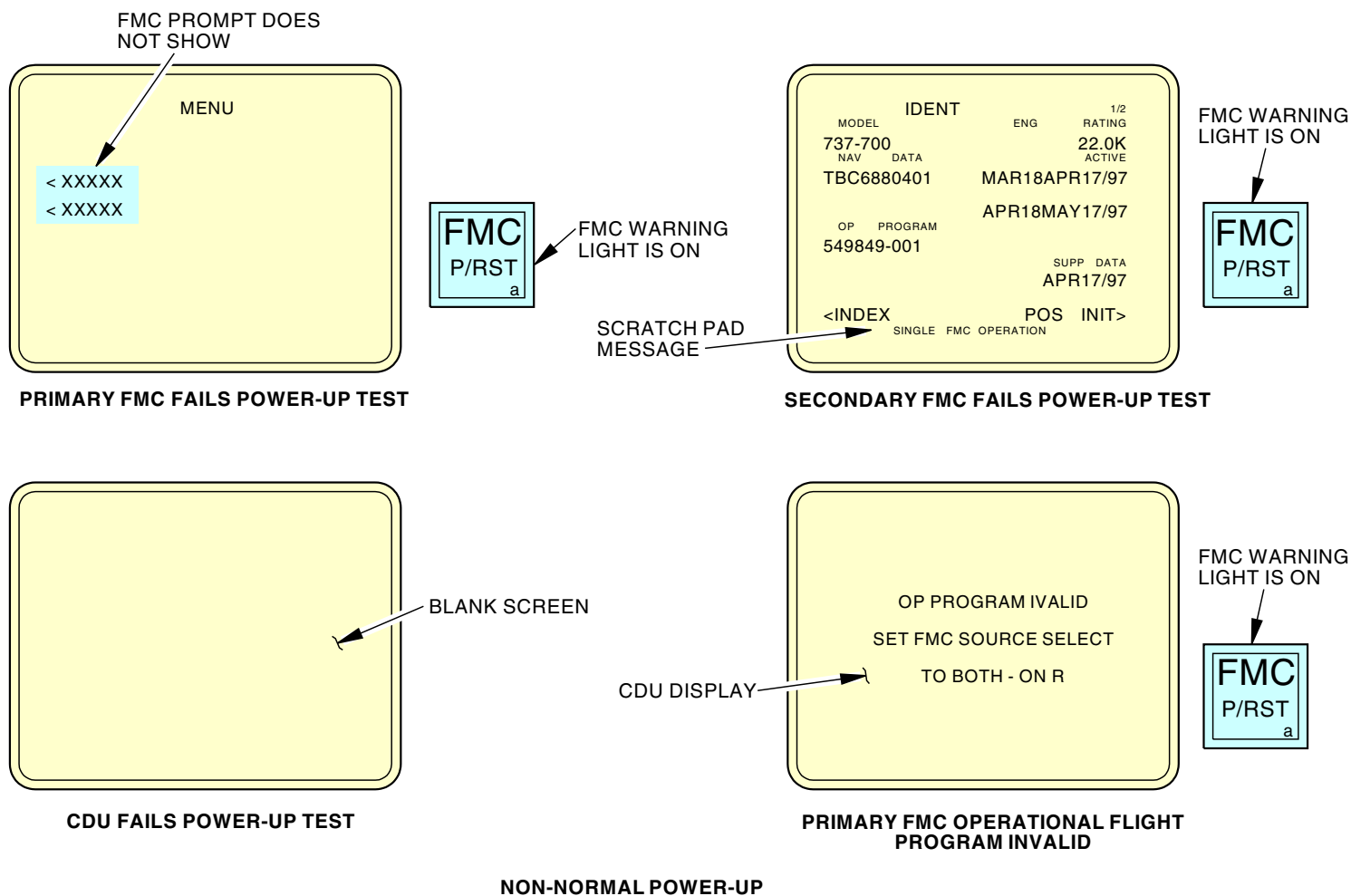
The FMCs also do a check of these functions at power-up:

- Airplane and engine configuration program pins for parity
- Cross compare FMC 1 and FMC 2 data bases and operational flight programs.

For example, the message OP PROGRAM INVALID shows if the operational flight program (OFP) of the primary FMC is invalid at power-up. If the secondary FMC has a valid OFP, the message tells the operator to switch to the both on right position.

EFFECTIVITY	
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FMCS - DISPLAYS - CDU - GROUND POWER UP - 2



2370132 S00061521041_V2

FMCS - DISPLAYS - CDU - GROUND POWER UP - 2

34-61-00

FMCS - DISPLAYS - CDU - PRE-FLIGHT INTRODUCTION

General

This is an introduction to the CDU pages the flight crew uses to enter pre-flight data into the FMCS. More information about each page is described in detail on subsequent pages.

Data

The flight crew uses this type of data to pre-flight the FMCS:

- Airplane initial position
- Route structure
- Performance data.

The flight crew uses the line select keys (LSK) and function keys to enter and verify data on these pages:

- IDENT
- POS INIT
- RTE
- DEP/ARR INDEX
- PERF INIT
- N1 LIMIT
- TAKEOFF REF.

IDENT Page

This page lets the flight crew verify the FMCS operational flight program and data base identification numbers.

POS INIT Page

This page lets the flight crew set the reference airplane initial position. This data is necessary to start ADIRU alignment. Access to the POS REF and POS SHIFT pages is from this page.

RTE Page

This page lets the flight crew make a flight plan or set a company route from the navigation data base. If the entered route or company route does not have an origin departure or destination approach the crew must also select a departure runway and arrival data.

DEP/ARR INDEX Page

This page lets the flight crew select the departure runway and standard instrument departure (SID) data. The standard terminal arrival route (STAR), approach, and destination runway can also be selected on this page.

PERF INIT Page

This page lets the flight crew enter aircraft and atmospheric parameters necessary for the FMCS to calculate the vertical flight profile performance data.

N1 LIMIT Page

This page lets the flight crew select the engine thrust limits for display by the N1 limit bugs on the engine indication and for use by the autothrottle. Outside air temperature is also selected from this page.

TAKEOFF REF Page

This page lets the flight crew select the takeoff flaps setting and takeoff V speed values.

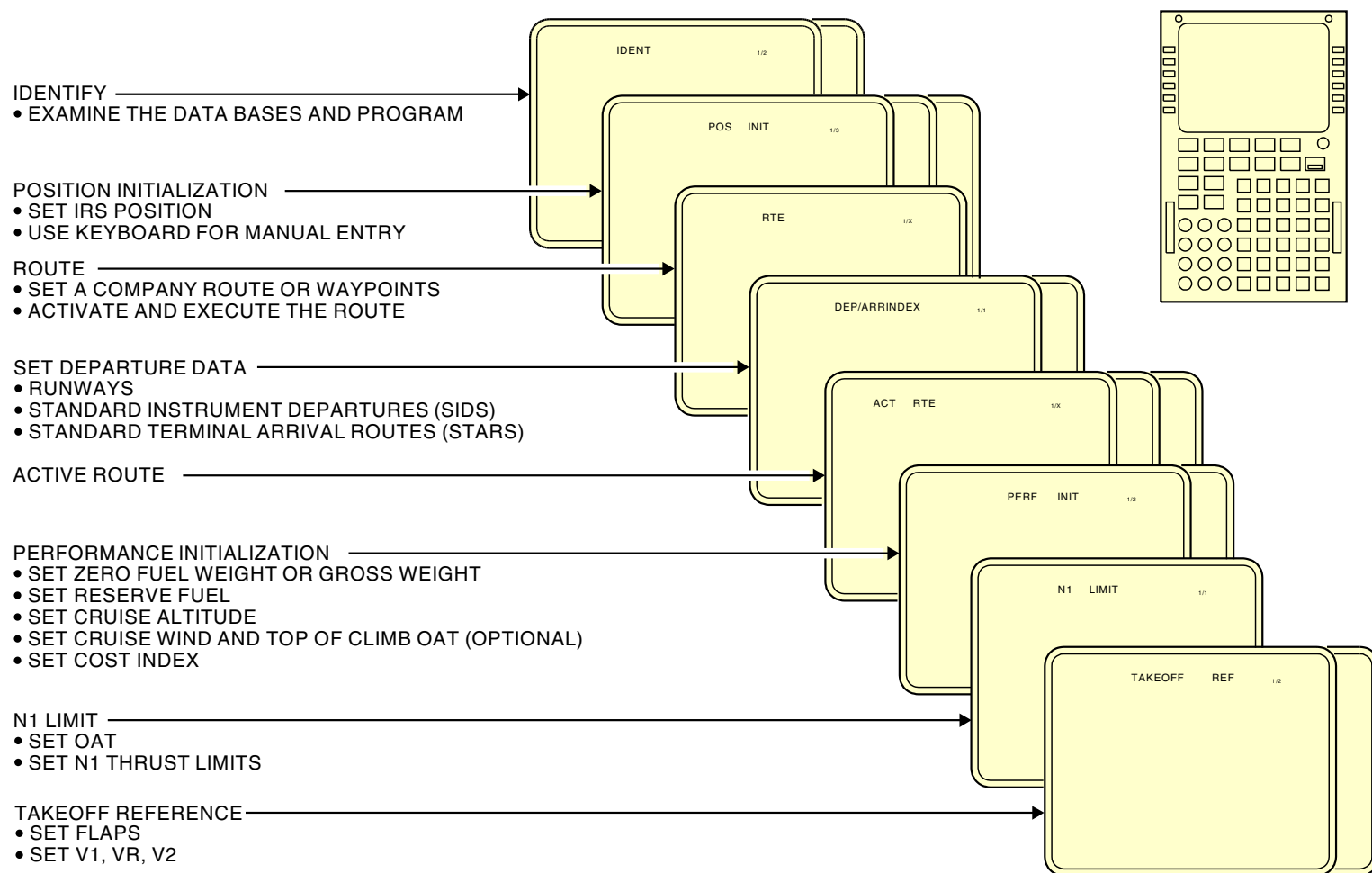


CAUTION

OBEY THESE PRECAUTIONS. IF YOU IGNORE THESE PRECAUTIONS, DAMAGE TO EQUIPMENT WILL OCCUR.

All FMC entries made on the non-BITE pages must be removed when maintenance is completed. This prevents routine maintenance inputs from affecting the FMC flight operations. Use the delete key or turn the power off to the FMC for a minimum of 10 seconds.

FMCS - DISPLAYS - CDU - PRE-FLIGHT INTRODUCTION



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FMCS - DISPLAYS - CDU - PRE-FLIGHT INTRODUCTION

34-61-00

**FMCS - DISPLAYS - CDU - IDENT PAGE****Purpose**

The IDENT page lets the crew verify the FMCS operational flight program and data base identification numbers. Also, you can select the POS INIT and INDEX pages from the IDENT page.

Page Access

The IDENT page is the first page that shows on the CDU when you select the FMC prompt on the MENU page. It can also be selected from the INIT/REF INDEX page.

Page 1 Information

Line 1L shows the airplane model. The airframe/engine program pin configuration sets this information. This line is blank if the FMC finds a parity error for the airframe/engine program pins or a valid performance data base is not loaded into the FMC. It is also blank if the loaded performance data base does not contain data for the current airframe/engine program pin configuration.

Line 2L shows the navigation data base identification number loaded in the FMC. This data field is blank if a navigation data base is not loaded.

Line 4L shows the FMC operational program software part number and the update version.

Line 5L can show the Smiths Industries operational program software part number. To show the number, enter the word SIPART into the scratch pad and select key 5L. This line is blank when the part number is not shown.

Line 6L shows the INDEX prompt. This selects the INIT/REF page.

Line 1R shows the engine thrust rating. This information is set by the airframe/engine program pin configuration. This line is blank if the FMC finds a parity error for the airframe/engine program pins or a valid performance data base is not loaded into the FMC. It is also blank if the loaded performance data base does not contain data for the current airframe/engine program pin configuration.

Lines 2R and 3R show the effective dates of the active and inactive navigation data bases. You can exchange the data on these two lines to activate a new data base or recall the old one. The exchange can only be done when the airplane is on the ground. The active data base is compared to the FMC clock input at initial power-up and if the active data base is out of date, the CDU message NAV DATA OUT OF DATE shows in the scratchpad.

Line 5R shows there is supplemental data and gives the effective date of that data. The line is blank if an effective date is not set or there is no supplemental data.

Line 6R shows the POS INIT prompt. This selects the POS INIT page.

Page 2 Information

Line 1L shows the identification number of the performance default data base in the FMC operational flight program.

Line 2L shows the identification number of the software options data base.

Line 4L shows the identification number of the ACARS datalink configuration file.

Line 5L shows the identification number of the model/engine performance data base. This line is blank if the data base is not loaded.

Line 6L shows the INDEX prompt. This selects the INIT/REF page.

Line 6R shows the POS INIT prompt. This selects the POS INIT page.

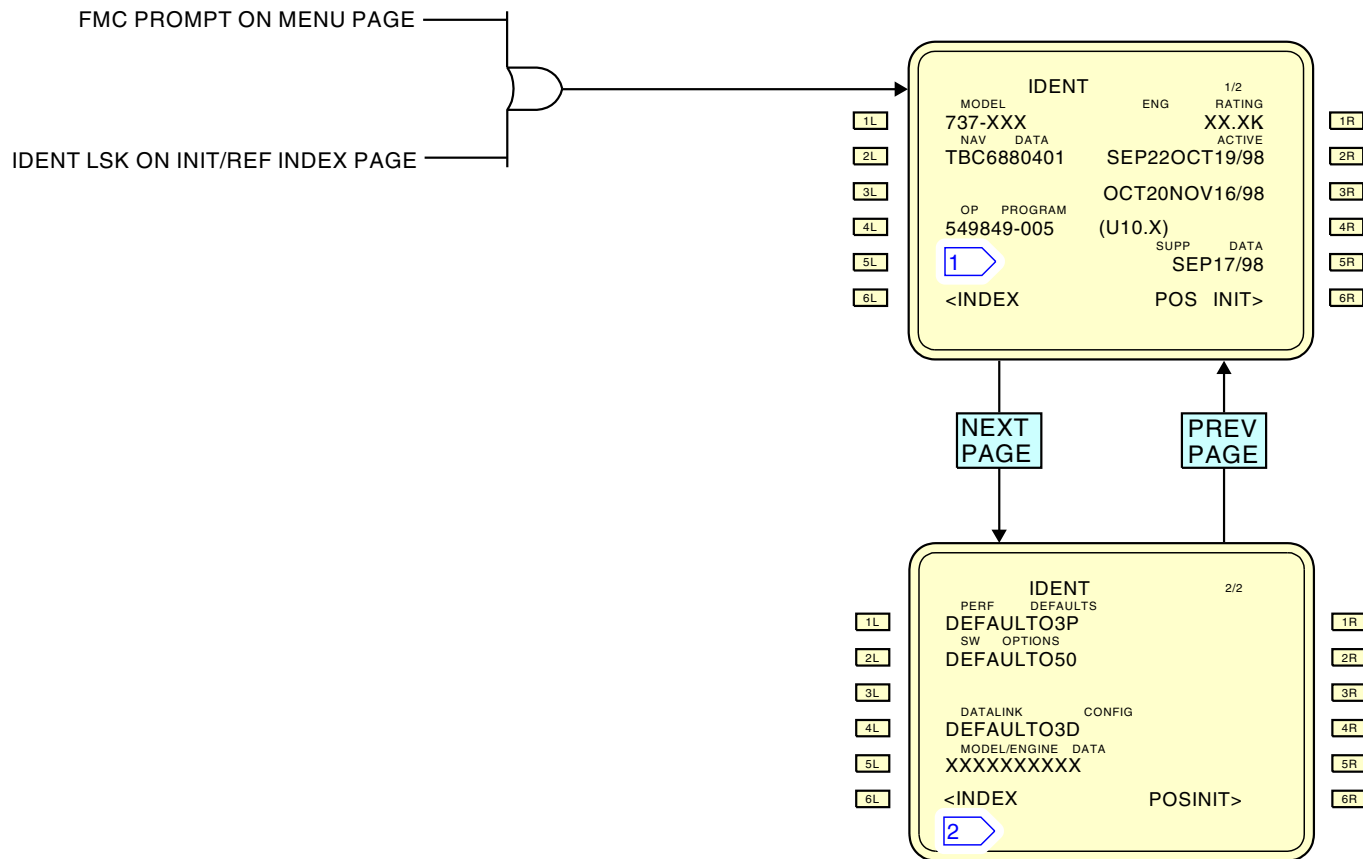
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FMCS - DISPLAYS - CDU - IDENT PAGE



- 1 ENTER SIPART AT KEY AT 5L AND PUSH 5L TO SHOW THE SMITHS INDUSTRIES OPERATION PROGRAM PART NUMBER.
- 2 THESE ARE EXAMPLES OF THE DATA BASE IDENT NUMBERS AND MIGHT NOT REPRESENT THE DATA BASE IDENT NUMBERS ON YOUR AIRPLANE(S).

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FMCS - DISPLAYS - CDU - IDENT PAGE

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**FMCS - DISPLAYS - CDU - INIT/REF INDEX PAGE****Purpose**

The INIT/REF INDEX page shows a menu of pages you can use to initialize the following:

- FMCS
- ADIRU
- Other reference data.

Also, you can use this page to go to the FMCS MAINT BITE INDEX page.

Page Access

To select this page, push line select key 6L on pages that show the index prompt and are not BITE pages. The INDEX prompt on BITE pages changes the display back to the last menu.

Information

Line select key 1L (LSK) shows the first page of the configuration identification IDENT pages. These pages show the FMCS data base and program configuration data.

LSK 2L shows the first page of the position initialization (POS) pages. These pages are for ADIRS initialization and to show navigation sensor positions.

LSK 3L shows the first page of the performance initialization (PERF) pages. These pages are to enter the airplane parameters that the FMC needs for VNAV calculations.

LSK 4L shows the first page of the TAKEOFF pages. These pages are to select takeoff thrusts and speeds.

LSK 5L shows the approach reference (APPROACH) page. This page gives specific information on the condition of the airplane and the selected runway and approach procedures of the flight plan.

LSK 6L shows the OFFSET page. This page is to start and end an offset to the flight plan route.

LSK 1R shows the navigation data reference (NAV DATA) page. This page is to enter this data into the temporary navigation data base:

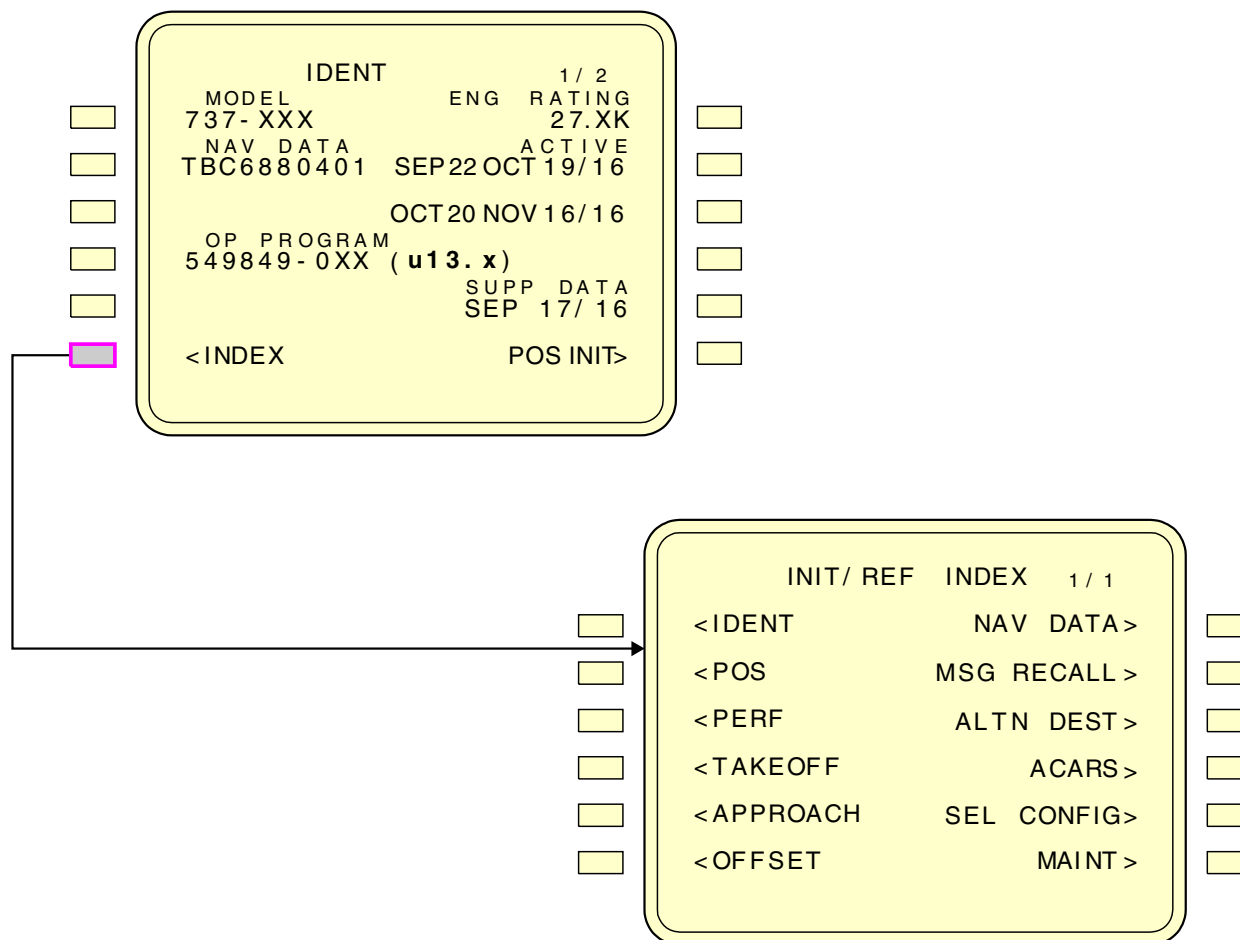
- Waypoints
- Navaids
- Airports.

LSK 4R shows the ACARS page. This page is customer defined and shows prompts to uplink/downlink FMC data.

LSK 5R shows the selectable configuration (SEL CONFIG) page. This page is used to see the configuration data for loadable software. It shows only when the airplane is on the ground.

LSK 6R shows the maintenance bite index MAINT page. The MAINT prompt shows only when the airplane is on the ground and the groundspeed is less than 20 knots. When the airplane is in the air, the NAV STATUS prompt shows in place of the MAINT prompt.

FMCS - DISPLAYS - CDU - INIT/REF INDEX PAGE



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FMCS - DISPLAYS - CDU - INIT/REF INDEX PAGE

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**FMCS - DISPLAYS - CDU - POSITION PAGES****Purpose**

These are the three position pages:

- Position initialization (POS INIT)
- Position reference (POS REF)
- Position shift (POS SHIFT).

The POS INIT page is used to enter the present position for ADIRU alignment.

The box prompts show that data must be entered to complete the preflight. The dash prompts show that the data entry is optional.

The POS REF page shows airplane position and groundspeed as calculated by the FMC, each ADIRU, each GPS, and radio position.

The POS SHIFT page is used to shift the FMC position to the specified navigation sensor position.

Page Access

You use the INIT REF function key or these CDU pages, to go to the first position page:

- INIT/REF INDEX
- IDENT
- TAKEOFF REF.

POS INIT Page

Line 2L shows dash prompts for an airport identifier. The identifiers you put here must also be in the navigation data base. If the identifier you put in is valid and is in the data base, the latitude/longitude (LAT/LON) for the airport shows at LSK 2R.

Line 3L shows dash prompts for airport gate identifiers. If the identifier you put in is valid and is in the data base, the LAT/LON for the gate shows at LSK 3R. The airport identifier must have been entered first.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 1R shows the last calculated present position of the primary FMC. This data is saved in the FMC at power down.

Lines 2R and 3R show the LAT/LON position for the reference airport and gate identifiers set at Line 2L and 3L.

Line 4R shows the header SET IRS POS and box prompts. This data field is used to enter present position for initialization of the ADIRUs when the airplane is on the ground.

Line 5R shows the header SET IRS HDG. This data field is used to enter heading data when any ADIRU is in the attitude (ATT) mode. It will be blank if there is no ADIRU in the ATT mode.

Line 6R shows the ROUTE prompt. This selects the route page.

POS REF Page

This page shows the airplane position and ground speed calculated by the FMC, each ADIRU, each GPS and radio position. Any data field may be selected to the scratchpad and used to initialize the ADIRUs. These data fields will be blank if the position data is invalid.

The radio position will always be blank on the ground.

POS SHIFT Page

This page shows the bearing and distance between the FMCS calculated position shown on the POS REF page and the position of the individual FMCs, ADIRUs, GPS, and radio systems. This page also provides the capability to update the FMCS calculated position to one of the positions shown when the airplane is in the air.

The FMC position may be overridden by selection of the particular navigation sensor position with the line select key. The selected sensor will now be highlighted and the EXEC light will come on. When you select EXEC, the FMC navigation position changes to the selected sensor position and UPDATE COMPLETE will show at line 5L in small font.

The FMC, ADIRU, GPS, and radio data fields are blank on the ground.

Line 4L shows the RNP/ANP values.

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**FMCS - DISPLAYS - CDU - POSITION PAGES**

Line 5L shows UPDATE COMPLETE in small font after a position shift has been selected and executed (EXEC).

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

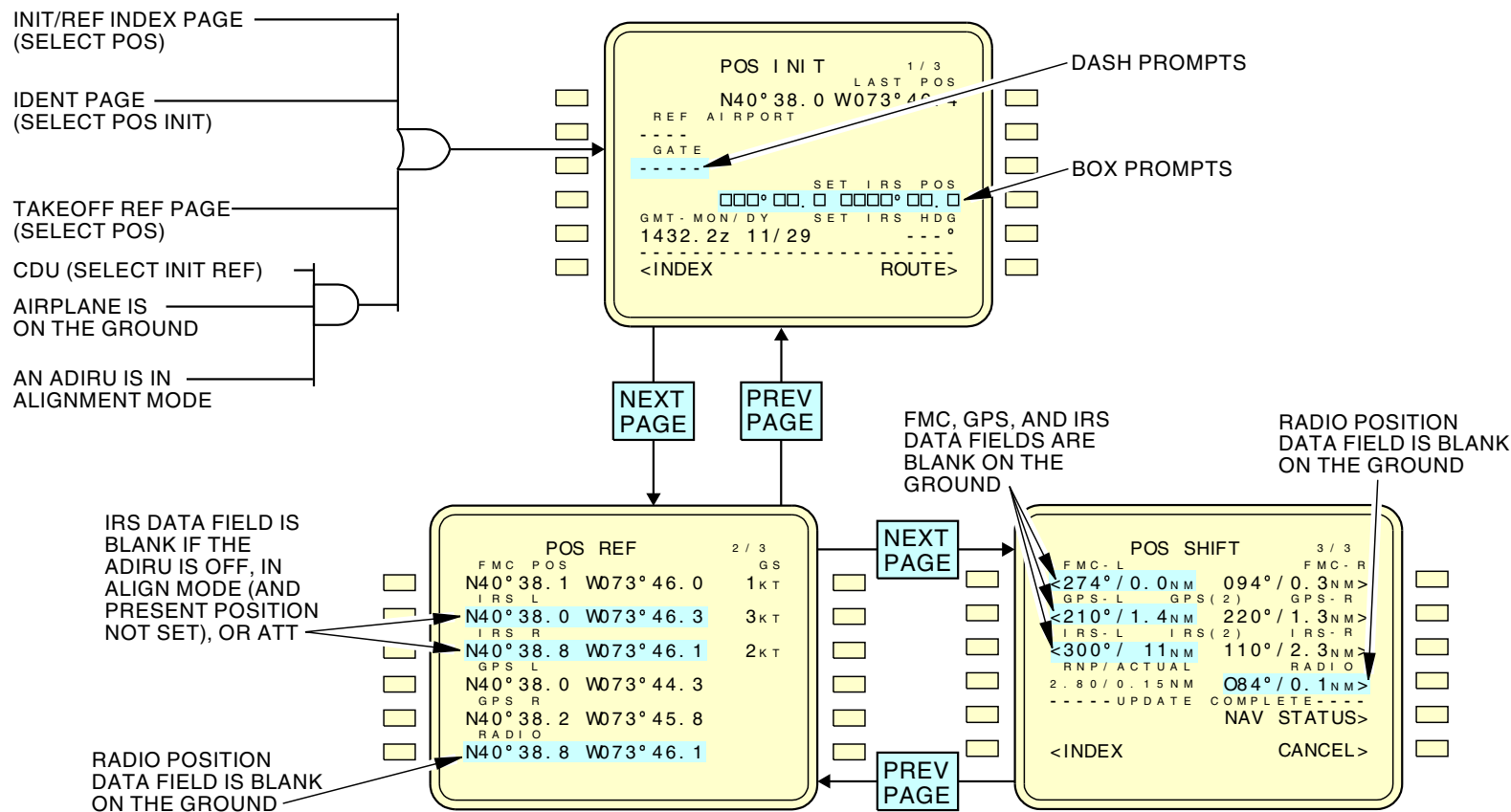
Line 5R shows the NAV STATUS prompt. This selects the NAV STATUS pages.

Line 6R shows the CANCEL prompt. This shows only when a sensor has been selected for position shift. This lets the crew cancel the selected sensor for position shift.

The data in the center of the GPS and IRS data fields at line 2 and 3 shows that both GPSs and ADIRUs are used in the FMC position calculation.

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FMCS - DISPLAYS - CDU - POSITION PAGES



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FMCS - DISPLAYS - CDU - POSITION PAGES

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**FMCS - DISPLAYS - CDU - ROUTE PAGE****Purpose**

The route (RTE) page lets the flight crew enter the route into the FMCS.

The route may be entered manually or uplinked on an ACARS message.

Page Access

Access to this page may be from any of these pages:

- POS INIT
- TAKEOFF REF
- DEP/ARR
- SELECT DESIRED WPT.

Also, selection of the RTE mode key on the CDU will get access to this page.

Page 1/X Information

Line 1L shows dash prompts for an origin airport identifier. The origin airport may be entered here or it may be in the company route data. The navigation data base must contain the airport identifier. Entry or re-entry of the origin airport identifier will clear any existing route.

Line 2L shows dash prompts for a company route. The company route can be entered either manually or uplinked via an ACARS message. After it is set, the route structure shows on the route pages. The navigation data base must contain the company route.

If the company route is uplinked on an ACARS message and the route is not in the navigation data base but a valid origin airport identifier has been loaded, the uplinked company route shows in the data field. For this condition, the message NOT IN THE DATABASE does not show in the scratch pad and the data header field changes to REF CO ROUTE.

Line 3L shows dash prompts for a departure runway. The runway may be set from this page or the DEP/ARR pages. Alternatively, it may be uplinked on an ACARS message. The navigation data base must contain the runway identifier. This data field is removed when the airplane gets to the first waypoint in the flight plan.

Lines 4L and 5L show the VIA prompt. The VIA data fields show the lateral path AIRWAYS, SIDs, STARs, and DIRECT great circle paths. When a waypoint is set into the TO field, DIRECT shows in the VIA field.

Line 6L can show one of these prompts:

- ERASE - This shows on all modified pages. It lets you delete a route modification and return the display to the first active RTE page
- LOAD - This shows when there is an ACARS uplink to load. Selection uplinks the flight plan data and the ERASE prompt shows
- ALTN DEST - This lets the flight crew select the alternate destination page. It will not show if there is an ACARS uplink pending.

Line 1R shows box prompts for a route destination identifier. The destination may be entered here or it may be in the company route data, either of which may be uplinked via an ACARS message. The navigation data base must contain the identifier. A valid entry is necessary in this data field to enable VNAV.

Line 2R shows dash prompts for a flight number. The flight number shows on the PROGRESS page title line. This data field shows dashes again at flight completion.

Line 3R shows the REQUEST prompt. This lets the flight crew request flight plan data on an ACARS uplink message.

Lines 4R and 5R show the TO prompt. The TO data fields show valid navaid or waypoint identifiers in the route that are in the data base or have been entered on the keyboard.

Line 6R can show one of these prompts:

- ACTIVATE - This shows only on non-active route pages. Selection causes the EXEC light. After the EXEC key is selected, the PERF INIT prompt shows
- PERF INIT - This shows on the ground on active or modified pages if the PERF INIT page is not complete. This selects the PERF INIT page
- TAKEOFF - This shows on the ground on active or modified pages if the PERF INIT page is complete. This selects the TAKEOFF REF page

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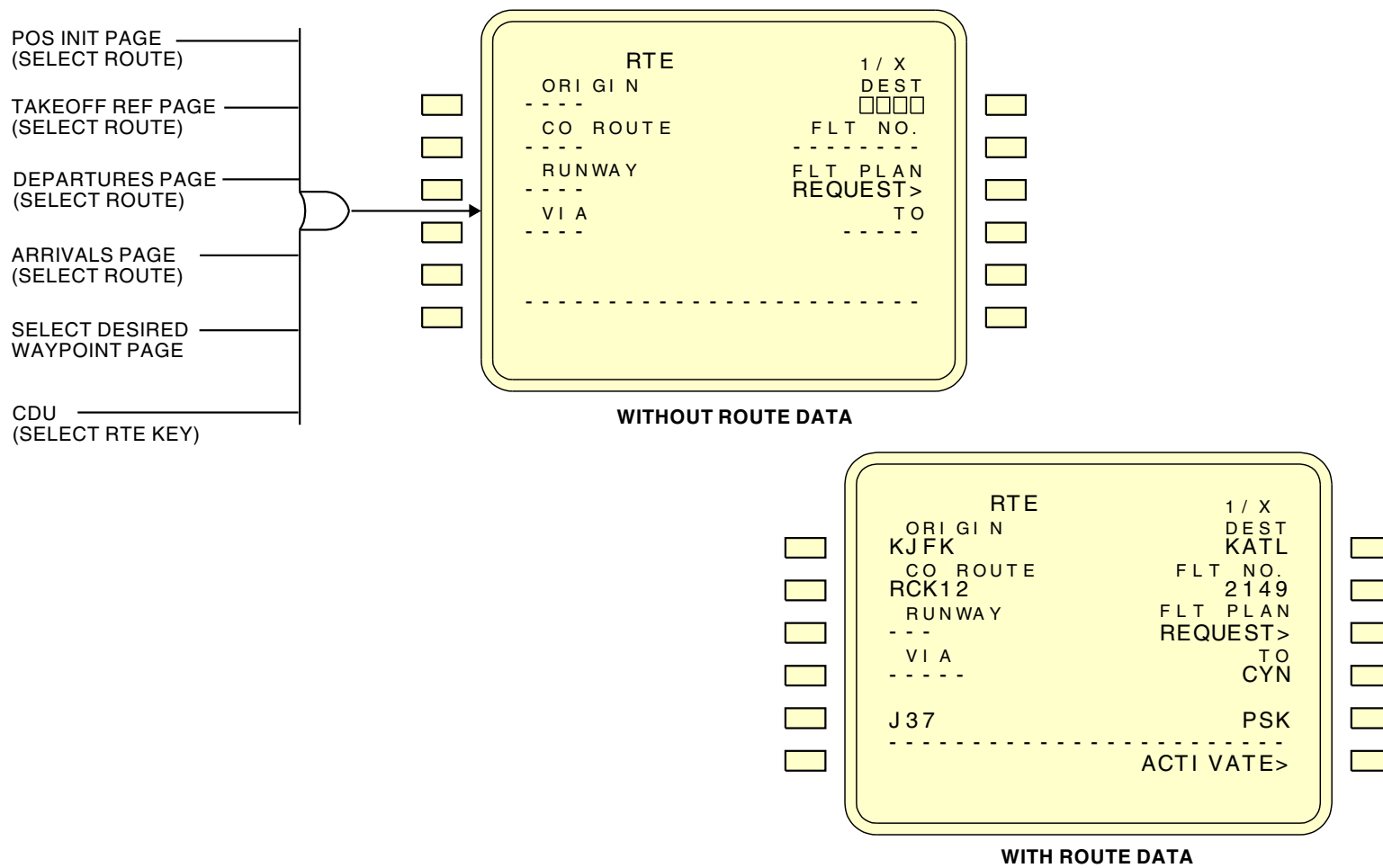


FMCS - DISPLAYS - CDU - ROUTE PAGE

- OFFSET - This shows only in the air on active or modified pages. This selects the LATERAL OFFSET page.

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FMCS - DISPLAYS - CDU - ROUTE PAGE



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FMCS - DISPLAYS - CDU - ROUTE PAGE

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**FMCS - DISPLAYS - CDU - DEP/ARR INDEX PAGE****Purpose**

The DEP/ARR INDEX page gives access to the departure and arrival data for the origin and destination of each of the stored routes and for other selected airports in the navigation data base.

Page Access

Select the DEP/ARR mode select key on the CDU to get access to this page.

DEP/ARR INDEX Page

Line 1L shows the <DEP prompt for the origin airport (KJFK in this example). This selects the DEPARTURE page for that airport.

Line 6L shows the OTHER DEP prompt. This lets the flight crew enter other airport identifiers that are in the navigation data base. After an airport identifier is entered, the DEPARTURES page for that airport shows.

Line 1R shows the ARR> prompt for the origin airport (KJFK). This selects the ARRIVALS page for that airport.

Line 2R shows the ARR> prompt for the destination airport (KATL). This selects the ARRIVALS page for that airport.

Line 6R shows the OTHER ARR prompt. This lets the flight crew enter other airport identifiers that are in the navigation data base. After an airport identifier is entered, the ARRIVALS page for that airport shows.

DEPARTURES Page

This page lets the flight crew select a departure procedure from the origin airport.

Lines 1L through 5L show an alphabetical list of the standard instrument departures (SIDs) for the selected airport. When you select one of the SIDs, the selected SID shows and the EXEC light comes on.

Line 6L shows the INDEX prompt. This selects the DEP/ARR INDEX page.

Lines 1R through 5R show a numerical list of the runways for the selected airport. When you select one of the runways, the selected runway shows and the EXEC light comes on.

Line 6R shows the ROUTE prompt. This selects the ROUTE page.

ARRIVALS Page

This page lets the flight crew select an arrival procedure for the destination airport.

Lines 1L through 5L show an alphabetical list of the standard terminal arrival routes (STARs) for the selected airport. When you select one of the STARs, the selected STAR shows and the EXEC light comes on.

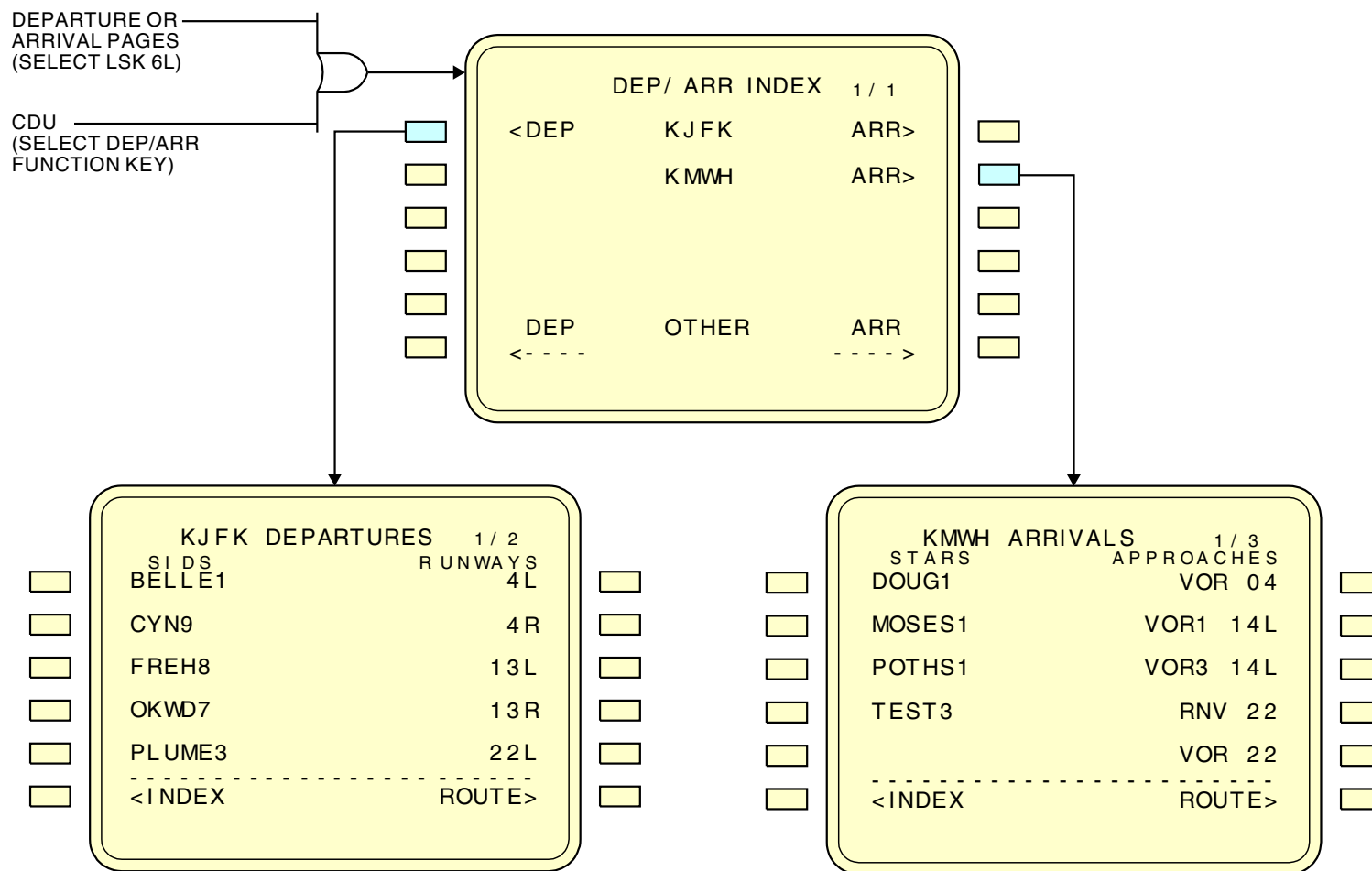
Line 6L shows the INDEX prompt. This selects the DEP/ARR INDEX page.

Lines 1R through 5R show a list of approaches followed by a list of runways for the selected airport. When you select one, the selected approach/runway shows and the EXEC light comes on.

Line 6R shows the ROUTE prompt. This selects the ROUTE page.

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SIA ALL	

FMCS - DISPLAYS - CDU - DEP/ARR INDEX PAGE



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FMCS - DISPLAYS - CDU - DEP/ARR INDEX PAGE



FMCS - DISPLAYS - CDU - LEGS PAGE

General

The LEGS page is used by the flight crew to enter and review data for each leg of the active route.

Page Access

This page may be accessed from any of these pages:

- RTE DATA
- SELECT DESIRED WPT page.

Alternatively, selecting the LEGS mode key on the CDU will access this page.

Legs Page Information

Line select key 1L shows the active waypoint in the flight plan. The computed course to the active waypoint is shown above the identifier as well as the distance to go (DTG) to the active waypoint. Speed and altitude at the waypoint are also shown.

Line select keys 2L through 5L show subsequent waypoints in the active flight plan with this data:

- Computed course to waypoint
- Computed leg length
- Speed and altitude.

NOTE: If the leg is a great circle track, the computed course to the next waypoint will be shown. If the leg is a constant heading leg, the computed course will be shown with the suffix HDG.

Line select key 6L shows these prompts:

- ERASE (shows when data is being modified)
- LOAD (shows when data may be uplinked via an ACARS message)
- RNP/ACTUAL (required navigation performance/actual navigation performance).

Line select key 6R shows these prompts:

- RTE DATA (selects the RTE DATA page)
- ACTIVATE (shown before the route has been activated and executed by the flight crew)
- MAP CTR STEP.

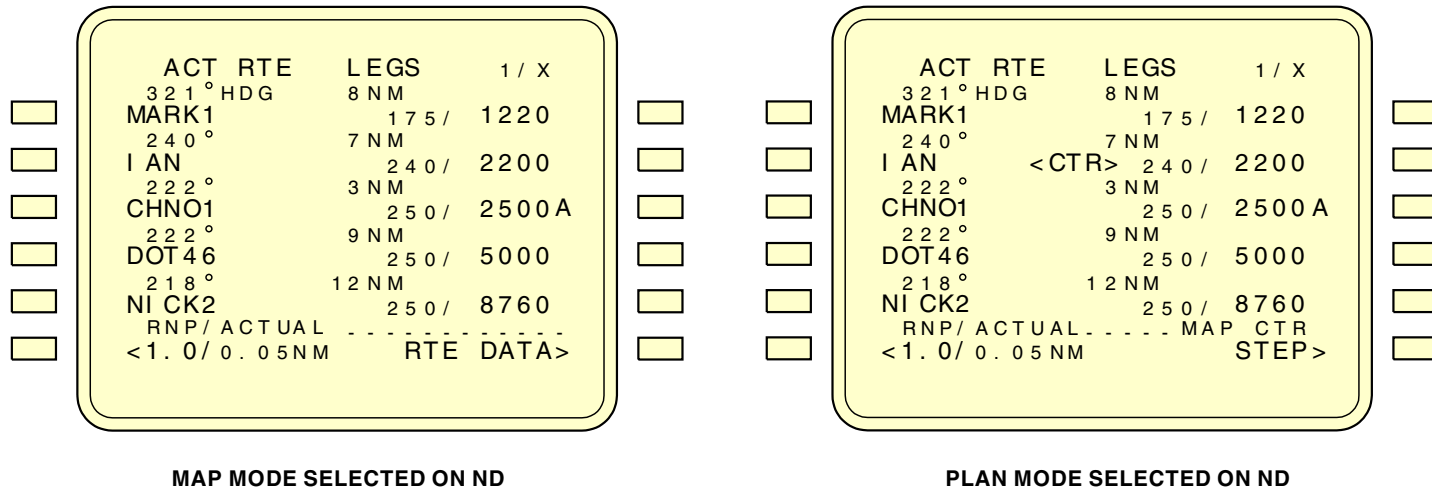
The MAP CTR STEP function is enabled when the PLAN mode has been selected on the EFIS control panel. It lets the flight crew step through the active flight plan and review the data for each waypoint. The selected waypoint will be shown in the center of the navigation display. The <CTR> prompt shows the selected waypoint on the LEGS page.

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FMCS - DISPLAYS - CDU - LEGS PAGE



FMCS - DISPLAYS - CDU - LEGS PAGE

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**FMCS - DISPLAYS - CDU - PERF INIT PAGE****General**

The performance initialization pages let you initialize the FMCS for performance calculations. The data may be entered by the flight crew or uplinked with an ACARS message.

Page Access

Access to this page is from any one of these pages:

- ROUTE
- TAKEOFF REF
- INIT/REF INDEX
- INIT/REF mode key (if ADIRUs are aligned and the airplane is on the ground).

Performance Initialization Page

Line 1L shows the GW/CRZ CG prompt. This lets the flight crew enter the airplane gross weight.

If zero fuel weight (LSK 3L) was entered first, the calculated gross weight will show here automatically.

Line 2L shows the PLAN/FUEL prompt. Total fuel weight from the fuel quantity indicating system (FQIS) shows. If a fuel value is set for PLAN fuel, this value is used in place of the total fuel weight from the FQIS for the calculation of gross weight. This allows performance calculations during airplane refueling. The PLAN display will be blank at engine start, at entry of a new gross weight, or when the airplane is in the air.

Line 2L shows the FUEL data field. This shows the total fuel weight from the fuel quantity indication system (FQIS).

Line 3L shows the ZFW prompt. This lets the flight crew enter the airplane zero fuel weight.

If gross weight (LSK 1L) was entered first, the calculated zero fuel weight will show automatically.

Line 4L shows the RESERVES prompt. This lets the flight crew enter the reserve fuel weight.

Line 5L shows the COST INDEX prompt. The default value for this data field is box prompts. The range of values is 0-200.

Line 6L shows one of these prompts:

- INDEX (selects the INIT/REF INDEX page)
- LOAD (shows when data may be uplinked with an ACARS message)
- ERASE (shows when data is modified).

LOAD shows when the ACARS performance initialization data has the highest load priority.

This data may be uplinked with an ACARS message:

- Gross weight
- Cruise center of gravity
- Plan fuel
- Zero fuel weight
- Reserve fuel
- Cost Index
- Trip/cruise altitude
- Cruise wind
- Top of climb outside air temperature
- Transition altitude.

Line 1R shows the TRIP/CRZ ALT data field. The trip altitude gives the crew a reference to select the cruise altitude. Trip altitude is the best cost altitude for the minimum cruise time. It is calculated and shows after this data is set:

- Origin and destination airports (ROUTE page)
- Gross weight
- Cost index.

The CRZ ALT box prompt lets the flight crew enter the cruise altitude. The cruise altitude set on this page also shows on the CLIMB, CRUISE, and RTE legs pages. CRZ ALT may be entered as an altitude (feet) or a flight level.

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**FMCS - DISPLAYS - CDU - PERF INIT PAGE**

Line 2R shows the CRZ WIND prompt. This lets the flight crew enter the cruise wind speed and direction. The default is 000/000.

Line 3R shows the T/C OAT prompt. This shows the forecast top of climb outside air temperature. The data format is +/-XX F or +/-XX C.

Line 4R shows the TRANS ALT data field. This shows the altitude where the FMCS changes to standard barometric altitude. The default value is 18000 feet. However, the flight crew may enter another value. It will change automatically if the departure procedure has a different transition altitude and the crew does not enter a value manually.

Line 5R shows the PERF INIT REQUEST prompt. This lets the flight crew uplink the performance initialization data with an ACARS message.

Line 6R shows the N1 LIMIT prompt. This selects the N1 LIMIT page.

These data fields will clear at flight completion:

- Gross weight
- Cruise center of gravity
- Zero fuel weight
- Reserves
- Trip/cruise altitude
- Cruise wind
- Top of climb OAT.

Performance Limits page

Line 1L shows the TIME ERROR TOLERANCE data field. This shows the time error tolerance at a waypoint which is used by the required time of arrival (RTA) function. The FMCS uses this tolerance to calculate the airplane speed. The data entry range is five seconds to 30 seconds. The default value is 30 seconds.

Lines 2L and 2R through 4L and 4R show the minimum and maximum speed limits for climb, cruise and descent. The flight crew may change the values in these data fields.

Line 5L shows the PERF LIM REPORT prompt. This lets the flight crew downlink the performance limits with an ACARS message.

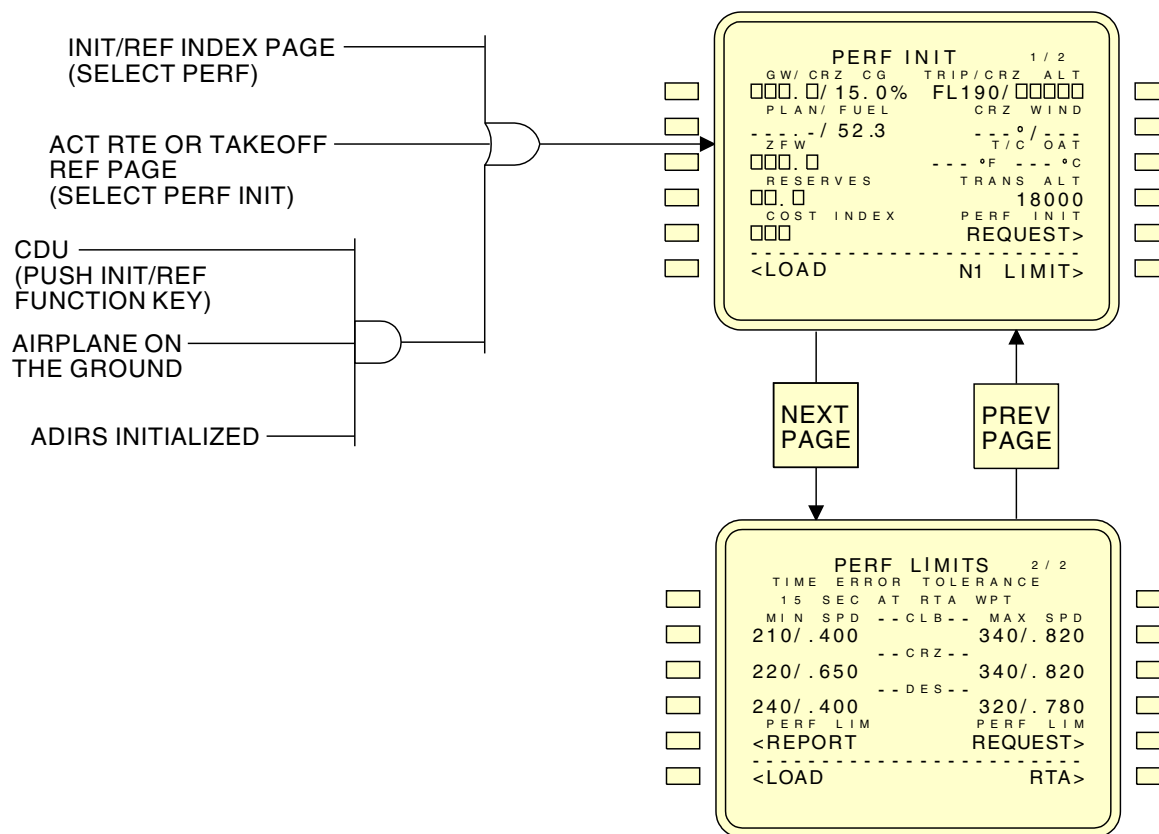
Line 6L shows one of these prompts:

- INDEX (selects the INIT/REF INDEX page)
- LOAD (shows when data may be uplinked with an ACARS message)
- ERASE (shows when data is modified).

Line 5R shows the PERF LIM REQUEST prompt. This lets the flight crew uplink the performance limits with an ACARS message.

Line 6R shows the RTA prompt. This selects the RTA PROGRESS page.

FMCS - DISPLAYS - CDU - PERF INIT PAGE



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FMCS - DISPLAYS - CDU - PERF INIT PAGE

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**FMCS - DISPLAYS - CDU - N1 LIMIT PAGE****General**

The N1 LIMIT pages let the flight crew select engine thrust limits to show on the MAX Display System (MDS) and for use by the autothrottle.

Page Access

Access to these pages is by selection of the N1 LIMIT mode select key on the CDU or the N1 LIMIT prompt on the PERF INIT or TAKEOFF REF pages.

N1 Limits Page (On Ground)

Line 1L shows the SEL/OAT prompt. This data field shows the outside air temperature (OAT) as measured by the aspirated TAT probe or manually entered. An assumed temperature (SEL) can also be entered for reduced thrust takeoffs.

Line 2L shows the TO prompt. This selects full takeoff thrust.

When a specific takeoff thrust is selected, the <ACT> prompt shows adjacent to the selected thrust. The FMCS always selects the highest possible climb thrust which would not result in a thrust increase when a takeoff thrust is selected. This prevents a throttle push at transition from takeoff thrust to climb thrust.

Line 6L shows the PERF INIT prompt. This selects the PERF INIT page.

Line 1R shows the TAKEOFF N1 prompt. This data field shows the active takeoff thrust calculated by the FMCS.

Line 2R shows the CLB prompt. This enables and shows the maximum climb thrust for the autothrottle and the N1 bugs after transition from the takeoff mode.

Line 3R shows the CLB-1 prompt. This selects the first derate climb thrust to be used after transition from takeoff mode.

Line 4R shows the CLB-2 prompt. This selects the second derate climb thrust to be used after transition from takeoff mode.

The selected climb thrust shows by the <SEL> prompt in large font adjacent to the selected thrust data field.

Line 6R shows the TAKEOFF prompt. This selects the TAKEOFF REF page.

N1 Limits Page (In Air)

The N1 limit page lets the flight crew select an N1 limit for these thrust limit modes:

- Go-around (GA)
- Continuous (CON)
- Climb (CLB)
- Cruise (CRZ)
- Climb - 1
- Climb - 2.

Line 1L shows the AUTO prompt. This selection lets the FMCS calculate N1 limit values. AUTO is the default selection.

Line 2L and 2R show the GA (go-around) N1 limit.

Line 3L and 3R show the CON (continuous) N1 limit.

Line 4L and 4R show the CLB (climb) N1 limit.

Line 5L and 5R show the CRZ (cruise) N1 limit.

Line 6L and 6R show the CLB-1 and CLB-2 prompts. Selection will show the reduced climb N1 limit.

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FMCS - DISPLAYS - CDU - N1 LIMIT PAGE

N1 LIMIT				1 / 1
SEL / OAT			26 K N1	
/ +15°C			99.5 / 99.5	
26 K	<TO	<ACT>	<SEL>	CLB>
24 K DERATE	<TO-1			CLB-1>
22 K DERATE	<TO-2			CLB-2>

<PERF INIT		TAKEOFF>		

N1 LIMIT
(ON GROUND)

N1 LIMIT				1 / 1
<AUTO		<ACT>		
<GA		101.6 / 101.6%		
<CON		99.8 / 99.8%		
<CLB		89.8 / 89.8%		
<CRZ		83.8 / 83.8%		
----- REDUCED CLB -----				
<CLB-1		<SEL>	CLB-2	

N1 LIMIT
(IN AIR)

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FMCS - DISPLAYS - CDU - N1 LIMIT PAGE

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**FMCS - DISPLAYS - CDU - TAKEOFF REF PAGE****Purpose**

The takeoff reference pages show this data for takeoff:

- Temperature
- Takeoff thrust
- V speed data
- Runway data.

Page Access

You get access to this page from one of these pages:

- INIT/REF INDEX
- PERF INIT
- RTE.

Page 1 Information

This page lets the flight crew see FMC calculated takeoff thrusts, crew entered takeoff data, and V speed data.

Line 1L shows the FLAPS prompt. This lets the flight crew enter the takeoff flap setting. Box prompts show before there is a valid entry. Allowable entries are flaps 1, 5, 10, 15, and 25. This data field may also be uplinked in an ACARS takeoff data message.

Line 2L shows the active N1 takeoff thrust calculated by the FMCS. The data field header line changes to show whether it is one of these:

- Full rated thrust
- Reduced thrust from a SEL (assumed) temperature entry
- First takeoff derate thrust
- Second takeoff derate thrust.

If the takeoff N1 value is calculated from ACARS uplinked data, the N1 values show in small font until the flight crew accepts the data.

Line 3L shows the prompts for center of gravity (CG) and TRIM. This lets the flight crew enter CG. If gross weight is entered, the trim will be calculated and shown. This data field may be uplinked in an ACARS data message. The CG/TRIM values show in small font until the crew accepts the data.

Line 4L shows the TAKEOFF DATA REQUEST prompt. This lets the flight crew request takeoff data from the ACARS datalink. Selection will result in the TAKEOFF DATA REJECT prompt in this data field and the ACCEPT prompt at line 5R.

Line 6L shows one of these prompts:

- POS INIT
- PERF INIT
- ROUTE
- DEPARTURE
- INDEX.

The INDEX prompt shows when the necessary data is set in the pre-flight pages and the pre-flight is complete. If one of the other prompts show, the necessary data is not complete for that page. When all the necessary data is entered, the INDEX prompt shows.

Lines 1R, 2R, and 3R are for the flight crew to set calculated takeoff speeds (V1, VR, and V2). Dash prompts show if a new performance value is set that affects the calculation of the speeds (gross weight, zero fuel weight, reserve fuel, cost index or cruise altitude).

Line 4R shows the GW/TOW prompt. The GW data field shows the current airplane gross weight. The TOW data field shows the GW that corresponds to the large font takeoff speeds in lines 1R, 2R, and 3R.

Line 5R shows the ACCEPT prompt. This prompt shows when the flight crew requests takeoff data from an ACARS uplink (LSK 4L). This lets the flight crew accept the uplinked takeoff data. Selection results in the V speeds in large font and the V speed data on the MAX Display System (MDS).

FMCS - DISPLAYS - CDU - TAKEOFF REF PAGE

Page 2 Information

This page lets the flight crew see the takeoff runway data and takeoff thrusts. It also lets them select a reduced takeoff thrust limit and select the appropriate runway surface condition.

Line 1L shows the RW/WIND prompt. This lets the flight crew enter the takeoff wind conditions. If this data is uplinked in an ACARS message, it shows in small font until the flight crew accepts the takeoff data. When it is accepted, it will show in large font. The default value is 000/0 and dashes shown before an entry.

Line 2L shows the RW SLOPE/HDG prompt. This lets the flight crew enter the runway gradient and the runway heading. It is entered as a percentage either U (+) or D (-) from the runway threshold. If the selected takeoff runway is in the navigation data base, the runway heading shows. Otherwise, it must be entered manually. If this data is uplinked in an ACARS message, it shows in small font until the flight crew accepts the takeoff data. When it is accepted, it will show in large font.

Line 4L shows the SEL OAT prompt. This lets the flight crew enter the outside air temperature or an assumed temperature for a reduced thrust takeoff. Before entry, dashes show in the SEL data field and box prompts show in the OAT data field. Both the SEL and OAT may be uplinked in an ACARS message.

The temperature is set in degrees Celsius. The temperature is set in Fahrenheit if you put in the temperature followed by the letter F.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 4R shows the active N1 takeoff thrust calculated by the FMCS. The header line changes to show whether it is one of these:

- Full rated thrust
- Reduced thrust from a SEL (assumed) temperature entry
- First takeoff derate
- Second takeoff derate.



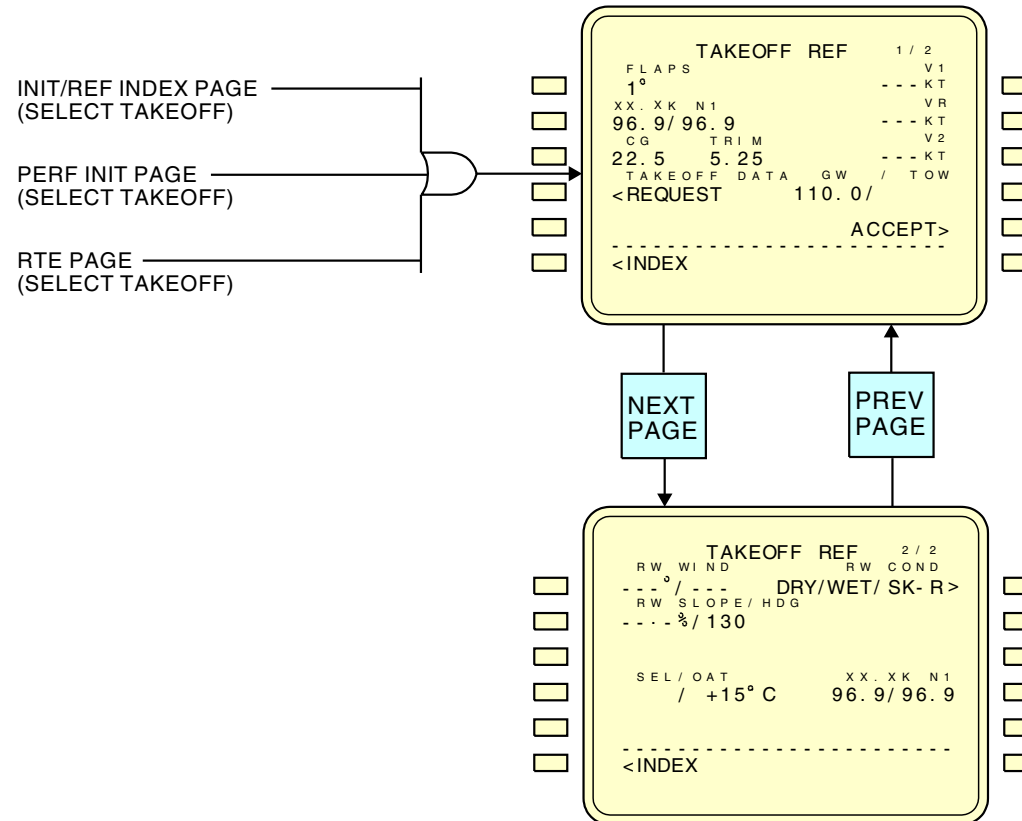
WARNING

OBEY THE PRECAUTIONS. IF YOU DO NOT OBEY THE PRECAUTIONS, INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

Obey these precautions. Changes to the takeoff REF pages can cause a lower thrust at takeoff than the thrust that the flight crew calculated.

- Do not change the takeoff REF pages. When changes are made to these pages, always remove all the changes.
- Make sure that there are not fixed derates selected.
- Make sure that the SEL TEMP FIELD on pages 1/2 and 2/2 are empty.

FMCS - DISPLAYS - CDU - TAKEOFF REF PAGE



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FMCS - DISPLAYS - CDU - TAKEOFF REF PAGE

**FMCS - DISPLAYS - CDU - CLIMB PAGES****Purpose**

The CLB pages let the flight crew review and select one of these climb performance modes:

- Economy climb (ECON CLB)
- Maximum angle climb (MAX ANGLE CLB)
- Manual speed climb (XXX KT CLB)
- Maximum rate of climb (MAX RATE CLB)
- Step climb during cruise (CRZ CLB)
- Required time of arrival (RTA CLB).

Also, there is an ENG OUT page which shows advisory information only (VNAV cannot be engaged in this mode).

Page Access

Selection of the CLB mode key on the CDU provides access to the climb page.

Selection of the VNAV mode key on the CDU provides access to the climb pages when the airplane is in the climb phase of the flight.

Climb Pages

The default climb mode is the economy (ECON) mode but the other modes may be selected from this page.

The CRZ CLB page will show automatically when the flight crew enter a higher cruise altitude on the CRZ page. Cruise climbs give the flight crew the means of initiating step climbs during cruise. These climbs will be done at the airplane's cruise speed.

The MANUAL SPD CLB page will show automatically when the flight crew enters a different target speed.

This data shows on each page:

- Target cruise altitude
- Target speed (highlighted)

- Speed restriction
- Active waypoint
- Distance and time to active waypoint or flight level
- Predicted undershoot at active waypoint
- Target N1.

On the CRZ CLB page, the predicted undershoot is replaced by the wind speed and direction data.

Also on the CRZ CLB page, the target N1 values are replaced by the savings/penalty for the specified step climb. These values show as a percentage.

On the RTA CLB page, time and distance to the active waypoint is replaced by the time error at the active waypoint.

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FMCS - DISPLAYS - CDU - CLIMB PAGES

ACT ECON CLB		1 / 1
CRZ ALT	AT CR102	
FL330		2500A
TGT SPD	TO CR102	
280/.720	2004.3z/	19NM
SPD REST	ERR CR102	
250/10000		310LO
----- CLB 1-N1		
97.3/ 97.3%		

<MAX RATE	ENG OUT>	
<MAX ANGLE	RTA>	

ECON CLB

ACT MAX ANGLE CLB		1 / 1
CRZ ALT	AT CR102	
FL330		2500A
TGT SPD	TO CR102	
220/.700	2004.3z/	19NM
SPD REST	ERR CR102	
250/10000		260LO
----- CLB 2-N1		
<ECON 93.8/ 93.8%		

<MAX RATE	ENG OUT>	
<MAX ANGLE	RTA>	

MAX ANGLE CLB

ACT 280KT CLB		1 / 1
CRZ ALT		
FL350		
TGT SPD	TO FL350	
280/.720	2056.2z/	88NM
SPD REST		
250/10000		
----- CLB 2-N1		
<ECON 93.8/ 93.8%		

<MAX RATE	ENG OUT>	
<MAX ANGLE	RTA>	

MANUAL SPD CLB

ACT MAX RATE CLB		1 / 1
CRZ ALT		
FL350		
TGT SPD	TO FL350	
265/.720	2043.6z/	82NM
SPD REST		
250/10000		
----- CLB 2-N1		
<ECON 93.8/ 93.8%		

ENG OUT>		
<MAX ANGLE	RTA>	

MAX RATE CLB

MOD CRZ CLB		1 / 1
CRZ ALT		
FL290		
TGT SPD	TO FL290	
780	2145.3z/	15NM
SPD REST	ACTUAL WIND	
250/10000		290°/14
----- PENALTY		
<ECON 1.1%		

<MAX RATE	ENG OUT>	
<MAX ANGLE	ERASE>	

CRZ CLB

ACT RTA CLB		1 / 1
CRZ ALT	AT LACRE	
FL250		2500
TGT SPD	TIME ERROR	
294/.703		ON TIME
SPD REST		
250/10000		

<ECON		

<MAX RATE	ENG OUT>	
<MAX ANGLE	RTA>	

RTA CLB

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FMCS - DISPLAYS - CDU - CLIMB PAGES

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**FMCS - DISPLAYS - CDU - CRUISE PAGES****Purpose**

The cruise pages let the flight crew review and select one of these cruise performance modes:

- Economy cruise (ECON CRZ)
- Long range cruise (LRC CRZ)
- Manual speed cruise (XXX KT CLB)
- Required time of arrival cruise (RTA CRZ).

In addition there is an ENG OUT page which shows advisory information only (VNAV cannot be engaged in this mode).

Page Access

Selection of the CRZ mode key on the CDU provides access to the cruise page.

Selection of the VNAV mode key on the CDU provides access to the cruise pages when the airplane is in the cruise phase of the flight.

Cruise Pages

The default cruise mode is the economy (ECON) mode but the other modes may be selected from this page.

The MANUAL SPD CRZ page will show automatically when the flight crew enter a different target cruise speed.

This data shows on each page:

- Actual cruise altitude
- Optimum and maximum cruise altitudes
- Target speed (highlighted)
- Turbulence N1 target
- Fuel remaining at destination
- Step to altitude
- Step point (ETA and DTG)
- Current wind speed and direction

- Predicted savings/penalty if airplane is flown to a selected step altitude.

The turbulence N1 target is advisory information for the flight crew only and cannot be used by the FMCS.

On the RTA CRZ page, the turbulence N1 target is replaced by the RTA time error.

On the ENG OUT page, the fuel remaining data field is replaced by the maximum continuous N1 thrust. The STEP data field is replaced by the engine out maximum altitude and the STEP POINT is replaced by the time and distance to the top of descent point.

NOTE: Entry of a different cruise altitude on the CRZ page brings up either the CRZ CLB or CRZ DES pages.

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FMCS - DISPLAYS - CDU - CRUISE PAGES

ACT ECON CRZ				1 / 1
CRZ	ALT	OPT/MAX	STEP	
FL330	FL340/361	FL350		
TGT	SPD	STEP	POINT	
780		2004.5z/100NM		
TURB	N1	ACTUAL	WIND	
87.3/	87.3%	129 ⁰ /	14	
FUEL	AT KATL	SAVINGS		
W/STEP	12.5	1.3%		

<ECON				ENG OUT>
<LRC				RTA>

ECON CRZ

MOD LRC CRZ				1 / 1
CRZ	ALT	OPT/MAX	STEP	
FL330	FL340/361	FL390		
TGT	SPD	STEP	POINT	
770		2004.5z/100NM		
TURB	N1	ACTUAL	WIND	
87.3/	87.3%	129 ⁰ /	14	
FUEL	AT KATL	SAVINGS		
W/STEP	12.5	1.3%		

<ECON				ENG OUT>
				ERASE>

LRC CRZ

ACT M.780 CRZ				1 / 1
CRZ	ALT	OPT/MAX	STEP	
FL330	FL340/361	FL350		
TGT	SPD	STEP	POINT	
780		2004.5z/100NM		
TURB	N1	ACTUAL	WIND	
87.3/	87.3%	129 ⁰ /	14	
FUEL	AT KATL	SAVINGS		
W/STEP	12.5	1.3%		

<ECON				ENG OUT>
<LRC				RTA>

MANUAL SPD CRZ

ACT RTA CRZ				1 / 1
CRZ	ALT	OPT/MAX		
FL250	FL340/361			
TGT	SPD			
703				
TIME	ERROR	ACTUAL	WIND	
EARLY	05:31			
FUEL	AT KEG			
	12.5			

<ECON				ENG OUT>
<LRC				RTA>

RTA CRZ

ACT ENG OUT CRZ				1 / 1
CRZ	ALT	MAX	ALT	
FL330		FL187		
TGT	SPD	TO T/D		
280	KT	1314.0z/	26NM	
N1				
97.9%				

<LT ENG OUT				RT ENG OUT>
<ECON				
<LRC				RTA>

ENG OUT CRZ

FMCS - DISPLAYS - CDU - CRUISE PAGES

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**FMCS - DISPLAYS - CDU - DESCENT PAGES****Purpose**

The descent pages let the flight crew review and select one of the following descent performance modes:

- Economy descent (ECON DES)
- Step descent during cruise (CRZ DES)
- Required time of arrival descents (RTA DES).

Page Access

Selection of the DES mode key on the CDU provides access to the descent page.

Selection of the VNAV mode key on the CDU provides access to the descent pages when the airplane is in the descent phase of the flight.

Descent pages

The economy (ECON) descent mode has a maximum speed restriction of 240 knots below 10000 feet.

If the flight crew starts an early descent, the initial descent rate is 1000 feet per minute until the descent path is captured.

The CRZ DES page will show automatically when the flight crew select an altitude that is below the cruise altitude.

This data shows on each page:

- End of descent altitude
- Target speed (highlighted)
- Speed restriction
- Vertical deviation
- Active waypoint
- Distance and time to top of descent, waypoint or flight level
- Waypoint and altitude used for FPA, V/B and V/S
- Flight path angle (FPA)
- Vertical bearing (V/B)

- Vertical speed (V/S).

On the CRZ DES page, the E/D ALT is replaced by the new cruise altitude (CRZ ALT). The waypoint and altitude data is replaced by the actual wind speed and direction data. Also, the savings/penalty for the specified cruise descent shows. These values show as a percentage.

On the RTA DES pages, the distance and time is replaced by the time error.

The speed propagation software option is enabled to propagate an airspeed or mach manually entered on the FMCS Control Display Unit cruise page to the descent page. Selection of ECON on the cruise page shall also propagate to the descent phase of the FMC.

Descent Forecasts Page

The descent forecasts page lets the flight crew enter other performance values to more accurately define the calculated descent profile.

Access to this page is through the FORECASTS prompt (LSK 6L).

This data shows on the descent forecasts page:

- Transition level
- Cabin rate of descent
- Altitude wind speed and direction data
- TAI on/off altitudes
- ISA DEV/QNH selections.

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FMCS - DISPLAYS - CDU - DESCENT PAGES

ACT ECON	DES 1 / 1
E / D ALT	AT MACEY
2013	230 / 6000 A
TGT SPD	TO MACEY
720 / 280	2004.3 Z / 19 NM
SPD REST	WPT / ALT
240 / 10000	MACEY / 6000
VERT DEV	FPA V / B V / S
88 HI	3.8 6.2 2360

<FORECAST	RTA>

ECON DES

MOD CRZ DES	1 / 1
CRZ ALT	
FL310	
TGT SPD	TO FL310
780	2145.3 Z / 15 NM
SPD REST	ACTUAL WIND
240 / 10000	1290 / 14
	SAVINGS
	1.3%

PLANNED DES>	
<FORECAST	RTA>

CRZ DES

ACT RTA	DES 1 / 1
E / D ALT	AT MACEY
2013	230 / 6000 A
TGT SPD	TIME ERROR
740 / 260	ON TIME
SPD REST	WPT / ALT
240 / 10000	MACEY / 6000
VERT DEV	FPA V / B V / S
24 HI	3.8 6.2 2360

<ECON	
<FORECAST	RTA>

RTA DES

ACT RTA CRZ DES	1 / 1
CRZ ALT	TIME ERROR
10000	LATE 10:54
TGT SPD	TO FL100
491	1548.6 Z / 6.6 NM
SPD REST	ACTUAL WIND
240 / 10000	0000 / 0

PLANNED DES>	
<FORECAST	RTA>

RTA CRZ DES

MOD DES FORECASTS	1 / 1
TRANS LVL	TAI ON / OFF
FL180	----- / -----
CABIN RATE	ISA DEV / QNH
480FPM	----- C / -----
ALT----- WIND	--- DIR / SPD
FL210	0780 / 69KT
5000	1300 / 29KT
-----	---0 / ---KT

ERASE>	

DES FORECASTS

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FMCS - DISPLAYS - CDU - DESCENT PAGES

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**FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES****General**

The progress pages let the flight crew monitor the progress during the flight. The navigation status/options pages let the flight crew monitor the status of the nav aids tuned by the FMCS.

Page Access

Access to the PROGRESS page is by selection of the PROG mode key on the CDU.

Access to the NAV STATUS page is from one of these pages:

- POS SHIFT page
- PROGRESS page
- INIT/REF INDEX page (in the air).

Progress Page 1/5

This page shows airplane progress on the active route. The flight number entered on the ROUTE page shows in the title line. The flight number may contain up to 8 alphanumeric characters. The flight number clears when the flight is complete.

Select the PROG mode select key on the CDU to get access to this page.

Lines 1L and 1R show the FROM data field. They show the waypoint identifier, heading, altitude, actual time of arrival (ATA) and fuel at the last waypoint.

Lines 2L and 2R show the TO data field. They show this data:

- Active waypoint
- Heading
- Distance-to-go (DTG)
- Estimated time of arrival (ETA)
- Fuel remaining at that waypoint.

The active waypoint is highlighted.

Lines 3L and 3R show the NEXT data field and these data:

- Subsequent waypoint
- DTG
- ETA
- Fuel remaining.

Lines 4L and 4R show the DESTINATION data field. It shows the same data as 3L and 3R for the destination airport.

Line 5L shows the TO data field. This shows the time at and distance to one of these:

- T/C (top of climb)
- STEP POINT
- T/D (top of descent)
- E/D (end of descent).

Line 6L shows the WIND data field. This shows the wind speed and direction.

Line 5R shows the FUEL data field. This shows the current fuel quantity from the fuel quantity indicating system (FQIS).

Line 6R shows the NAV STATUS prompt. This selects the NAV STATUS page.

Progress Page 2/5

This page lets the flight crew set the required time of arrival (RTA) function.

The flight number does not show on this page.

Line 1L shows the RTA WPT prompt. This lets the flight crew enter the waypoint identifier for the RTA function. Entry of an RTA waypoint shows the remainder of the data fields and headers for this page after the EXEC key is pushed.

This data field will show dashes if no RTA waypoint is entered and no other data shows on this page.

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**FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES**

Line 2L shows the RTA SPD data field. This shows the speed schedule for the current flight phase necessary to meet the RTA.

Line 3L shows the SPD REST data field. This shows the active default speed restriction during climb and descent. This data field is blank during cruise and on the ground.

Line 4L shows the DIST TO data field. This shows the distance from the present position to the RTA waypoint.

Lines 5L and 5R show the RTA WINDOW data field. This shows the earliest and latest arrival times at the RTA waypoint.

Line 6L shows one of these prompts:

- LIMITS (selects the PERF LIMITS page)
- ERASE (shows when RTA data is being modified)
- LOAD (shows when RTA data may be uplinked with an ACARS message).

Line 1R shows the RTA prompt. The RTA time is entered in this data field by the flight crew. If no RTA waypoint is entered in LSK 1L, this data field is blank.

Line 2R shows the TIME ERROR data field. This shows the most current time error at the RTA waypoint.

Line 3R shows the GMT data field. This shows current time.

Line 4R shows the ALT/ETA data field. This shows the predicted altitude and the estimated time of arrival at the RTA waypoint.

Progress Page 3/5

This page shows wind data and vertical and lateral track deviation.

The flight number entered on the ROUTE page shows in the title line.

Line 1L shows the HEADWIND data field. This shows the current headwind or tailwind component. The header changes to reflect the wind component.

Line 2L shows the WIND data field. This shows the current wind speed and direction.

Line 3L shows the XTK ERROR data field. This shows the current crosstrack error direction and magnitude.

Line 5L shows the PRE-FLIGHT REPORT prompt. This lets the flight crew downlink the pre-flight report with an ACARS message.

Line 6L shows the WEATHER REQUEST prompt. This lets the flight crew request the weather for the destination and alternate airports with an ACARS message.

Line 1R shows the CROSSWIND data field. This shows the current crosswind component direction and speed.

Line 2R shows the SAT/ISA DEV data field. This shows the current static air temperature (SAT) and the equivalent international standard atmosphere (ISA) deviation. The SAT indication is blank on the ground.

Line 3R shows the VERT DEV data field. This shows the present vertical deviation from the calculated vertical guidance path during descent. In climb and cruise, this data field is blank.

Line 4R shows the TAS data field. This shows the current true airspeed.

Line 5R shows the PROGRESS REPORT prompt. This lets the flight crew downlink a flight progress report with an ACARS message.

Line 6R shows the POSITION REPORT prompt. This lets the flight crew downlink a position report with an ACARS message.

Progress Page 4/5

Displays RNP (Required Navigation Performance) information related to the flight. Only the RNP/ACTUAL line may be altered on this page. All other changeable information must be made on other pages. The first line displays the go/to waypoint from the active flight plan (RTE LEGS page line 1). When a heading is associated with that waypoint, it is displayed above it along with the FMC computed distance to go. The current FMC speed and altitude is also provided. Leg info (i.e., OFFSET, BYPASS, GP angle) is also displayed above the flight level when applicable.

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**FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES**

Line 2L RNP/ACTUAL - displays the current FMC RNP/ANP values. The RNP may be overwritten (manual entries are displayed in large font) and affects the approach RNP value. The RNP value displayed is selected from the performance defaults database (environment default) if not specified in the navigation database.

Line 3L XTK ERROR - displays the current cross/track error from the desired track shown on the ND display. When the value is zero, a direction (L or R) is not displayed.

Line 6L and 6R Approach RNP - displays the current lowest applicable navigation database or default RNP for the approach.

Line 2R VERT RNP/ANP - when the MDS LNAV/VNAV scales are enabled line 2R displays the vertical RNP/ANP in feet for the descent and for the approach.

During descent after the path is captured, the vertical deviation is displayed in line 3R.

Progress Page 5/5

Line 6L and 6R - provides system fuel source selection, between two fuel quantity sources (FQIS TOTALIZER and FMC CALCULATED). This page also displays the fuel used by the Auxiliary Power unit (APU), since the APU started up (Line 4L). TOTALIZER - The value displayed in this field originates from the Fuel Quantity Indicating System/Fuel Quantity Processor Unit. This is a "sensed" value, measured directly from the aircraft fuel tank sensors. The fuel value is displayed in thousands and tenths of thousands of pounds. CALCULATED - This fuel value is based on an initial total fuel quantity; either the first TOTALIZER reading (or less commonly, a pilot manual entry, if the totalizer function is inoperable). This value then decreases, based on fuel flow data (essentially fuel burn rate) from the Engines, and the Auxiliary Power Unit, over time. The fuel value is displayed in thousands and tenths of thousands of pounds.

The crew may select either TOTALIZER or CALCULATED as the fuel quantity source, by selecting LSK 6L, or LSK 6R, respectively. The selected source is identified by the label. TOTALIZER is the default fuel quantity source selected.

Nav Status Page

This page shows the status of the nav aids tuned or in use by the FMCS.

Line 1L and 1R show the VOR/ILS data fields. This shows the VOR or ILS identifiers and frequencies that are currently tuned on the navigation control panels.

The frequency is prefixed by a single character code in small font. This shows the method used to tune the frequency. These codes can show:

- M (manual tuning)
- P (procedural tuning)
- A (auto tuning).

Line 2L - 2R through 4L - 4R show the DME data fields. This shows the status of the DME identifiers of frequencies that are tuned by the FMCS through the DME interrogators.

The status of each tuned DME identifier/frequency shows this information:

- If the nav aid input is used in the navigation calculation, the nav aid identifier and frequency will be in large font and the identifier will have a highlight.
- If the nav aid input is received but is not used in the navigation calculation, the identifier and frequency will be in large font and there will be no highlight.
- If the frequency is tuned but valid data is not received, the identifier and frequency will be in small font and there will be no highlight.
- If no frequency is received or the frequency sign status matrix (SSM) is fail, FAIL will show in small font.
- If there is no identifier for a frequency shown, the identifier field will be blank.
- If the nav aid frequency SSM is no computed data (NCD), the identifier and frequency are blank.

Lines 5L and 5R show the currently selected GPS and IRS used in the FMCS navigation sub-function calculations. The GPS display is blank if the GPS is inhibited for use in the navigation sub-function.

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**FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES**

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 6R shows the POS SHIFT prompt. This selects the POS SHIFT page.

Nav Options page

This page lets the flight crew inhibit the use of specific nav aids in the FMCS navigation sub-function.

Lines 1L and 1R show the DME INHIBIT prompt. This lets the flight crew inhibit the use of up to two DME nav aids.

Lines 2L and 2R show the VOR INHIBIT prompt. This lets the flight crew inhibit the use of up to two VOR nav aids.

Line 3L shows the DME UPDATE ON/OFF prompt. This lets the flight crew select the DME update mode. The default is DME update ON. Selection toggles the DME update mode between ON and OFF. The current selected mode shows in large font and the non-selected mode shows in small font.

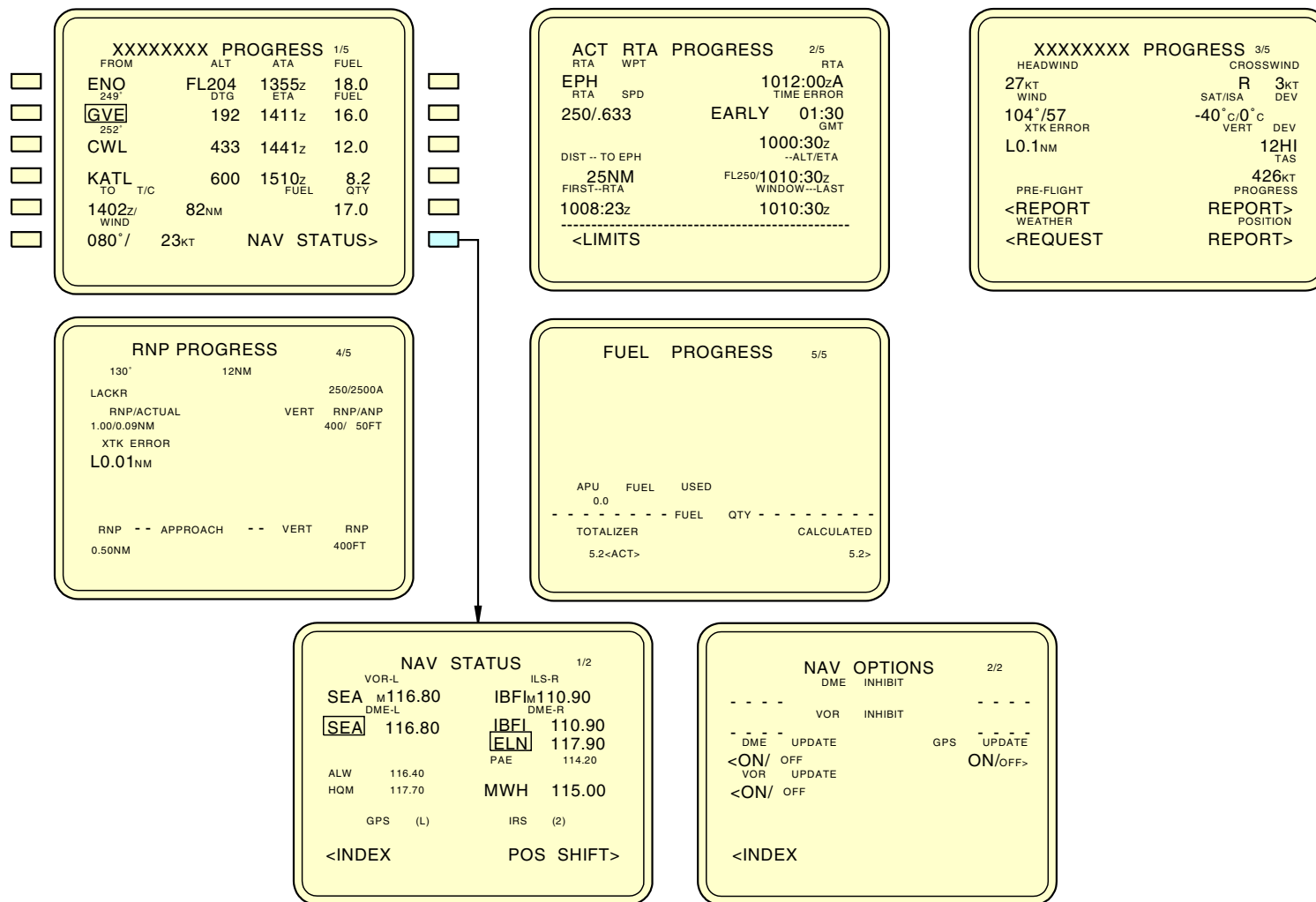
Line 4L shows the VOR UPDATE ON/OFF prompt. This lets the flight crew select the VOR update mode. The default is VOR update ON. Selection toggles the VOR update mode between ON and OFF. The current selected mode shows in large font and the non selected mode shows in small font.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 3R shows the GPS UPDATE ON/OFF prompt. This lets the flight crew select the GPS update mode. The default is GPS update ON. Selection toggles the GPS update mode between ON and OFF. The current selected mode shows in large font and the non selected mode shows in small font.

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FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES



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FMCS - DISPLAYS - CDU - PROGRESS/NAV STATUS PAGES

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**FMCS - DISPLAYS - CDU - LATERAL OFFSET PAGE****General**

The LATERAL OFFSET page lets the flight crew select a lateral offset to the left or the right of the normal route. Offsets are available from 0.1 nautical miles (nm) up to a maximum of 99.9 nm and are set in 0.1 nm increments.

Page Access

Access to this page is from these pages:

- ROUTE
- INIT/REF INDEX.

Lateral Offset Page

Line 2L shows the OFFSET DIST prompt. This lets the flight crew enter the specific distance for the offset route. Dashes show initially.

Line 3L shows the START WAYPOINT prompt. This lets the flight crew enter the specific waypoint where the offset will begin. This data field is blank until a valid distance is entered in LSK 2L. Then the box prompts show.

Line 4L shows the END WAYPOINT prompt. This lets the flight crew enter the specific waypoint where the offset is to end. This data field also is blank until a valid distance is entered in LSK 2L. Then the box prompts show.

Waypoint identifiers may contain up to 6 alphanumeric characters. If the entered identifier is not a valid waypoint, the message INVALID ENTRY shows in the scratchpad.

If the entered waypoint identifier is valid but is not in the flight plan, the message NOT IN FLIGHT PLAN shows.

If the entered waypoint identifier is a non-offsetable waypoint, the entry is rejected and the message NO OFFSET AT LEG XXXXX shows in the scratchpad.

After the data is entered, the EXEC light comes on. Push the EXEC key to activate the offset route. The OFST annunciators on the CDUs come on to show that the offset is active and the offset route shows on each crew members navigation display.

Line 6L shows the ERASE prompt. This shows on pages that are modified and they let the flight crew erase the entered data and return to the initial lateral offset page.

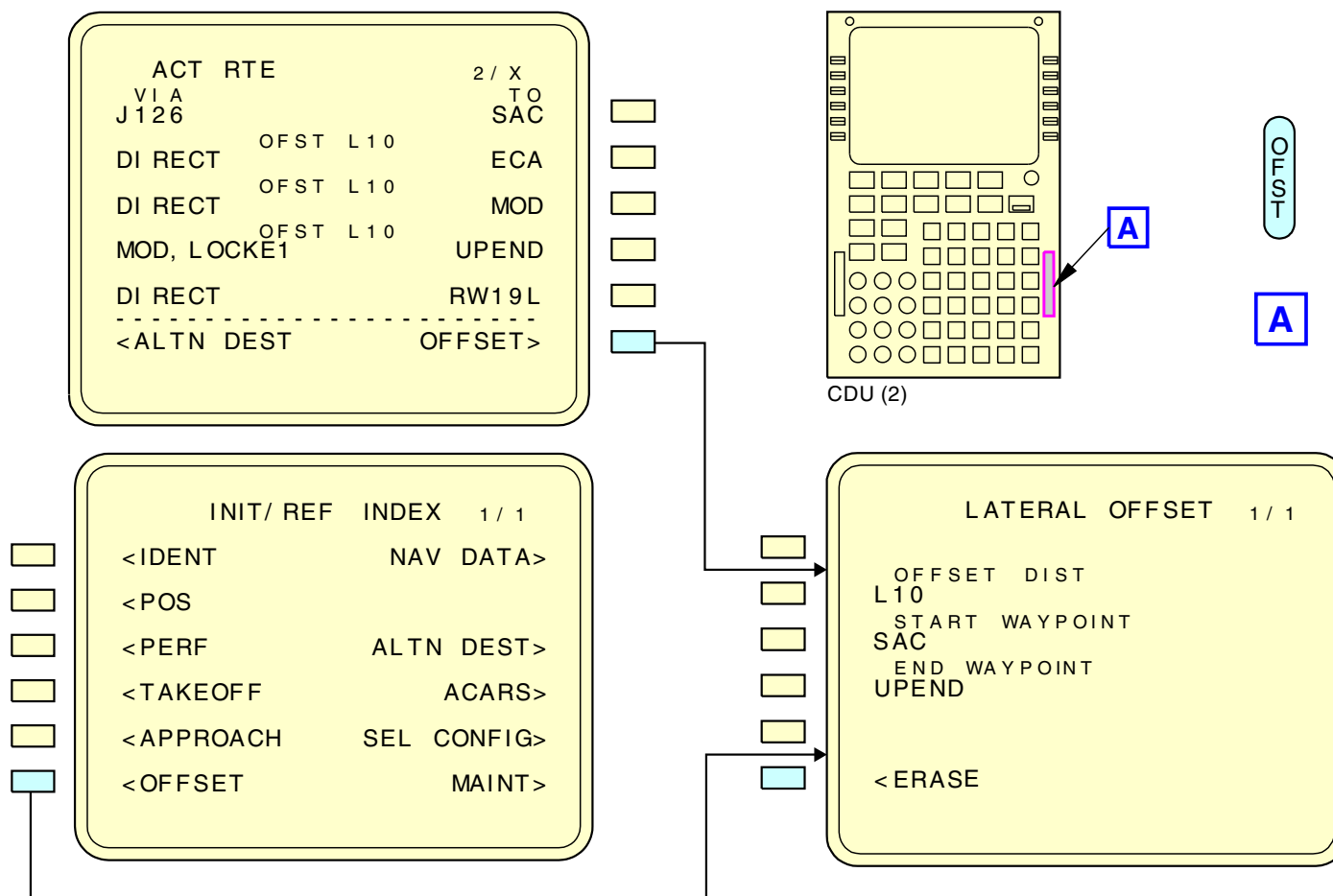
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FMCS - DISPLAYS - CDU - LATERAL OFFSET PAGE



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FMCS - DISPLAYS - CDU - LATERAL OFFSET PAGE

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**FMCS - DISPLAYS - CDU - APPROACH REFERENCE PAGE****General**

The APPROACH REF page lets the flight crew review performance data related to the approach phase of the flight.

Page Access

This page may be accessed by selection of the INIT/REF mode select key on the CDU when the airplane is in flight or from the APPROACH prompt on the INIT/REF INDEX page.

Approach Reference Page 1

The approach reference (APPROACH REF 1/1) page shows the following data:

- Gross weight
- Go-around N1
- Runway length
- ILS frequency and identifier
- VREF speeds for specific landing flap settings
- Wind correction values
- Front course.

Line 1L shows the GROSS WT prompt. Calculated gross weight as shown on the PERF INIT page or pilot entered value is shown. If the calculated gross weight is not valid, box prompts show.

Line 2L shows the GA N1 prompt. The go-around N1 Limit shows for both engines.

Line 4L shows the runway length prompt. This data field shows the runway length for the destination runway in feet and meters. This data field clears at flight completion.

Line 5L shows the arrivals approach identifier. If an ILS approach is selected in the active flight plan, the ILS frequency and identifier shows. If there is no ILS approach selected in the flight plan, this header and data field is blank.

Line 6L shows the INIT/REF INDEX prompt. This selects the INIT/REF INDEX page.

Lines 1R, 2R, and 3R show the VREF prompts. These show the calculated VREF speeds for the three flap settings at the calculated gross weight. Initially, the VREF speeds shows in small font until the flight crew selects one specific speed, then it shows in large font. In the example shown, the VREF speed for flaps 30 was selected by the flight crew.

Line 4R shows the WIND CORR prompt. The wind correction is added to the VREF speed selected in the VREF speed data field. The default value is +05 knots and the allowable entry range is 0 to 20 knots.

Line 5R shows the FRONT CRS prompt. This shows the front course if an ILS or LOC shows in line 5L. If there is no ILS or LOC in line 5L, this data field is blank. The front course value has a suffix of a T if the course is relative to true north.



FMCS - DISPLAYS - CDU - APPROACH REFERENCE PAGE

APPROACH REF			1 / 1
GROSS WT	FLAPS	VREF	
105.3	15 ⁰	135 KT	
GA N1			
98.0 /	98.0 %	30 ⁰	127 KT
	40 ⁰	124 KT	
KATL26R	WIND CORR		
10000 FT 3048 M	+05 KT		
ILS26R	FRONT CRS		
108.70 IATL	257 ⁰		

<INDEX		ALTN DEST>	

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FMCS - DISPLAYS - CDU - APPROACH REFERENCE PAGE

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**FMCS - DISPLAYS - CDU - NAVIGATION REFERENCE PAGES****General**

The navigation reference data pages let the flight crew review data from the permanent, temporary, or supplemental navigation data base for these references:

- Waypoint
- Navaid
- Runway
- Airport.

Waypoints, navaids, and airports not in the data base are entered into the temporary navigation data base from these pages. This is the reference data the crew can see on the CDUs:

- Reference navigation data (REF NAV DATA)
- Temporary navigation data (TEMP NAV DATA)
- Supplementary navigation data (SUPP NAV DATA).

Reference Navigation Data

On these pages, the crew examines navigation data for these references that are in the data base:

- Waypoints
- Airports
- Navaids
- Runways.

You get access to this page by selection of NAV DATA (LSK 1R) on the INIT/REF INDEX page. Also, you get access by selection of INDEX on the NAV SUMMARY page or the individual identifier pages.

Line 1L shows the WPT IDENT prompt. The waypoint or runway identifier is entered here.

The waypoint identifier page shows this data for the specified waypoint:

- Latitude and longitude

- Magnetic variation
- Reference identifier
- Radial/distance.

The runway identifier page shows this data in feet and meters for the specified runway:

- Airport identifier
- Latitude and longitude
- Elevation
- Runway length (feet and meters).

Line 2L shows the AIRPORT IDENT prompt. The airport identifier is entered here.

The airport identifier page shows this data:

- Latitude and longitude
- Elevation
- Magnetic variation for the airport.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 1R shows the NAVAID IDENT prompt. The navaid identifier is entered here.

The navaid identifier page shows this data for the entered navaid:

- Classification
- Latitude and longitude
- Frequency
- Elevation
- Magnetic variation.

If the identifier that is entered is not in the permanent, temporary, or supplemental data base, a display that shows only box prompts in all the data fields except the entered identifier shows.

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**FMCS - DISPLAYS - CDU - NAVIGATION REFERENCE PAGES**

In the example, the navaid identifier SEA was entered and the data base does not contain any data for this identifier.

Line 2R shows the SUMMARY prompt. This selects the NAV SUMMARY page that shows the temporary and supplemental data base data. The temporary data shows first. If there is no temporary or supplemental data, this data field is blank.

Line 6R shows the NAV OPTIONS prompt. This selects the NAV OPTIONS page.

Temporary Navigation Data

The temporary navigation data base holds up to this many items:

- 20 waypoints
- 40 nav aids
- 6 airports.

The total storage capacity of the temporary navigation data base is shared with the supplemental data base. The entries in this data base are deleted at flight completion.

This page may be accessed by selecting the SUMMARY prompt on the REF NAV DATA page.

Supplementary Navigation Data

The supplemental navigation data base provides long term storage of navigation data that is not in the permanent data base. The supplemental data base holds up to this many items:

- 20 waypoints
- 40 nav aids
- 6 airports.

To get access to this page, enter SUPP in the scratchpad on the INIT/REF INDEX page and select NAV DATA (LSK 1R). Also, you can get access by selection of INDEX from the SUPP SUMMARY page or the individual identifier pages.

Line 3R shows the effectivity date of the supplemental data base. For this data base to be valid, an effectivity date must be entered. If no valid date has been entered, box prompts show in this data field. This effectivity date also shows on the IDENT page.

Line 4L and 4R show the ACARS prompts. This lets the flight crew uplink or downlink the contents of the supplemental data base in an ACARS message.

Individual entries are removed with the DEL key on the CDU or all of the supplemental data base is removed by selection of DELETE ALL SUPP DATA (LSK 6R).

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FMCS - DISPLAYS - CDU - NAVIGATION REFERENCE PAGES

```

REF NAV DATA
WPT IDENT  NAVAID IDENT
-----
AIRPORT IDENT  SUMMARY>
-----
<INDEX      NAV OPTIONS>

```

INITIAL REF NAV DATA PAGE

```

REF NAV DATA
WPT IDENT  NAVAID IDENT
MACON
-----
LATITUDE    LONGITUDE
N30°36.4     W082°16.4
MAG VAR
W 5°
REF IDENT   RADIAL/DIST
SAVNH       270 / 150NM
-----
<INDEX

```

WAYPOINT IDENTIFIER

```

REF NAV DATA
NAVAID IDENT  SEA
CLASS
VTHA
-----
LATITUDE    LONGITUDE
N47°26.1     W122°18.5
FREQ
116.80       ELEVATION
MAG VAR      340 FT
E 22°
-----
<INDEX

```

NAVAID IDENTIFIER

```

REF NAV DATA
RUNWAY IDENT
RW09
AIRPORT IDENT
KATL
-----
LATITUDE    LONGITUDE
N51°48.7     W082°12.3
ELEVATION
1572 FT
LENGTH
9000 FT / 2748 W
-----
<INDEX

```

RUNWAY IDENTIFIER

```

REF NAV DATA
RUNWAY IDENT
KATL
-----
LATITUDE    LONGITUDE
N51°48.7     W082°12.3
ELEVATION
1572 FT
MAG VAR
E 21°
-----
<INDEX

```

AIRPORT IDENTIFIER

```

REF NAV DATA
NAVAID IDENT  SEA
CLASS
-----
LATITUDE    LONGITUDE
-----
FREQ
-----
MAG VAR
-----
<INDEX

```

IDENTIFIER NOT IN DATA BASE

```

TEMP NAV SUMMARY 1 / 1
WAYPOINTS
BCSD N19°56.3 W063°11.4
GUKAC N23°41.7 W052°47.6
NAVAIDS
FOL N39°28.2 W055°14.1
-----
<INDEX

```

TEMP DATA BASE SUMMARY

```

SUPP NAV DATA
WPT IDENT  NAVAID IDENT
-----
AIRPORT IDENT  SUMMARY>
-----
EFF FRM MON DY/YR
SUPP NAV      JAN 15/99
<REPORT      SUPP NAV
REQUEST>
-----
DELETE ALL
<INDEX      SUPP DATA>

```

SUPP NAV DATA PAGE

```

SUPP NAV SUMMARY 1 / 2
WAYPOINTS
ABCD N28°36.4 W082°16.4
TOUTL N42°23.3 W120°35.6
BAKER HUMPP 035/102
COWLZ N43°18.0 W121°12.6
GFK RDR 025/5
SQUAK S13°45.9 E064°11.6
NAVAIDS
RDR N37°46.2 W075°54.1
BFI N45°23.1 W122°45.3
IIS N45°02.6 E123°54.2
-----
<INDEX

```

SUPP DATA BASE SUMMARY

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FMCS - DISPLAYS - CDU - NAVIGATION REFERENCE PAGES

**FMCS - DISPLAYS - CDU - HOLD PAGE****GENERAL**

The RTE LEGS HOLD AT page is used by the flight crew to select the airplanes present position or any other waypoint as a holding pattern fix.

The RTE HOLD page is used by the flight crew to enter and review data for a specific holding pattern.

Page Access

The RTE LEGS HOLD AT page is accessed from the RTE LEGS page by selecting the HOLD mode key on the CDU.

The RTE HOLD page is accessed from the HOLD AT page by:

- Entering HOLD AT XXXXX in the scratchpad and selecting LSK 6L
- Entering the holding pattern fix waypoint in line 6L and selecting LSK 6L
- Entering PPOS at line 6R and selecting LSK 6R.

Rte Legs Hold At Page Information

Line select keys 1L through 5L show the active waypoint and subsequent waypoints in the active flight plan with this data:

- Computed course to waypoint
- Computed leg length
- Speed and altitude.

Line select key 6L shows the HOLD AT box prompts. The flight crew enters the desired waypoint for the holding pattern fix point.

Line select key 6R shows the PPOS prompt. The flight crew enters the desired position for the holding pattern fix point.

Rte Hold Page

Line select key 1L shows the FIX data. This is the holding pattern fix point as defined on the HOLD AT page.

Line select key 4L shows the LEG TIME prompt. The leg time is entered through the CDU. The default times are 1.5 minutes above 14000 feet and 1.0 minutes at or below 14000 feet.

Line select key 5L shows the LEG DIST (leg distance) prompt. This data field lets the flight crew enter the leg distance for the holding pattern.

Line select key 6L shows one of these prompts:

- NEXT HOLD (selects the HOLD AT page)
- ERASE (shows when data is being modified).

Line select key 2R shows the FIX ETA prompt. This data field shows the time at which the holding pattern fix is reached.

Line select key 3R shows the EFC TIME prompt. This data field shows the time at which the holding pattern is exited.

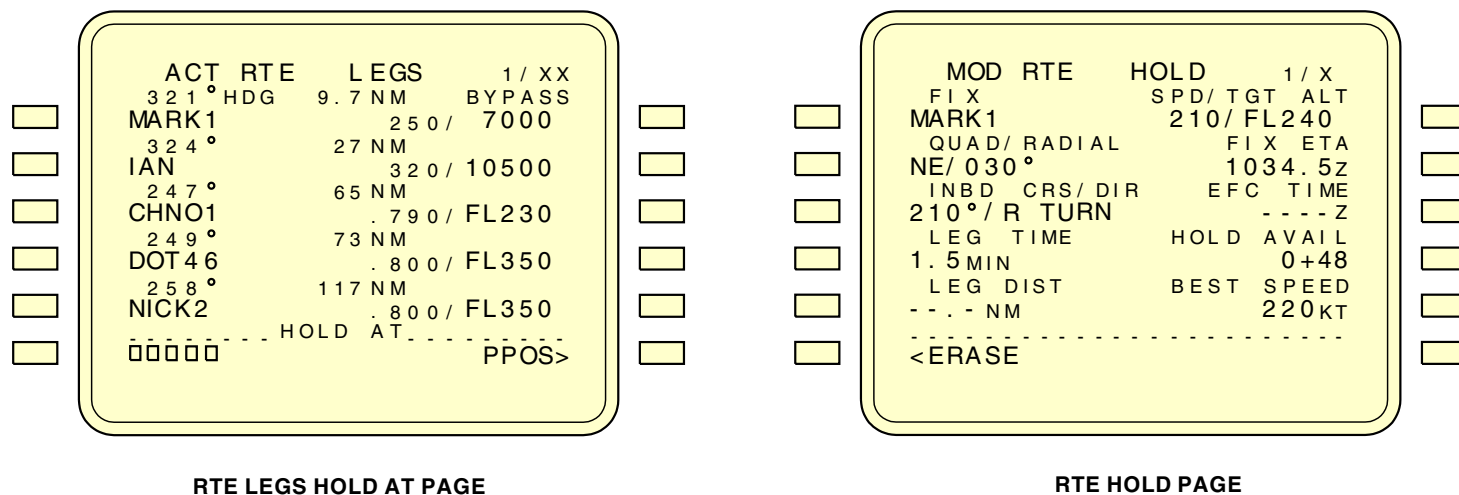
Line select key 4R shows the HOLD AVAIL prompt. This data field shows the holding time available before exit is necessary to reach the destination with the necessary fuel reserves.

Line select key 5R shows the BEST SPEED prompt. This data field shows the best holding speed for the current altitude and conditions.

Line select key 6R shows the EXIT HOLD prompt. This data field shows when the airplane is in an active holding pattern. After selection of this prompt, the EXEC key lights and EXIT HOLD is replaced with EXIT ARMED. When the EXEC key is pushed, the airplane exits the holding pattern from the FIX point and resumes the active flight plan.

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FMCS - DISPLAYS - CDU - HOLD PAGE



FMCS - DISPLAYS - CDU - HOLD PAGE

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**FMCS - DISPLAYS - CDU - FIX PAGE****General**

The FIX INFO page is used by the flight crew to show the current bearing and distance from a selected reference point (SRP). It is also used to calculate the abeam point of the airplane along the flight plan route from the entered SRP.

Page Access

To get access to the FIX INFO page push the FIX mode key on the CDU.

Fix Info Page Information

Line select key 1L shows the FIX prompt. The FIX identifier is entered here by typing the identifier in the scratchpad and line selecting it. These are the valid entries kept in the navigation data base:

- Airports
- Nav aids
- Waypoints (up to a maximum of six alphanumeric characters).

After you enter the fix identifier, the bearing and distance from that fix is shown in line 1 on the CDU. The fix identifiers also shown on the MDS navigation display.

Line select keys 2L through 4L are used by the flight crew to enter bearings or distances from the fix identifier. The entered data is again typed in the scratchpad and line selected.

These bearings and distances also are calculated and shown from the fix identifier:

- Estimated time of arrival (ETA)
- Distance to the fix waypoint (DTG)
- Altitude (ALT) at the fix waypoint.

The specific radial is then shown on the MDS navigation displays.

Line select key 5L shows the ABM prompt. Selection of this prompt causes the FMC to calculate and show the abeam point with these results:

- Bearing/distance
- ETA
- DTG
- Altitude at the abeam point.

Any of the fix waypoints in LSK 2L through 5L is line selected to the scratchpad for possible use on the RTE or LEGS pages as a waypoint.

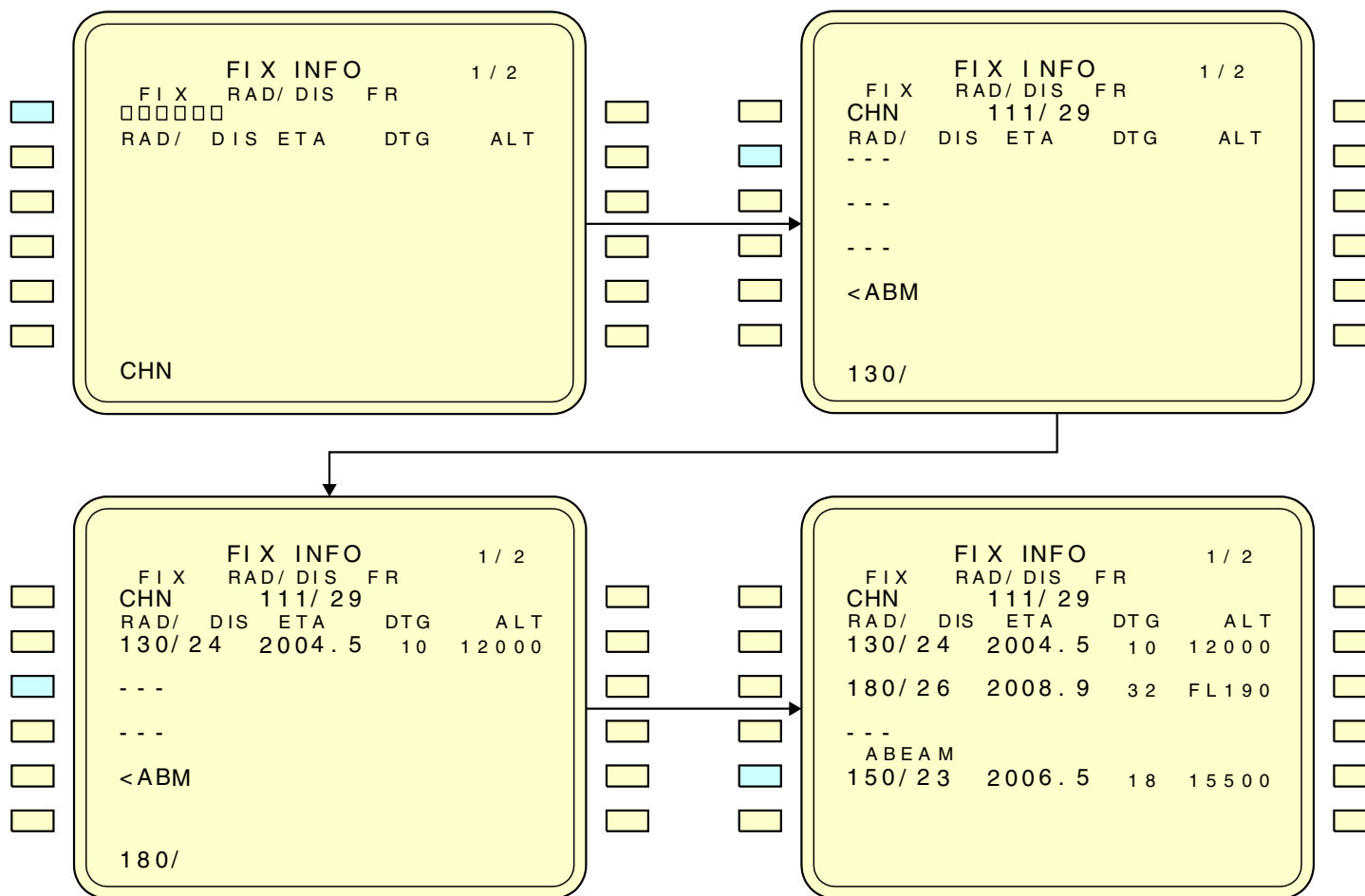
The DELETE key is used to erase the FIX identifier and its entries.

The second FIX INFO page lets the flight crew select a second fix waypoint and enter the bearings and/or distances to that fix waypoint.

The FMC is limited to a maximum of two FIX INFO pages.

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FMCS - DISPLAYS - CDU - FIX PAGE



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FMCS - DISPLAYS - CDU - FIX PAGE

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**FMCS - DISPLAYS - CDU - FMC COMM PAGE****General**

The FMC COMM page lets the flight crew get access to the airline operational communications page to start ACARS uplinks or downlinks of FMC data.

Page Access

Access to this page is by selection of the FMC COMM mode key on the CDU.

FMC COMM Page

Line 1L shows the FLT PLAN REQUEST prompt. This lets the flight crew request flight plan data with an ACARS message.

Line 2L shows the WINDS REQUEST prompt. This lets the flight crew request enroute waypoint wind data with an ACARS message.

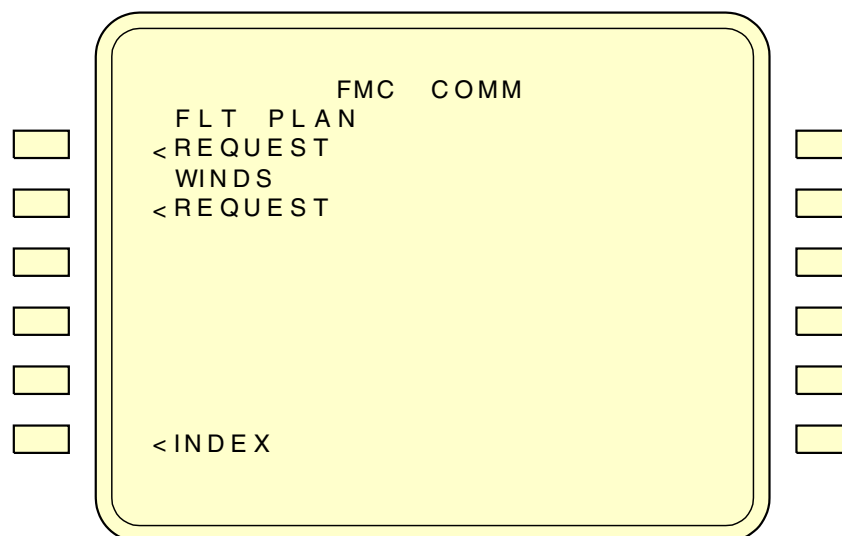
Lines 3L through 5L may be defined for the individual operators configuration.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

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FMCS - DISPLAYS - CDU - FMC COMM PAGE



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FMCS - DISPLAYS - CDU - FMC COMM PAGE

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FMCS - DISPLAYS - CDU - MESSAGES

General

The Flight Management Computer System (FMCS) shows alerting or advisory messages when there is a condition that degrades the system. The FMCS also shows entry error and Aircraft Communications Addressing And Reporting System (ACARS) messages.

The messages are prioritized and show in the Control Display Unit (CDU) scratch pad. This is the priority:

- Data entry error advisory
- Alerting messages
- Advisory messages.
- ACARS status messages.

Entry error messages show that the entered data is not correct. The message must first be cleared and then the data must be entered correctly. These messages will only show on the CDU on which the incorrect data entry was made. The MSG annunciator on the CDU on which the invalid entry was made will be on for these messages.

Alerting messages show an Flight Management Computer (FMC) condition that must be shown to the flight crew and corrected before further FMC operation is advisable or possible. The MSG annunciators will be on for these messages as well as the FMC warning lights on the Autoland Status Annunciator (ASA)s.

Advisory messages show the FMCS status and certain flight profile parameters and requirements. The MSG annunciators will be on for these messages.

ACARS status messages show ACARS system availability and status. The MSG annunciators will not be on for these messages.

The message with the highest priority will show in the scratch pad. If there are two messages of the same priority, the one that occurred first will show. When it is cleared the next message will show.

To clear a message, push the CLR key or remove the conditions that caused the message. Some messages clear when you change the page. The PROGRAM PIN ERROR message cannot be cleared with the CLR key or a page change.

Below are the messages in the different categories. The airplane operations manual contains a complete list of the CDU messages.

Entry Error Advisory Messages

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
ALT CONSTRAINT XXXXX	CHANGE OF CRZ ALT OR EDIT OF ALT CONSTRAINT HAS CAUSED ALT CONFLICT AT WPT XXXXX	REVIEW ALTERNATES AND CLEAR MESSAGE.
DATA BASE FULL	ENTRY HAS EXCEEDED CAPACITY OF TEMP OR SUPP DATA BASE	DELETE UNNECESSARY TEMP WPTS, NAVAIDS OR AIRPORTS FROM DATA BASE.
INVALID DELETE	DELETE KEY OPERATION NOT APPLICABLE TO DATA FIELD SELECTED	CLEAR MESSAGE AND SELECT PROPER FIELD AFTER DEL KEY IS PUSHED.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID ENTRY	DATA ENTRY HAS INCORRECT FORMAT OR RANGE FOR DATA FIELD SELECTED	CLEAR MESSAGE AND SCRATCH PAD ENTRY. REPEAT ENTRY WITH CORRECT DATA.



FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
NO OFFSET AT LEG XXXXX	ENTERED OFFSET WPT IS NOT APPLICABLE FOR START OR END OF OFFSET	CLEAR MESSAGE AND ENTER CORRECT WPT.
NOT IN DATA BASE	FMC COULD NOT FIND DATA FOR ENTERED IDENTIFIER	CLEAR MESSAGE AND CHECK DATA ENTRY OR ENTER NECESSARY DATA INTO TEMP OR SUPP DATA BASE.
NOT IN FLIGHT PLAN	ENTERED RTA WPT IS NOT IN THE CURRENT FLIGHT PLAN	CLEAR MESSAGE AND SELECT WPT THAT IS PART OF THE CURRENT FLIGHT PLAN.
ROUTE FULL	ENTRY OF MORE THAN 99 WPTS OR 5 HOLDING PATTERNS IS ATTEMPTED	CLEAR MESSAGE AND REVIEW EXISTING AND DESIRED ROUTE SEGMENTS FOR POSSIBLE DELETION.

Alerting Messages

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CYCLE IRS OFF -NAV	IRS LOGIC REQUIRES MANUALLY RESTART OF THE ALIGNMENT	TURN THE IRS MODE SWITCH TO OFF AND THEN TO NAV.
DATA BASE INVALID	VALIDITY TEST OF NAV DATA BASE HAS FAILED	RELOAD THE DATA BASE

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
DISCO INSRTD AFTR XXXXX	GEOMETRY OF NEXT WPTS WILL NOT ALLOW THE FMC TO FLY THE ACTIVE PLAN WITHOUT BYPASS OF MORE THAN ONE WPT	CHANGE THE ACTIVE FLIGHT PLAN.
DISCONTINUITY	PASSED THE LAST WPT IN THE PLAN PRIOR TO A ROUTE DISCONTINUITY	SELECT THE RTE OR RTE LEGS PAGE TO SPECIFY THE WPTS FOR A CONTINUOUS PLAN OR CAPTURE NEXT LEG.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
END OF OFFSET	2 MINS PRIOR TO PASSING OFFSET LEG TERMINATION	NONE REQUIRED.
END OF ROUTE	PASSING LAST ROUTE LEG TERMINATION	GO TO RTE OR RTE LEGS PAGE AND EXEC A ROUTE MODIFICATION.
ENTER IRS POSITION	IRS DID NOT ALIGN TO THE SET POSITION OR IRS IS IN THE ALIGN MODE AND NEEDS A POSITION ENTRY	ENTER THE IRS POSITION ON THE POS INIT PAGE.



FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
FMC DISAGREE	DURING APPROACH OR WHEN THE AIRPLANE IS ON THE GROUND, THE FMC SENSES A DISAGREEMENT IN MONITORED PARAMETERS REQUIRED FOR DUAL FMC OPERATION.	MONITOR FMC'S CLOSELY. BOTH FMC'S REMAIN ONLINE. LIMIT APPROACHES TO SINGLE FMC ONLY. IF DESIRED, REVERT TO SINGLE FMC OPERATION.
INSUFFICIENT FUEL	CHANGE IN CONDITIONS OR FLIGHT PLAN ROUTE CAUSES PREDICTIONS TO SHOW LESS THAN 2000LBS FUEL AT DESTINATION	MODIFY ROUTE PLAN OR CRUISING ALTITUDE OR DIVERT FOR ADDITIONAL FUEL.
IRS MOTION	IRS DETECTED EXCESSIVE MOTION DURING ALIGNMENT	CLEAR THE MESSAGE AND REDUCE AIRPLANE MOTION.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
IRS NAV ONLY	FMC HAS CHANGED TO THE DEAD RECKONING MODE OF NAVIGATION	CLEAR MESSAGE AND CHECK NAV RADIO AUTOTUNE FUNCTION.
IRS POS / ORIGIN DISAGREE FMC POS/RW DISAGREE (Msgs enabled on ground)	FMCS AND POSITION SENSORS EXCEED ALLOWABLE TOLERANCES	CLEAR MESSAGE CHECK POSITIONS ON THE POS SHIFT PAGE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
LNAV BANK ANGLE LIMITED	AIRPLANE IS WITHIN 5 MINUTES OF TURN AND WILL EXCEED AIRSPACE CONTAINMENT AREA	CLEAR MESSAGE AND NOTIFY ATC IF NECESSARY
MAX ALT FL XXX	ALTITUDE INTERVENTION ATTEMPT TO RAISE CRZ ALT WHEN MCP ALT IS ABOVE THE MAX ALTITUDE	CLEAR MESSAGE.
MISSED CAPTURE	PROPER LOC CAPTURE STARTED BUT DFCS DID NOT CAPTURE	CLEAR MESSAGE.
MODEL ENGINE DATA INVALID	THE AIRPLANE MODEL/ ENGINE PERFORMANCE DATA BASE IS NOT LOADED OR IS NOT VALID	RELOAD THE DATA BASE.
NAV DATA OUT OF DATE	NAV DATA BASE DATE DOES NOT MATCH CLOCK DATE	SELECT CORRECT NAV DATA BASE OR LOAD NEW NAV DATA BASE

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
NAV INVALID-TUNE XXXXX	FMC IS UNABLE TO AUTOTUNE OR RECEIVE APPROACH PROCEDURE NAVAID	CROSS CHECK RADIOS AND MANUALLY TUNE SPECIFIED NAVAID.
OVERSPEED DISCONNECT	AIRPLANE EXCEEDS DESCENT SPEED RESTRICTION BY 15 KTS OR MORE	SLOW AIRPLANE TO WITHIN 10 KTS OF SPEED TARGET AND RE-ENGAGE VNAV.



FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
PERF DEFAULTS INVALID	LOADED PERF DEFAULTS DATA BASE IS FAILING ITS CRC CHECK	RELOAD THE PERF DEFAULTS DATA BASE.
RESET MCP ALTITUDE	WITHIN 5NM OF TOP OF DESCENT AND MCP ALTITUDE IS AT CRZ ALTITUDE	SELECT CORRECT MCP ALTITUDE AS CLEARANCES PERMIT
RTA UNACHIEVABLE	RTA IS CURRENTLY OUTSIDE THE COMPUTED WINDOW PLUS A TIME MARGIN AND NO CORRECTIVE ACTION MAY BE MADE DUE TO SPEED CONSTRAINTS	CLEAR MESSAGE, EXIT RTA FUNCTION OR ENTER ACHIEVABLE RTA.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
SCANNING DME FAIL	INPUTS FROM FREQUENCY SCANNING DME HAVE FAILED	CLEAR THE MESSAGE AND CHECK NAV RADIO FUNCTION
SELECT MODE AFTER RTA	RTA FUNCTION EXITED VIA WPT DELETION OR RTA WPT SEQUENCED	CLEAR MESSAGE OR SELECT ALTERNATE PERF MODE OR MESSAGE IS CLEARED WHEN AIRPLANE IS NO LONGER IN SAME FLIGHT PHASE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
SINGLE FMC OPERATION (DUAL FMC ONLY)	THE PRIMARY FMC HAS DETERMINED THAT THE SECONDARY FMC HAS FAILED	MOVE FMC SOURCE SELECT SWITCH TO BOTH ON L OR BOTH ON R
TAKEOFF SPEEDS DELETED	MANUALLY SELECTED TAKEOFF SPEEDS DELETED DUE TO CHANGE IN ONE OR MORE REQUIRED PARAMETERS	CLEAR MESSAGE AND RESELECT DESIRED TAKEOFF SPEEDS.
UNABLE HOLD AIRSPACE	HOLD PATTERN BUILT BY FMCS GUIDANCE FUNCTION EXCEEDS HOLD AIRSPACE	CLEAR MESSAGE AND NOTIFY ATC IF NECESSARY.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE NEXT ALT	NEXT CLB/DESC CONSTRAINT XANNOT BE ACHIEVED	CLEAR MESSAGE AND REVIEW FMCS ERROR AT PREDICTION.
UNABLE REQD NAV PERF-RNP	ACTUAL NAV PERFORMANCE IS NOT SUFFICIENT FOR MANUALLY ENTERED RNP VALUES	CLEAR MESSAGE AND VERIFY FMCS POSITION DATA ON POS SHIFT PAGE.
VERIFY GW AND FUEL	FAILURE OF TOTAL FUEL QTY OR IT HAS BEEN 30 MINUTES SINCE MANUAL FUEL QTY ENTRY. MESSAGE INHIBITED IN DESCENT	CLEAR MESSAGE AND CHECK GW AND FUEL. MAKE MANUAL ENTRY OF GW AS REQUIRED.



FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY POS: IRS-IRS VERIFY POS: IRS-FMC VERIFY POS: IRS-RADIO VERIFY POS: FMC-RADIO VERIFY POS: FMC-GPS VERIFY POS: FMC-FMC (Msgs enabled during flight)	FMCS AND POSITION SENSORS EXCEED ALLOWABLE TOLERANCES	CLEAR MESSAGE CHECK POSITIONS ON THE POS SHIFT PAGE.
VERIFY RNP	DEFAULT VALUE OF RNP IS LESS THAN THE MANUALLY ENTERED VALUE	CLEAR MESSAGE AND CHECK MANUALLY ENTERED RNP VALUE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY TAKEOFF SPEEDS	SYSTEM GROSS WEIGHT OR ZERO FUEL WEIGHT CHANGED SINCE THE T/O REF SPEEDS WERE SELECTED	RESELECT TAKEOFF SPEEDS.
VNAV DISCONNECT	CRITERIA FOR VNAV ENGAGEMENT NO LONGER EXISTS	MANUALLY CONTROL THE VERTICAL PATH. MESSAGE CLEARS IF VNAV RE-ENGAGED.

Advisory Messages

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	AIRPLANE EXCEEDS ITS MAXIMUM CERTIFIED ALTITUDE	DESCEND TO AN ALTITUDE BELOW THE MAXIMUM CERTIFIED ALTITUDE.
ALT CONSTRAINT XXXXX	FLIGHT PLAN EDIT HAS CAUSED AN ALTITUDE CONSTRAINT TO CONFLICT WITH A CONSTRAINT ALTITUDE AT OTHER WPTS IN THE ROUTE. XXXXX IS THE FIRST WPT	EDIT FLIGHT PLAN TO RESOLVE THE ALT CONSTRAINT CONFLICT AND CLEAR MESSAGE.
APPRCH VREF NOT SELECTED	FMC IN APPROACH ENVIRONMENT AND VREF NOT SELECTED	SELECT VREF ON APPROACH REF PAGE.
ARR N/A FOR RUNWAY	RUNWAY OR APPROACH SELECTED IS NOT COMPATIBLE WITH ARRIVAL SELECTED	GO TO ARRIVALS PAGE AND MODIFY SELECTION.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
BUFFET ALERT	CURRENT CONDITIONS RESULT IN MANEUVER MARGIN LESS THAN THAT SELECTED FOR AIRPLANE	BRING AIRPLANE BACK TO WITHIN OPERATING ENVELOPE.
CHECK FMC FUEL QUANTITY	THE FMCS DETECTED A DROP IN FUEL QUANTITY (> 1500 LBS FOR 120 SECONDS)	CHECK THE FUEL QUANTITY SYSTEM

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FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
DESCENT PATH UNACHIEVABLE	WHILE IN DESCENT, THE FMC PREDICTIONS SHOW THE PROFILE CONSTRAINTS AT THE NEXT WPT CANNOT BE MADE	MODIFY THE ACTIVE ROUTE LEGS OR DES PAGE PLANS AND RE-ENGAGE LNAV AND VNAV.
DRAG REQUIRED	DUE TO UNFORECAST CONDITIONS, THE AIRPLANE IS 10 KTS OR MORE ABOVE FMCS TARGET SPEED OR WITHIN 5 KTS OF VMO	USE SPEEDBRAKES OR TRIM AS NECESSARY TO BRING AIRPLANE BELOW FMCS TARGET SPEED.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
DUAL FMC OP RESTORED (DUAL FMC ONLY)	MOVEMENT OF FMC SOURCE SELECT SWITCH CAUSED A RESYNCH AND DUAL FMC OPERATION IS RESTORED	NONE REQUIRED.
INVALID OFFSET	ANY FLIGHT PLAN MOD THAT CAUSES THE START OF THE OFFSET TO BECOME OFF-SETTABLE	ERASE MOD AND ENTER VALID WPT FOR OFFSET START.
INVALID QUAD	INCORRECT DATA ENTERED IN QUAD FIELD ON HOLD PAGE	CLEAR MESSAGE AND ENTER CORRECT DATA.
LOC CAP ACTIVE	AIRCRAFT APPROACHES ITS TURN ONTO LOC COURSE	CLEAR MESSAGE OR WAIT FOR DFCS TO RESET

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
LOC CAP CANCELLED	FLIGHT PLAN MOD OR AIRPLANE CONDITION DID NOT FACILITATE LOC CAPTURE	CLEAR MESSAGE OR WAIT FOR DFCS TO SIGNAL RESET STATUS TO THE FMCS.
MAX ALT FL XXX	ALT ENTRY ON ANY PAGE IS ABOVE MAXIMUM ALTITUDE FOR ECON MODE	CLEAR MESSAGE AND AMEND DATA ENTRY IN SCRATCH PAD.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
MAX CAS XXX	ENTERED TARGET SPEED IS LIMITED BECAUSE IT EXCEEDS THE MAX BUFFET SPEED	ACCEPT LIMITED SPEED AND CLEAR MESSAGE OR ENTER NEW TARGET SPEED.
MAX MACH XXX	ENTERED TARGET SPEED IS LIMITED BECAUSE IT EXCEEDS THE MAX BUFFET SPEED	ACCEPT LIMITED SPEED AND CLEAR MESSAGE OR ENTER NEW TARGET SPEED.
MIN CAS XXX	ENTERED TARGET SPEED IS LIMITED BECAUSE IT IS LESS THAN MIN BUFFET SPEED	ACCEPT LIMITED SPEED AND CLEAR MESSAGE OR ENTER NEW TARGET SPEED.
MIN MACH XXX	ENTERED TARGET SPEED IS LIMITED BECAUSE IT IS LESS THAN MIN BUFFET SPEED	ACCEPT LIMITED SPEED AND CLEAR MESSAGE OR ENTER NEW TARGET SPEED.

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FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
NO DES PATH AFTER XXXXX	THE PROFILE CONSTRAINTS CANNOT BE ACHIEVED AND THE PATH MAINTAINED AS PLANNED	SELECT RTE LEGS OR DES PAGES TO DELETE OR MODIFY THE CONSTRAINTS AT THE DESCENT WPTS.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
NOT ON INTERCEPT HEADING	AIRCRAFT IS NOT WITHIN LEG CAPTURE CRITERIA	MANUALLY STEER AIRCRAFT ONTO HEADING WHICH WILL INTERCEPT PLANNED ROUTE
OFFSET DELETED	THE START WPT IS DELETED FROM THE FLIGHT PLAN VIA A FLIGHT PLAN EDIT ON OTHER THAN THE OFFSET PAGE	RE-ENTER THE OFFSET AS APPROPRIATE FOR THE NEW FLIGHT PLAN.
OFFSET ENDS ABEAM XXXXX	ENTRY OF AN END WPT WHICH RESULTS IN A NON-OFFSETTABLE LEG EXISTING BETWEEN THE END WPT AND THE START OF THE OFFSET	MODIFY THE OFFSET PARAMETERS TO PROVIDE A COMPLETE OFFSET PATH.
PROGRAM PIN ERROR	THE AIRFRAME /ENGINE PROGRAM PIN PARITY IS NOT VALID OR THE FMC IDENTIFICATION DISCRETES ARE NOT VALID	POWER DOWN THE FMCS AND CORRECT THE PROBLEM. THE CLEAR KEY OR A PAGE CHANGE WILL NOT CLEAR THE MESSAGE

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
PROGRAM PIN NOT IN DB	THE AIRFRAME OR ENGINE PROGRAM PINS DO NOT COMPARE TO DATA IN THE AIRPLANE MODEL/ ENGINE PERFORMANCE DATA BASE	CORRECT THE PROGRAM PIN CONFIGURATION OR LOAD THE CORRECT AIRPLANE MODEL/ ENGINE PERFORMANCE DATA BASE
RESET MCP ALTITUDE	NORMAL FMCS OPERATION WOULD TAKE AIRCRAFT AWAY FROM MCP ALTITUDE	RESET MCP ALTITUDE TO CORRECT VALUE
ROUTE FULL	NO MEMEORY SPACE AVAILABLE FOR PHANTOM WPTS REQUIRED BY THE VERTICAL FLIGHT PLAN	CLEAR MESSAGE AND REVIEW EXISTING AND DESIRED ROUTE SEGMENTS FOR POSSIBLE DELETION.
RUNWAY N/A FOR SID	THE SELECTED RUNWAY IS NOT APPLICABLE TO THE SELECTED DEPARTURE PROCEDURE	CLEAR MESSAGE AND CHECK SELECTIONS.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
SELECT ACTIVE WPT/ LEG	POWER-UP RESTART OR INSERTION OF A DIFFERENT FLIGHT PLAN WHILE AIRBORNE	EXECUTE A DIRECT-TO OR LEG-INTERCEPT TO TELL FMCS WHICH LEG IS ACTIVE.
STEEP DES AFTER XXXXX	FMC ALTITUDE CONSTRAINT AT XXXXX RESULTS IN A STEEP DESCENT TO NEXT WPT	CHECK CONSTRAINT AND REMOVE IF ALLOWED.

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FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
TAI ON ABOVE 10 DEGREES C	AIRCRAFT OPERATES WITH ANTI-ICING WITH TAT ABOVE 10 DEGREES C	CLEAR MESSAGE AND CHECK USE OF ANTI-ICING
UNABLE CRZ ALT	FMCS PREDICTS NO CRUISE TIME POSSIBLE AT ENTERED CRZ ALT	CLEAR MESSAGE AND REVIEW CRZ ALT SELECTION.
UNABLE MACH .XXX	SPEED ENTERED INTO TARGET SPEED FIELD IS IMPOSSIBLE TO ACHIEVE AT ANY ALTITUDE AT THE CURRENT AIRPLANE WEIGHT	RE-ENTER A NEW TARGET SPEED.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE TO OFFSET	A VALID LATERAL OFFSET CANNOT BE MADE DUE TO INABILITY TO FIT THE TURN SEGMENTS TO AND FROM THE OFFSET PATH	VERIFY THE NEED TO FLY A LATERAL OFFSET AND MODIFY THE FLIGHT PLAN ACCORDINGLY.
V SPEEDS UNAVAILABLE	FMC IS UNABLE TO CALCULATE T/O SPEEDS	CLEAR AND REVISE AND RE-ENTER INPUTS FOR THE T/O SPEED CALCULATIONS

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
USING RSV FUEL	A CHANGE IN ROUTE OR CONDITIONS CAUSES PREDICTED FUEL AT DESTINATION TO BE LESS THAN THE ENTERED RESERVES	CLEAR MESSAGE AND CHANGE THE ACTIVE FLIGHT PLAN IF NECESSARY.
VERIFY RNP VALUE	MANUALLY ENTERED RNP IS LARGER THAN DEFAULT VALUE	CLEAR MESSAGE AND VERIFY MANUALLY ENTERED VALUE

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
XXXX (AIRPORT NAME)	A REF AIRPORT IS ENTERED ON THE POS INIT PAGE AND NO ENTRY OF ORIGIN YET APPEARS ON RTE PAGE 1	SELECT THE AIRPORT IDENTIFIER INTO THE ORIGIN DATA FIELD.
XXXXX	RESETTING MCP ALTITUDE TO A VALUE NOT EQUAL TO THE CRZ ALT CAUSES THE VALUE TO APPEAR IN THE SCRATCH PAD	SELECT MCP ALTITUDE INTO THE APPROPRIATE TARGET ALTITUDE FIELD OR CLEAR THE DATA.

ACARS Status Messages

ACARS MESSAGE	CAUSE	CORRECTIVE ACTION
ACARS ALERT	FLIGHT CREW ACTION REQUESTED FOR ACARS	SELECT ACARS MU ON CDU AND DO NECESSARY ACTION. CLEAR MESSAGE.

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FMCS - DISPLAYS - CDU - MESSAGES

(Continued)

ACARS MESSAGE	CAUSE	CORRECTIVE ACTION
ACARS CALL	THE ACARS MU REQUESTS SERVICE FROM THE FLIGHT CREW	SELECT THE ACARS MU ON THE CDU MENU PAGE.
ACARS MU FAIL	THE ACARS MU HAS A HARDWARE FAILURE	VERIFY ACARS MU HAS POWER.
ACARS NO COMM	THERE IS NO ACARS LINK AVAILABLE (SAT, VHF OR MODE S)	CLEAR THE MESSAGE AND VERIFY COMMS STATUS.
ACARS UPLINK	ACARS MESSAGE WAITING	SELECT ACARS MU ON CDU AND DO NECESSARY ACTION. CLEAR MESSAGE.
ACARS VOICE	VHF TRANSCEIVER SET TO VOICE	CLEAR MESSAGE.

ACARS MESSAGE	CAUSE	CORRECTIVE ACTION
ACARS VOICE BUSY	ALL VHF CIRCUITS ARE BUSY	MESSAGE WILL CLEAR WHEN A CIRCUIT BECOMES AVAILABLE.
ACARS MESSAGES 7 THRU 19	USER DEFINED	USER DEFINED.
PRINTER FAIL (OPTIONAL)	FLIGHT DECK PRINTER FAILED	CHECK PRINTER AND CLEAR MESSAGE.
PRINTER UPLINK (OPTIONAL)	ACARS UPLINK HAS A MESSAGE FOR THE PRINTER	SELECT ACARS MU ON THE CDU AND DO NECESSARY ACTIONS. CLEAR MESSAGE.

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FMCS - DISPLAYS - CDU - MESSAGES

TYPE OF MESSAGE	OTHER INDICATION FOR THIS MESSAGE	EXAMPLE CDU MESSAGES
ALERTING	 	DATA BASE INVALID NAV DATA OUT OF DATE ENTER IRS POSITION CYCLE IRS OFF-NAV IRS MOTION MODEL ENGINE DATA INVALID
ENTRY ERROR ADVISORY		INVALID ENTRY NOT IN DATA BASE
ADVISORY		PROGRAM PIN ERROR CHECK FMC FUEL QUANTITY PROGRAM PIN NOT IN DB

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FMCS - DISPLAYS - CDU - MESSAGES

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**FMCS - DISPLAYS - MDS - FLIGHT MODE ANNUNCIATIONS****FMCS Flight Mode Annunciation**

The DFCS makes all the FMC flight mode annunciations (FMAs). They show in green at the top of the primary flight displays.

These are the active FMCS flight mode annunciations that can show during FMCS operation:

- Autothrottle (A/T) mode annunciation
- Pitch mode annunciation
- Roll mode annunciation.

Autothrottle Mode Annunciation

These are the autothrottle modes that can show during FMCS operation:

- FMC SPD
- N1
- RETARD
- ARM.

Pitch Mode Annunciations

These are the pitch modes that can show during FMCS operation:

- VNAV PTH
- VNAV SPD.

Roll Mode Annunciation

The roll mode annunciation LNAV can show during FMCS operation.

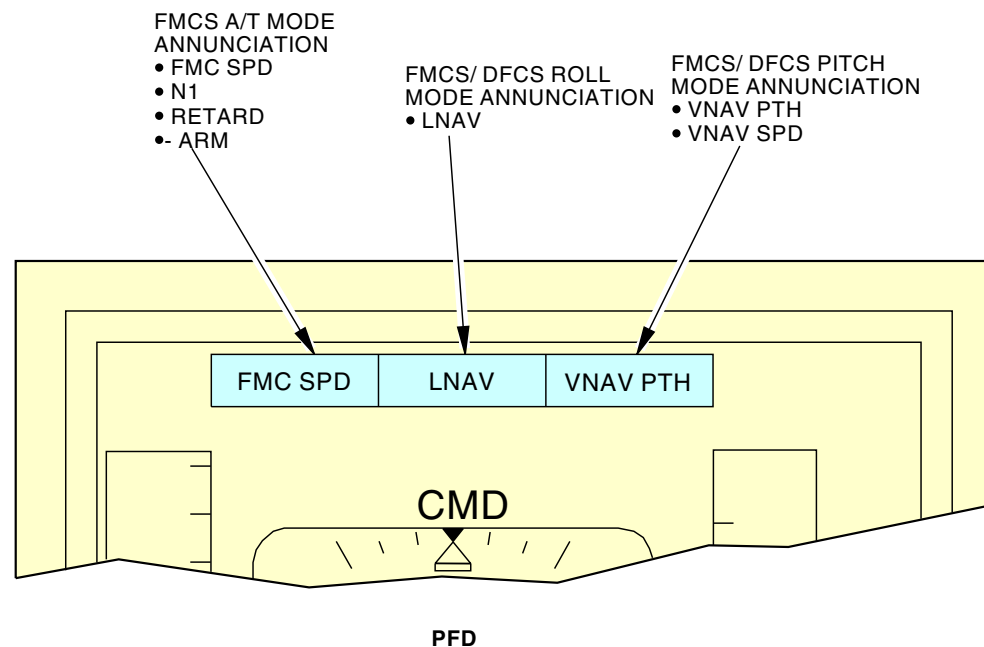
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FMCS - DISPLAYS - MDS - FLIGHT MODE ANNUNCIATIONS



FMCS - DISPLAYS - MDS - FLIGHT MODE ANNUNCIATIONS

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**FMCS - DISPLAYS - MDS - THRUST MODE****General**

The thrust mode annunciation display shows the active N1 limit mode calculated by the FMCS. The reference N1 bugs (2) show the N1 limit for the active mode. The N1 limit mode controls the N1 limit for autothrottle operation.

The reference N1 readouts may be set manually. They are set with the N1 SET CONTROL inner knob. When the reference N1 readout is set manually, the N1 bugs show the N1 reference readout value. These manually set limits have no effect on autothrottle operation.

The N1 maximum indication shows as an amber marker in the N1 dial.

Thrust Mode Display

These thrust modes show on the engine display:

- TO (Takeoff)
- TO 1 (Reduced Takeoff with Fixed Derate - 1)
- TO 2 (Reduced Takeoff with Fixed Derate - 2)
- D-TO (Reduced Takeoff with Assumed Temperature Derate)
- D-TO 1 (TO 1 with Assumed Temperature Derate)
- D-TO 2 (TO 2 with Assumed Temperature Derate)
- TO B (Takeoff Bump)
- CLB (Climb)
- CLB 1 (Reduced Climb with Fixed Derate - 1)
- CLB 2 (Reduced Climb with Fixed Derate - 2)
- Q CLB (Reduced Climb with Cutback)
- CRZ (Cruise)
- CON (Continuous)
- GA (Go-around)
- - - - (no computed data from the FMCS).

Only one thrust mode can show and be active.

Display Control

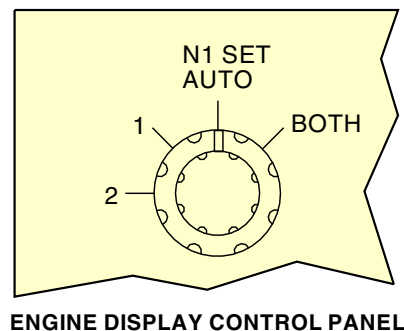
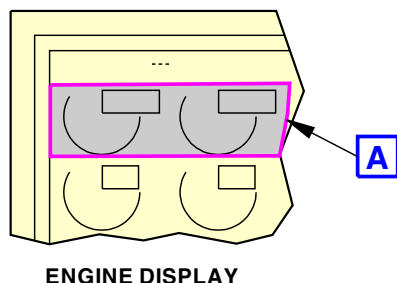
When the N1 SET CONTROL outer knob is set to the AUTO position, the thrust mode display and N1 bug position are set by the FMCS as a function of DFCS mode logic. To override automatic control, you can line select another mode from the N1 limit page. The displays go back to automatic control when the DFCS pitch mode changes.

When the outer knob is set to the BOTH, 1 or 2 position, you can manually set the reference N1 bugs and the N1 reference readouts will be displayed above the digital N1 displays. With the outer knob in the AUTO position, the readout is blank.

Non-Normal Operation

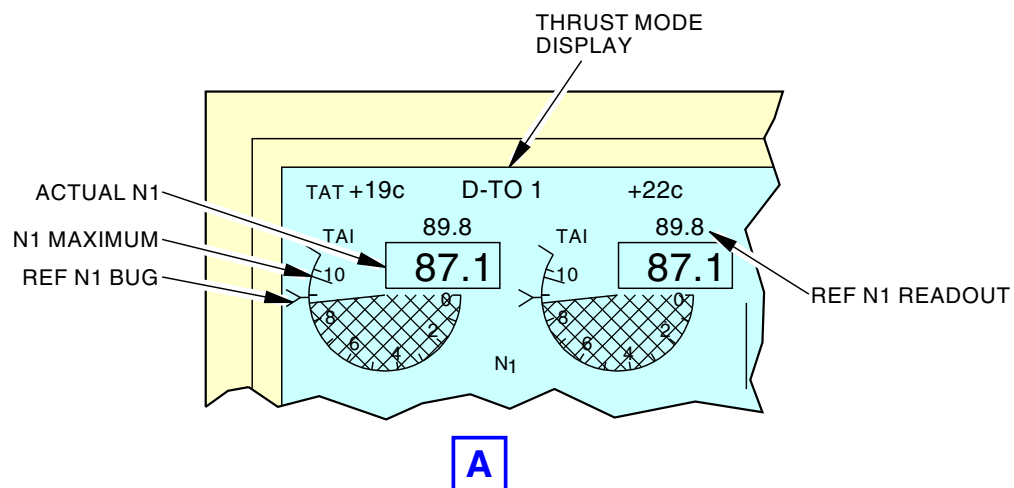
In automatic operation, the thrust mode display and reference N1 bug readout are calculated by the FMCS. If the FMCS calculations are not valid, the autothrottle limit message A/T LIM shows. The autothrottle computer then calculates a single N1 limit for both engines.

FMCS - DISPLAYS - MDS - THRUST MODE



N1 LIMIT		1 / 1
AUTO		
GA	101.6 / 101.6%	
CON	99.8 / 99.8%	
CLB	89.8 / 89.8%	
CRZ	83.8 / 83.8%	
----- REDUCED CLB -----		
CLB-1 <SEL>	CLB-2	

N1 LIMIT PAGE



ACT ECON CLB		1 / 1
CRZ ALT	AT CR102	
FL330	2500A	
TGT SPD	TO CR102	
280 / .720	2004.3z / 19NM	
SPD REST	ERR AT CR102	
250 / 10000	310LO	
----- CLB 1 - N1 -----		
87.1 / 87.1%		
<MAX RATE		ENG OUT>
<MAX ANGLE		RTA>

CLIMB PAGE

2959510 S0000737846_V1

FMCS - DISPLAYS - MDS - THRUST MODE

34-61-00-055

EFFECTIVITY	
SIA ALL	

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-61-00

**FMCS - DISPLAYS - MDS - AIRSPEED INDICATION****General**

The takeoff and landing airspeed bugs show on the PFD speed tape indication. The bugs are set automatically by the FMC or, they can be set manually by the flight crew using the speed reference selector on the engine control panel. When set manually, the airspeeds show on the PFD speed tape indication and a digital display of the set value shows.

You also use the speed reference selector to manually set the airplane takeoff or landing gross weight. MDS will use this weight value to calculate and display the flap maneuvering speeds.

Speed Reference Selector

The outer control has these functions:

- AUTO (the FMCS supplies the reference airspeeds and gross weight automatically)
- V1 (shows the takeoff decision speed on the ground and shows INVALID ENTRY in-flight)
- VR (shows takeoff rotation speed on the ground and shows INVALID ENTRY in-flight)
- WT (the pilot can set the gross weight manually)
- VREF (shows the landing reference speed (REF) in the air and shows INVALID ENTRY on the ground)
- Triangle symbol (shows an airspeed bug the pilot can set)
- SET (the FMC and the inner control cannot move the airspeed bugs).

The inner control sets the selected bug to the desired airspeed or sets gross weight. The control is spring loaded to center.

Takeoff

This data shows on the PFD speed tape indication:

- Digital display (the display shows if the airspeed bug(s) or weight is set with the speed reference selector)
- V1 (decision speed)
- VR (rotation speed)

- Selected speed (indicates the airspeed manually set in the IAS/MACH display on the DFCS mode control panel (MCP) or the FMC computed airspeed when the IAS/MACH window is blank)
- V2 (single engine climb speed)
- V2+15 (single engine climb speed plus 15 knots)
- Flap maneuver speed (maneuver speed for flap position shown. It does not show for 30 or 40 units of flap.)
- Flaps up speed (shows after zero fuel weight is set in the CDU and takeoff gross weight is calculated, or after takeoff gross weight is set with the speed reference selector)
- Airspeed bug at 100 knots (this shows during preflight and is removed when the flaps start to retract).

Approach/Landing

This data can show on the PFD speed tape during approach:

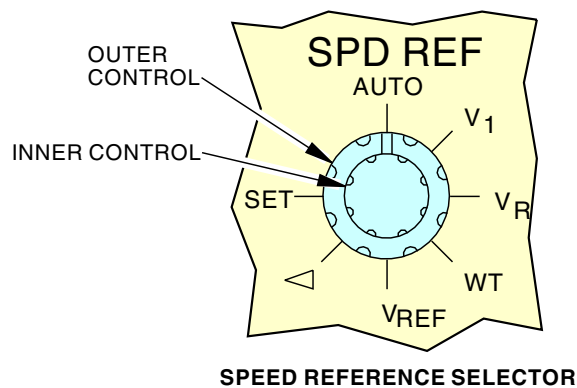
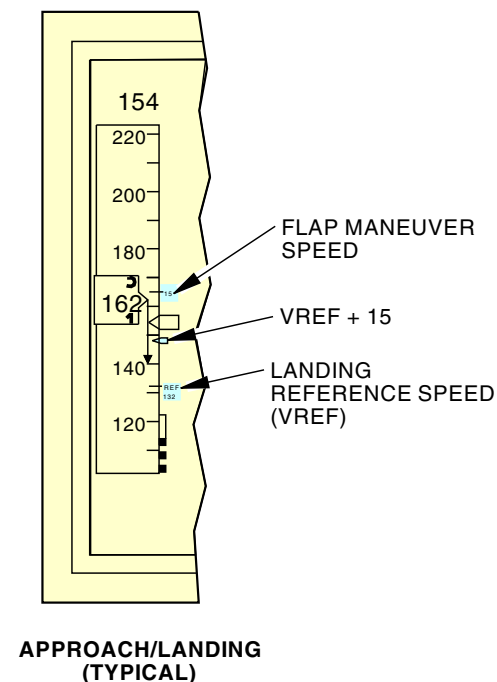
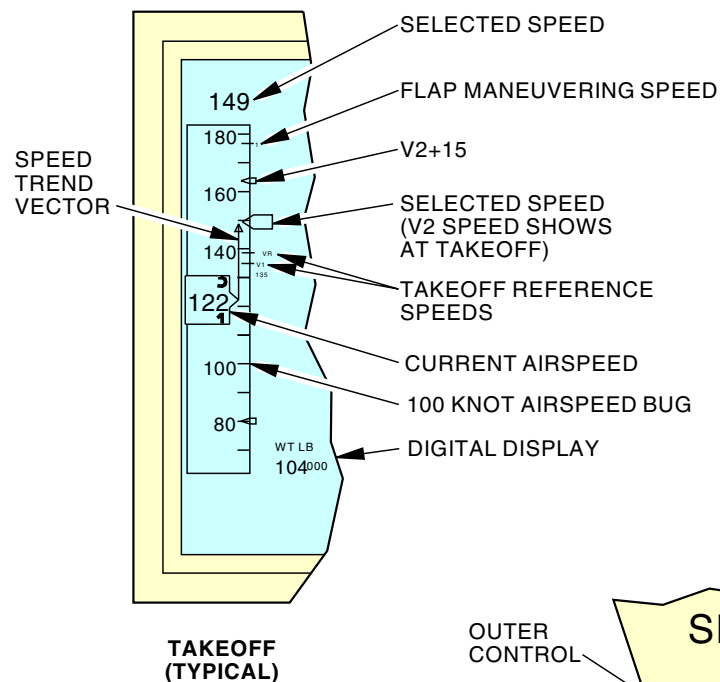
- REF (landing reference speed VREF is set on the CDU APPROACH REF page or set with the speed reference selector)
- VREF+15 (this shows after VREF is set)
- Flap maneuver speed (maneuver speed for flap position shown).

34-61-00

EFFECTIVITY	
SIA ALL	

D633AM102-SIA

FMCS - DISPLAYS - MDS - AIRSPEED INDICATION



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FMCS - DISPLAYS - MDS - AIRSPEED INDICATION

34-61-00-056

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-61-00

**FMCS - DISPLAYS - MDS - MAP DISPLAY****General**

The FMCS provides the navigation data for the MAP mode displays on the MAX Display System (MDS). There are two types of navigation data, dynamic data and background data. Dynamic data changes as a function of time while background data is stationary data that does not move as a function of time.

The FMCS formats and transmits the data (FMC bus 08 and FMC bus 09) to show the airplane position with respect to the flight plan and vertical profile. The MDS controls symbol color, size, and brightness.

Map Mode

The map mode shows the progress of the flight and is the normal display the crew uses for navigation in flight. This display may show in either the expanded mode or the centered mode. The display is dynamic and moves as the airplane moves.

Symbol Definitions

This data is shown:

- Active waypoint distance (distance to go to the active waypoint. White)
- Active waypoint ETA (estimated time of arrival for the active waypoint. White)
- T/C altitude profile point (top of climb position in the active route. Green)
- T/D altitude profile point (top of descent position in the active route. Green)
- E/D altitude profile point (end of descent position in the active route. Green)
- S/C altitude profile point (step climb position in the active route. Green)
- Speed profile point (deceleration point in the active route. Green)
- Active waypoint (next waypoint in the active route. Magenta)
- Range to altitude arc (range at which the airplane will reach the MCP altitude. Green)
- Trend vector (predicted position of airplane at the end of 30, 60 or 90 second intervals. White)

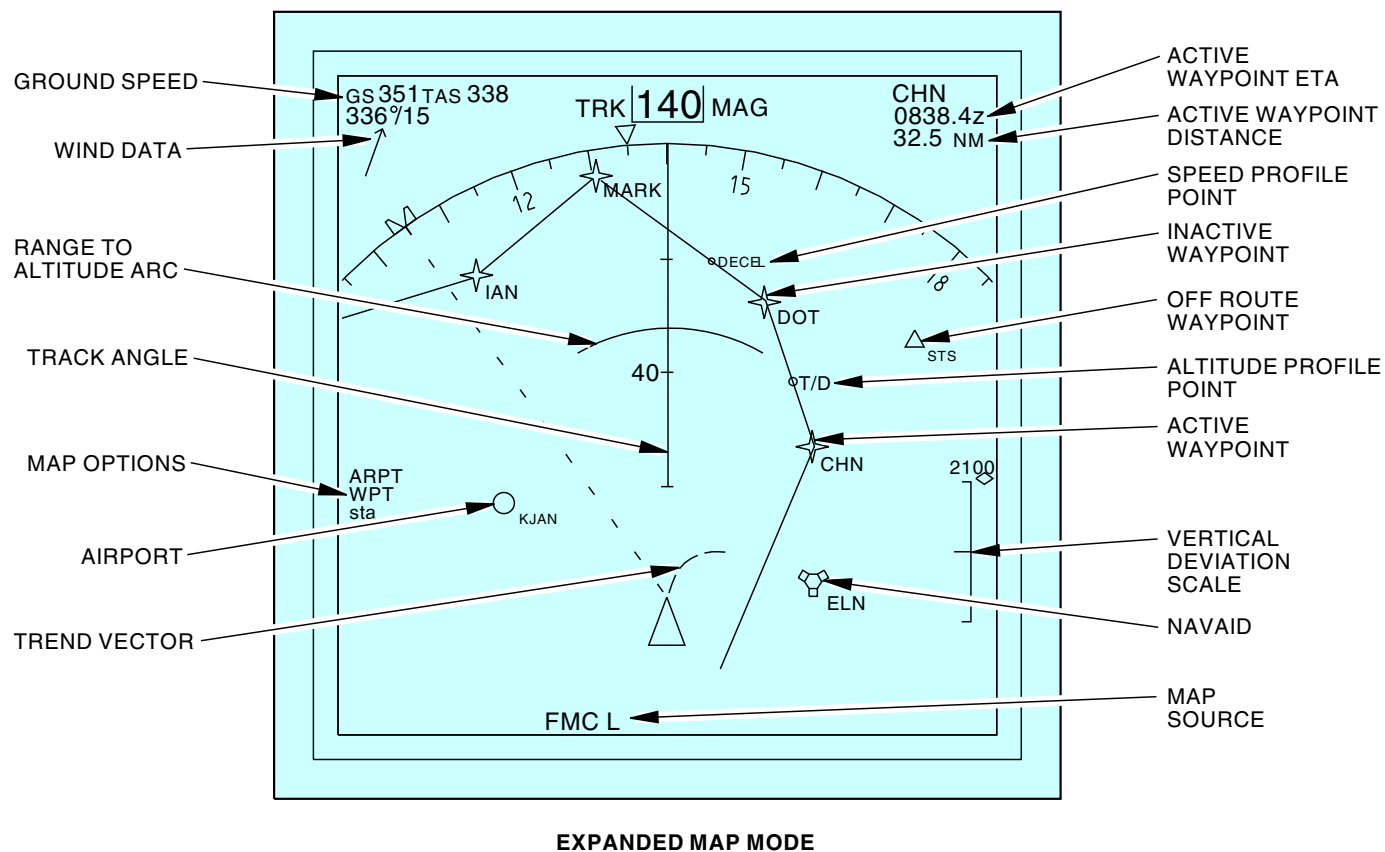
- Inactive waypoint (waypoint other than the active waypoint in the active route. White)
- Vertical deviation scale (vertical deviation from the calculated descent profile. Scale is white and pointer is magenta)
- Map options (options selected on the EFIS control panel. Cyan)
- Wind data (wind speed and direction. White)
- Map source (source of dynamic and background data. Green)
- Nav aids (navigation stations within the selected map area. Cyan)
- Off route waypoints (waypoints within the selected map area but not in the active route. Cyan)
- Airports (airports within the selected map area. Cyan)
- Route data (altitude constraints and ETAs for the waypoint in the active route. Magenta or white)
- Track angle (airplane track. White).

34-61-00

EFFECTIVITY	
SIA ALL	

D633AM102-SIA

FMCS - DISPLAYS - MDS - MAP DISPLAY



EXPANDED MAP MODE

2370158 S00061521093_V2

FMCS - DISPLAYS - MDS - MAP DISPLAY

34-61-00-057

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

34-61-00

**FMCS - DISPLAYS - MDS - PLAN DISPLAY****General**

The FMCS provides the navigation data for the PLAN mode displays on the MAX Display System (MDS). There are two types of navigation data, dynamic data and background data. Dynamic data changes as a function of time while background data is stationary data that does not move as a function of time.

The FMCS formats and transmits the data (FMC bus 08 and FMC bus 09) to accurately show the airplane position with respect to the flight plan and vertical profile. The MDS controls symbol color, size, and brightness.

Plan Mode

The plan mode shows NORTH UP. The crew uses the plan mode with the FMC/CDU LEGS page and the STEP line select key to review the route. The plan mode display is a static display.

Range information shows as circles around the reference point that is in the middle of the display.

The airplane symbol shows the current position and track if the airplane is in the range of the flight plan shown.

Display Data

Ground speed, wind data, and true airspeed show the same as for the APP, VOR, and MAP modes except that the wind direction arrow does not show.

This data shows in the upper right corner:

- Active waypoint identifier
- Estimated time of arrival at the active waypoint
- Distance to the waypoint.

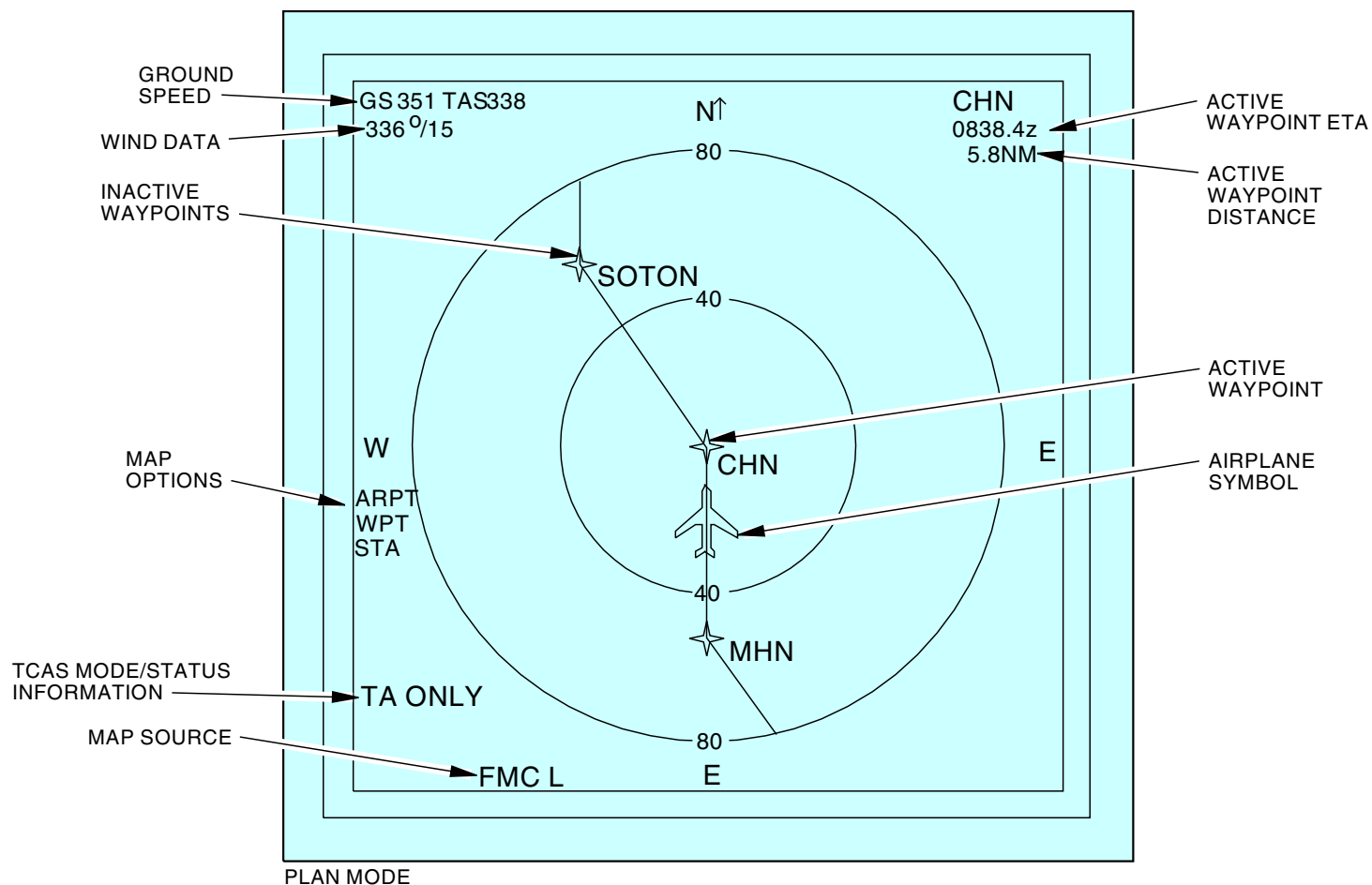
Only TCAS traffic data messages show in the plan mode. TCAS mode/status information shows in the lower left corner.

Symbol Definitions

This data shows:

- Distance to go to the active waypoint (white)
- Estimated time of arrival for the active waypoint (white)
- Active waypoint (next waypoint in active route) (magenta)
- Waypoints other than the active waypoint in the active route (white)
- Options selected on the EFIS control panel (cyan)
- Source of the dynamic and background data (green).

FMCS - DISPLAYS - MDS - PLAN DISPLAY



2370159 S00061521095_V2

FMCS - DISPLAYS - MDS - PLAN DISPLAY

34-61-00-058

EFFECTIVITY
SIA ALL

34-61-00

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**FMCS - DISPLAYS - MDS - NON-NORMAL DISPLAYS****General**

These non-normal messages can show:

- UNABLE REQD NAV PERF - RNP
- MAP RANGE DISAGREE
- RUNWAY DISAGREE.

These non-normal flags can show:

- MAP flag
- Vertical track (VTK).

The UNABLE REQD NAV PERF - RNP message shows when the actual navigation performance (ANP) exceeds the required navigation performance (RNP) for the current flight environment. The map data is not blanked in this condition.

The MAP RANGE DISAGREE message shows when a new range has been selected on the EFIS control panel and new map data is not received from the FMC. All map data is blanked in this condition.

The RUNWAY DISAGREE message shows on the Navigation Display (ND) when the pilot has selected a departure runway into the active flight plan, Global Positioning System (GPS) updating is enabled, and the FMC has detected the beginning of the takeoff roll. The FMC P/RST lights will also illuminate amber on the Auto Flight Status Annunciators (ASA).

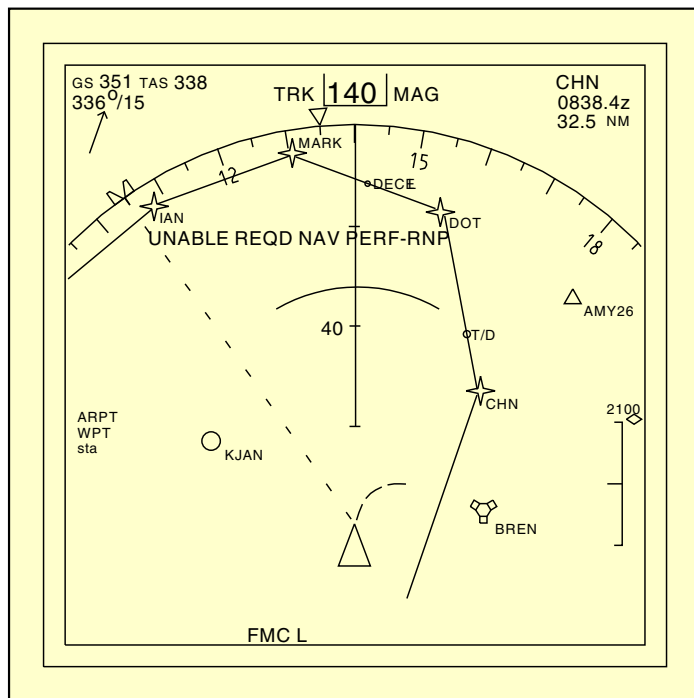
The MAP flag shows if the map data from the FMC is invalid or NCD. All map data is blanked in this condition.

The VTK (vertical track) flag shows when the vertical deviation data from the FMC is invalid or NCD. Only the vertical deviation scale is blanked in this condition.

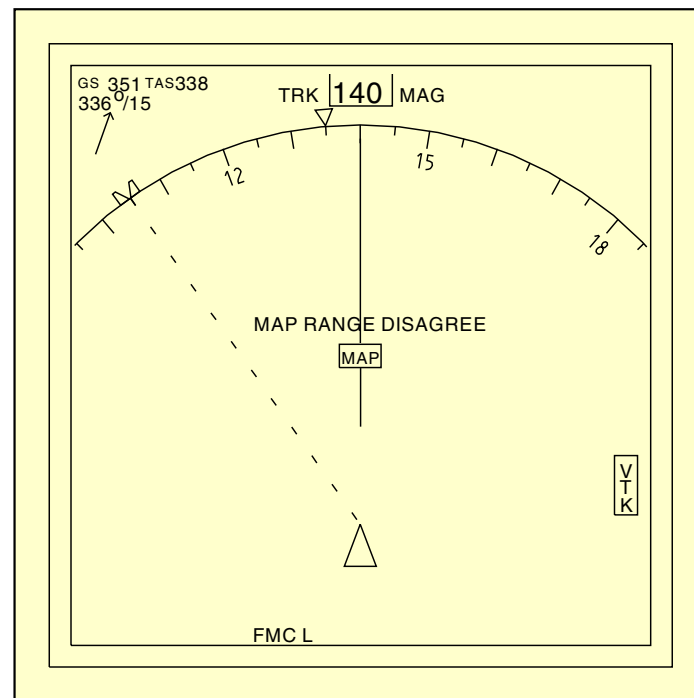
All these non-normal messages and flags can show in the map and plan modes. They are amber.

EFFECTIVITY	
SIA ALL	

FMCS - DISPLAYS - MDS - NON-NORMAL DISPLAYS



EXPANDED MAP MODE



EXPANDED MAP MODE

2370160 S00061521097_V2

FMCS - DISPLAYS - MDS - NON-NORMAL DISPLAYS

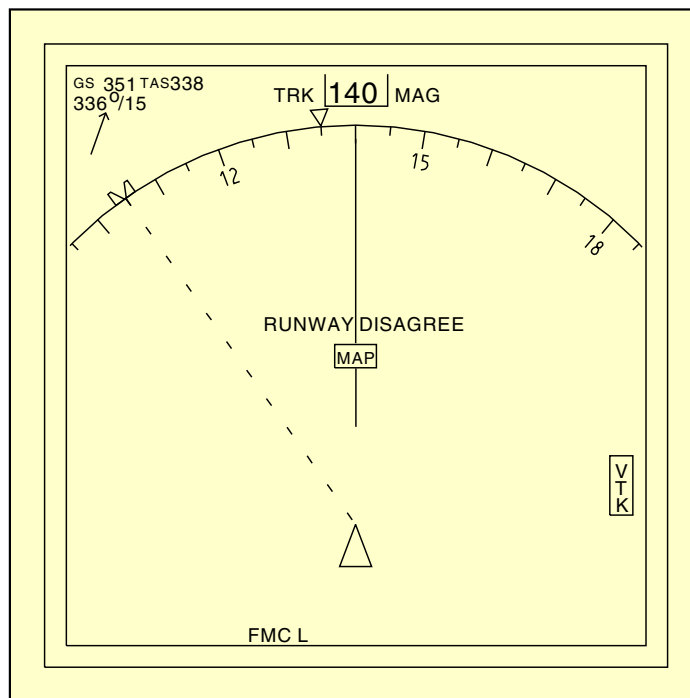
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

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FMCS - DISPLAYS - MDS - NON-NORMAL DISPLAYS



EXPANDED MAP MODE

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FMCS - DISPLAYS - MDS - NON-NORMAL DISPLAYS

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**FMCS - VNAV - SPEED INTERVENTION****General**

The speed intervention function lets the flight crew change the FMC target airspeed without having to disengage VNAV.

Speed Intervention

The flight crew enable speed intervention by pushing the speed intervention pushbutton on the DFCS mode control panel (MCP). The current FMC target airspeed now shows in the MCP speed window and the pilot can change the target speed to the desired value and use the MCP speed selector.

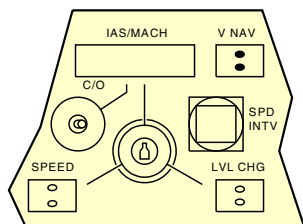
The FMC now uses the entered target airspeed instead of its own calculated value and the active flight plan is not affected. The new selected airspeed shows on the IAS/MACH display and the applicable CLB/CRZ/DES page on the CDUs.

Speed intervention is exited when you push the speed intervention pushbutton again and the FMC now reverts to its own calculated target airspeed. The MCP speed window is blank again. Disengaging VNAV also disables speed intervention.

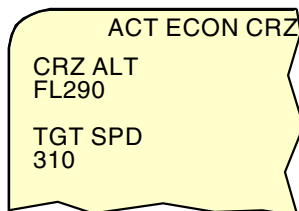
NOTE: If the FMC is flying a path descent (VNAV PATH) and speed intervention is selected, the FMC changes to a speed descent (VNAV SPD).

EFFECTIVITY	
SIA ALL	

FMCS - VNAV - SPEED INTERVENTION

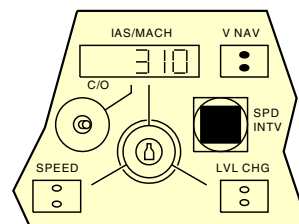


MCP

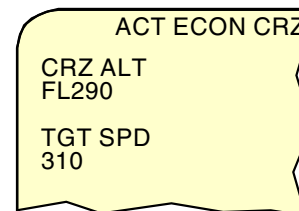


CDU

1 - VNAV ACTIVE SO FMC TARGET SPEED DOES NOT SHOW IN IAS/MACH DISPLAY.

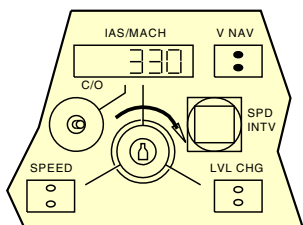


MCP

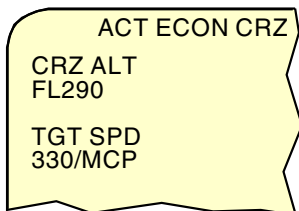


CDU

2 - PUSH SPEED INTERVENTION PUSHBUTTON AND FMC TARGET SPEED SHOWS IN IAS/MACH DISPLAY.

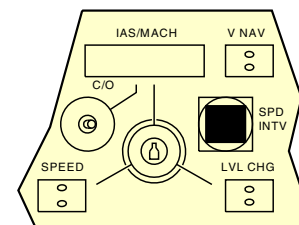


MCP

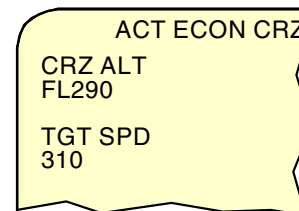


CDU

3 - TURN IAS/MACH SELECTOR TO SELECT NEW FMC SPEED. NEW SPEED SHOWS ON CDU.



MCP



CDU

4 - PUSH SPEED INTERVENTION PUSHBUTTON TO RETURN TO ORIGINAL FMC TARGET SPEED.

2370161 S00061521099_V2

FMCS - VNAV - SPEED INTERVENTION

34-61-00

FMCS - VNAV - ALTITUDE INTERVENTION

General

The altitude intervention function allows the flight crew to do these operations without having to disengage VNAV:

- Delete the next altitude constraint (climb or descent)
- Increase the cruise altitude while in the climb phase
- Resume a climb or descent after holding an MCP altitude
- Cruise climb/descent transition.

Altitude Constraint Deletion

During a climb or a descent, the next altitude constraint may be deleted by setting the DFCS mode control panel (MCP) altitude above/below the next altitude constraint in the flight plan and pressing the altitude intervention pushbutton. The airplane will now climb/descend to the MCP selected altitude. Up to a maximum of eight altitude constraints can be deleted using the altitude intervention pushbutton.

During a descent, if the MCP altitude is set to or above the end of descent (E/D) altitude, the airplane will descend at 1000 feet/minute until it gets to the altitude from where it can make the planned VNAV PATH descent. If the MCP altitude is set to below the E/D altitude, the airplane will descend in VNAV SPD mode.

Increase Cruise Altitude during Climb

During the climb or cruise phases of the flight, the flight crew can increase the cruise altitude by setting the higher altitude in the MCP and pressing the altitude intervention pushbutton. In order to do this in the climb, there must be no altitude constraints in the climb phase.

If the selected altitude is above the maximum allowable cruise altitude, the use of the altitude intervention pushbutton does not change the cruise altitude and the message MAX ALT FLXXX shows in the CDU scratchpad.

NOTE: Cruise altitude can not be decreased using altitude intervention.

Resuming Climb/Descent

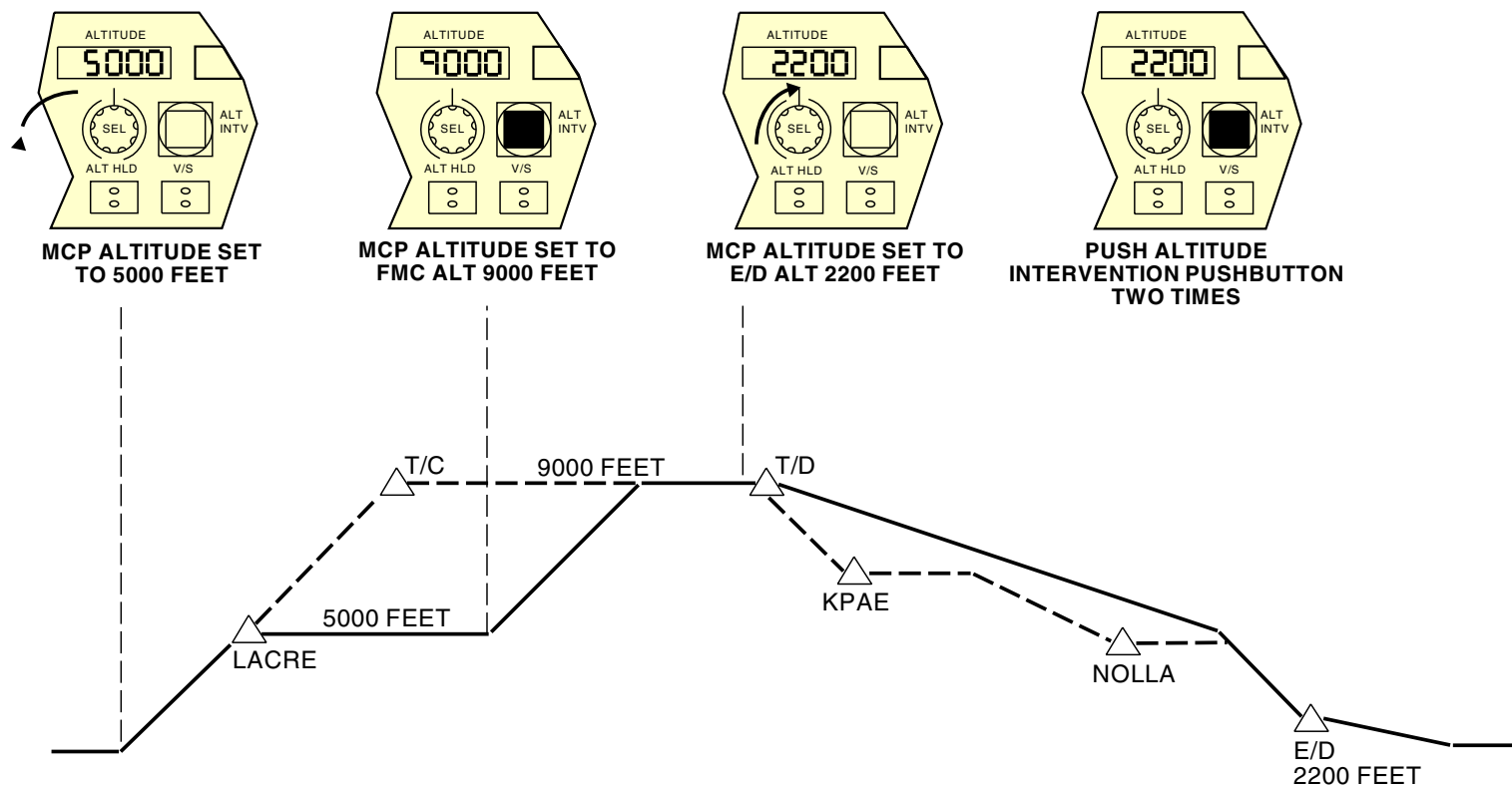
During a hold of the selected MCP altitude, the flight crew can resume the climb/descent by setting the new altitude in the MCP and pressing the altitude intervention pushbutton.

Cruise Climb/Descent Transition

During the cruise phase of the flight, the flight crew can select a cruise climb to a higher altitude by setting the new altitude on the MCP and pressing the altitude intervention pushbutton.

Also, the flight crew can select a lower altitude on the MCP and pressing the altitude intervention pushbutton will initiate a transition to descent to the selected altitude.

FMCS - VNAV - ALTITUDE INTERVENTION



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FMCS - VNAV - ALTITUDE INTERVENTION

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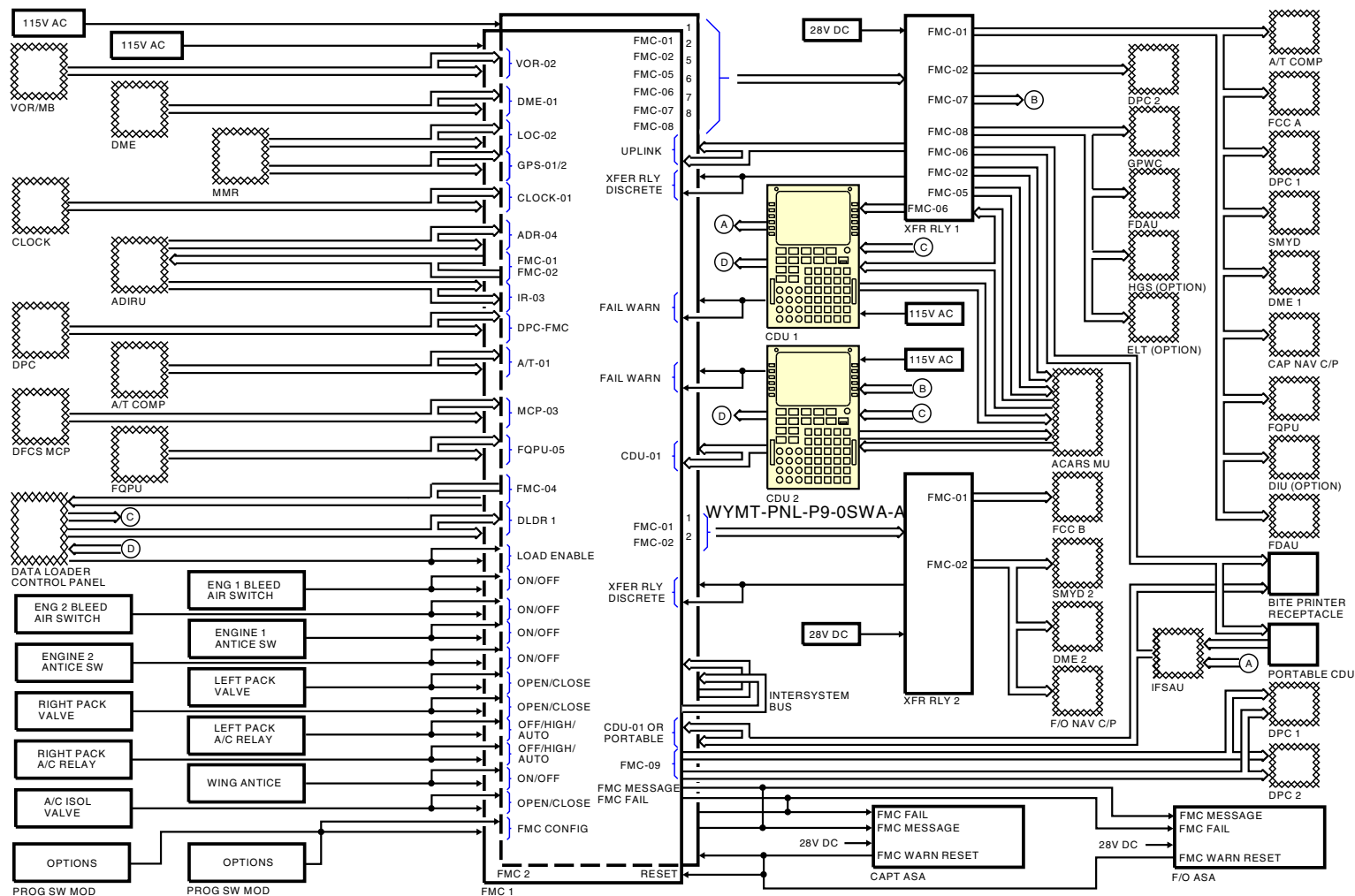
FMCS - SYSTEM SUMMARY

General

This page is for reference.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

FMCS - SYSTEM SUMMARY

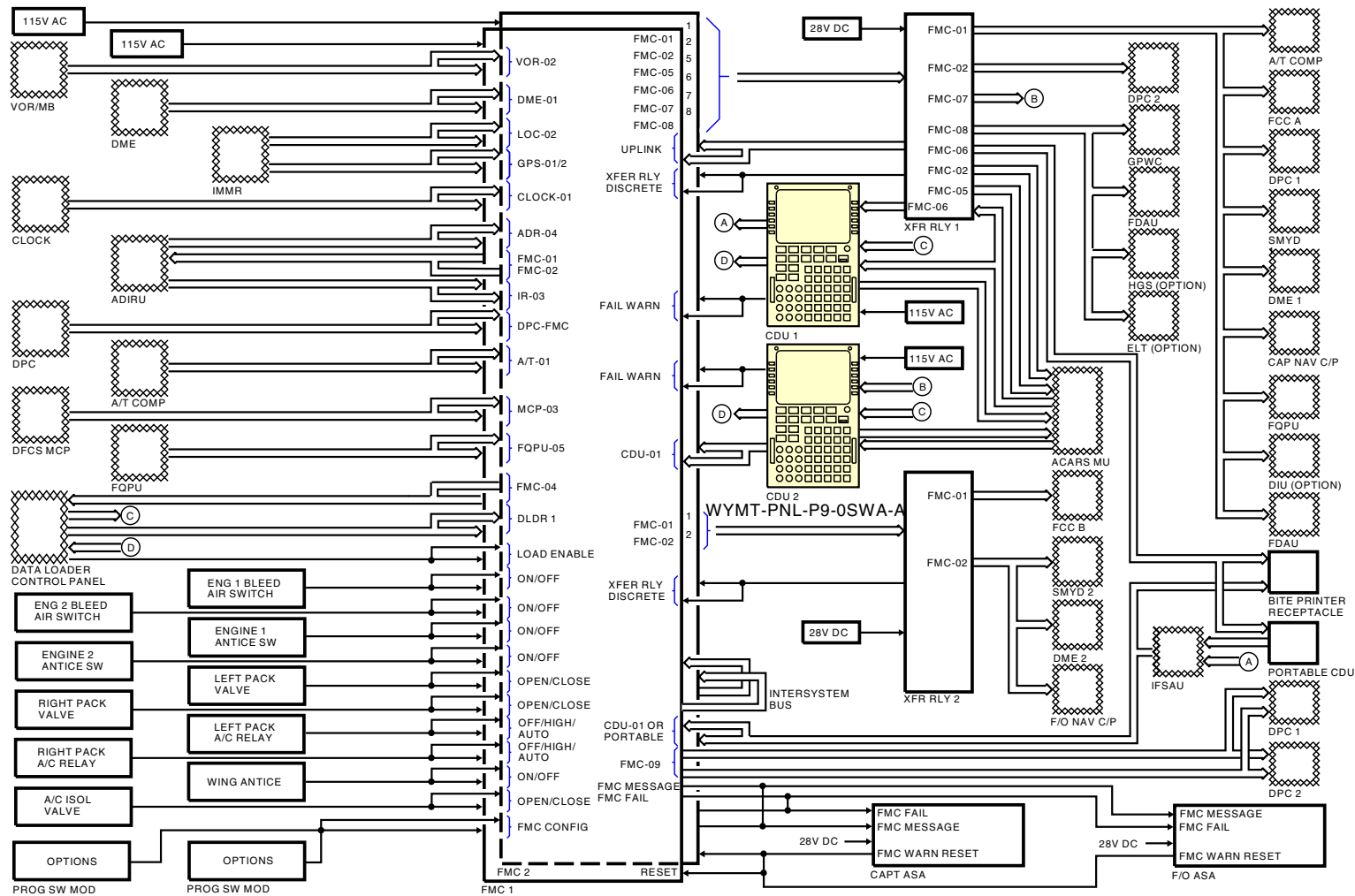


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FMCS - SYSTEM SUMMARY

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FMCS - SYSTEM SUMMARY



2804407 S0000643445_V1

FMCS - SYSTEM SUMMARY

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