

CHAPTER

77

Engine Indicating

(LEAP-1B ENGINES)

CHAPTER 77
ENGINE INDICATING

Subject/Page	Date	COC	Subject/Page	Date	COC
77-EFFECTIVE PAGES			77-11-00 (cont.)		
1	Sep 15/2023		11	Sep 15/2021	
2	BLANK		12	BLANK	
77-CONTENTS			77-21-00		
1	Sep 15/2021		1	Sep 15/2021	
2	BLANK		2	Sep 15/2021	
77-00-00			3	Sep 15/2021	
1	Sep 15/2021		4	Sep 15/2021	
2	Sep 15/2021		5	Sep 15/2021	
3	Sep 15/2021		6	Sep 15/2021	
4	Sep 15/2021		7	Sep 15/2021	
5	Sep 15/2021		8	Sep 15/2021	
6	May 15/2022		9	Sep 15/2021	
7	Sep 15/2021		10	BLANK	
8	BLANK		77-31-00		
77-11-00			1	Sep 15/2021	
1	Sep 15/2021		2	Sep 15/2021	
2	Sep 15/2021		3	Sep 15/2021	
3	Sep 15/2021		4	Sep 15/2021	
4	Sep 15/2021		5	Sep 15/2021	
5	Sep 15/2021		6	Sep 15/2021	
6	Sep 15/2021		7	Sep 15/2021	
7	Sep 15/2021		8	BLANK	
8	Sep 15/2021				
9	Sep 15/2021				
10	Sep 15/2021				

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

77-EFFECTIVE PAGES

**CHAPTER 77
ENGINE INDICATING**

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
77-00-00	ENGINE INDICATING - INTRODUCTION	2	SIA ALL
77-00-00	ENGINE INDICATING - GENERAL DESCRIPTION	5	SIA ALL
77-11-00	ENGINE TACHOMETER SYSTEM - GENERAL DESCRIPTION	2	SIA ALL
77-11-00	ENGINE TACHOMETER SYSTEM - N1 SPEED SENSOR	4	SIA ALL
77-11-00	ENGINE TACHOMETER SYSTEM - N2 SPEED SENSOR	6	SIA ALL
77-11-00	ENGINE TACHOMETER SYSTEM - FUNCTIONAL DESCRIPTION	9	SIA ALL
77-21-00	EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - GENERAL DESCRIPTION	2	SIA ALL
77-21-00	EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - EGT THERMOCOUPLES AND HARNESSSES	4	SIA ALL
77-21-00	EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION	7	SIA ALL
77-31-00	VIBRATION MONITORING SYSTEM (VMS) - GENERAL DESCRIPTION	2	SIA ALL
77-31-00	VIBRATION MONITORING SYSTEM - COMPONENT LOCATION	4	SIA ALL
77-31-00	VIBRATION MONITORING SYSTEM - FUNCTIONAL DESCRIPTION	6	SIA ALL

77-CONTENTS



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-00-00



ENGINE INDICATING - INTRODUCTION

Purpose

The engine indicating system supplies engine data to the MAX display system (MDS). The engine indicating system has these subsystems:

- Low pressure rotor tachometer (N1)
- High pressure rotor tachometer (N2)
- Exhaust gas temperature (EGT)
- Airborne vibration monitoring (AVM).

The MDS usually shows engine indication (EI) data on the left or right inboard display unit (DU). EI data can also show on one of the outboard DUs if the inboard display unit on that side has a failure.

Abbreviations and Acronyms

- altn - alternate
- ACMS - airplane condition monitoring system
- AGB - accessory gearbox
- AMP - amplitude
- AVM - airborne vibration monitoring
- BB - broadband
- CONT - continuous
- CU - cockpit unit
- DFDAU - digital flight data acquisition unit
- DPC - display processing computer
- DSP - digital signal processor
- DU - display unit
- EEC - electronic engine control
- EGT - exhaust gas temperature
- EHM - engine health management
- EI - engine indication
- EPCS - electronic propulsion control system
- FDR - flight data recorder

- FMCS - flight management computer system
- GRD - ground
- HPC - high pressure compressor
- HPT - high pressure turbine
- LPC - low pressure compressor
- LPT - low pressure turbine
- MFP - multi-function panel
- MDS - MAX display system
- N1 - low pressure rotor
- N2 - high pressure rotor
- NFS - network file server
- NOB - number one bearing
- NVM - non-volatile memory
- ONS - onboard network system
- PMA - permanent magnet alternator
- PMD - portable maintenance device
- SPD REF - speed reference
- TCF - turbine center frame
- VIB - vibration

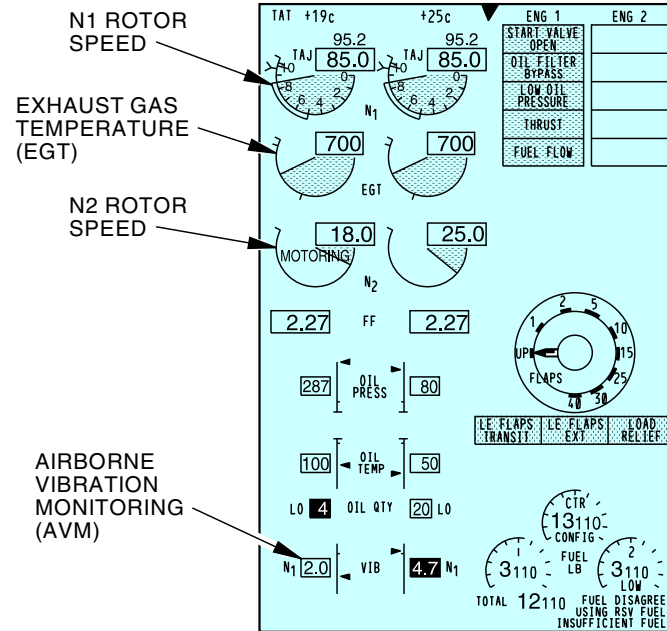
77-00-00

SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ENGINE INDICATING - INTRODUCTION



ENGINE INDICATION (EI) DISPLAY
(INBOARD DISPLAY UNIT)

2370693 S00061522275_V2

ENGINE INDICATING - INTRODUCTION

77-00-00

SIA ALL	EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-00-00



ENGINE INDICATING - GENERAL DESCRIPTION

General

The engine indicating system shows these parameters for each engine:

- Low pressure rotor speed (N1)
- High pressure rotor speed (N2)
- Exhaust gas temperature (EGT)
- Engine vibration (VIB).

Electronic Engine Control

The electronic engine controls (EECs) receive an analog input from these engine sensors:

- N1 speed sensor
- N2 speed sensor
- EGT probes (T48)
- Number 1 bearing accelerometer
- Turbine center frame (TCF) accelerometer.

The EECs change the analog signals to digital signals. The EECs send the digital signals on an ARINC 429 data bus to two display processing computers (DPC)s for the engine indication. Auxiliary analog N1 and N2 parameters go directly to the DPCs. They do not go through the EECs.

The EECs also have an Ethernet (ARINC 615A) interface with the network file server (NFS) for the engine health management (EHM) functions. The EHM uses engine configuration data and flight data to calculate the trim balance solution for the engine. The trim balance procedure uses the vibration data from the No. 1 bearing and the turbine center frame accelerometers. The EHM is only available on the portable maintenance device (PMD). Access to the EHM is through the OTHER FUNCTIONS menu in the ONBD MAINT function.

See the onboard network system (ONS) section for more information on the EHM. (SECTION 46-13)

The EECs attach to the right side of the engine fan case. The EECs are part of the engine fuel and control system. See the engine fuel and control chapter for more functional description information on the EEC. (CHAPTER 73)

Display Processing Computer

The two display processing computers (DPCs) use digital input from the EECs to show these engine parameters on the MAX display system (MDS):

- N1
- N2
- EGT
- VIB.

The DPCs send the data to the MDS through a fiber-optic cable.

The DPCs use their analog N1 and N2 signals as auxiliary inputs when the EECs do not have electrical power. The EGT and the engine vibration indication shows only when the EECs have electrical power.

The DPCs have an Ethernet (ARINC 615A) interface with the ONS in the NFS, for the software data loading function. The DPCs have an ARINC 429 interface with the digital flight data acquisition unit (DFDAU). The engine indication (EI) application in the DPCs transmits many engine parameters to the DFDAU. The DFDAU records these parameters. The DFDAU also supplies data back to the DPCs through the ARINC 429 bus.

Network File Server

The network file server (NFS) has an Ethernet (ARINC 615A) interface with the DFDAU for the airplane condition monitoring system (ACMS). The ACMS collects maintenance data and makes reports that let the airline do trend analysis of the data. These are the baseline ACMS reports:

- Engine exceedance
- Engine fault snapshot
- Engine in-flight failure
- Engine performance

77-00-00

SIA ALL EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ENGINE INDICATING - GENERAL DESCRIPTION

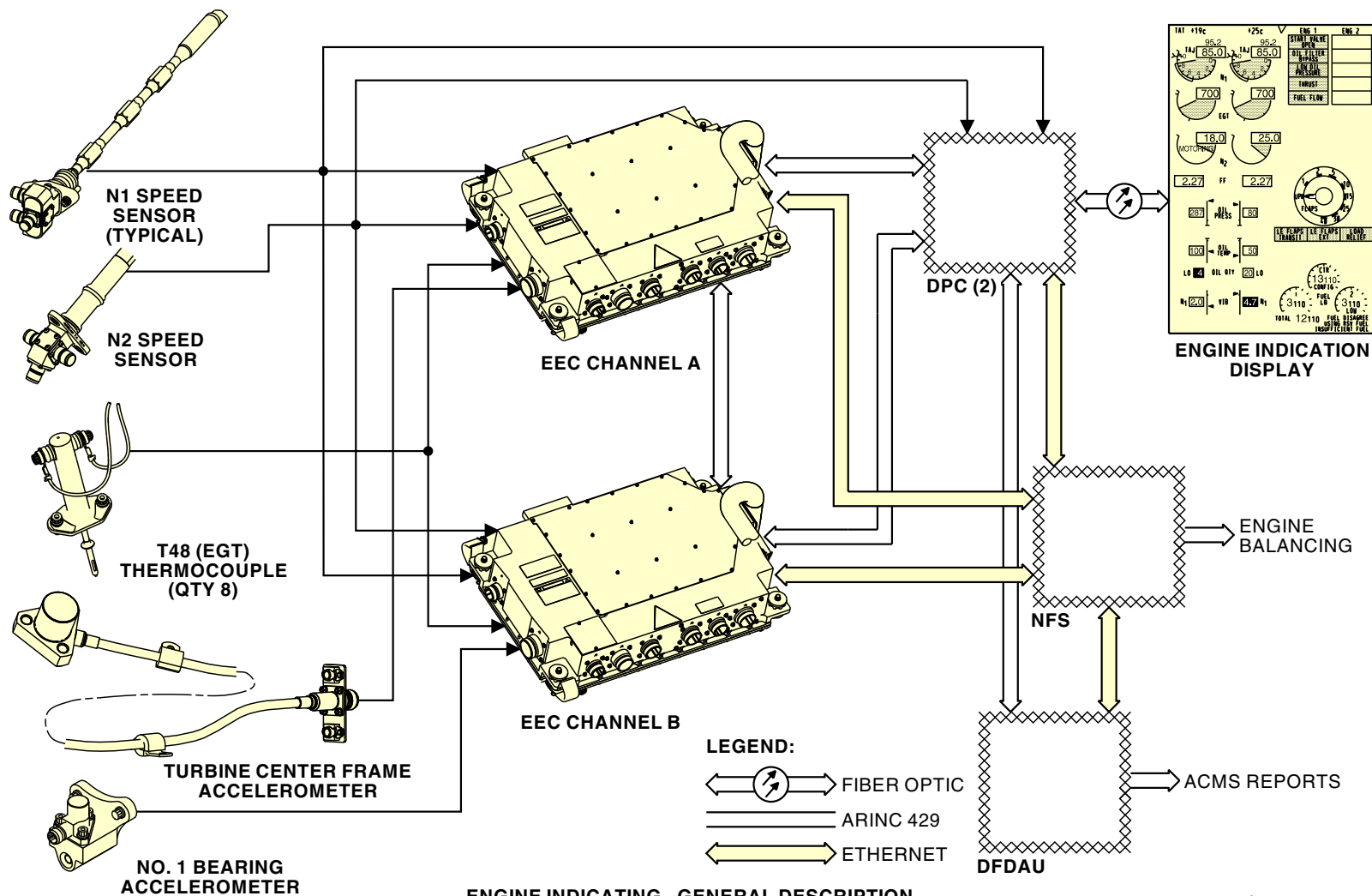
- Engine start.

This data also lets the airline do troubleshooting of airplane problems with real-time flight data.

Access to the ACMS functions is through the control display unit (CDU).

SIA ALL	EFFECTIVITY
D633AM102-SIA	

ENGINE INDICATING - GENERAL DESCRIPTION



ENGINE INDICATING - GENERAL DESCRIPTION
ENGINE INDICATING - GENERAL DESCRIPTION

2370694 S00061522277_V2

77-00-00-002

SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

77-00-00



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-11-00

**ENGINE TACHOMETER SYSTEM - GENERAL DESCRIPTION****Purpose**

The engine tachometer system supplies the engine low pressure rotor (N1) and the engine high pressure rotor (N2) speed signals to these components:

- Electronic engine controls (EECs)
- Display processing computers (DPCs).

General Description

Each EEC channel gets an analog signal from the N1 and the N2 speed sensors. The EECs change these analog signals to digital signals.

The EECs use the two signals for channel A and channel B operation. Each channel sends data to each DPC on an ARINC 429 data bus.

Usually, the DPCs use inputs from the EECs to show N1 and N2 on the MAX display system (MDS). The DPCs can also use the analog input directly from the speed sensors to show N1 and N2 indications. The DPCs send the data to the display unit through a fiber-optic cable. N1 and N2 speeds show on the engine indication (EI) display of the MDS. N1 and N2 speeds also show on the electronic propulsion control system (EPCS) maintenance data pages and the PERFORMANCE maintenance data page.

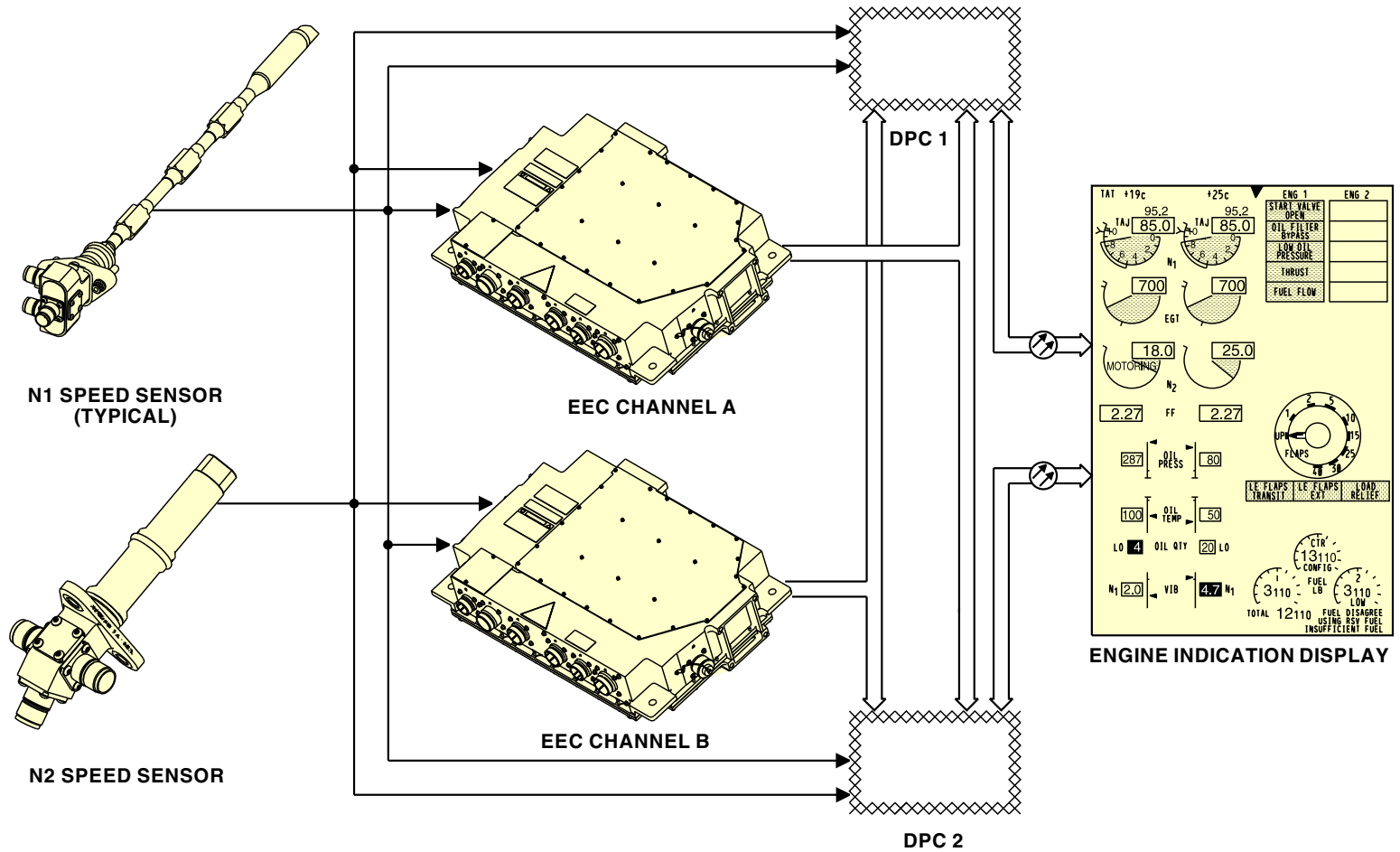
The AVM function in the EECs receives an analog input from the speed sensors to help calculate vibration levels. See the AVM system section for more information. (SECTION 77-31)

77-11-00**SIA ALL EFFECTIVITY**

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ENGINE TACHOMETER SYSTEM - GENERAL DESCRIPTION



2370698 S00061522287_V2

ENGINE TACHOMETER SYSTEM - GENERAL DESCRIPTION

77-11-00-001

SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

77-11-00

**ENGINE TACHOMETER SYSTEM - N1 SPEED SENSOR****Purpose**

The N1 speed sensor measures the rotational speed of the low pressure (LP) rotor for:

- Engine control
- Vibration monitoring
- Flight deck indication.

The procedure for the fan trim balance also uses the signal from the N1 speed sensor.

The sensor supplies the speed signal to the electronic engine controls (EECs) and the display processing computers (DPCs).

Component Location

The N1 speed sensor is installed in a guide tube, in a strut at the 5 o'clock position of the fan hub. Only see the housing with the electrical connectors is visible when the sensor is on the engine. The right thrust reverser must be opened to get access to the N1 speed sensor.

Physical Description

The N1 sensor has three independent sensing elements at its end. Each sensing element has a pole piece and an electrical winding around a magnet. The N1 sensor has three electrical connectors. One connector is for the DPCs, one is for EEC channel A, and one is for EEC channel B.

The housing of the speed sensor touches the end of the guide tube when it is installed. When the bolts that attach the speed sensor into its position are tightened, a spring in the speed sensor housing is compressed. The spring pressure on the speed sensor decreases speed sensor vibration.

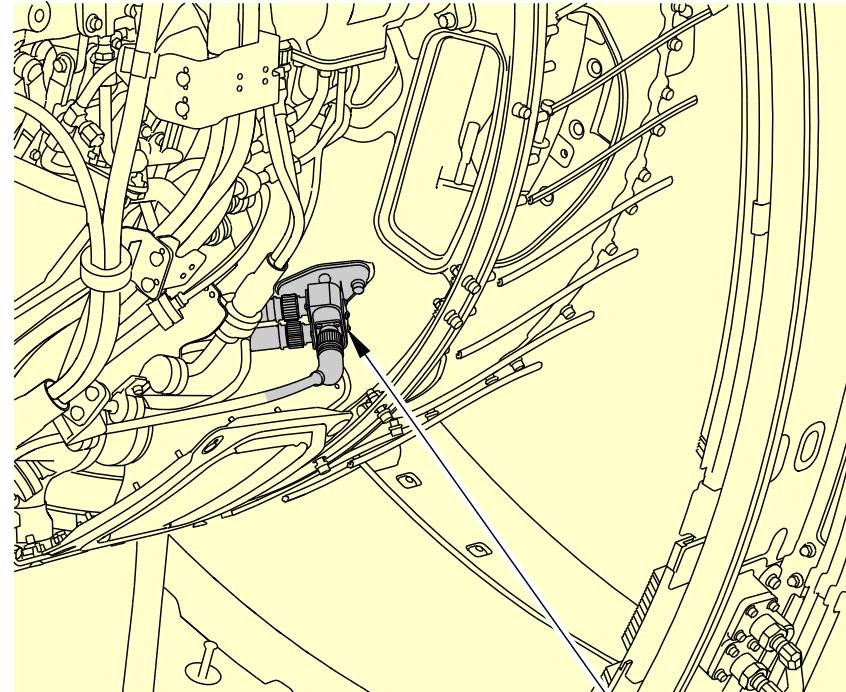
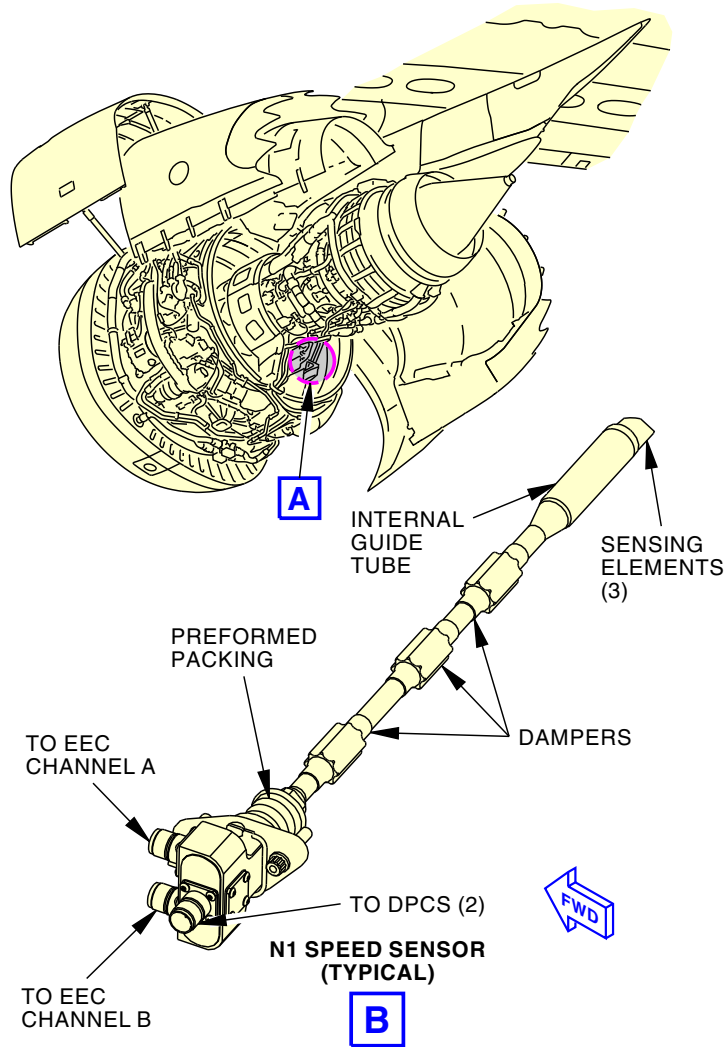
The damper(s) on the speed sensor shaft is to prevent sensor vibration.

77-11-00**SIA ALL EFFECTIVITY**

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ENGINE TACHOMETER SYSTEM - N1 SPEED SENSOR



N1 SPEED SENSOR

ENGINE TACHOMETER SYSTEM - N1 SPEED SENSOR

2370699 S00061522289_V2

**ENGINE TACHOMETER SYSTEM - N2 SPEED SENSOR****Purpose**

The N2 speed sensor measures the rotational speed of the high pressure (HP) rotor for:

- Engine control
- Vibration monitoring
- Over-speed detection
- Flight deck indication.

The sensor supplies the high pressure rotor speed signal to the electronic engine controls (EECs) and the display processing computers (DPCs).

Component Location

The N2 speed sensor is on the engine accessory gearbox (AGB) at the 7 o'clock position. The left fan cowl must be opened to get access to the N2 speed sensor.

Physical Description

The N2 sensor has three independent sensing elements at its end. Each element has a pole piece and an electrical winding around a magnet.

The N2 sensor has three electrical connectors. One connector is for the DPCs, one is for EEC channel A, and one is for EEC channel B.

EFFECTIVITY	
SIA ALL	



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-11-00

**ENGINE TACHOMETER SYSTEM - FUNCTIONAL DESCRIPTION****General**

The speed of the engine low pressure rotor shows in percent N1.

The speed of the engine high pressure rotor shows in percent N2.

Usually, the display processing computers (DPCs) use inputs from the electronic engine controls (EECs) to show N1 and N2. The DPCs use the analog signals directly from the speed sensors if the EECs do not supply a digital input.

N1 Actual (Digital Display and Pointer)

The N1 Actual is a digital display that shows the current engine fan speed. It shows in units of percent. The N1 digital display and the box around the digital display are white when N1 is less than the N1 redline.

A pointer on a circular dial also shows N1 speed. A shaded area follows this pointer. The pointer is usually white. The shaded area is usually gray.

These indications change to red when N1 is more than the N1 redline:

- N1 digital display
- Box around the N1 digital display
- N1 pointer
- Shaded area.

When N1 speed goes below the redline limit, the indication goes back to the usual color.

At engine shutdown, the box around the digital display changes to red if there was an N1 exceedance during engine operation.

N1 Redline

The N1 redline shows the maximum approved engine low pressure rotor speed for the LEAP-1B engine. The EECs supply the redline values to the DPCs. The redline shows in red.

N1 Command Sector

The command sector shows when there is a difference between the current N1 speed and the commanded N1 speed. The EECs use the thrust lever angle position to set the commanded N1.

The commanded N1 shows at the top edge of the command sector when the thrust lever position is more than the current engine speed. It shows at the lower edge of the command sector when the thrust lever position is less than the current engine speed.

The command sector and N1 command are white.

N1 Reference Bug

The N1 reference bug shows the N1 thrust target position. The N1 reference bug is green. The flight management computers (FMCs) usually calculate the bug position and send it to the DPCs.

The flight crew can set the position of the N1 reference bug manually. Use the N1/SPD REF (speed reference) SET page to set the position. The N1/SPD REF SET page shows on the control display unit (CDU) when you push the N1/SPD REF button.

The N1 reference digital display also shows the N1 thrust target position. The display is green and shows above the N1 digital display.

See the FMCS section for more information about the N1 target. (SECTION 34-61)

N2 Digital Display and Pointer

The N2 digital display and the box around the digital display are white when N2 is less than the N2 redline.

A pointer on a circular dial also shows N2 speed. A shaded area follows this pointer. The pointer is usually white. The shaded area is usually gray.

These indications change to red when N2 is more than the N2 redline:

- N2 digital display
- Box around the N2 digital display

77-11-00

SIA ALL

EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ENGINE TACHOMETER SYSTEM - FUNCTIONAL DESCRIPTION**

- N2 pointer
- Shaded area.

When N2 speed goes below the redline limit, the indication goes back to the usual color.

At engine shutdown, the box around the digital display changes to red if there was an N2 exceedance during engine operation.

N2 Redline

The N2 redline shows the maximum approved engine high pressure rotor speed for the LEAP-1B engine. The EECs supply the redline value to the DPCs. The redline shows in red.

N1 and N2 Exceedances

The DPCs calculate and keep N1 and N2 exceedance data. Red line exceedances and the time of the exceedances show on the engine exceedance maintenance data page.

Maintenance Data Pages

N1 data and N2 data for each engine shows on the performance maintenance data page. Only the data from the EEC channel in control shows on the performance maintenance page.

N1 data and N2 data for each engine also shows on the electronic propulsion control system (EPCS) maintenance data pages. Data from the 2 EEC channels shows on the EPCS pages.

THRUST Alert Message

In flight, if the engine does not give the commanded thrust, the EECs send a signal to the DPCs. This causes the amber THRUST alert message to show. The EEC sends a high engine thrust or a low engine thrust discrete on the ARINC 429 data bus. The THRUST alert flashes for 10 seconds, then shows continuously. Also, the adjacent message blocks for the same engine flash but do not show text. The message stops when the over-thrust or the under-thrust condition stops.

The DPCs inhibit the flash mode for the takeoff and the landing. The THRUST message shows but the indication does not flash.

There is one THRUST alert message for each engine. Alert messages show in the top right corner of the engine indication (EI) display.

FUEL FLOW Alert Message

The EECs send the fuel flow data from the fuel flow meter to the DPCs for the flight deck indication. The fuel flow data also goes to the FMCS. The FMCS continuously calculate the fuel used by each engine and the APU. It also calculates the total fuel used, the total fuel that remains and an estimate of the fuel that remains at the end of the flight.

In cruise flight, the FMC compares the indicated fuel flow and the expected fuel flow. If the difference is more than the threshold limit for 5 minutes, the FMC supplies the logic for the FUEL FLOW alert message to show. The FUEL FLOW alert message flashes for 10 seconds then shows continuously. Also, the adjacent message blocks for the same engine flash but do not show text. The message stops when the fuel flow difference stops.

The DPCs inhibit the flash mode for the takeoff and the landing. When the inhibit is active, the FUEL FLOW message shows but the indication does not flash.

There is one FUEL FLOW alert message for each engine. Alert messages show in the top right corner of the EI display.

Engine Failure Annunciation

The amber ENG FAIL message shows on the related EGT display if all of these conditions occur:

- The two engine speeds are at or above idle
- The two engine fire handles are stowed
- The two start levers are in the idle position
- One of the two engine N2 speed then goes below idle.

The alert stops when the engine speed goes to idle or more, or the crew moves the engine start lever to the CUTOFF position.

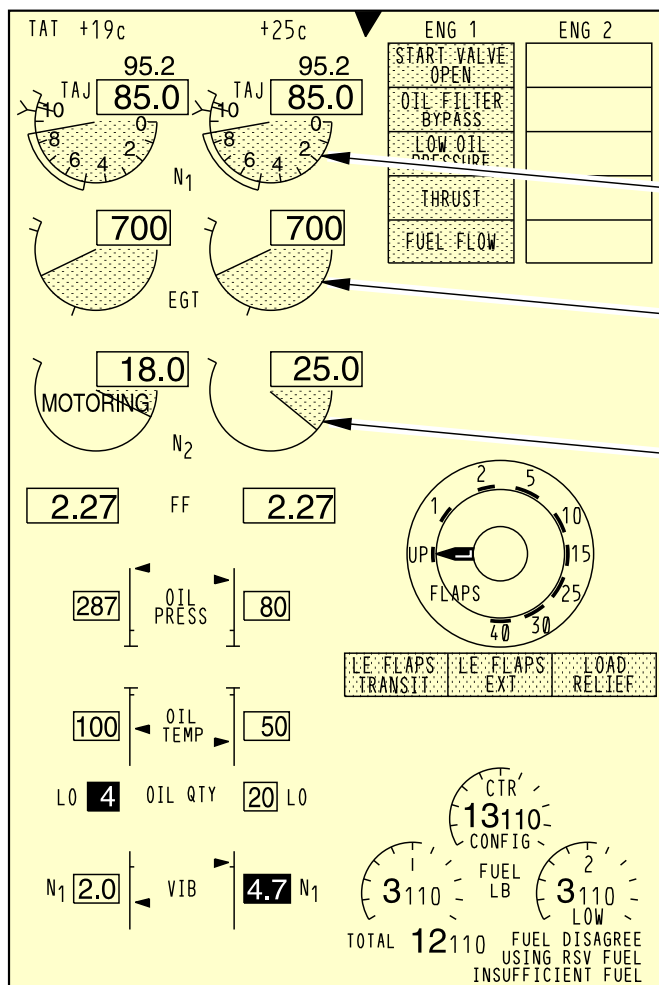
77-11-00

EFFECTIVITY
SIA ALL

D633AM102-SIA

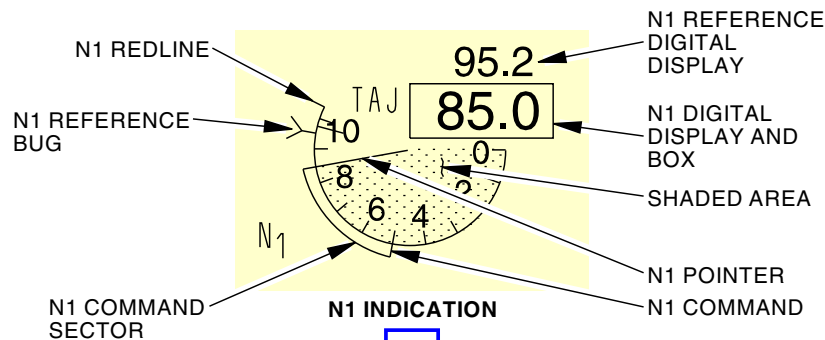
ECCN 9E991 BOEING PROPRIETARY - See title page for details

ENGINE TACHOMETER SYSTEM - FUNCTIONAL DESCRIPTION



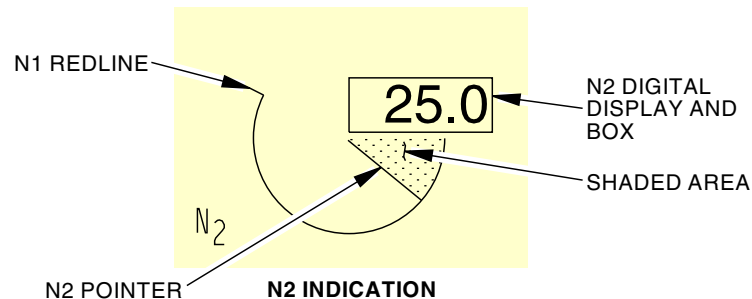
ENGINE INDICATION (EI) DISPLAY

ENGINE TACHOMETER SYSTEM - FUNCTIONAL DESCRIPTION



ENG FAIL

ENGINE FAIL MESSAGE



2370701 S00061522293_V1



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-21-00

**EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - GENERAL DESCRIPTION****Purpose**

The exhaust gas temperature (EGT) indication system monitors the exhaust gas temperature at the stage one nozzle of the low pressure turbine.

General Description

The EGT system has eight sensors and two EGT harness assemblies. Each assembly has four of the sensors and supplies input to the electronic engine controls (EECs).

The EECs use the EGT signals to measure the T48 temperature at:

- Engine start
- Engine re-light
- Engine normal operation.

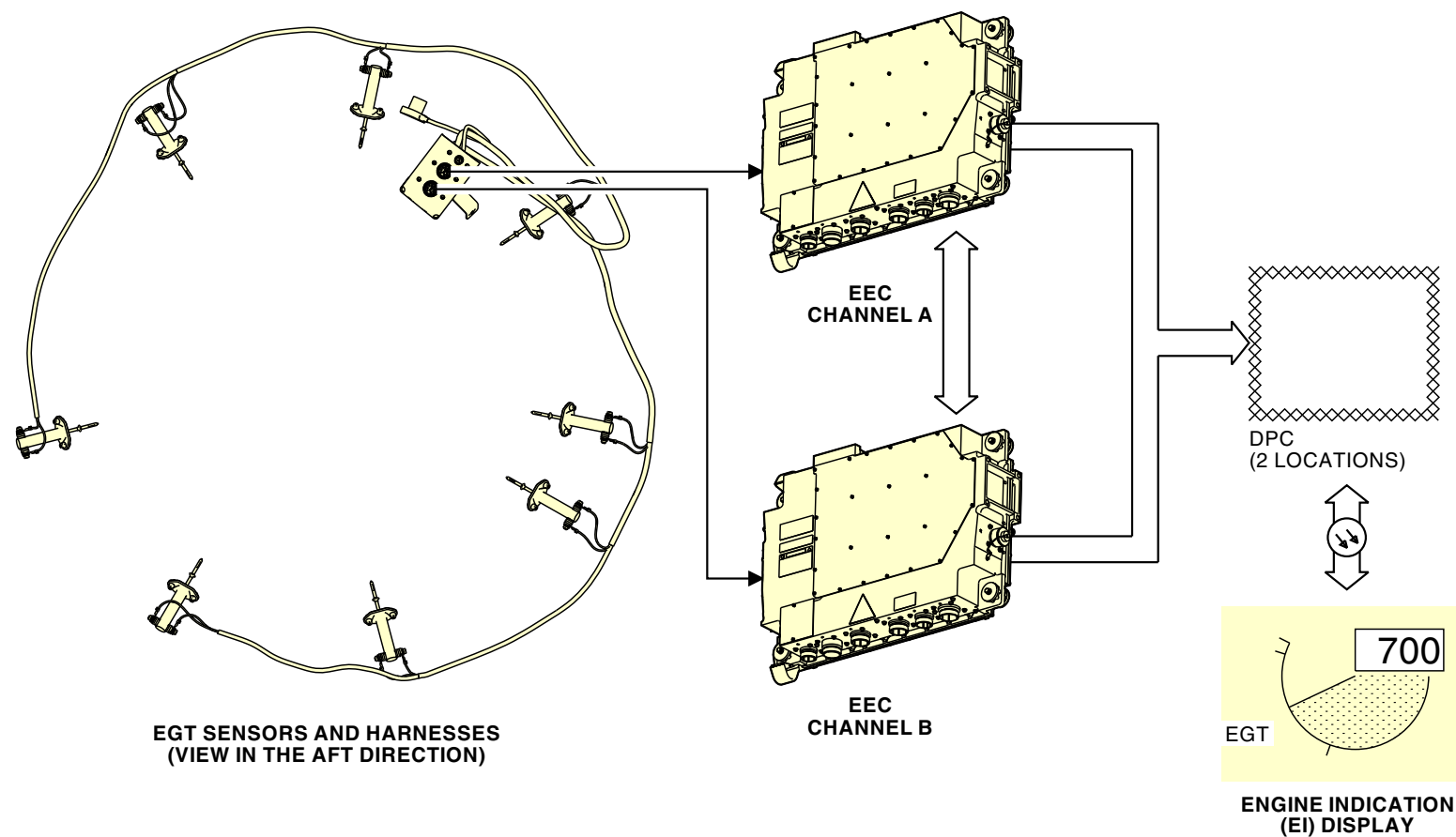
The EECs also use the signals to calculate the EGT margin. The EGT margin is the difference between the maximum permitted EGT (the EGT red-line) and the highest EGT that occurs on the engine during the takeoff. The EGT margin is an indicator of engine performance deterioration.

The EECs send the EGT data to the display processing computers (DPCs) on an ARINC 429 bus.

The DPCs are part of the MAX display system (MDS). The DPCs send the EGT data to show on the engine indication (EI) page. The EI page usually shows on the inboard display unit (DU). EGT data also shows on the electronic propulsion control system (EPCS) maintenance pages and on the PERFORMANCE maintenance page.

EFFECTIVITY	
SIA ALL	

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - GENERAL DESCRIPTION



2370702 S00061522297_V1

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - GENERAL DESCRIPTION

77-21-00-001

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

77-21-00

**EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - EGT THERMOCOUPLES AND HARNESSSES****General**

There are eight EGT (T48) sensors and two EGT harnesses on each engine. The two EGT harnesses connect the sensors to two engine harnesses. The engine harnesses connect to the EECs.

Purpose

The EGT sensors supply analog signals in proportion to the exhaust gas temperature.

The EGT harnesses send the sensor signals to the EECs. The EECs use these signals for the engine control and indication.

Component Locations

The sensors measure the temperature at the stage one nozzle of the low pressure turbine (LPT). The turbine center frame (TCF) holds the sensors in their position. Each EGT sensor has one sensing element that has two conductive wires. A housing contains the conductive wires in a protective coil. The protective coil has the shape of a spring to push and seal the interface between the EGT sensor and the stage one nozzle. This makes sure that there is the correct depth of the sensor in the engine gaspath.

The sensors are numbered from 1 to 8, counterclockwise, aft looking forward on the turbine center frame. Sensor number 1 is installed at the 10 o'clock position. Sensor number 8 is installed at the 12 o'clock position. All of the EGT sensors are the same and are interchangeable.

There are two EGT harnesses, a left harness and right harness. The left harness connects EGT sensor number 1, 8, 7, and 6 to EEC channel A. The right harness connects EGT sensor number 2, 3, 4, and 5 to EEC channel B. Wires at the top of the sensor housing connect the sensor to the EGT harness.

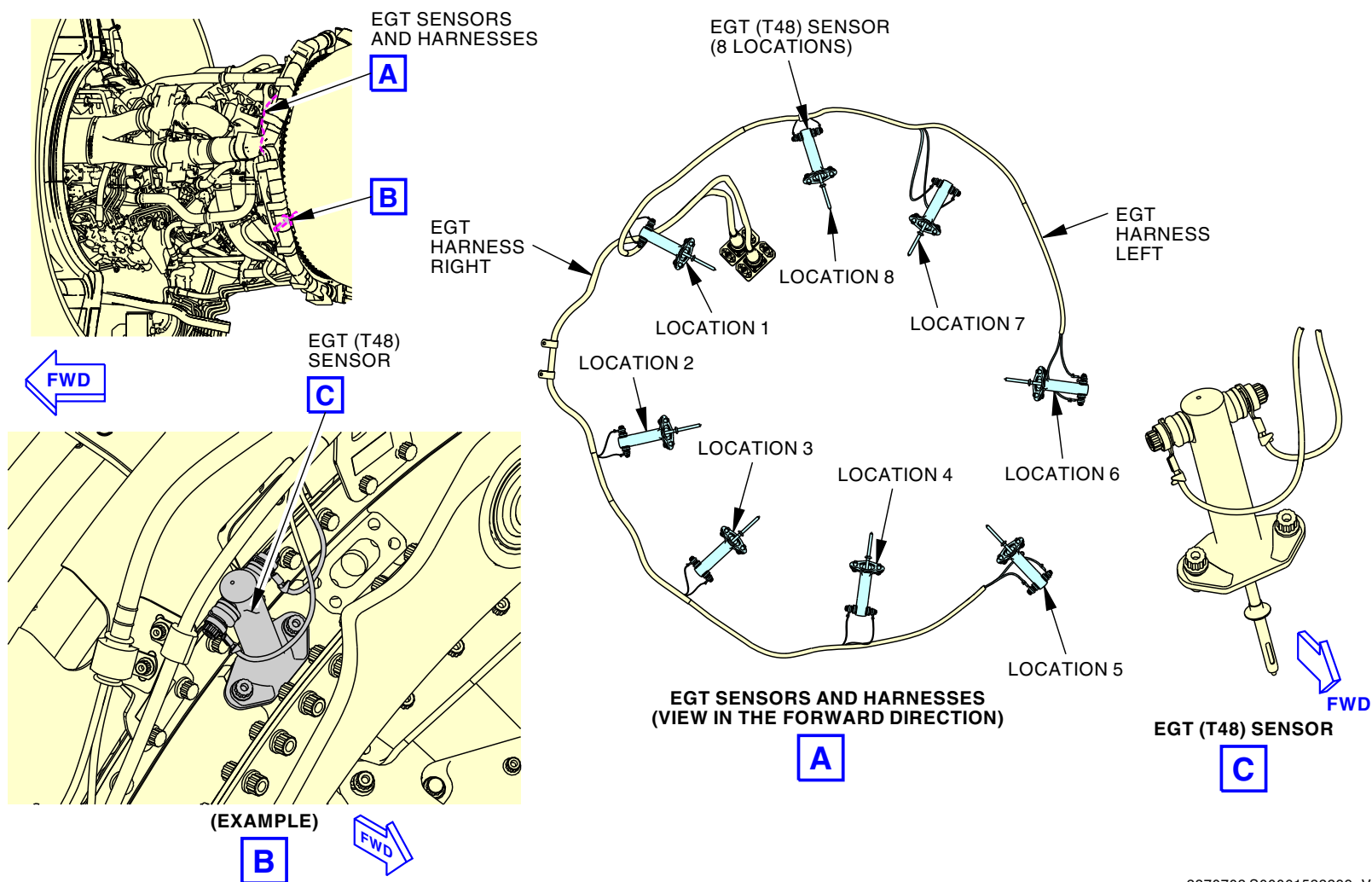
77-21-00

EFFECTIVITY	
SIA ALL	

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - EGT THERMOCOUPLES AND HARNESSES



2370703 S00061522299_V2

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - EGT THERMOCOUPLES AND HARNESSES



THIS PAGE IS INTENTIONALLY LEFT BLANK

77-21-00

**EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION****General**

The electronic engine controls (EECs) send the exhaust gas temperature (EGT) data to the MAX display system (MDS) display processing computers (DPCs). The temperature that shows is an average from the eight EGT sensors on the engine.

When the EECs are de-energized, they do not send the EGT data. The digital display, pointer, and shaded area then go blank.

The EECs energize when one of these conditions occurs:

- The engine start lever is set to the IDLE position
- The engine start switch is set to the ground (GRD) position
- The engine start switch is set to the continuous (CONT) position
- The N2 speed is >8.5%. (This is when the PMA supplies power to the EEC. Initially, the EEC gets power from the airplane during the start of the engine start procedure)
- The EEC MAINT POWER switch on the MISC SYSTEM CONTROLS (MSC) page is set to the TEST position.

EGT Digital Display and Pointer

The digital display shows EGT in degrees Celsius (C). The digital display and the box around the digital display are usually white.

A pointer on a circular dial also shows EGT. The dial does not have a scale. The pointer is usually white and the area behind the pointer is usually shaded gray.

The EGT indication changes color when the temperature is above one of these limits:

- The EGT start redline limit of 750 degrees C
- The EGT maximum continuous amber limit of 1013 degrees C
- The EGT redline limit of 1038 degrees C.

These EGT indications change to an amber color when the temperature is more than the EGT maximum continuous limit, but less than the EGT redline:

- The EGT digital display
- The box around the digital display
- The pointer
- The shaded area.

During take-off, the amber band color change is inhibited for five minutes or until completion of take-off, whichever comes first. If one engine fails within the first five minutes of the amber band inhibit, the amber band color change inhibit will be extended to ten minutes for the operating engine.

These EGT indications change to red color when the temperature is more than the EGT redline:

- The EGT digital display
- The box around the digital display
- The pointer
- The shaded area.

When the exhaust gas temperature goes back to the normal range, the indication color goes to white.

EGT Start Redline

The EGT start redline (750 degrees C) is the maximum limit for the EGT during an engine start on the ground. The EGT start redline shows as a red radial line on the EGT indication during the engine pre-start. The start redline goes blank when the engine is at the idle speed.

During an engine start when the airplane is on the ground, the EEC will do a check for a possible hot start. If the EEC senses a hot start, the white box around the digital display flashes on and off 2 times for each second. It continues to flash until the start lever is moved to the cutoff position.

**EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION**

If there was an EGT start redline exceedance (>750 degrees C), the box around the digital display will be red. It will be red only after the airplane is on the ground and the EECs on the two engines are de-energized. The box will stay red until reset with a selection on the engine exceedance maintenance page.

See the engine tachometer system section for more information the exceedance data display. (SECTION 77-11)

The EGT digital display and box flash during an engine ground start if the EEC sees a possible hot start. This function does not work in flight. See the engine starting chapter for more information. (CHAPTER 80)

EGT Maximum Continuous Limit and Amber Band

The EGT maximum continuous limit (1013 degrees C) is the start of the EGT caution range. Continuous operation of an engine with EGT more than this value could cause damage to the engine. The EEC sends the EGT maximum continuous limit value to the DPCs. The limit shows as an amber color.

The EGT caution range shows as an arc with an amber color. The range is between the maximum continuous limit and the EGT redline. This is an advisory range and not an exceedance. When the EGT goes below 1013 degrees C, the EGT indications go back to the usual indications.

During the takeoff, the amber color change is inhibited for five minutes or until the takeoff is completed, whichever comes first. If one engine has a failure during the inhibit period, then the amber color change inhibit extends to ten minutes for the engine that operates.

EGT Redline

The EGT redline (1038 degrees C) is the approved engine operation limit for EGT. The EGT redline shows as a red radial line on the EGT indication.

If there was an EGT redline exceedance (>1038 degrees C), the box around the digital display will be red. It will be red only after the airplane is on the ground and the EECs on the two engines are de-energized. The box will stay red until reset with a selection on the engine exceedance maintenance page.

Engine Failure Message

The amber ENG FAIL message shows on the related EGT display if these conditions occur:

- The speed of the two engines are at or above idle.
- The two engine fire handles are stowed
- The two engine start levers are in the idle position
- The N2 speed of one of the two engines then goes below idle.

77-21-00

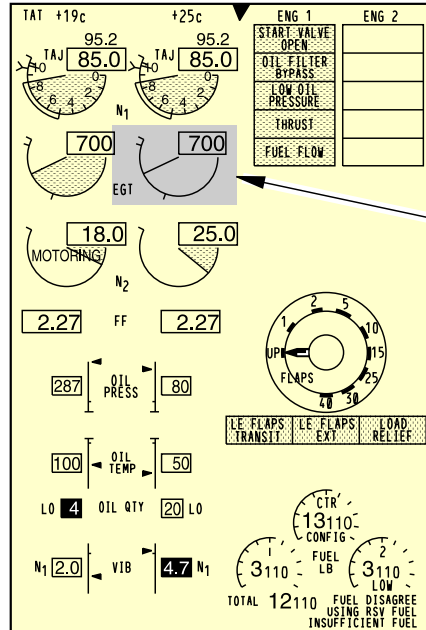
EFFECTIVITY

SIA ALL

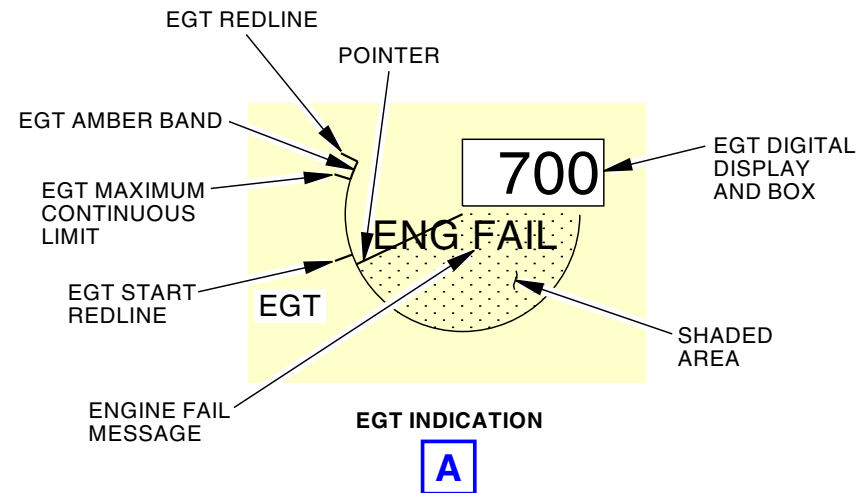
D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION



ENGINE INDICATION
DISPLAY



EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION

2370704 S00061522301_V1



LEAP-1B ENGINES

737-7/8/8200/9/10 SYSTEM DESCRIPTION SECTION

EXHAUST GAS TEMPERATURE (EGT) INDICATING SYSTEM - FUNCTIONAL DESCRIPTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

77-31-00

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Page 1
Sep 15/2021

**VIBRATION MONITORING SYSTEM (VMS) - GENERAL DESCRIPTION****General**

The Vibration Monitoring System (VMS) is included in the EEC. The EEC contains the Airborne Vibration Monitor (AVM). The AVM is an advance vibration processing software that converts the signals from the vibration sensors to a format that is transmitted to the ARINC 429 data bus.

Purpose

The VMS gives real time indication of engine vibration levels to the flight deck during engine operation. The vibration data is also stored in the Network File System (NFS) and in the Digital Flight Data Acquisition Unit (DFDAU). The vibration data stored in the flight history is used by the mechanic to calculate trim balance solutions.

Components

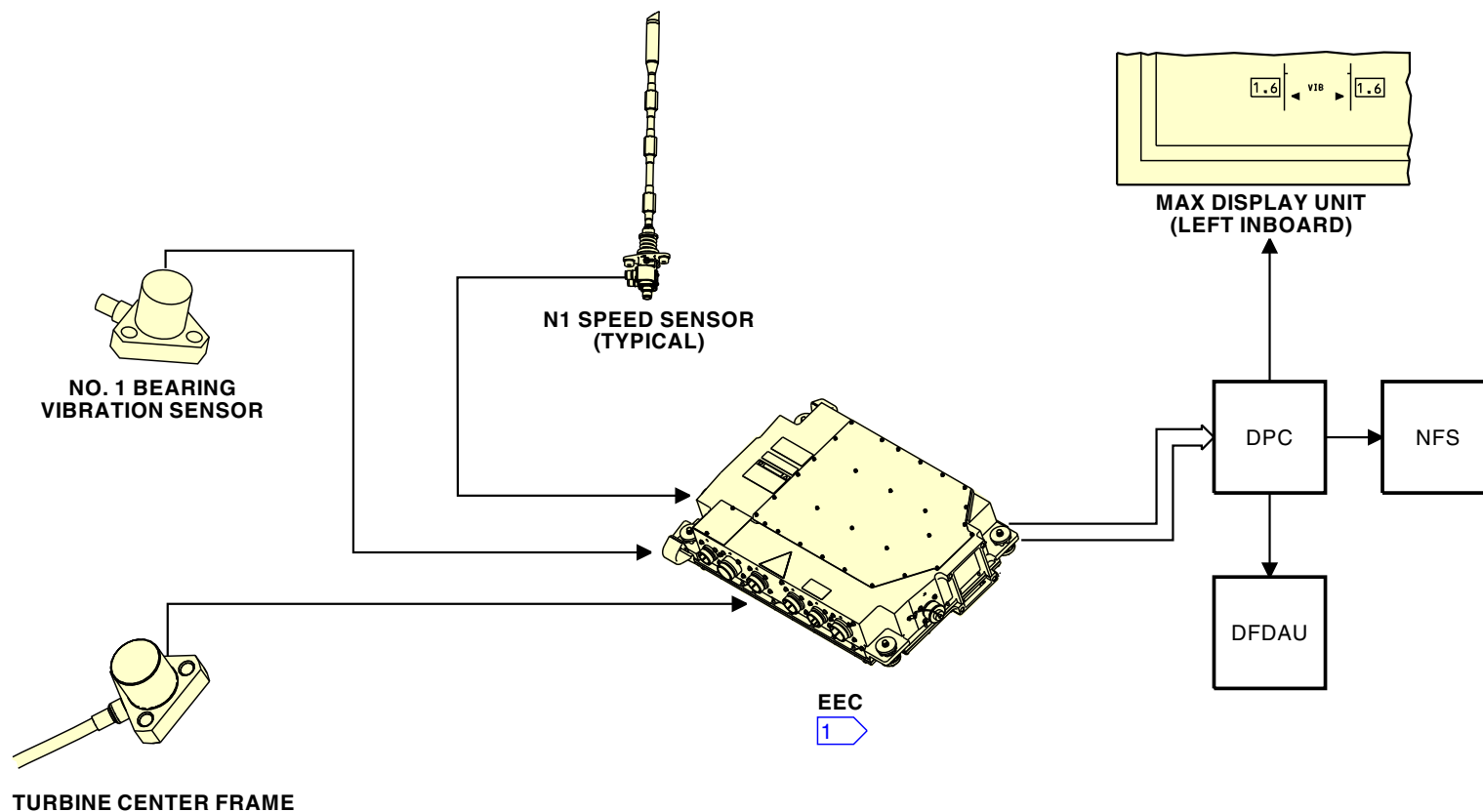
The VMS has these components:

- A vibration sensor (piezoelectric accelerometer) near the N1 shaft at the No. 1 Bearing (NOB)
- A vibration sensor (piezoelectric accelerometer) at the aft end of the engine on the Turbine Case Frame (TCF).
- Airborne Vibration Monitor (AVM) software in the EECs.

The signals from these sensors are sent to the EECs. The vibration data from the EECs are then sent via ARINC 429 data bus to the following:

- Display Processing Computers (DPCs)
- Network File Server (NFS)
- Digital Flight Data Acquisition Unit (DFDAU)
- Engine indicating display.

VIBRATION MONITORING SYSTEM (VMS) - GENERAL DESCRIPTION



1 THERE ARE TWO EEC UNITS, CHANNELS A AND B. SIGNALS FROM THE TCF SENSOR GOES TO CH A. SIGNALS FROM THE NOB SENSOR GOES TO CH B.

2370705 S00061522305_V3

VIBRATION MONITORING SYSTEM - GENERAL DESCRIPTION

**VIBRATION MONITORING SYSTEM - COMPONENT LOCATION****General**

The Vibration Monitoring System (VMS) has two vibration sensors (piezoelectric accelerometers) on the engine.

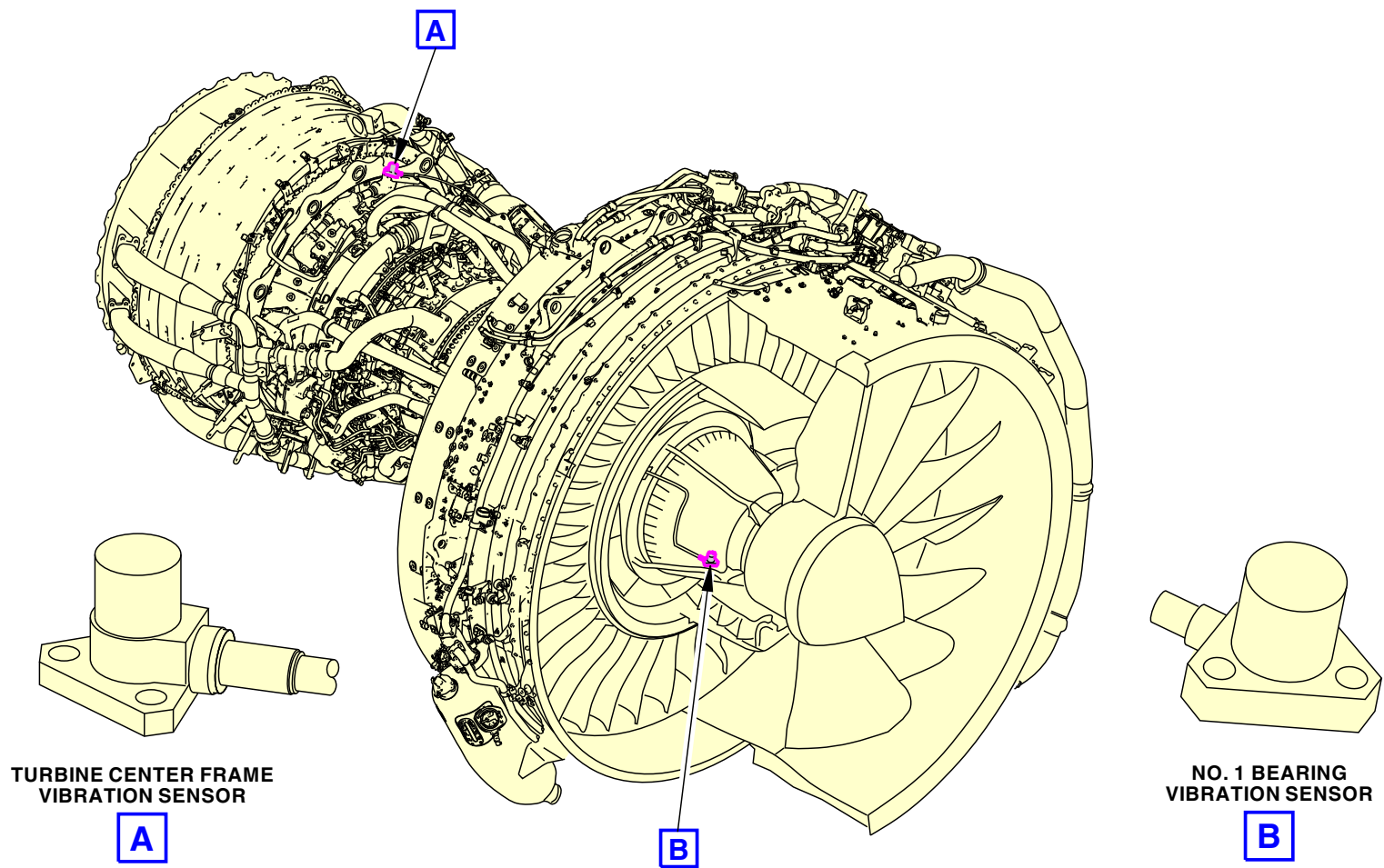
Vibration Sensors

The number 1 bearing vibration sensor is installed on the number 1 and number 2 bearing support at 4 o'clock and goes through the fan hub strut. The sensor is not visible on the assembled engine and is only accessible during engine overhaul.

The second vibration sensor is mounted on the turbine center frame at 12:00 o'clock at the aft section of the engine.

SIA ALL	EFFECTIVITY
	D633AM102-SIA

VIBRATION MONITORING SYSTEM - COMPONENT LOCATION



2370707 S00061522308_V2

VIBRATION MONITORING SYSTEM - COMPONENT LOCATION

77-31-00-002

SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

77-31-00

**VIBRATION MONITORING SYSTEM - FUNCTIONAL DESCRIPTION****General**

The Vibration Monitoring System (VMS) uses these inputs to calculate engine vibration levels:

- N1 speed sensor
- No. 1 Bearing (NOB) vibration sensor
- Turbine Center Frame (TCF) vibration sensor.

The highest engine vibration level for each engine continuously shows on the MAX Display System (MDS). The VMS also keeps system fault data and historical vibration data in the Network File System (NFS).

Vibration Sensors

The vibration sensors are self-exciting piezoelectric crystals. The sensors supply a small electrical signal output and functions as accelerometers. The output level of the sensor changes when the engine structure moves in the radial direction. The output difference is proportional to the vibration level of the engine. The NOB sensor is installed inside the engine and can only be accessed during engine overhaul. The TCF sensor is installed on the outside of the engine.

EEC

The EEC uses the speed sensor inputs and the vibration sensor signals to calculate vibration levels for these engine components:

- Fan
- High Pressure Compressor (HPC)
- Low Pressure Turbine (LPT)
- High Pressure Turbine (HPT).

The vibration signals continuously go to the EECs. The signals are converted to digital data and sent via the ARINC 429 databus to the DPCs. The vibration data from the DPCs then go to the Display Unit (DU), the Network File Server (NFS) of the Onboard Network System (ONS), and to the Digital Flight Data Acquisition Unit (DFDAU).

The OMF of the ONS holds vibration data in its non-volatile memory.

The EEC communicates with the ONS to perform Engine Trim Balance (ETB) operations. ETB for one plane (Fan) or two plane (Fan and LPT) can be performed using a Portable Maintenance Device (PMD). One or two plane balances may be performed without running the engine so long as suitable data has been stored on the EEC either from ground runs or collected during flight.

The ETB has the following functions:

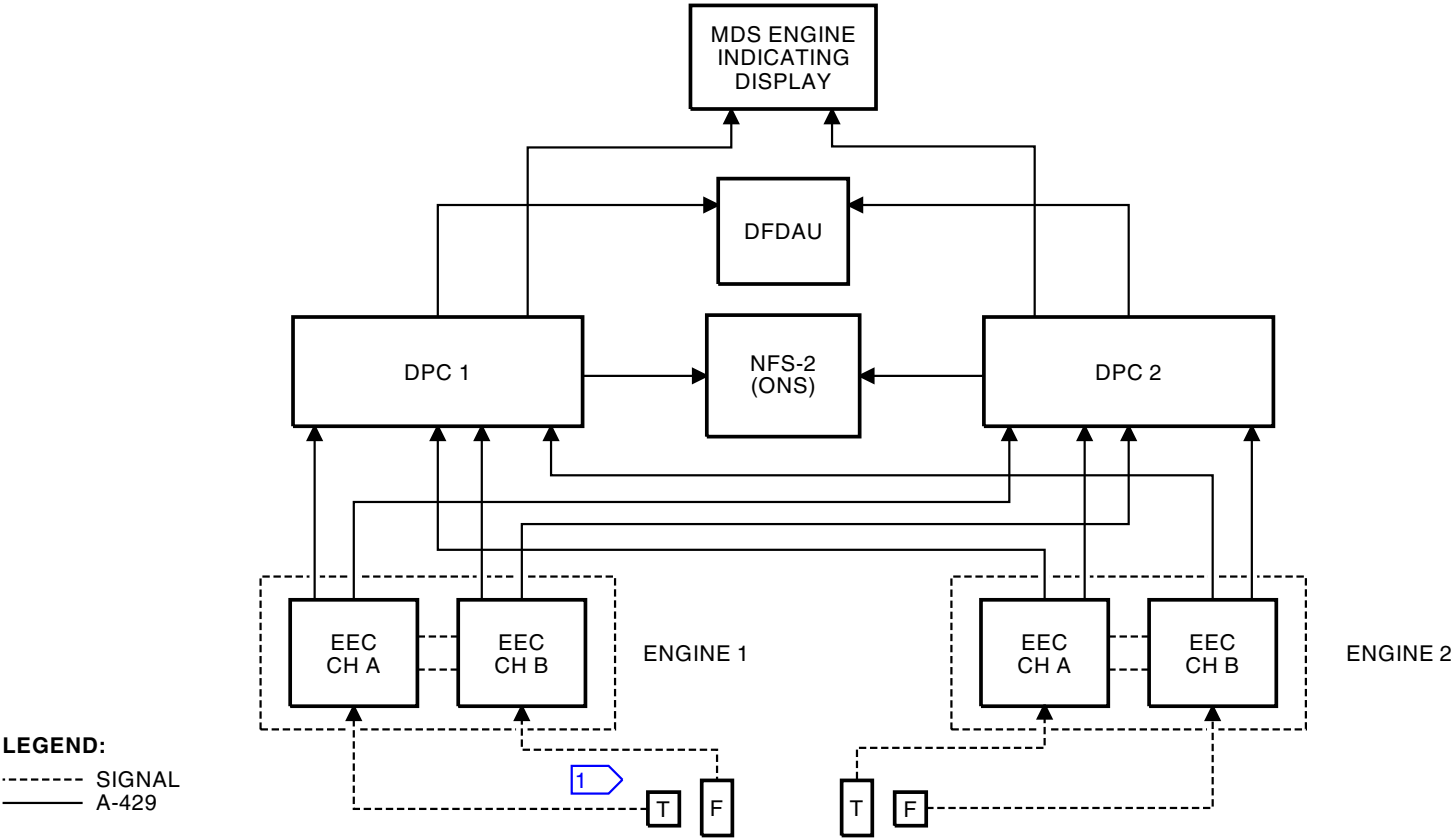
- Trim balance for one and two plane balance solutions using available flight or ground run data along with the use of Generic or Specific Coefficients.
- Ground run and advanced ground run recording.
- Calculation of Specific Coefficients.
- Editing of current and previous weight configurations.
- EEC data down load from the Non-Volatile Memory (NVM).

77-31-00**EFFECTIVITY**
SIA ALL

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

VIBRATION MONITORING SYSTEM - FUNCTIONAL DESCRIPTION



LEGEND:
 - - - - - SIGNAL
 ——— A-429

1 TURBINE CENTER FRAME AND NO. 1 BEARING ACCELEROMETERS (VIBRATION SENSORS)

2370713 S00061522315_V2

VIBRATION MONITORING SYSTEM - FUNCTIONAL DESCRIPTION

