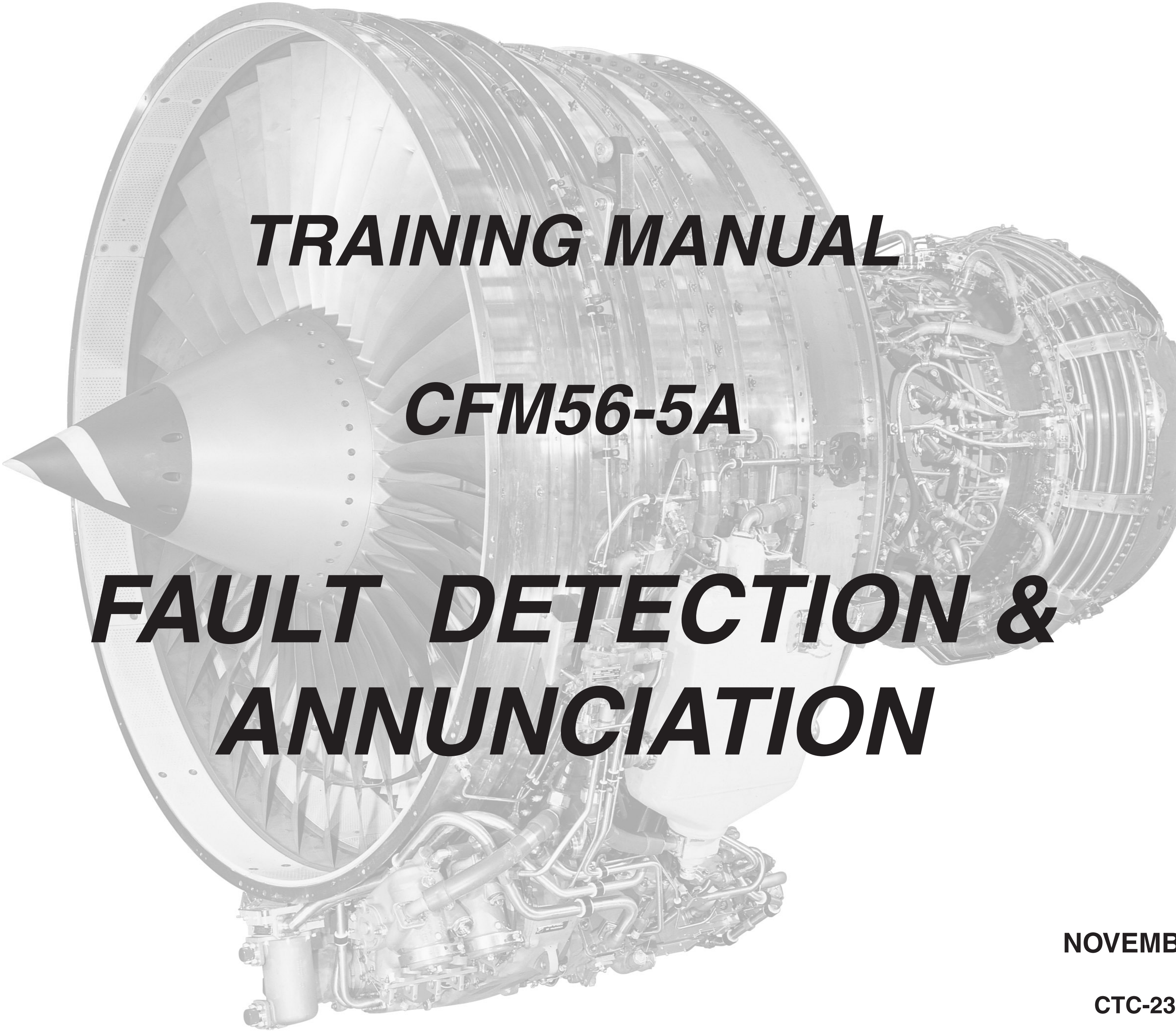
THE POWER
OF FLIGHT



TRAINING MANUAL

CFM56-5A

FAULT DETECTION & ANNUNCIATION

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CTC-239 Level 4

TOC

FAULT DETECTION & ANNUNCIATION

THE POWER
OF FLIGHT

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LEXIS

A

A/C	AIRCRAFT
AC	ALTERNATING CURRENT
ACARS	AIRCRAFT COMMUNICATION ADRESSING and REPORTING SYSTEM
ACMS	AIRCRAFT CONDITION MONITORING SYSTEM
ACS	AIRCRAFT CONTROL SYSTEM
ADC	AIR DATA COMPUTER
ADEPT	AIRLINE DATA ENGINE PERFORMANCE TREND
ADIRS	AIR DATA AND INERTIAL REFERENCE SYSTEM
ADIRU	AIR DATA AND INERTIAL REFERENCE UNIT
AGB	ACCESSORY GEARBOX
AIDS	AIRCRAFT INTEGRATED DATA SYSTEM
ALF	AFT LOOKING FORWARD
ALT	ALTITUDE
ALTN	ALTERNATE
AMB	AMBIENT
AMM	AIRCRAFT MAINTENANCE MANUAL
AOG	AIRCRAFT ON GROUND
A/P	AIR PLANE
APU	AUXILIARY POWER UNIT
ARINC	AERONAUTICAL RADIO, INC. (SPECIFICATION)
ASM	AUTOTHROTTLE SERVO MECHANISM
A/T	AUTOTHROTTLE
ATA	AIR TRANSPORT ASSOCIATION
ATC	AUTOTHROTTLE COMPUTER
ATHR	AUTO THRUST
ATO	ABORTED TAKE OFF
AVM	AIRCRAFT VIBRATION MONITORING

B

BITE	BUILT IN TEST EQUIPMENT
BMC	BLEED MANAGEMENT COMPUTER
BPRV	BLEED PRESSURE REGULATING VALVE
BSI	BORESCOPE INSPECTION
BSV	BURNER STAGING VALVE (SAC)
BSV	BURNER SELECTION VALVE (DAC)
BVCS	BLEED VALVE CONTROL SOLENOID

C

C	CELSIUS or CENTIGRADE
CAS	CALIBRATED AIR SPEED
CBP	(HP) COMPRESSOR BLEED PRESSURE
CCDL	CROSS CHANNEL DATA LINK
CCFG	COMPACT CONSTANT FREQUENCY GENERATOR
CCU	COMPUTER CONTROL UNIT
CCW	COUNTER CLOCKWISE
CDP	(HP) COMPRESSOR DISCHARGE PRESSURE
CDS	COMMON DISPLAY SYSTEM
CDU	CONTROL DISPLAY UNIT
CFDIU	CENTRALIZED FAULT DISPLAY INTERFACE UNIT
CFDS	CENTRALIZED FAULT DISPLAY SYSTEM

CFMI	JOINT GE/SNECMA COMPANY (CFM INTERNATIONAL)
CG	CENTER OF GRAVITY
Ch A	channel A
Ch B	channel B
CHATV	CHANNEL ACTIVE
CIP(HP)	COMPRESSOR INLET PRESSURE
CIT(HP)	COMPRESSOR INLET TEMPERATURE
cm.g	CENTIMETER X GRAMS
CMC	CENTRALIZED MAINTENANCE COMPUTER
CMM	COMPONENT MAINTENANCE MANUAL
CMS	CENTRALIZED MAINTENANCE SYSTEM
CMS	CENTRAL MAINTENANCE SYSTEM
CODEP	HIGH TEMPERATURE COATING
CONT	CONTINUOUS
CPU	CENTRAL PROCESSING UNIT
CRT	CATHODE RAY TUBE
CSD	CONSTANT SPEED DRIVE
CSI	CYCLES SINCE INSTALLATION
CSN	CYCLES SINCE NEW
CTAI	COWL THERMAL ANTI-ICING
CTEC	CUSTOMER TECHNICAL EDUCATION CENTER
CTL	CONTROL
Cu.Ni.In	COPPER.NICKEL.INDIUM
CW	CLOCKWISE

D

DAC	DOUBLE ANNULAR COMBUSTOR
DAMV	DOUBLE ANNULAR MODULATED VALVE
DAR	DIGITAL ACMS RECORDER
DC	DIRECT CURRENT
DCU	DATA CONVERSION UNIT
DCV	DIRECTIONAL CONTROL VALVE BOEING
DEU	DISPLAY ELECTRONIC UNIT
DFCS	DIGITAL FLIGHT CONTROL SYSTEM
DFDAU	DIGITAL FLIGHT DATA ACQUISITION UNIT
DFDRS	DIGITAL FLIGHT DATA RECORDING SYSTEM
DISC	DISCRETE
DIU	DIGITAL INTERFACE UNIT
DMC	DISPLAY MANAGEMENT COMPUTER
DMD	DEMAND
DMS	DEBRIS MONITORING SYSTEM
DMU	DATA MANAGEMENT UNIT
DOD	DOMESTIC OBJECT DAMAGE
DPU	DIGITAL PROCESSING MODULE
DRT	DE-RATED TAKE-OFF

E

EAU	ENGINE ACCESSORY UNIT
EBU	ENGINE BUILDUP UNIT
ECA	ELECTRICAL CHASSIS ASSEMBLY
ECAM	ELECTRONIC CENTRALIZED AIRCRAFT MONITORING
ECS	ENVIRONMENTAL CONTROL SYSTEM
ECU	ELECTRONIC CONTROL UNIT
EE	ELECTRONIC EQUIPMENT
EEC	ELECTRONIC ENGINE CONTROL

EFH	ENGINE FLIGHT HOURS
EFIS	ELECTRONIC FLIGHT INSTRUMENT SYSTEM
EGT	EXHAUST GAS TEMPERATURE
EHSV	ELECTRO-HYDRAULIC SERVO VALVE
EICAS	ENGINE INDICATING AND CREW ALERTING SYSTEM
EIS	ELECTRONIC INSTRUMENT SYSTEM
EIU	ENGINE INTERFACE UNIT
EIVMU	ENGINE INTERFACE AND VIBRATION MONITORING UNIT
EMF	ELECTROMOTIVE FORCE
EMI	ELECTRO MAGNETIC INTERFERENCE
EMU	ENGINE MAINTENANCE UNIT
EPROM	ERASABLE PROGRAMMABLE READ ONLY MEMORY
(E)EPROM	(ELECTRICALLY) ERASABLE PROGRAMMABLE READ ONLY MEMORY
ESN	ENGINE SERIAL NUMBER
ETOPS	EXTENDED TWIN OPERATION SYSTEMS
EWD/SD	ENGINE WARNING DISPLAY / SYSTEM DISPLAY

F

F	FARENHEIT
FAA	FEDERAL AVIATION AGENCY
FADEC	FULL AUTHORITY DIGITAL ENGINE CONTROL
FAR	FUEL/AIR RATIO
FCC	FLIGHT CONTROL COMPUTER
FCU	FLIGHT CONTROL UNIT
FDAMS	FLIGHT DATA ACQUISITION & MANAGEMENT SYSTEM
FDIU	FLIGHT DATA INTERFACE UNIT
FDRS	FLIGHT DATA RECORDING SYSTEM
FDU	FIRE DETECTION UNIT
FEIM	FIELD ENGINEERING INVESTIGATION MEMO
FF	FUEL FLOW (see Wf) -7B
FFCCV	FAN FRAME/COMPRESSOR CASE VERTICAL (VIBRATION SENSOR)
FI	FLIGHT IDLE (F/I)
FIM	FAULT ISOLATION MANUAL
FIN	FUNCTIONAL ITEM NUMBER
FIT	FAN INLET TEMPERATURE
FLA	FORWARD LOOKING AFT
FLX TO	FLEXIBLE TAKE-OFF
FMC	FLIGHT MANAGEMENT COMPUTER
FMCS	FLIGHT MANAGEMENT COMPUTER SYSTEM
FMGC	FLIGHT MANAGEMENT AND GUIDANCE COMPUTER
FMGEC	FLIGHT MANAGEMENT AND GUIDANCE ENVELOPE COMPUTER
FMS	FLIGHT MANAGEMENT SYSTEM
FMV	FUEL METERING VALVE
FOD	FOREIGN OBJECT DAMAGE
FPA	FRONT PANEL ASSEMBLY
FPI	FLUORESCENT PENETRANT INSPECTION
FQIS	FUEL QUANTITY INDICATING SYSTEM

FRV	FUEL RETURN VALVE
FWC	FAULT WARNING COMPUTER
FWD	FORWARD

G

g.in	GRAM X INCHES
GE	GENERAL ELECTRIC
GEAE	GENERAL ELECTRIC AIRCRAFT ENGINES
GEM	GROUND-BASED ENGINE MONITORING
GI	GROUND IDLE (G/I)
GMM	GROUND MAINTENANCE MODE
GMT	GREENWICH MEAN TIME
GND	GROUND
GPH	GALLON PER HOUR
GPU	GROUND POWER UNIT
GSE	GROUND SUPPORT EQUIPMENT

H

HCF	HIGH CYCLE FATIGUE
HCU	HYDRAULIC CONTROL UNIT
HDS	HORIZONTAL DRIVE SHAFT
HMU	HYDROMECHANICAL UNIT
HP	HIGH PRESSURE
HPC	HIGH PRESSURE COMPRESSOR
HPCR	HIGH PRESSURE COMPRESSOR ROTOR
HPRV	HIGH PRESSURE REGULATING VALVE
HPSOV	HIGH PRESSURE SHUT-OFF VALVE
HPT	HIGH PRESSURE TURBINE
HPT(A)CC	HIGH PRESSURE TURBINE (ACTIVE) CLEARANCE CONTROL
HPTC	HIGH PRESSURE TURBINE CLEARANCE
HPTCCV	HIGH PRESSURE TURBINE CLEARANCE CONTROL VALVE
HPTN	HIGH PRESSURE TURBINE NOZZLE
HPTR	HIGH PRESSURE TURBINE ROTOR
Hz	HERTZ (CYCLES PER SECOND)

I

I/O	INPUT/OUTPUT
IAS	INDICATED AIR SPEED
ID	INSIDE DIAMETER
ID PLUG	IDENTIFICATION PLUG
IDG	INTEGRATED DRIVE GENERATOR
IFSD	IN FLIGHT SHUT DOWN
IGB	INLET GEARBOX
IGN	IGNITION
IGV	INLET GUIDE VANE
in.	INCH
IOM	INPUT OUTPUT MODULE
IPB	ILLUSTRATED PARTS BREAKDOWN
IPC	ILLUSTRATED PARTS CATALOG
IPCV	INTERMEDIATE PRESSURE CHECK VALVE
IPS	INCHES PER SECOND
IR	INFRA RED

K

°K	KELVIN
k	X 1000
KIAS	INDICATED AIR SPEED IN KNOTS
kV	KILOVOLTS

Kph KILOGRAMS PER HOUR

L

L LEFT
L/H LEFT HAND
lbs. POUNDS, WEIGHT
LCD LIQUID CRYSTAL DISPLAY
LCF LOW CYCLE FATIGUE
LE (L/E) LEADING EDGE
LGCIU LANDING GEAR CONTROL INTERFACE UNIT
LP LOW PRESSURE
LPC LOW PRESSURE COMPRESSOR
LPT LOW PRESSURE TURBINE
LPT(A)CC LOW PRESSURE TURBINE (ACTIVE) CLEARANCE CONTROL
LPTC LOW PRESSURE TURBINE CLEARANCE
LPTN LOW PRESSURE TURBINE NOZZLE
LPTR LOW PRESSURE TURBINE ROTOR
LRU LINE REPLACEABLE UNIT
LVDT LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

M

mA MILLIAMPERES (CURRENT)
MCD MAGNETIC CHIP DETECTOR
MCDU MULTIPURPOSE CONTROL AND DISPLAY UNIT
MCL MAXIMUM CLIMB
MCR MAXIMUM CRUISE
MCT MAXIMUM CONTINUOUS
MDDU MULTIPURPOSE DISK DRIVE UNIT
MEC MAIN ENGINE CONTROL
milsD.A. Mils DOUBLE AMPLITUDE
mm. MILLIMETERS
MMEL MAIN MINIMUM EQUIPMENT LIST
MO AIRCRAFT SPEED MACH NUMBER
MPA MAXIMUM POWER ASSURANCE
MPH MILES PER HOUR
MTBF MEAN TIME BETWEEN FAILURES
MTBR MEAN TIME BETWEEN REMOVALS
mV MILLIVOLTS
Mvdc MILLIVOLTS DIRECT CURRENT

N

N1 (NL) LOW PRESSURE ROTOR ROTATIONAL SPEED
N1* DESIRED N1
N1ACT ACTUAL N1
N1CMD COMMANDED N1
N1DMD DEMANDED N1
N1K CORRECTED FAN SPEED
N1TARGET TARGETED FAN SPEED
N2 (NH) HIGH PRESSURE ROTOR ROTATIONAL SPEED
N2* DESIRED N2
N2ACT ACTUAL N2
N2K CORRECTED CORE SPEED
N/C NORMALLY CLOSED
N/O NORMALLY OPEN

NAC	NACELLE
NVM	NON VOLATILE MEMORY

O

OAT	OUTSIDE AIR TEMPERATURE
OD	OUTLET DIAMETER
OGV	OUTLET GUIDE VANE
OSG	OVERSPEED GOVERNOR
OVBD	OVERBOARD
OVHT	OVERHEAT

P

Pb	BYPASS PRESSURE
Pc	REGULATED SERVO PRESSURE
Pcr	CASE REGULATED PRESSURE
Pf	HEATED SERVO PRESSURE
P/T25	HP COMPRESSOR INLET TOTAL AIR PRESSURE/TEMPERATURE
P/N	PART NUMBER
P0	AMBIENT STATIC PRESSURE
P25	HP COMPRESSOR INLET TOTAL AIR TEMPERATURE
PCU	PRESSURE CONVERTER UNIT
PLA	POWER LEVER ANGLE
PMC	POWER MANAGEMENT CONTROL
PMUX	PROPULSION MULTIPLEXER
PPH	POUNDS PER HOUR
PRSOV	PRESSURE REGULATING SERVO VALVE
Ps	PUMP SUPPLY PRESSURE
PS12	FAN INLET STATIC AIR PRESSURE
PS13	FAN OUTLET STATIC AIR PRESSURE
PS3HP	COMPRESSOR DISCHARGE STATIC AIR PRESSURE (CDP)
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSID	POUNDS PER SQUARE INCH DIFFERENTIAL
psig	POUNDS PER SQUARE INCH GAGE
PSM	POWER SUPPLY MODULE
PSS	(ECU) PRESSURE SUB-SYSTEM
PSU	POWER SUPPLY UNIT
PT	TOTAL PRESSURE
PT2	FAN INLET TOTAL AIR PRESSURE (PRIMARY FLOW)
PT25	HPC TOTAL INLET PRESSURE

Q

QAD	QUICK ATTACH DETACH
QEC	QUICK ENGINE CHANGE
QTY	QUANTITY
QWR	QUICK WINDMILL RELIGHT

R

R/H	RIGHT HAND
RAC/SB	ROTOR ACTIVE CLEARANCE/START BLEED
RACC	ROTOR ACTIVE CLEARANCE CONTROL
RAM	RANDOM ACCESS MEMORY
RCC	REMOTE CHARGE CONVERTER
RDS	RADIAL DRIVE SHAFT

RPM	REVOLUTIONS PER MINUTE
RTD	RESISTIVE THERMAL DEVICE
RTO	REFUSED TAKE OFF
RTV	ROOM TEMPERATURE VULCANIZING (MATERIAL)
RVDT	ROTARY VARIABLE DIFFERENTIAL TRANSFORMER

S

S/N	SERIAL NUMBER
S/R	SERVICE REQUEST
S/V	SHOP VISIT
SAC	SINGLE ANNULAR COMBUSTOR
SAR	SMART ACMS RECORDER
SAV	STARTER AIR VALVE
SB	SERVICE BULLETIN
SCU	SIGNAL CONDITIONING UNIT
SDAC	SYSTEM DATA ACQUISITION CONCENTRATOR
SDI	SOURCE/DESTINATION IDENTIFIER (BITS) (CF ARINC SPEC)
SDU	SOLENOID DRIVER UNIT
SER	SERVICE EVALUATION REQUEST
SFC	SPECIFIC FUEL CONSUMPTION
SFCC	SLAT FLAP CONTROL COMPUTER
SG	SPECIFIC GRAVITY
SLS	SEA LEVEL STANDARD (CONDITIONS : 29.92 in.Hg / 59°F)
SLSD	SEA LEVEL STANDARD DAY (CONDITIONS : 29.92 in.Hg / 59°F)
SMM	STATUS MATRIX
SMP	SOFTWARE MANAGEMENT PLAN
SN	SERIAL NUMBER
SNECMA	SOCIETE NATIONALE D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION
SOL	SOLENOID
SOV	SHUT-OFF VALVE
STP	STANDARD TEMPERATURE AND PRESSURE
SVR	SHOP VISIT RATE
SW	SWITCH BOEING
SYS	SYSTEM

T

T oil	OIL TEMPERATURE
T/C	THERMOCOUPLE
T/E	TRAILING EDGE
T/O	TAKE OFF
T/R	THRUST REVERSER
T12	FAN INLET TOTAL AIR TEMPERATURE
T25	HP COMPRESSOR INLET AIR TEMPERATURE
T3	HP COMPRESSOR DISCHARGE AIR TEMPERATURE
T49.5	EXHAUST GAS TEMPERATURE
T5	LOW PRESSURE TURBINE DISCHARGE TOTAL AIR TEMPERATURE
TAI	THERMAL ANTI ICE
TAT	TOTAL AIR TEMPERATURE

TBC	THERMAL BARRIER COATING
TBD	TO BE DETERMINED
TBO	TIME BETWEEN OVERHAUL
TBV	TRANSIENT BLEED VALVE
TC(TCase)	HP TURBINE CASE TEMPERATURE
TCC	TURBINE CLEARANCE CONTROL
TCCV	TURBINE CLEARANCE CONTROL VALVE
TCJ	TEMPERATURE COLD JUNCTION
T/E	TRAILING EDGE
TECU	ELECTRONIC CONTROL UNIT INTERNAL TEMPERATURE
TEO	ENGINE OIL TEMPERATURE
TGB	TRANSFER GEARBOX
Ti	TITANIUM
TLA	THROTTLE LEVER ANGLE AIRBUS
TLA	THRUST LEVER ANGLE BOEING
TM	TORQUE MOTOR
TMC	TORQUE MOTOR CURRENT
T/O	TAKE OFF
TO/GA	TAKE OFF/GO AROUND
T/P	TEMPERATURE/PRESSURE SENSOR
TPU	TRANSIENT PROTECTION UNIT
TR	TRANSFORMER RECTIFIER
TRA	THROTTLE RESOLVER ANGLE AIRBUS
TRA	THRUST RESOLVER ANGLE BOEING
TRDV	THRUST REVERSER DIRECTIONAL VALVE
TRF	TURBINE REAR FRAME
TRPV	THRUST REVERSER PRESSURIZING VALVE
TSI	TIME SINCE INSTALLATION (HOURS)
TSN	TIME SINCE NEW (HOURS)
TTL	TRANSISTOR TRANSISTOR LOGIC

U

UER	UNSCHEDULED ENGINE REMOVAL
UTC	UNIVERSAL TIME CONSTANT

V

VAC	VOLTAGE, ALTERNATING CURRENT
VBV	VARIABLE BLEED VALVE
VDC	VOLTAGE, DIRECT CURRENT
VDT	VARIABLE DIFFERENTIAL TRANSFORMER
VIB	VIBRATION
VLV	VALVE
VRT	VARIABLE RESISTANCE TRANSDUCER
VSV	VARIABLE STATOR VANE

W

WDM	WATCHDOG MONITOR
Wf	WEIGHT OF FUEL OR FUEL FLOW
WFM	WEIGHT OF FUEL METERED
WOW	WEIGHT ON WHEELS
WTAI	WING THERMAL ANTI-ICING

IMPERIAL / METRIC CONVERSIONS

1 mile	= 1,609 km
1 ft	= 30,48 cm
1 in.	= 25,4 mm
1 mil.	= 25,4 μ
1 sq.in.	= 6,4516 cm^2
1 USG	= 3,785 l (dm^3)
1 cu.in.	= 16.39 cm^3
1 lb.	= 0.454 kg
1 psi.	= 6.890 kPa
°F	= 1.8 x °C + 32

METRIC / IMPERIAL CONVERSIONS

1 km	= 0.621 mile
1 m	= 3.281 ft. or 39.37 in.
1 cm	= 0.3937 in.
1 mm	= 39.37 mils.
1 m^2	= 10.76 sq. ft.
1 cm^2	= 0.155 sq.in.
1 m^3	= 35.31 cu. ft.
1 dm^3	= 0.264 USA gallon
1 cm^3	= 0.061 cu.in.
1 kg	= 2.205 lbs
1 Pa	= 1.45 10-4 psi.
1 kPa	= 0.145 psi
1 bar	= 14.5 psi
°C	= (°F - 32) /1.8

ARCHITECTURE

ENGINE CONTROL SYSTEM

System components.

The CFM56-5A engine incorporates a computer-based Full Authority Digital Engine Control (FADEC) system.

The engine control system is composed of the following elements :

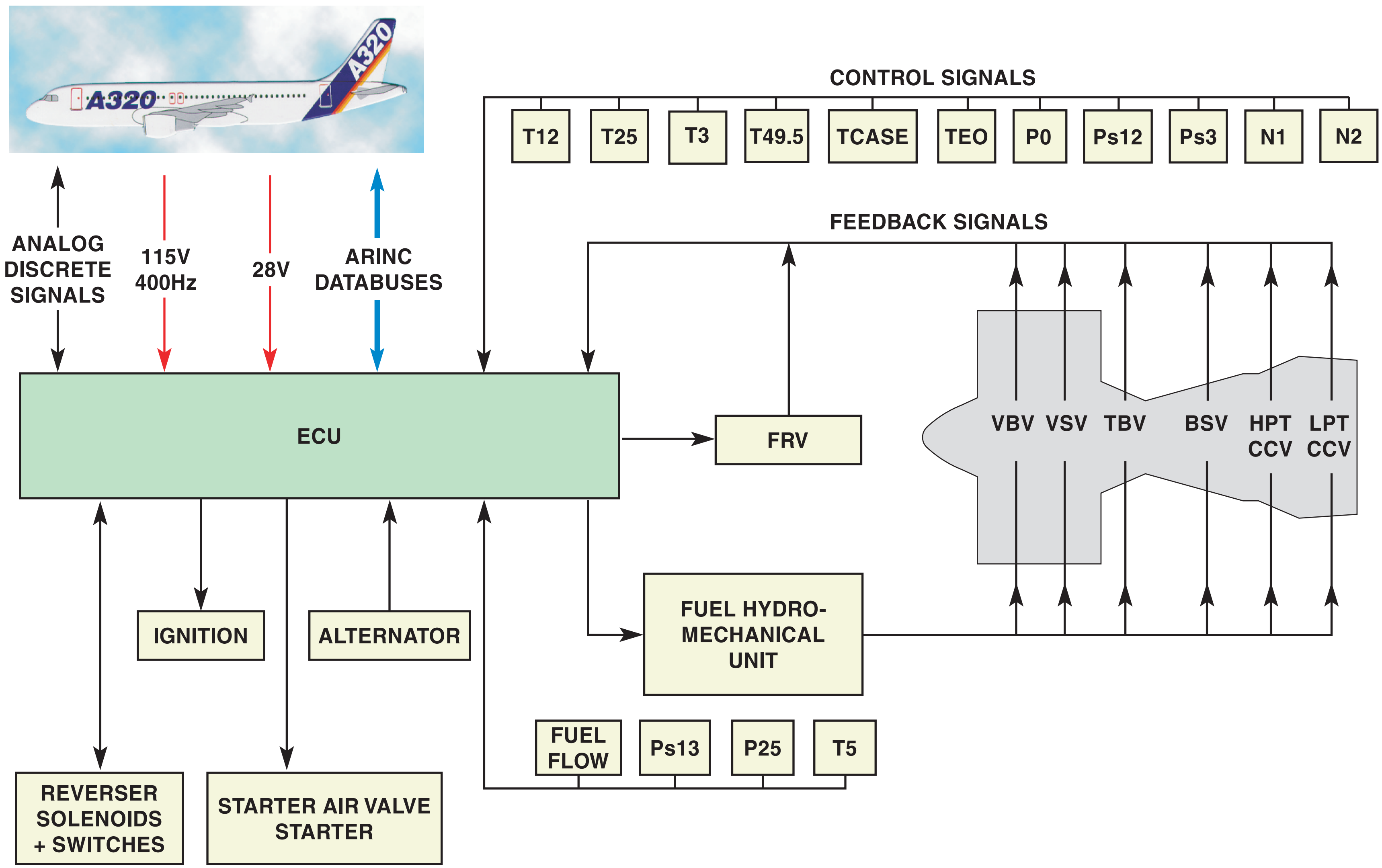
- Electronic Control Unit (ECU), containing two identical computers, designated channel A & B.
- Hydro-mechanical Unit (HMU), which converts electrical signals from the ECU into hydraulic pressures to drive the engine's valves and actuators.
- ECU alternator.
- Engine Identification plug (ID plug).
- Engine pressure, temperature and speed sensors.
- Variable Stator Vane (VSV) actuators.
- Variable Bleed Valve (VBV) actuators.
- High Pressure Turbine Clearance Control (HPTCC).
- Low Pressure Turbine Clearance Control (LPTCC).
- Transient Bleed Valve (TBV).
- Burner Staging Valve (BSV).
- Fuel Return Valve (FRV).
- Thrust Reverser (TR) control.
- Starter Air Valve (SAV).
- Ignition components / control system.

Electronic Control Unit (ECU).

The ECU is the prime component of the engine control system.

The ECU governs the engine in response to thrust command inputs from the airplane and provides information to the airplane for flight compartment indication, maintenance reporting and, optionally, engine condition monitoring.

Control system maintenance is assisted by extensive ECU internal software called Built-In-Test-Equipment (BITE), which monitors engine data and ECU status flags to detect engine failures.



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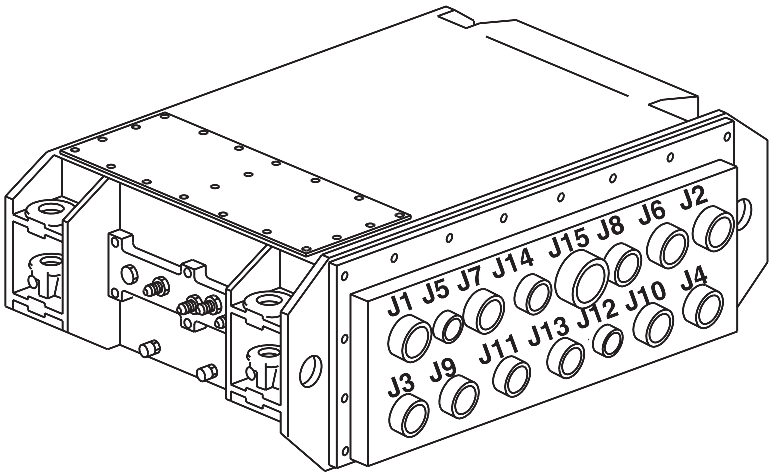
FADEC COMPONENTS

ECU INPUTS AND OUTPUTS.

Electrical interfaces.

The following chart is a summary of the ECU electrical interfaces to show which connectors interface with channel A and which interface with channel B.



CHANNEL A CONNECTOR (ODD)	CHANNEL B CONNECTOR (EVEN)	FUNCTION
J1	J2	A/C POWER (28V) AND IGNITER POWER (115V)
J3	J4	A/C INPUT/OUTPUT AND TLA
J5	J6	THRUST REVERSER
J7	J8	SOLENOIDS, TORQUE MOTORS, RESOLVERS, N2
J9	J10	ALTERNATOR, SAV, N1 AND T12
J11	J12	LVDT'S, RVDT'S, T25, BSV POSITION SWITCH
SHARED	J14	ENGINE IDENTIFICATION PLUG
J13	SHARED	WF METER, THERMOCOUPLES
J15	SHARED	TEST INTERFACE

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ELECTRICAL CONNECTORS

ENGINE TESTS

ECU initialization.

If the engine is not running, the ECU becomes fully operational within a maximum of three seconds after application of airplane power, or an external reset.

If the core speed is greater than 10% N2, the ECU performs a short initialization and is fully functional in less than 750ms after application of airplane power.

Each ECU channel performs a reset initialization sequence in response to aircraft-generated resets, or at power-up.

An aircraft-commanded reset occurs when the master lever is toggled from ON to OFF.

During reset initialization, all RAM variables are initialized, except for a special reserved area. This area of RAM is not initialized as it is allocated to parameters critical to engine operation and which must maintain their values prior to the reset operation.

Built-In-Tests.

Built-In-Test-Equipment (BITE) monitors the system and memorizes failures.

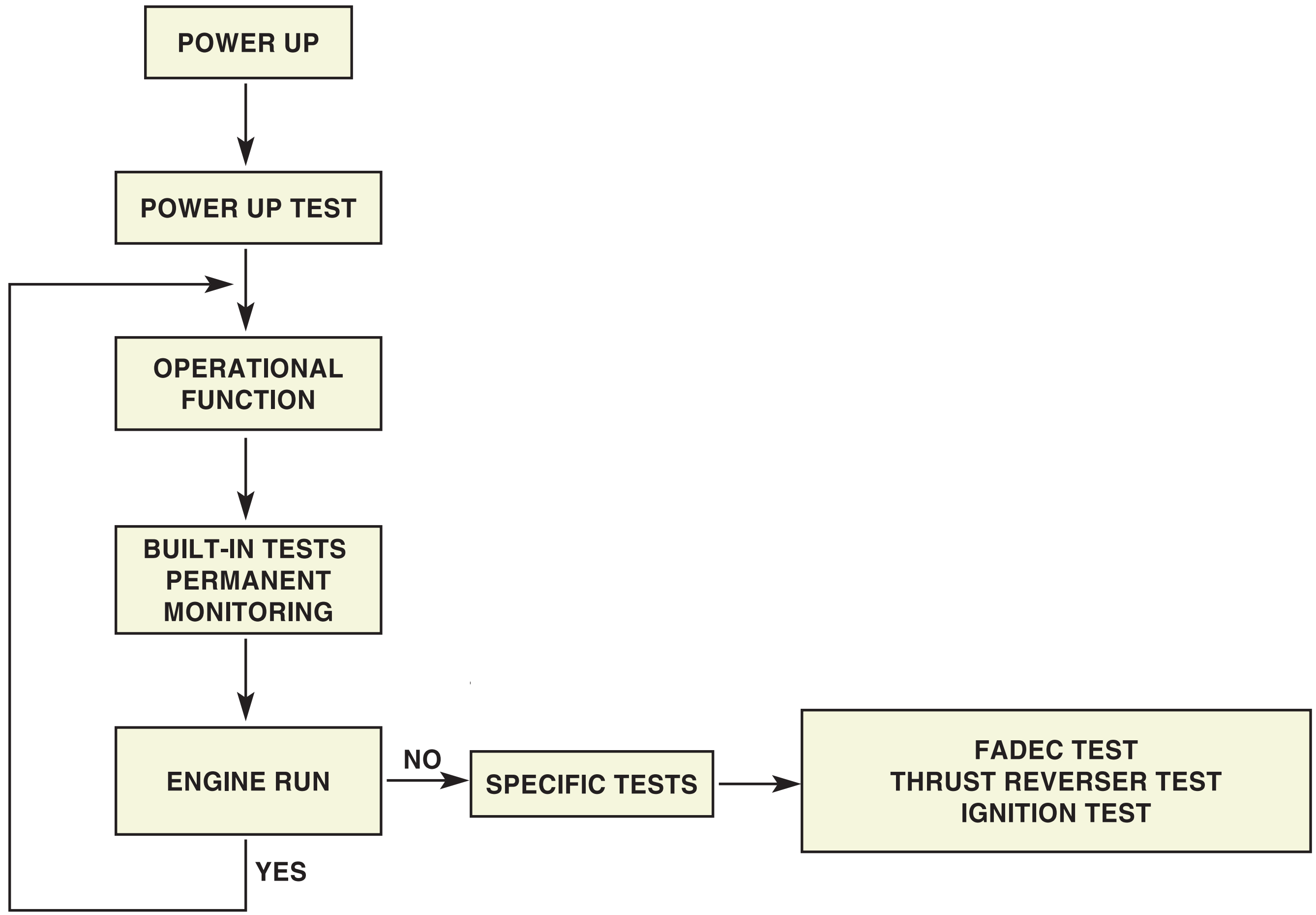
The BITE detects and isolates failures, or combinations of failures, in order to determine the health status of the channels and to transmit maintenance data to the aircraft.

There are two types of Built-In-Test : Initialization test and Periodic test.

The Initialization tests cover functions which cannot be continually tested without disturbing the ECU system operation. The typical tasks of an Initialization test are processor test, memories test and output driver disconnect tests.

The Periodic tests cover functions which can be continually tested. These tests are similar to the Initialization tests, but are run in background as time permits.

Specific tests are available to verify certain engine functions. These tests are the FADEC test (Non-motoring & motoring), ignition test and thrust reverser test.



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TESTS

ENGINE CONTROL SYSTEM

Electronic Control Unit (ECU).

The ECU has two channels, A and B, and both channels are capable of controlling the engine.

The two channels are identical and permanently operational, but they operate independently from each other. Each channel has a full complement of sensors, interfaces to the engine and aircraft, central processor and output drivers.

As well as continuously checking and processing their own inputs, the channels compare each others data over a Cross Channel Data Link (CCDL), to ensure that there are no anomalies.

The two ECU channels operate their output drivers on an active/standby principle. Both channels always receive inputs and process them, but only the channel in control, called the Active channel, delivers control outputs (solenoids/torque motors). The other is called the Standby channel.

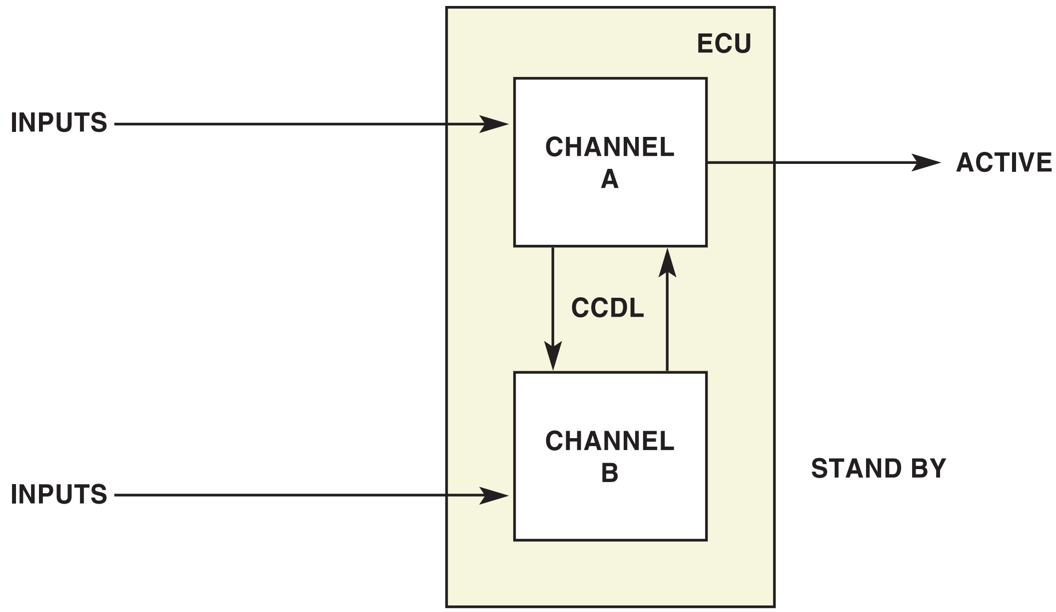
The purpose of the dual-redundant architecture is to minimize the effects of control system faults on the engine operation.

Channel selection and fault strategy.

Active and Standby channel selection is performed at ECU power-up and during operation.

Active and Standby selection is based upon the health of the channels and each channel determines its own health status. The healthiest is selected as the Active channel.

When both channels have an equal health status, active/standby channel selection alternates with every engine start, if N2 was greater than 11,000 RPM during the last run.



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ECU DESIGN

CHANNEL SELECTION

Channel selection determination.

Each ECU channel determines whether to be in the active state, or the standby state, based on a comparison of its health with that of the cross channel.

The channel with the better health status becomes the active channel. When both channels are of equal health, the channel selection state remains as the previous selection state.

A hierarchy is assigned to the list of possible faults that could lead to a channel switch.

When a single fault occurs, the channel with lower priority faults (if any) becomes active. If the same equal priority fault(s) exist on both channels, no switching occurs.

The internal logic of the ECU ensures that each channel achieves an active status on an alternating basis. An NVM flag is assigned to identify the channel that is presently active.

The last-active flag is only set when N2 becomes less than 35% speed.

The NVM last-active flag becomes the lowest priority status in channel health determination.

The occurrence of any higher priority faults overrides the last-active flag to ensure the healthiest channel is made the active channel.

NO.	HEALTH STATUS DISCRETE DESCRIPTION
1	GROUP 1 FAULT (SERIOUS ECU INTERNAL FAULT)
2	FMV LOOP FAULT
3	VSV LOOP FAULT
4	VBV LOOP FAULT
5	LATCHED CHANNEL CCDL SERIAL FAULT
6	SAV WRAPAROUND FAULT
7	TRPV WRAPAROUND FAULT
8	TR INDETERMINATE STATE FAULT
9	TRDV WRAPAROUND FAULT
10	BSV WRAPAROUND FAULT
11	SPARE
12	FRV 1 / FRV 2 WRAPAROUND FAULT
13	HPTC WRAPAROUND FAULT
14	TBV WRAPAROUND FAULT
15	LPTC WRAPAROUND FAULT
16	NVM FAULT
17	ARINC OUTPUT WRAPAROUND FAULT
18	ALTERNATOR WINDING FAULT
19	LAST ACTIVE CHANNEL FLAG

CTC-239-005-00

FAULT HIERARCHY

CHANNEL SELECTION

Output driver disconnect.

Once the active channel is determined, each channel executes the output driver disconnect logic to assign the respective active status for the disconnect relays.

The standby channel disconnects all its torque motor and solenoid output drivers from the external loads.

With a normal healthy status (no faults), all the assignments are connected in the active channel. Some driver output assignments are switched through paired disconnect relays.

The respective assignments are :

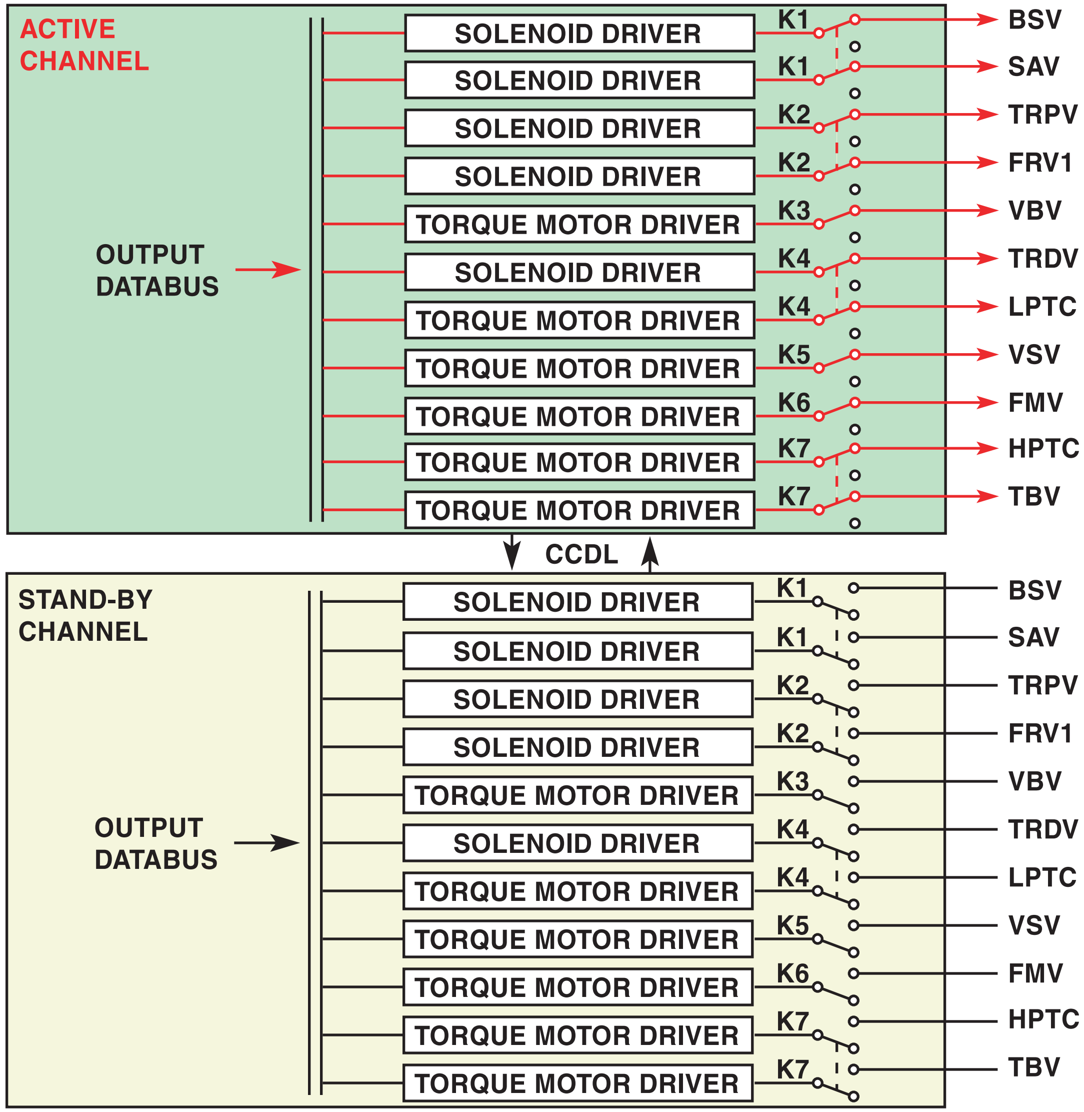
- BSV & SAV (K1)
- TRPV & FRV1 (K2)
- VBV (K3)
- TRDV & LPTC (K4)
- VSV (K5)
- FMV (K6)
- HPTC & TBV (K7)

If there is a failure on the active channel, the disconnect relays of the functions that are faulty are opened to prevent damage to the engine.

Cross channel active / standby sensing.

Each FMV and VSV output driver disconnect relay has a second set of contacts that are cross-connected to the opposite channel.

These relay contacts provide hardware confirmation of the cross channel active / standby status.



OUTPUT DRIVER DISCONNECT

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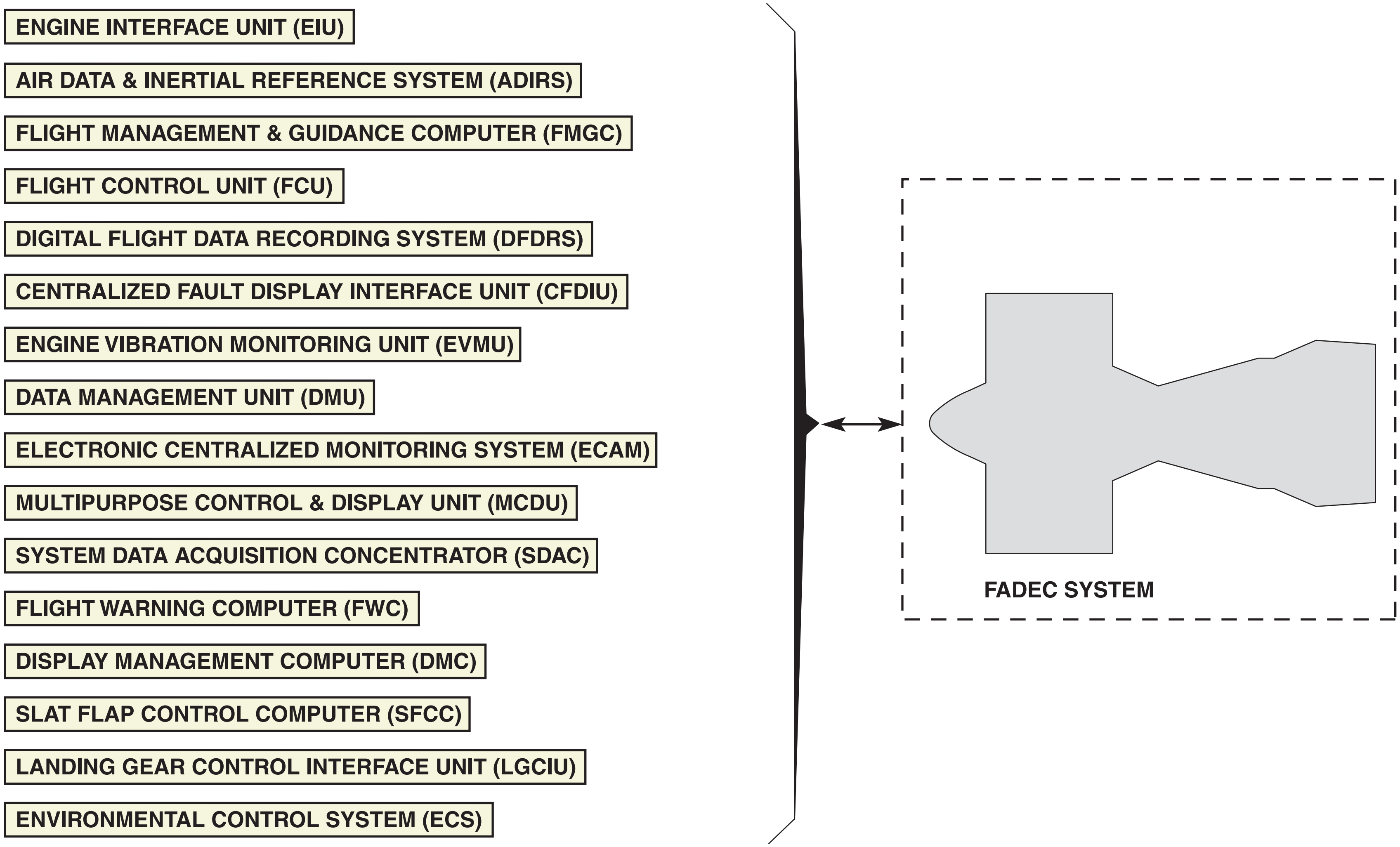
INTERFACES

FADEC INTERFACES

There are many aircraft computers and systems that interface directly, or indirectly with the engine FADEC system.

- Engine Interface Unit (EIU).
- Air Data & Inertial Reference System (ADIRS).
- Flight Management & Guidance Computer (FMGC).
- Flight Control Unit (FCU).
- Digital Flight Data Recording System (DFDRS).
- Centralized Fault Display Interface Unit (CFDIU).
- Engine Vibration Monitoring Unit (EVMU).
- Data Management Unit (DMU).
- Electronic Centralized Monitoring System (ECAM).
- Multipurpose Control & Display Unit (MCDU).
- System Data Acquisition Concentrator (SDAC).
- Flight Warning Computer (FWC).
- Display Management Computer (DMC).
- Slat Flap Control Computer (SFCC).
- Landing Gear Control Interface Unit (LGCIU).
- Environmental Control System (ECS).



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AIRCRAFT - ENGINE INTERFACES

FADEC INTERFACES

Each ECU interfaces with the aircraft systems, through its corresponding EIU. Each EIU is an interface concentrator, which collects information to be used by the ECU from various aircraft systems and also sends information from the engines to the aircraft systems.

The EVMU receives analog signals from the engine speed and vibration sensors for vibration monitoring and recording.

The ECU entirely supervises the thrust reverser operation. In case of malfunction, the reverser doors are commanded stowed (LGCIU, HCU).

The ADIRS sends air data parameters to the ECU for power management and engine control.

The ECU manages power according to 2 thrust modes :

- Manual mode, depending on Throttle Lever Angle.
- Autothrust mode, according to the autothrust function generated by the Auto-Flight System (AFS).

The FMGC computes the autothrust order and sends it to the ECU, via the FCU and EIU. The FCU is the interface for transmission of engine data from the FMGC to the EIU. Thrust limit computation is performed by the ECU, except if the alpha floor protection is activated.

The ECU provides idle mode selection :

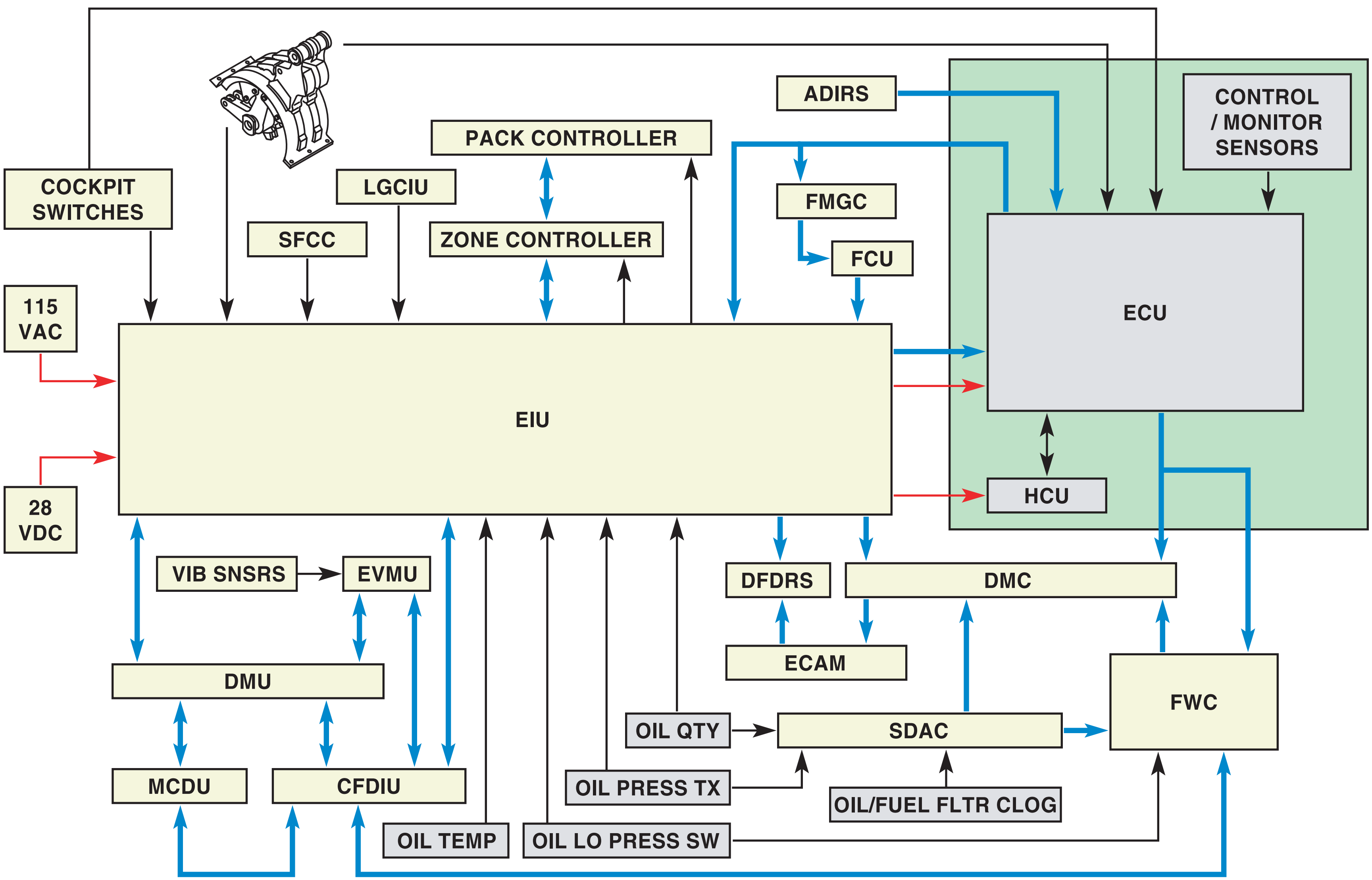
- Approach idle, when flaps are extended (SFCC), or landing gear is down (LGCIU).
- Modulated idle, modulated up to approach idle, depending on oil temperature (IDG cooling), air conditioning and anti-ice demand (zone & pack controller).

Primary parameters (N1, N2, EGT, Fuel Flow) are sent by the ECU directly to the ECAM, through the DMC. Secondary parameters are sent to the ECAM, through different aircraft computers (EIU, SDAC, FWC).

The DFDRS includes a Flight Data Interface Unit (FDIU) and a Flight Data Recorder (FDR). The FDIU collects various engine and A/C system parameters and processes them internally. The FDR stores data collected over the last 25 hours.

The DMU collects, stores and processes various A/C system data and generates condition reports.

The CFDIU memorizes warnings generated by the FWC and failure information produced by the BITE function integrated in the computers. Maintenance personnel can read out BITE memory information, through the MCDU's.



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FADEC INTERFACES

FADEC INTERFACES

The FADEC system is closely integrated into the aircraft ECAM system to provide cockpit fault indication and warnings.

Propulsion system survey parameters are directly displayed on dedicated Engine Warning and System Displays.

Information contained on the ECU output buses includes:
- Engine rating parameter information.
- Parameters used for engine control.
- FADEC system maintenance data.
- Engine condition monitoring parameters.
- ECU status and fault information.
- Propulsion system status and fault information.

This data is sent to :
- The EIU for use in the aircraft systems logic and transmission to the DMU (AIDS).
- The FWC for fault warning messages.
- The DMC for parameter displays.

The ECAM monitors operational data in order to display warnings and system information. FADEC system data is processed by the SDAC's, FWC's and DMC's before being presented on the ECAM Engine Warning Display (EWD) and System Display (SD).

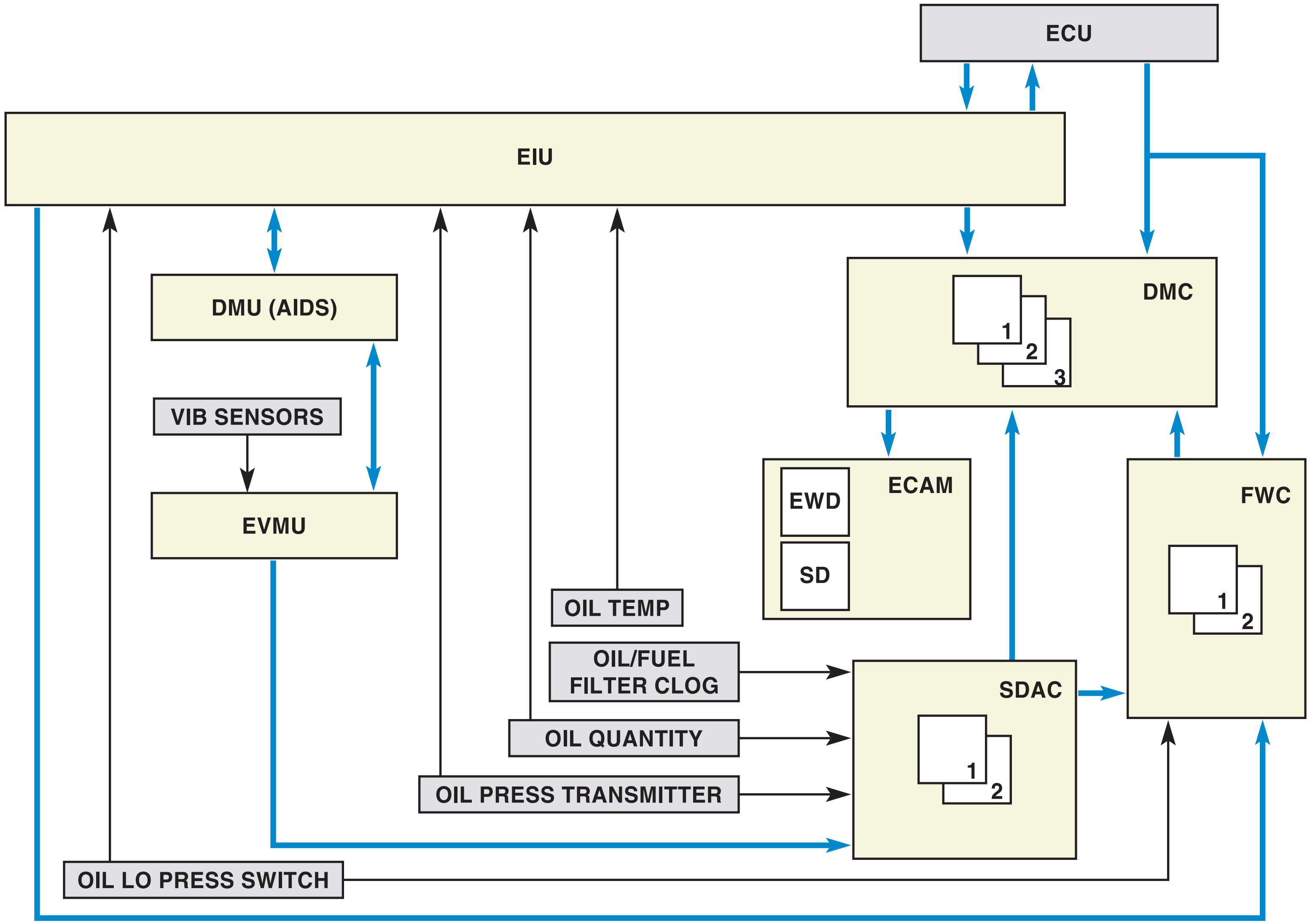
The EWD is dedicated to the primary engine parameters and engine warning messages. The SD is dedicated to the propulsion system parameters when the engine system page is called either automatically, or manually.

The SDAC's digitalize systems data and transmit it to the DMC's. The SDAC's receive systems information concerning amber cautions and transmit it to the FWC's.

The FWC's receive systems data concerning red warnings and memos, generate messages and activate attention getters. Both FWC's have the same engine monitoring capability.

The DMC's use outputs from the FWC's to display information on the lower part of the EWD.

The EVMU provides vibration information to the SDAC's for real time monitoring on the ECAM and to the DMU for condition monitoring.



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ENGINE DATA DISPLAY PROCESSING

ON-BOARD MAINTENANCE SYSTEM

Acquisition of aircraft system data is performed by the Centralized Fault Display System (CFDS). This includes the ECAM to display warnings and system information, the DFDRS, which is an obligatory recording system, the CFDIU and the DMU, which is the main component of the Aircraft Integrated Data System (AIDS).

In each aircraft system computer, a BITE monitors the system and memorizes the failures. After failure detection, the BITE is able to identify the possible failed LRU's and give a 'snapshot' of the system environment when the failure occurred. All information necessary for maintenance and troubleshooting is memorized in NVM.

The ECU is able to distinguish between faults external and internal to the FADEC system. External faults are defined as those detected on aircraft interfaces not dedicated to the FADEC system. External functions include the ADIRU's, the EIU and aircraft power supplies. All other faults in the system (ECU, HMU, sensors, cables, components, etc..) are considered internal faults.

The main components of the CFDS are the CFDIU, which has a main channel and a standby channel, and the aircraft system BITES. The CFDIU continuously scans the buses from the aircraft systems and if a failure message from a system BITE is present on a bus, the CFDIU copies and stores it.

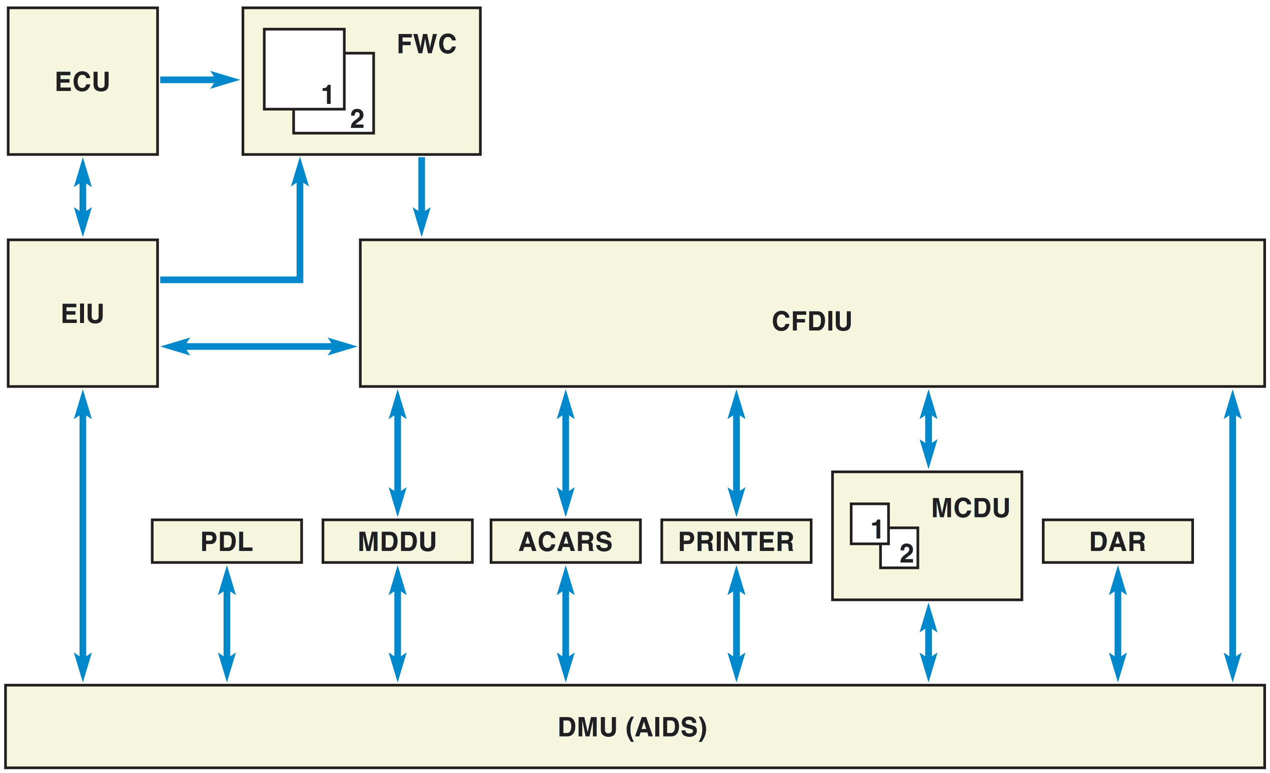
The CFDIU also stores the ECAM messages generated by the FWC's and acts as an interface for some class 2 failures, transmitted by the DMU, and used for the ECAM maintenance status.

The aircraft systems are divided into types 1, 2 and 3, depending on their capabilities and connection to the CFDIU. Most systems are type 1 and these can memorize failures which have occurred in the last 64 flights. The engine (FADEC) is a type 1 system.

The MCDU is the operators interface with the CFDIU.

The DMU records significant operational parameters in order to monitor the engines, the aircraft performance and to analyze specific aircraft problems. A Portable Data Loader (PDL) can be connected to the DMU for up and down loading. An optional Digital AIDS Recorder (DAR) enables data to be stored on a replaceable cassette.

Most reports may be printed and data can also be transmitted to the ground, manually or automatically, through the ACARS. Data may also be loaded into the maintenance computers, through the Multi-purpose Disk Drive unit (MDDU).



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ON-BOARD MAINTENANCE

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ECU SIGNALS

CATEGORIES

Two types of data and command values are transmitted between the aircraft systems and the engine controls using dedicated wiring.

<u>Discrete values.</u>

Discretes have one of two values, i.e. on/off, open/closed.

Discretes that supply aircraft configuration data and commands to the ECU are either pin-programmed, or a direct open/closed output of a switch operated by the flight crew, system, or valve.

Examples of discrete inputs from the aircraft include :
- Engine position.
- Master lever position.
- Autothrust engagement and disconnect.

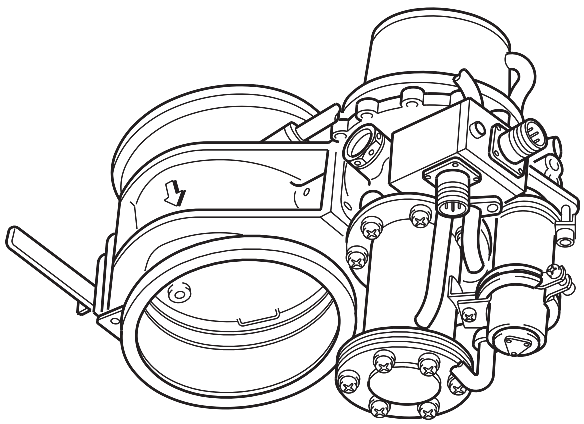
The ECU receives discrete inputs from the engine and the ID plug.

Examples of discrete inputs from the engine include :
- Overspeed governor switch (HMU).
- Starter Air Valve position switches.

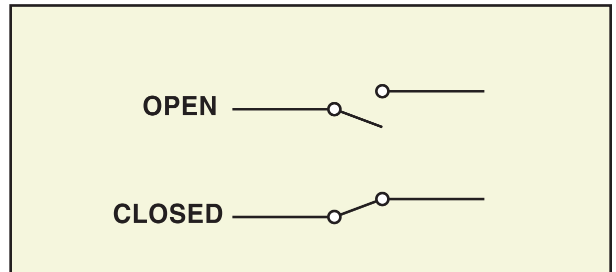
<u>Parametric values.</u>

Unlike discretes, parametric values are not fixed, but can vary over a specified range.

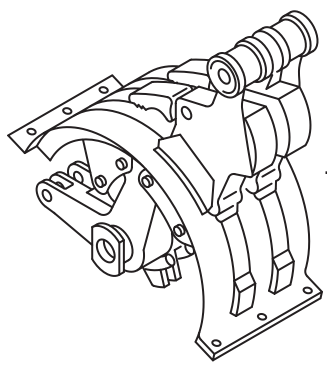
Examples of parametric values include :
- Throttle lever resolver angle (-38.00 - 85.50).
- N1 fan speed sensing (0 - 5000 rpm).
- Oil quantity (0 - 100%).



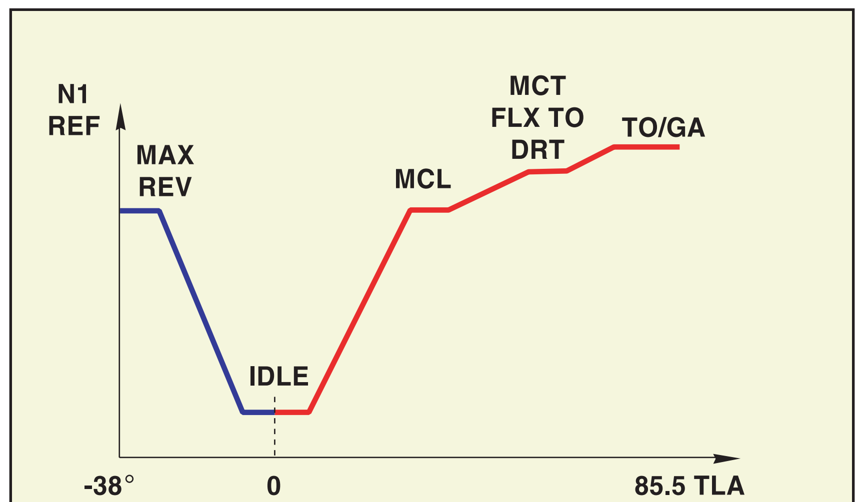
STARTER AIR VALVE



DISCRETE



THROTTLE LEVER ANGLE



PARAMETRIC

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CATEGORIES

SIGNAL TYPES

Analog signals.

The ECU receives and transmits discrete and parametric electrical values through dedicated wiring. These values can be those received from various sensors and switches, or those sent to control engine components, such as torque motors.

Because the values rarely have the same range and vary depending on the particular component, they are known as analog signals.

Digital signals.

Like all computers, the ECU contains logic boards to process the data received and transmitted, but they use a certain kind of electronic signal known as digital.

Much simplified, digital signals are a series of square-shaped waveforms, called data bits. The value of these data bits is described as a ‘1’, or ‘0’. Since a ‘1’, or ‘0’ can also be considered as ‘on’, or ‘off’, most discrete signals are processed as digital signals.

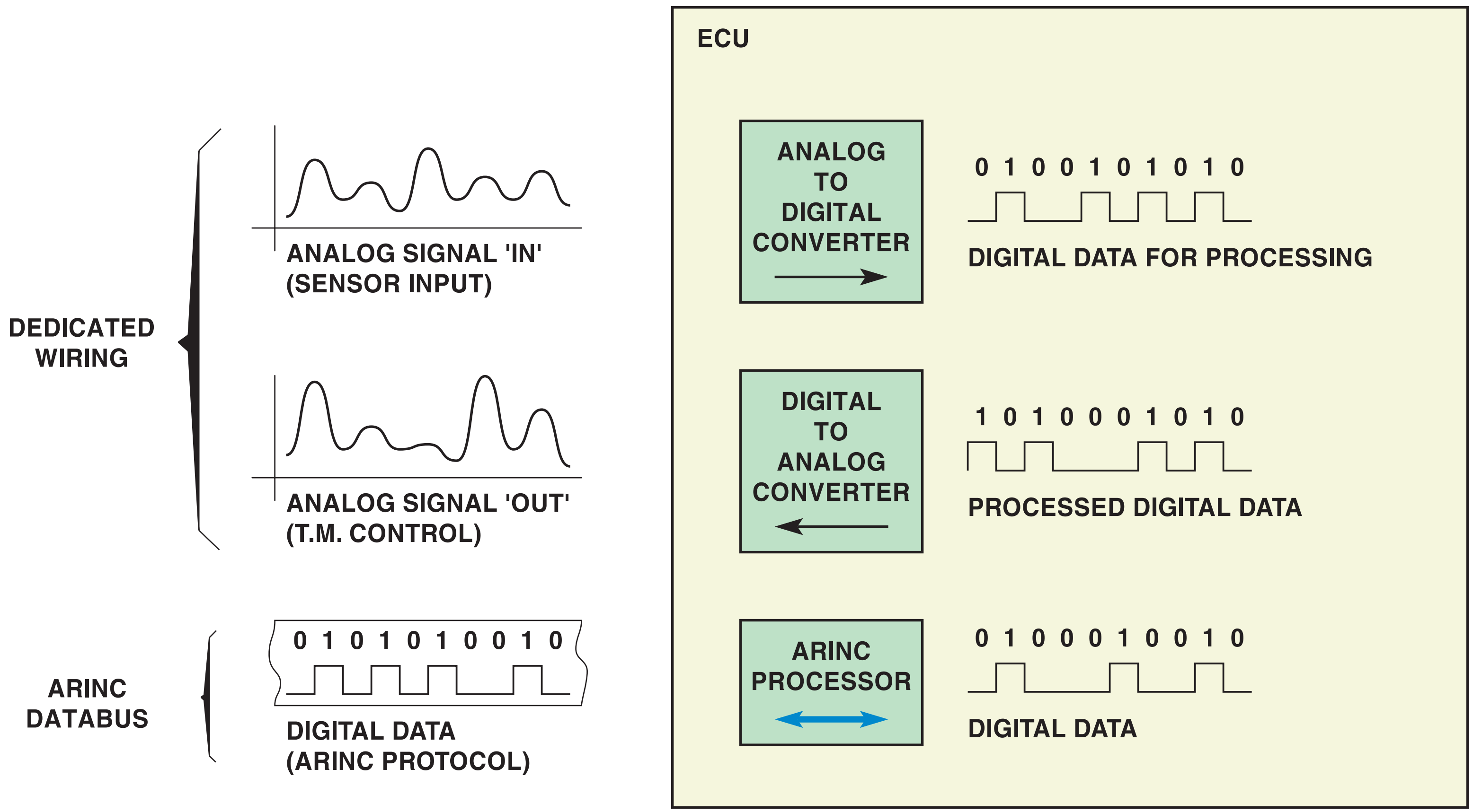
Analog and digital signals do not have the same format and therefore, analog signals go through a conversion process, before passing to, or from the ECU.

ARINC429.

Communications between the engine control system and aircraft systems are largely carried out using digital signals.

The digital signals are sent across serial databuses in a particular format, which can be recognized and decoded at either end of the communications link. Defined by Aeronautical Radio Inc, this format follows a particular protocol and is known as ARINC429.

Although these signals are digital, they do not use the same format as those internal to the ECU and therefore, have to be processed before being received, or transmitted.



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SIGNAL TYPES

DIGITAL SIGNAL INTERFACES

ARINC429 databuses.

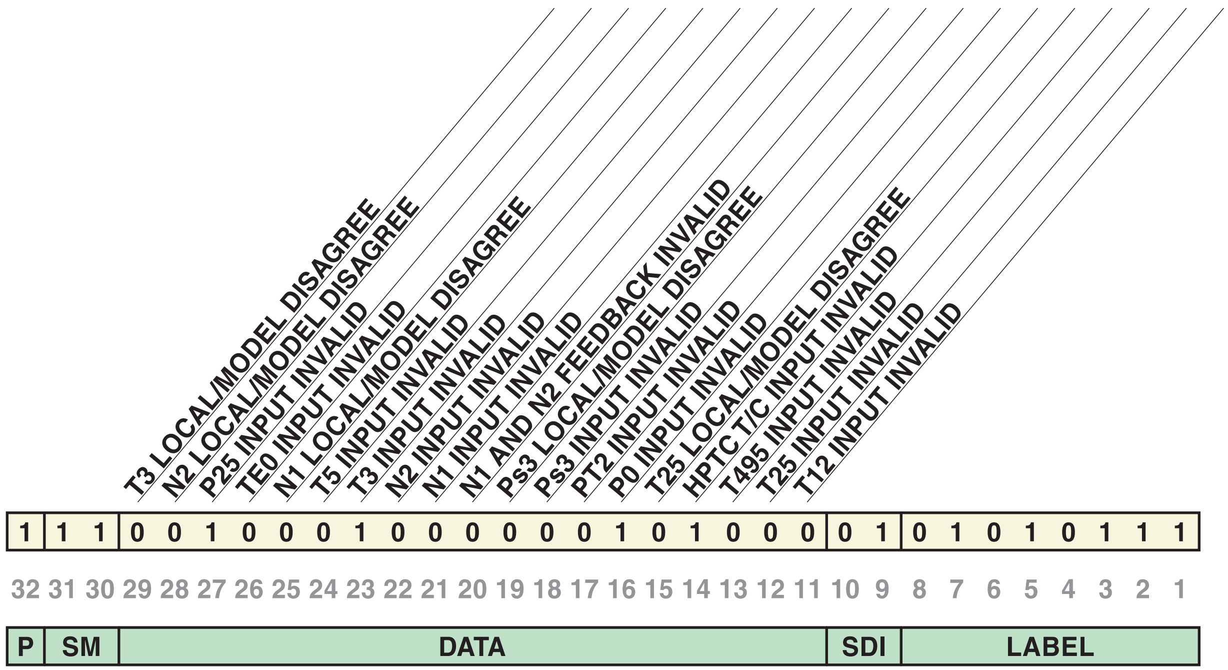
Digital communication between the aircraft and the engine is in the form of a serial group of 32 data bits arranged in a predefined order (ARINC429 protocol), that can be considered as a coded sentence.

This coded sentence is known as a 32-bit digital 'word'. The word is transmitted, or received through ARINC429 databuses.

32-bit words.

Each 32-bit word is made up of 5 sections that serve different purposes :

- The section using bits 1-8 is known as the label and is used to categorize the word, corresponding to ARINC429 definitions.
- Bits 9 and 10, are used as the Source/Destination Identifier (SDI).
  i.e. The source could be the name of the computer transmitting the data.
- The data section is made up of bits 11 to 29.
  i.e. Parametric, or discrete values put into digital format.
- Bits 30 and 31 are used for the Status Matrix (SM), which indicates the data word condition and validity.
- Bit 32 is the parity bit. ARINC protocol requires that the sum of '1' bits contained in the word must be an odd number, so the parity bit is set to either a '1', or '0' as necessary.



P : PARITY (ODD)
SM : STATUS MATRIX (DATA CONDITION/VALIDITY)
SDI : SOURCE/DESTINATION IDENTIFIER
LABEL : WORD-TYPE IDENTIFIER

CTC-239-013-00

ARINC 429 MESSAGE

ECU INPUTS

Each ECU channel receives critical engine signal inputs from separate sources.

Dual inputs :

LVDT/RVDT and resolver :
- VSV, VBV, TBV, LPTC, HPTC, FMV.

Valve position switches :
- SAV, FRV, BSV, HPSOV.

PS12.
PS3.
P0.
T25.
T12.
T3.
TEO.
TECU.
N1 and N2 signals.

Dual power :

Engine alternator.

When the signal is less critical, only one source sends a signal, which is connected to both channels.

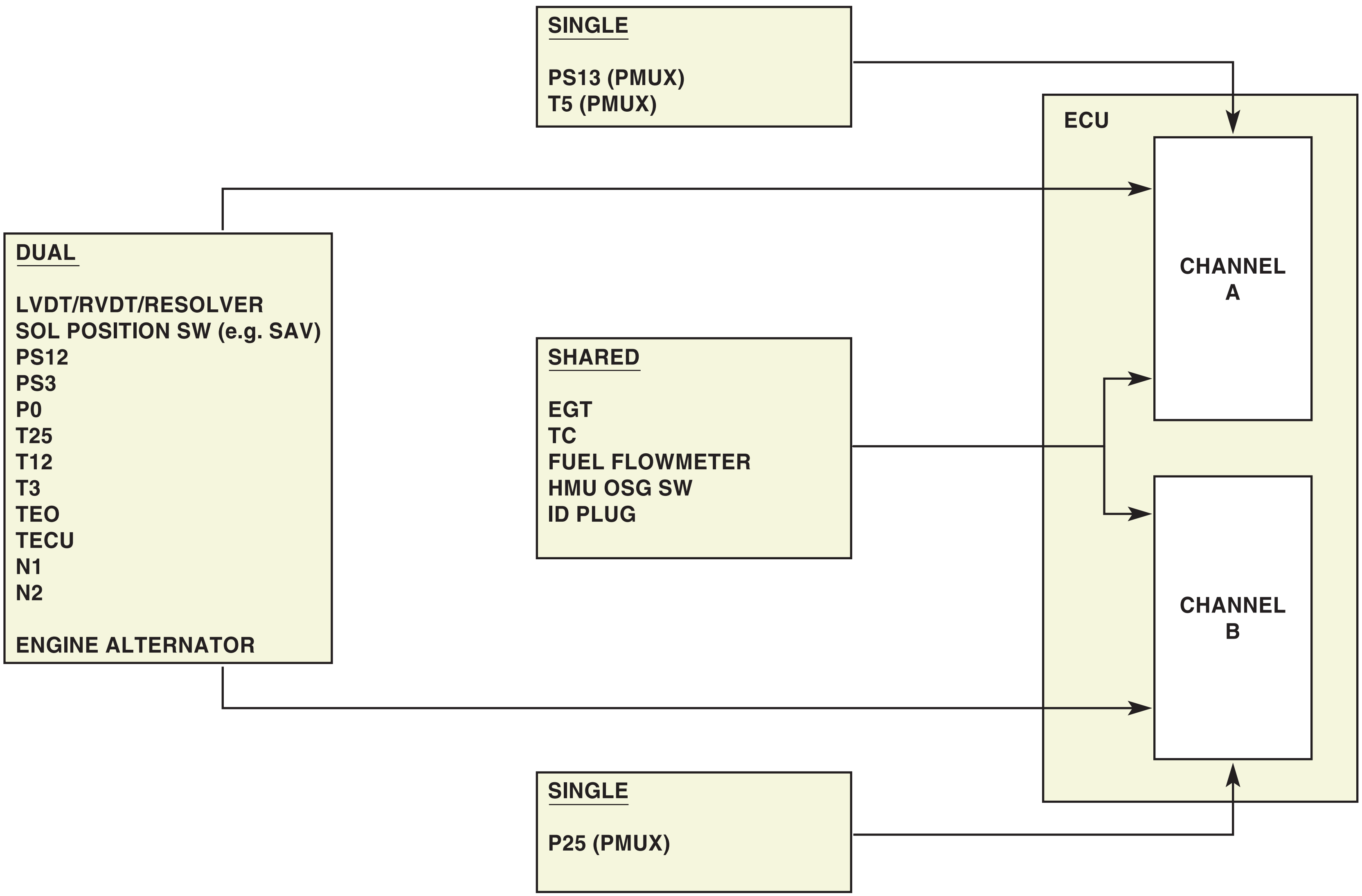
Shared inputs :

EGT.
T Case.
Fuel flowmeter.
HMU OSG switch.
ID plug inputs.

Non-critical control inputs are only sent to one channel.

Single inputs :

PS13 to channel A (PMUX option).
T5 to channel A (PMUX option).
P25 to channel B (PMUX option).



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ENGINE INPUTS TO THE ECU

ECU INPUTS

Identification plug parameters.

The engine identification (ID) plug provides the ECU with engine configuration information. It is plugged into connector J14 on the ECU and attached to the fan case by a metal strap. It remains with the engine even after ECU replacement.

It consists of a plug connector and a coding circuit. The coding circuit is welded to the plug connector pins and is equipped with fuse and push-pull links, which are used to ensure, or prohibit connection between the different plug connector pins.

Fuse links.

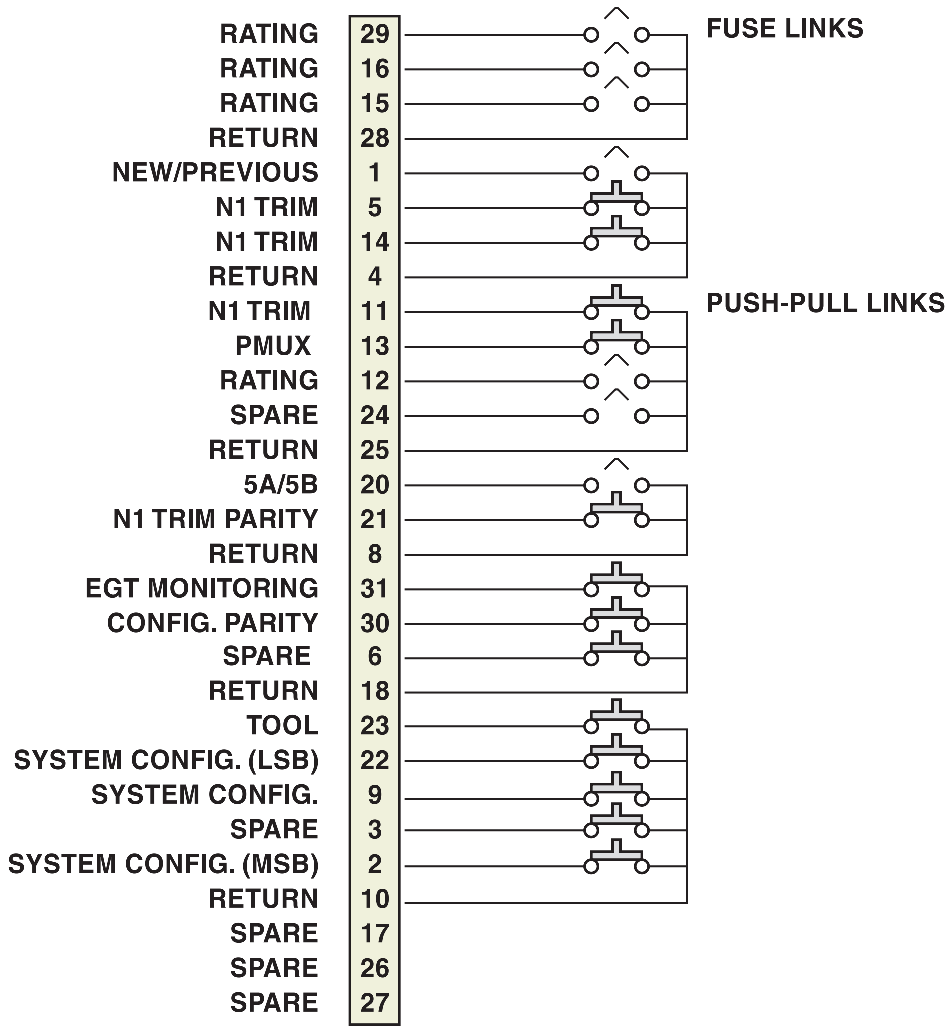
The fuse links are configured at production and cannot be changed. They are used to define engine thrust parameters :

- Rating.
- Bump.
- Plug type.

Push-pull links.

The push pull links are made by a switch mechanism located between two contacts. These links can be manually opened, or closed, according to requirements. These links are configured at the time of installation on the aircraft and define :

- Trim level : 0 to 7.
- Monitoring parameters : With, or without PMUX.
- Tool : Engine serial number programming tool.
- EGT monitoring : EGT monitoring selection.



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ID PLUG (J14) PARAMETERS

AIRCRAFT TO ECU INPUTS

The aircraft provides the electrical power supplies for the ECU and also the ignition system.

The aircraft normal and emergency buses supply the ECU with 28Vdc, through the EIU.

The 115Vac, 400Hz supply to each of the ignition exciters is routed from the aircraft, through the EIU and then the ECU, where it is switched on and off to control the operation of the exciters.

The ARINC429 databuses and some aircraft discretes are wired to the engine as simplex connections and split into duplex connections on the engine. The actual split is implemented within the ECU.

The aircraft provides the ECU with :

- Altitude.
- Total Air Temperature (TAT).
- Total Air Pressure (Pt).
- Mach number (M0).

From the ADC's, via ARINC429 serial databuses.

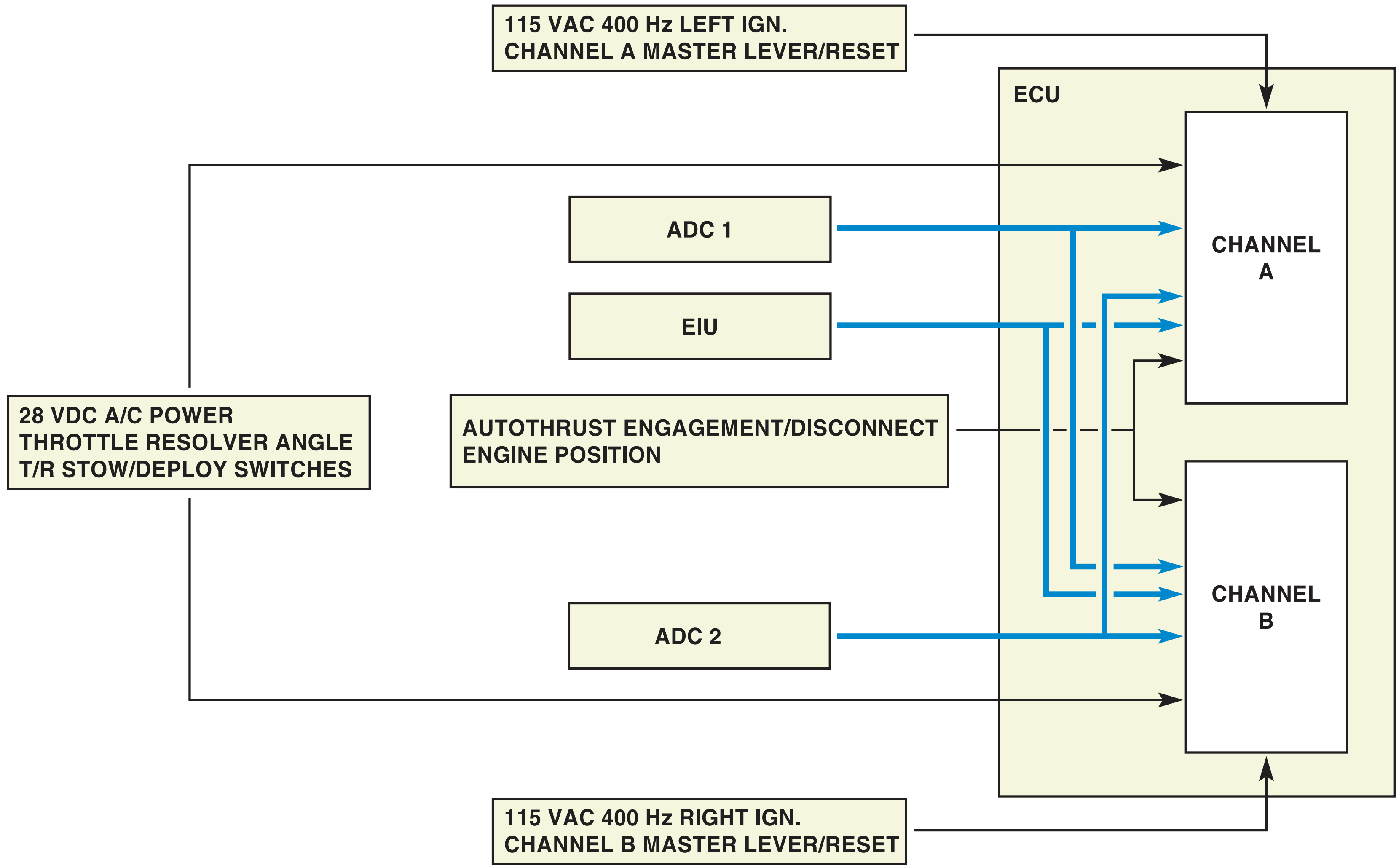
- General aircraft data.
- Idle setting data.
- Engine starting data.
- Autothrust function data.
- Maintenance function data.

From the EIU, via an ARINC429 serial databus.

- Throttle lever position in terms of electrical resolver angle. The resolver is mechanically linked to the throttle levers in the cockpit.

Selected hardwired discrete signals.

- Engine position discretes, which are used by the ECU to assign the SDI on ARINC outputs.
- Autothrust engagement and disconnect.
- Master lever reset.



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AIRCRAFT INPUTS TO THE ECU

ECU OUTPUTS

Each ECU channel has 2 independent ARINC429 serial databuses, which interface with the aircraft. There are no differences in the bus outputs, but data which is specific to a channel, such as fault and maintenance data, may differ from channel to channel. Sensor values that are output by the two separate ECU channels will also be slightly different, but within signal tolerance requirements.

Cockpit indication data is output to the aircraft to keep the flight crew informed of the operational status of system components and FADEC system controlled engine parameters.

Maintenance data is output, via the ARINC429 buses to the aircraft maintenance computer. This data provides information to help the ground crew identify system faults and isolate the faults to the correct LRU, or system interface.

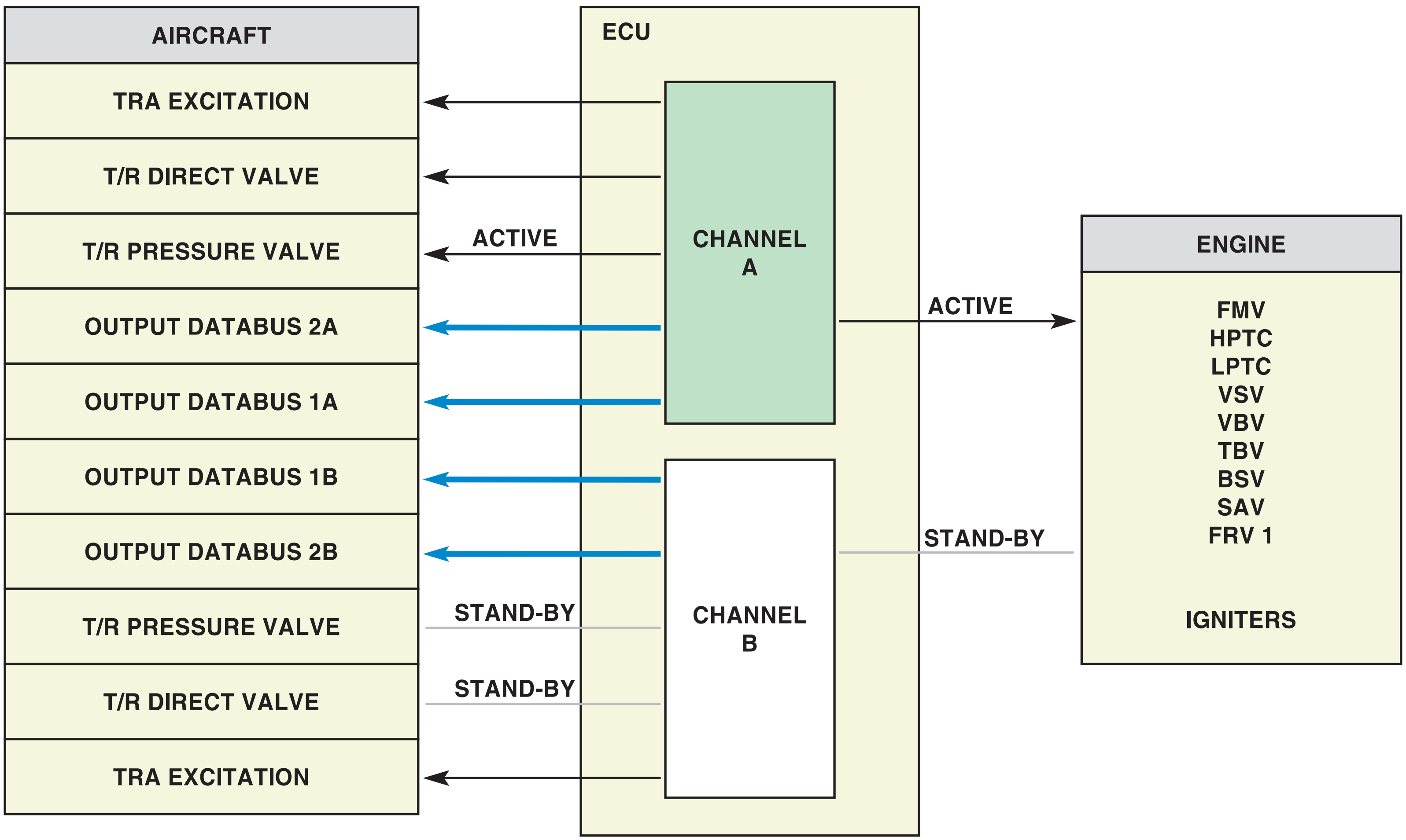
Engine condition monitoring parameters are output to the aircraft, via the ARINC buses, as digital equivalents of all sensor inputs to the ECU.

Channels A and B deliver constant outputs, irrespective of which channel is in control. Channel switch-over does not affect the output data of the ECU, except for the status indication for the channel in control, items specific to the channel in control and whatever faults caused the switch-over.

Both ECU channels are able to control torque motor and solenoid output loads, but only the active channel supplies control outputs during normal operation and the standby outputs are not used.

The ECU turns the two engine igniters on, or off, using relay-controlled switches, internal to the ECU.

Each channel of the ECU also provides excitation voltages for the throttle control system resolvers.



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ECU OUTPUTS

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FAULT DETECTION

FAULT DETECTION

Signal processing.

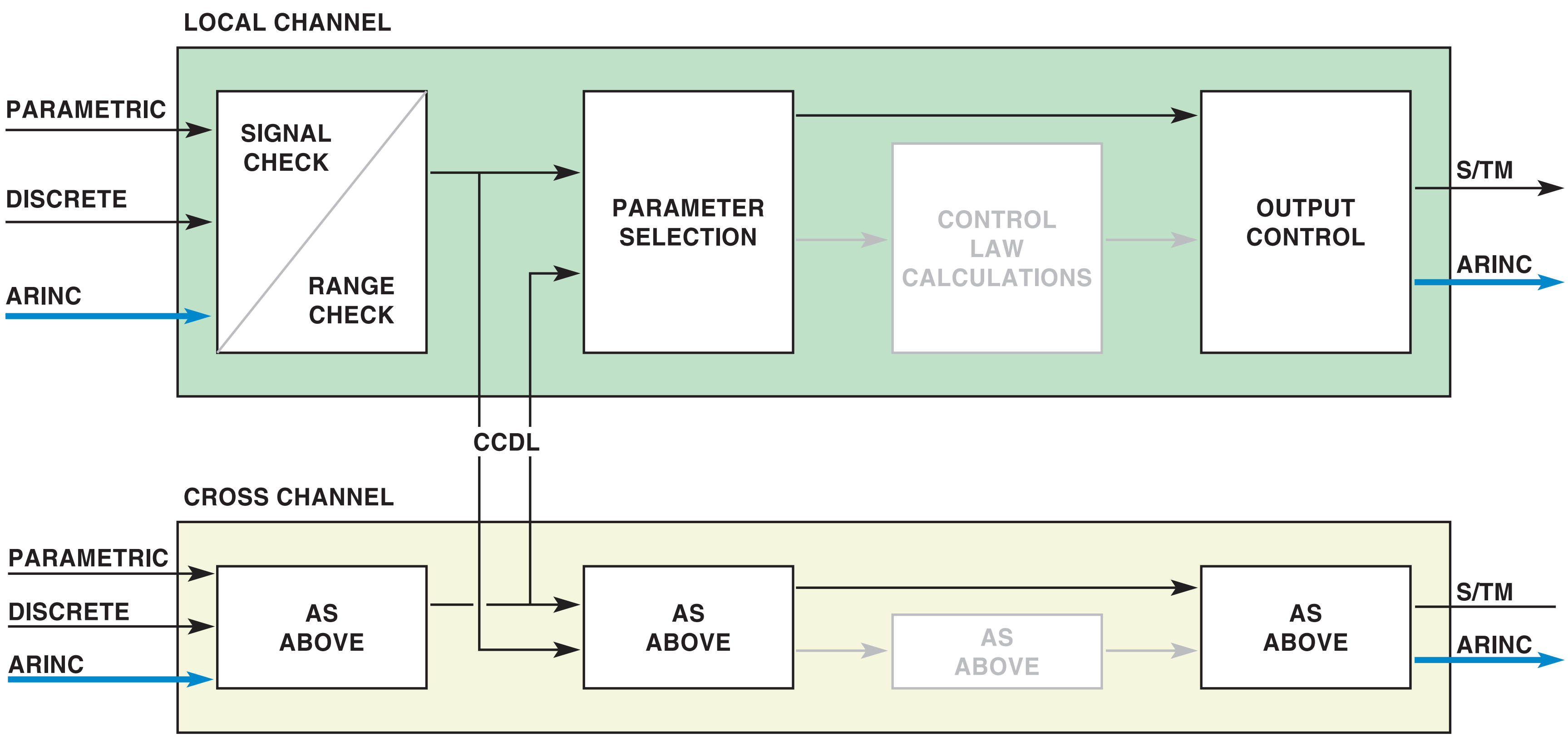
Within the ECU, the various inputs from sensors, switches and the aircraft pass through several stages of checks before the values received are finally selected to be used in the control law calculations.

Both ECU channels validate their inputs, process the data and check their outputs identically.

After they have been converted to a digital format, the parametric/discrete values and the ARINC datawords must first pass through a signal and range check logic.

The values are then compared across the CCDL before being selected for control low calculations. The control laws are entirely managed by the ECU software and will not be described here as they have no impact on fault detection.

After the values have been calculated and processed in the control law logic, they pass through to the output stage for transmission to engine, or aircraft systems.



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SIGNAL PROCESSING

INPUT VALIDATION

Parametric and discrete inputs.

The ECU provides fault accommodation for all engine control signals. This includes engine sensors, actuator/ solenoid position feedbacks and ARINC429 databus inputs.

The ECU converts parametric analog inputs into a digital format and then checks if the conversion has been successful. If the conversion test fails, the ECU sets a fault flag and the parameter status to invalid.

If the signal passes the conversion test, it is considered valid and passes onto a range test stage, which checks for minimum and maximum limits.

As most discrete inputs are treated as digital signals, they pass directly to the range test logic.

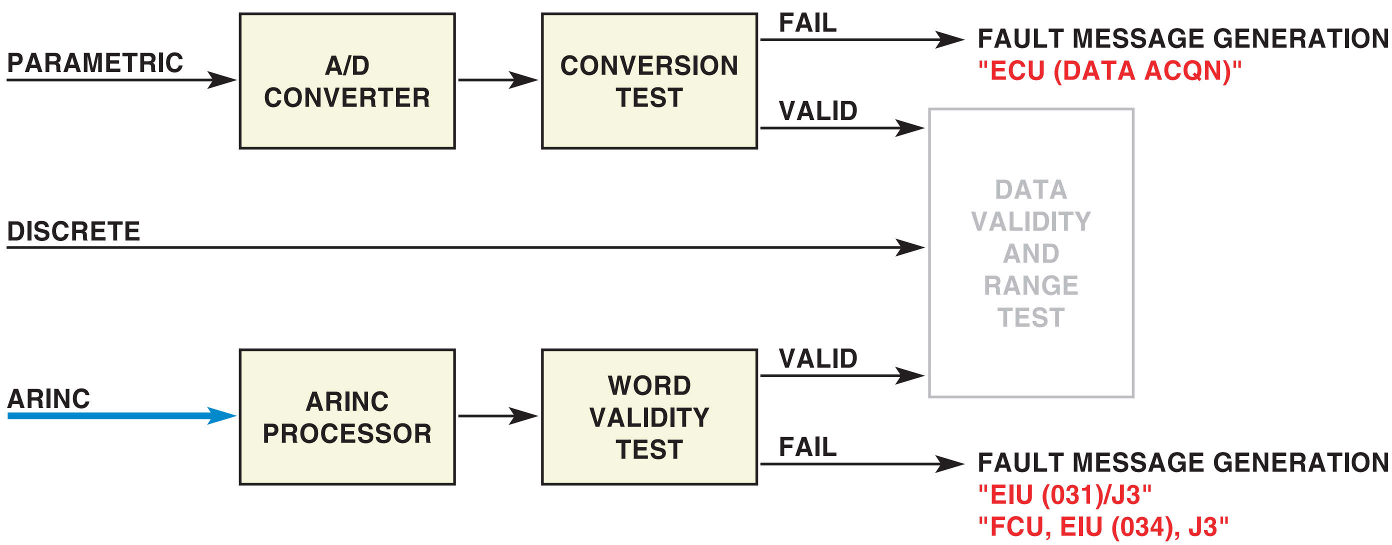
ARINC429 inputs.

The ECU monitors all ARINC429 inputs from the ADC's and the EIU for presence (activity).

ARINC429 words pass through an ARINC processor and the converted word is then checked for basic validity. The converted words are considered valid if they are received within the correct ARINC transmit interval and the parity is odd.

At the same time, the ECU checks the Status Matrix (SM). The SM depends on the label of the received word. For most labels, the word is considered valid if the SM is '11', but for some labels (e.g. EIU discrete words), the SM is a different value. If the word fails the basic validity check, the ECU flags the word as invalid.

If the word passes the validity test, the data contained in the word is then passed to the next check logic, which tests it for range.



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INPUT VALIDATION

RANGE TESTING

The ECU carries out range tests on the inputs after they have passed the validation tests.

The tests are managed by the ECU internal software and vary depending on the engine status.

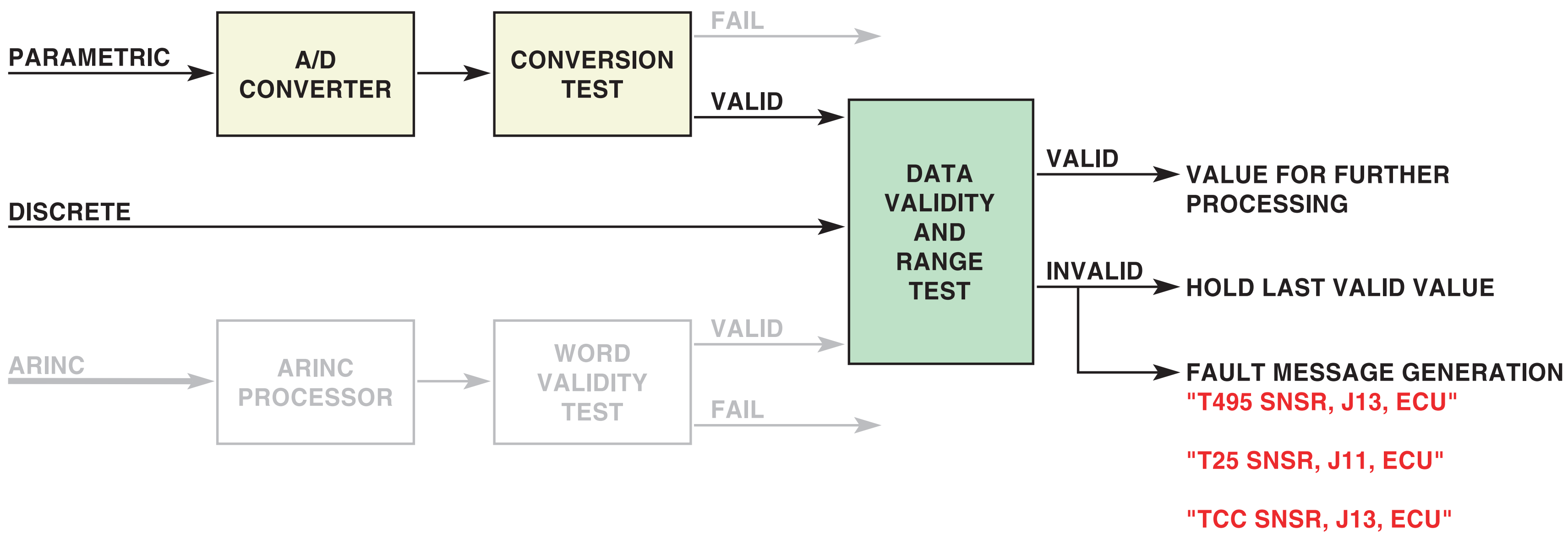
The simplest range test on a parameter is a check of maximum and minimum limits against predefined values.

Pressure sensors : P0, PS12, PS13, P25, PS3.
RTD temp sensors : T12, T25, TECU.
Thermocouple temp sensors : T3, EGT, T5, TC, TEO.
Speed sensors : N1, N2.

The ECU checks the sensor output signal and generates a fault message for that channel if the sensed pressure/ temperature is not within the specified maximum and minimum ranges.

If a parameter fails the tests, the ECU sets the validation status to 'Invalid' and holds the parameter at its last valid value.

When a parameter passes the range tests, the ECU sets the validation status to 'Valid' and the value is passed on for further processing.



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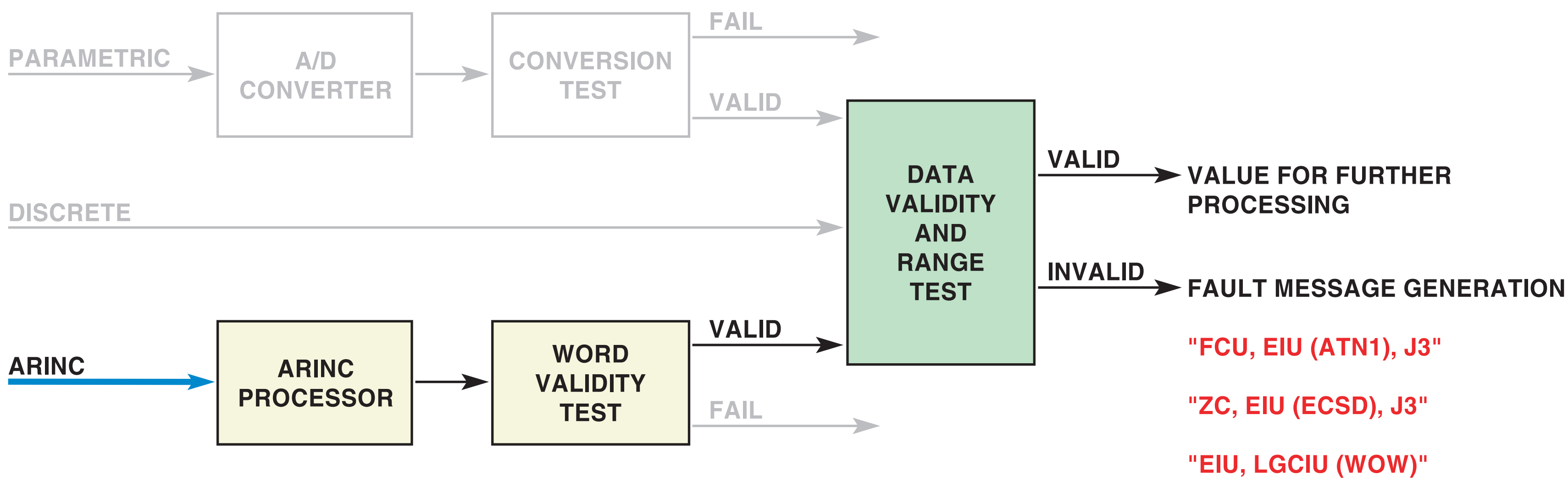
DATA VALIDATION AND RANGE TEST

DIGITAL DATA VALIDATION

If the digital word contains parametric data (parametric values transformed into digital values), the ECU extracts that data and checks the range limits.

ADC data received by the ECU can also be checked against inputs from the engine's dedicated sensors (P0, PS12, T12). After validation, a weighted average of ADC data and engine sensor values is selected. In the case where values from both ADC parameters and engine sensors are considered invalid, default values are assigned.

If the digital word contains discrete data (on/off, open/closed), the ECU determines its validity based on the validity of the word in which it resides. i.e. if the digital word has been passed as 'valid', then the ECU considers that the discrete data contained in that word is also valid.



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DIGITAL DATA VALIDATION

FEEDBACK LOOPS

RVDT/LVDT.
The RVDT's and LVDT's send actuator position information to the ECU and can be considered as a kind of electrical transformer.

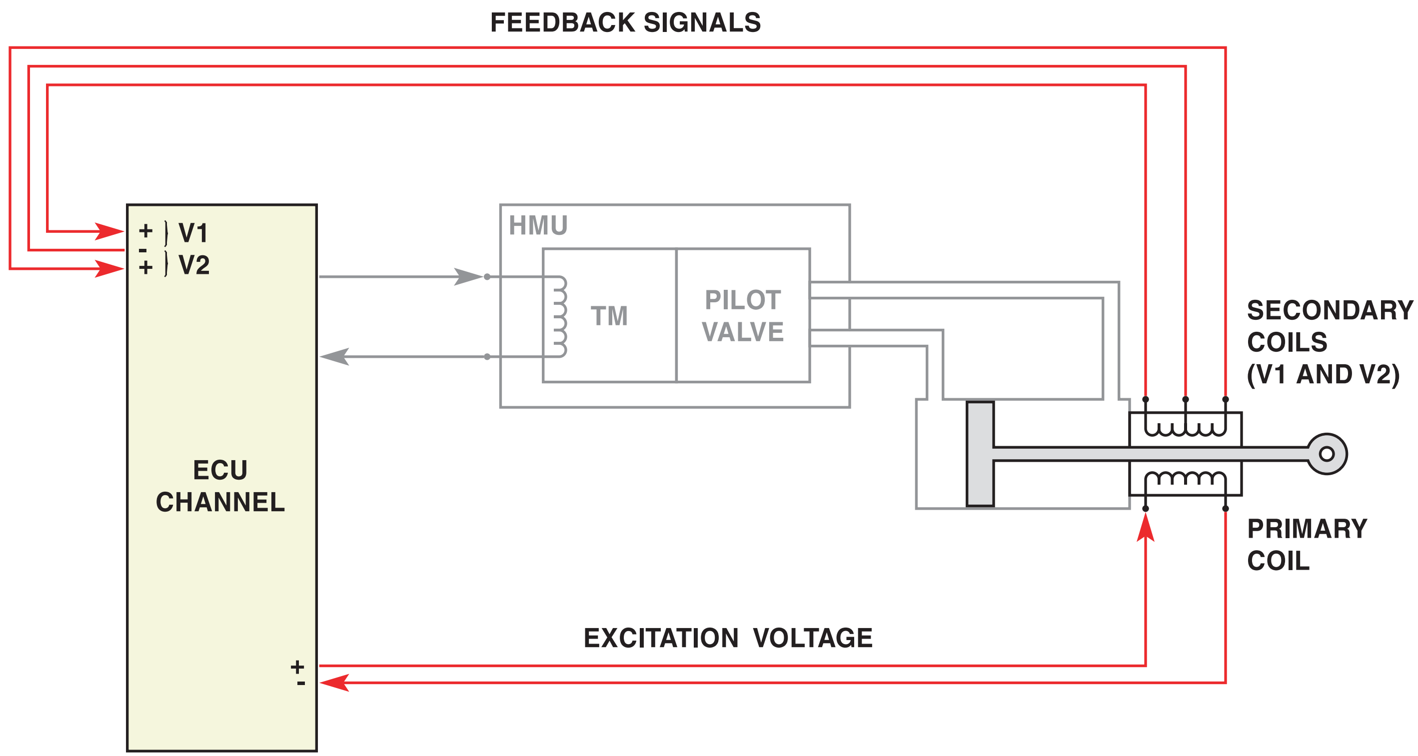
They consist of a primary coil (winding) and two secondary coils, separated by a moveable core.

Resolver.
The resolver is used because, compared to the RVDT's and LVDT's, it is more accurate.

The resolver also has two secondary coils, but the moveable core is a rotating primary coil.

Operation.
The excitation voltage for the primary coil is provided by the ECU channel output side and, as the actuator position changes, the moveable core changes the value of the voltage induced into the secondary coils.

The induced voltages from the two secondary coils are provided back to the input side of the ECU channel, where they are subjected to validation tests.



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VDT AND RESOLVER

FEEDBACK LOOPS

RVDT/LVDT.

The ECU checks the output voltage validity and generates a fault message if :

- V1 or V2 is out of range.
or,
- the sum of V1 + V2 is out range.
or,
- the calculated position is out of range.

Typical fault message.

VSV ACT, J11, ECU

VBV SNSR, J12, ECU

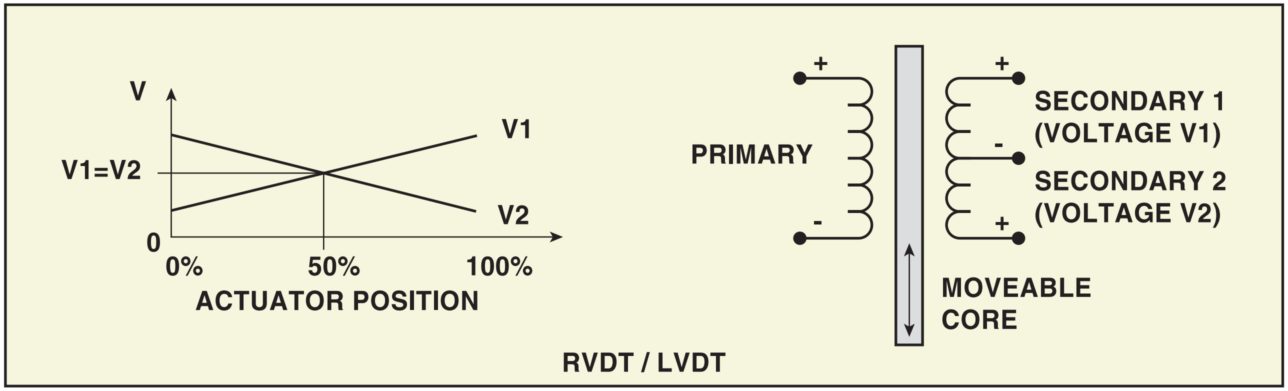
Resolver.

The ECU checks the output voltage validity and generates a fault message if :

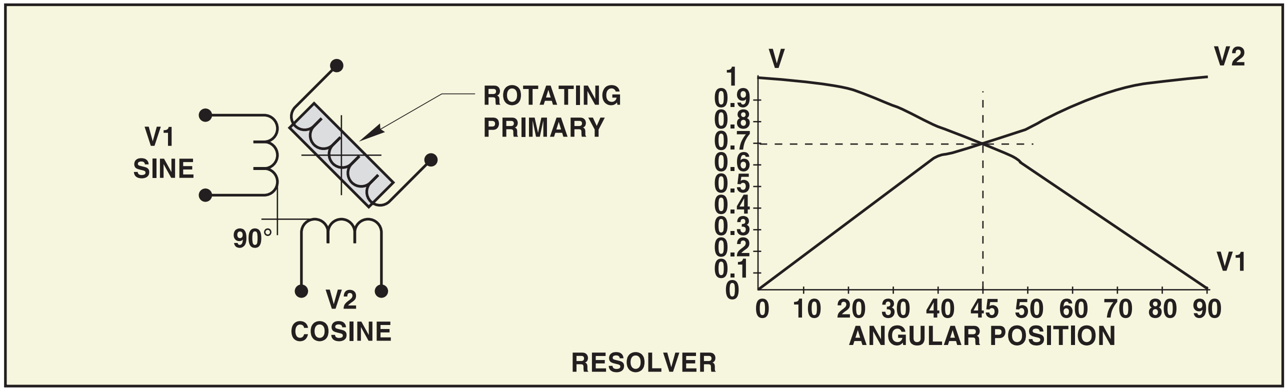
- V1 or V2 is out of range.
or,
- the sum of $V1^2 + V2^2$ is out range.
or,
- the calculated position is out of range.

Typical fault message.

J7, HMU(FMVRES), ECU



TYPICAL FAULT MESSAGE:
"VSV ACT, J11, ECU"



TYPICAL FAULT MESSAGE:
"J7, HMU (FMVRES), ECU"

CTC-239-023-00

FEEDBACK LOOPS

OSG VALIDATION

Overspeed governor switch.

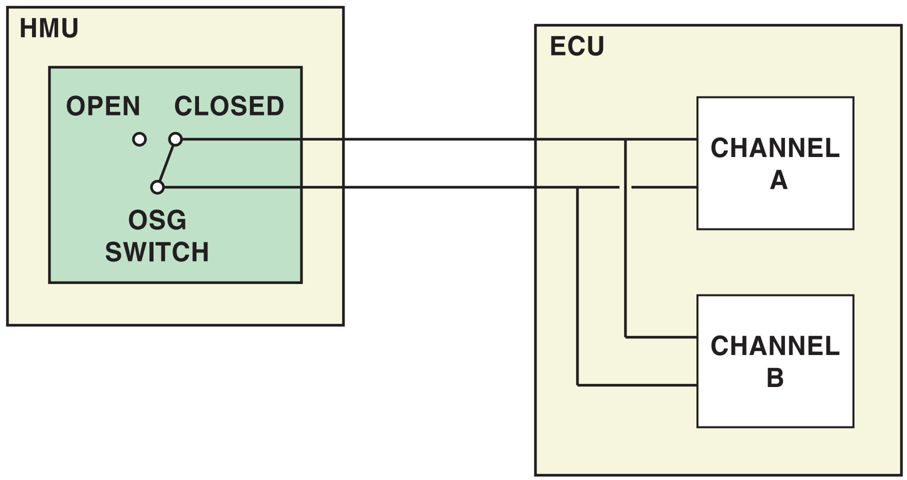
During startup, the ECU checks the state of the mechanical overspeed governor switch in the HMU.

The OSG switch is closed at zero engine speed. The overspeed governor begins to translate at 5554 RPM and the OSG switch should be open by 7000 RPM.

A fault message is generated and a fault flag set if :
- the N2 signal is valid,
  and,
- the aircraft is on ground,
  and,
- the fault persists for more than 1 second,
  and either,
- the local channel OSG switch indicates open at 3000 RPM,
  or,
- the local channel OSG switch indicates closed at 7500 RPM.

Typical fault message.

HMU (OSG), J7



TYPICAL FAULT MESSAGE
"HMU (OSG), J7"

CTC-239-024-00

OSG SWITCH

IDENTIFICATION PLUG VALIDATION

The information contained in the engine ID plug is coded by a combination of open/closed discretes and includes identification and configuration for :

- PMUX option
- Engine model - rating, N1 trim
- Configuration - EGT monitoring
- System configuration

Each ECU channel reads the state of the discretes only at power up initialization and not during an external reset. Once read, the information is held in reserved RAM.

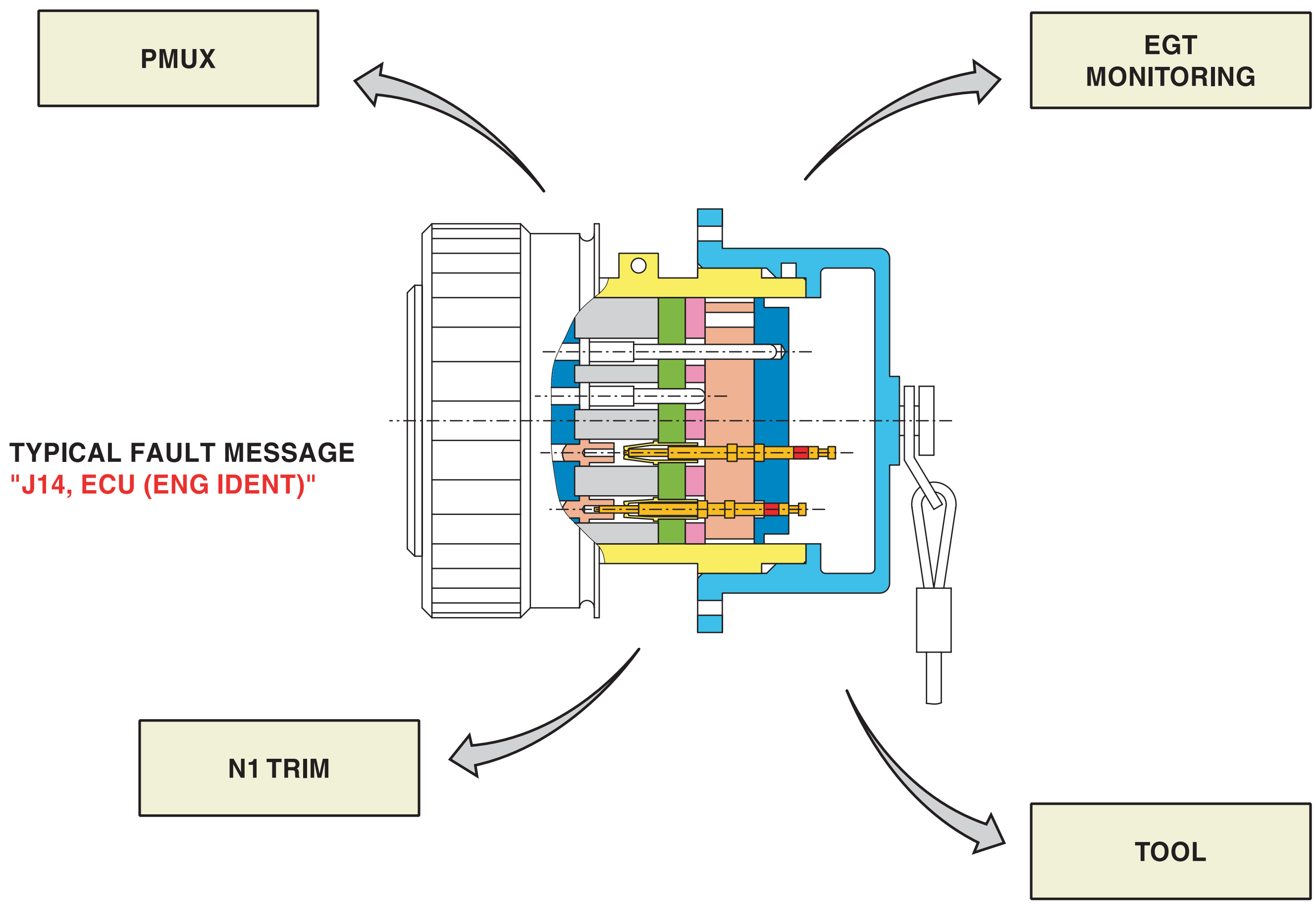
On ground, the reserved RAM values are compared with NVM. If they are different, and the reserved RAM values are valid, the RAM values are stored into NVM. If the reserved RAM values are not valid, the NVM values will not be overwritten.

The information is coded in such a way that the total number of closed discretes for a particular configuration is odd, in order for the ECU to check the information for correct parity (odd).

Short circuit faults cannot be detected unless the parity is affected.

Typical fault message.

J14, ECU (ENG IDENT)



CTC-239-025-00

ID PLUG

INPUT SELECTION

Cross channel validation.

Validated input signals and validation status data are transmitted from one channel of the ECU to the other. This cross channel data is then available for use in the data selection process. Data is transferred between channels A and B, via a set of discrete digital signals and two unidirectional databuses.

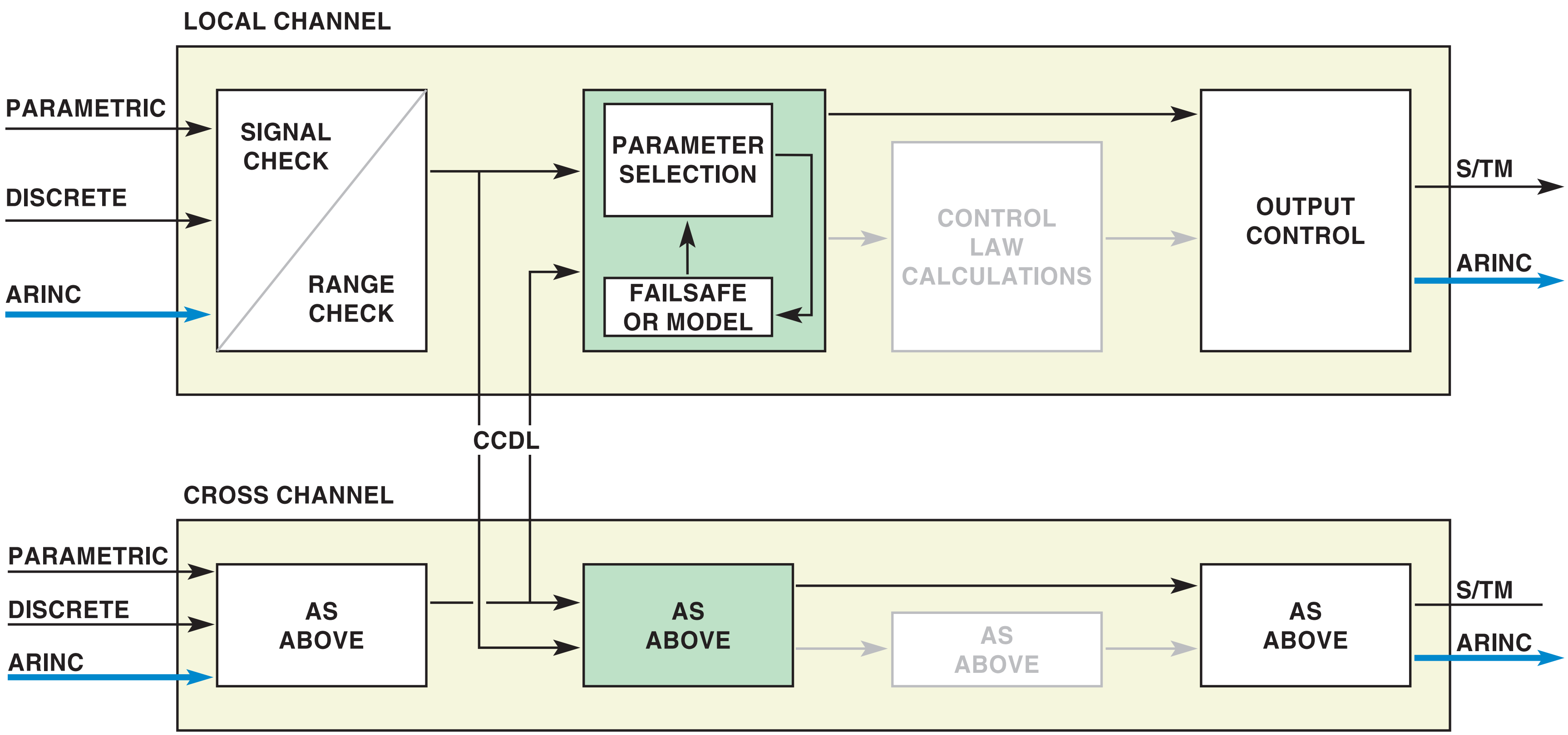
If the local channel digital data is invalid, or fails a maximum/minimum range check, then that channel uses the opposite channel's data, through the CCDL, provided that the data has passed validity and range checks. The validation status also indicates if cross channel data is unavailable.

If the parameters value fails the validation and max/min range checks on both channels, then the ECU selects either a failsafe value or, for certain parameters, a model value.

A failsafe value is one that has been predetermined and stored in the ECU memory. There are 2 failsafe values that can be selected : failsafe 1 and failsafe 2.

Failsafe 1 is a predetermined minimum, or maximum value. Failsafe 2 is a predetermined fixed value.

A model is a value which is mathematically calculated by the ECU from other parameter values.



CTC-239-026-00

SIGNAL PROCESSING

PARAMETER SELECTION

When both channels are operational and cross-channel data is available, the validity of channel A and B dual sensor measured values and the absolute difference between the two inputs are checked. The outcome of these tests determines the selected value and the corresponding selection status.

If one channel's input is invalid, then the other channel's value is selected. If both channels' inputs are invalid, and the sensor has an ECU calculated model, then the model value is selected. If the sensor does not have a calculated model, then failsafe value 2 is selected.

If channel A and B measured values are considered valid, the ECU checks that the absolute difference between the two inputs is within a predetermined range.

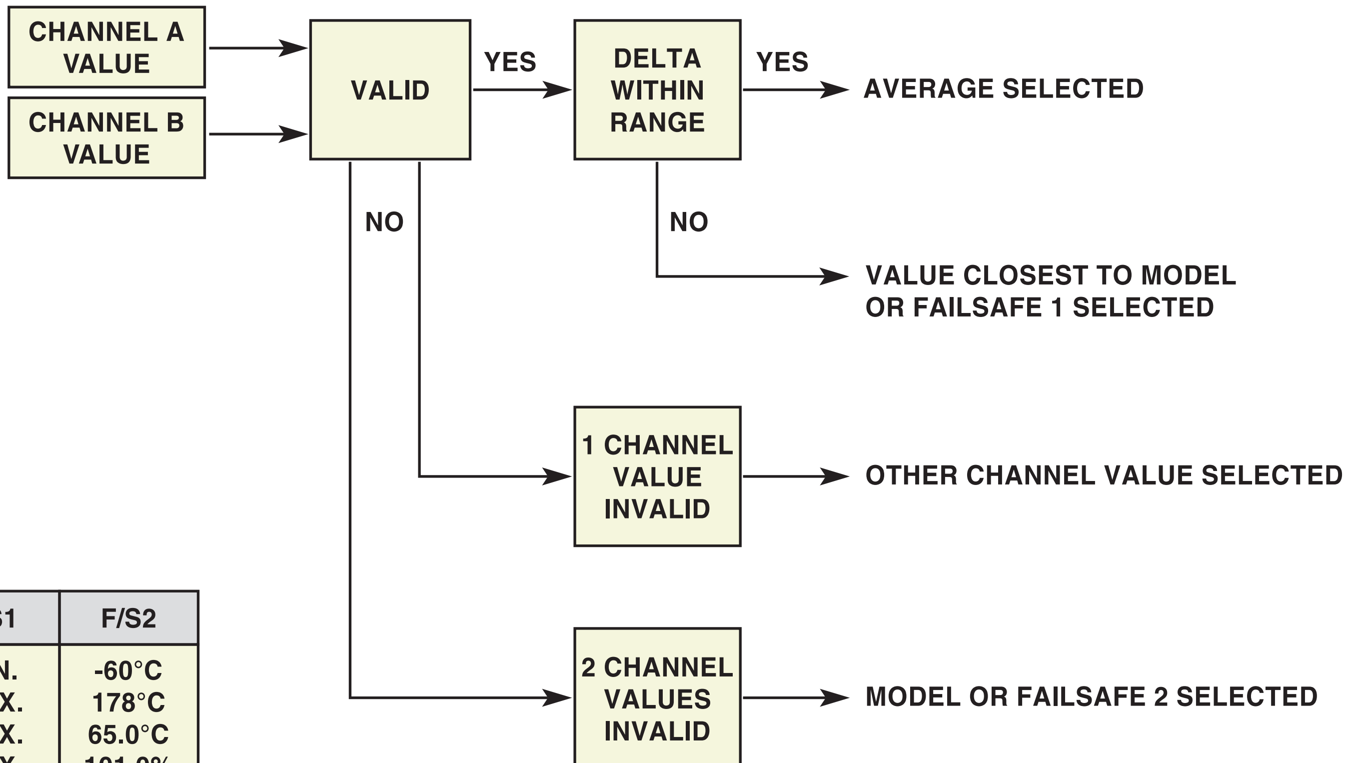
If the delta between the two inputs is outside the predetermined range and the inputs have a model, then the value that is closest to that model is selected. If the sensor does not have a model, failsafe value 1 is selected.

T495, TC, TEO, TECU, HPTC, TBV, LPTC are parameters without ECU-calculated models.

Input.	**F/S 1.**	**F/S 2.**
T495	Max	15°C
TC	Min	-60°C
TEO	Max	178°C
TECU	Max	65°C
HPTC	Max	101.0%
TBV	Max	101.0%
LPTC	Max	105.0%

Sensor inputs PS3, N1, N2, T3, T25, FMV, VSV and VBV have ECU-calculated models.

For persistent, or intermittent failures, the ECU sets latch flags after a specific number of fault counts are exceeded to prevent repeated switching between sensor values and modeled values. The dual sensor fault is latched until the next ECU reset.



INPUT	F/S1	F/S2
TC	MIN.	-60°C
TEO	MAX.	178°C
TECU	MAX.	65.0°C
HPTC	MAX.	101.0%
TBV	MAX.	101.0%
LPTC	MAX.	105.0%
T495	MAX.	15°C

CTC-239-027-00

INPUT DATA SELECTION

SIGNALS DISAGREE

TRA signals disagree.

The ECU interfaces with two TRA resolvers, one dedicated to channel A and the other to channel B. Each ECU channel provides excitation for and accepts inputs from its resolver.

The ECU performs input conversion checks (resolver sine and cosine signals to TRA degrees) and the input is rejected if a conversion fault is detected, or the value is outside the minimum/maximum range limits.

Validated channel A & B inputs are compared across the CCDL and if they are in agreement, the average is selected. The comparison difference is 3.0 degrees.

If there is a cross channel signals disagree for more than 1 second, the ECU generates a fault message and TRA selection is a function of flight/ground status and the selected throttle position at the time of fault detection.

Typical fault message :

TLA SNSR, J3, ECU

in conjunction with

TLA SNSR, J4, ECU

STATUS	SELECTED THROTTLE POSITION AT THE TIME OF FAULT DETECTION			
	REVERSE	IDLE THRU MAX CONT	FLX/DRT TAKEOFF	MAX TAKEOFF
GROUND	SELECT TLA CLOSEST TO, BUT NO GREATER THAN FORWARD IDLE	SELECT TLA = FORWARD IDLE	SELECT LARGER TLA	SELECT LARGER TLA
FLIGHT	NOT IN APPROACH PHASE : SELECT TLA CLOSEST TO, BUT NO GREATER THAN MAX CONT. IN APPROACH PHASE : SELECT TLA = FORWARD IDLE.	NOT IN APPROACH PHASE : SELECT TLA CLOSEST TO, BUT NO GREATER THAN MAX CONT. IN APPROACH PHASE : SELECT TLA = FORWARD IDLE.	SELECT LARGER TLA	SELECT LARGER TLA

TYPICAL FAULT MESSAGE

"TLA SNSR, J3, ECU"

IN CONJUNCTION WITH

"TLA SNSR, J4, ECU"

CTC-239-028-00

TRA SIGNALS DISAGREE

SIGNALS DISAGREE

BSV switch disagree.

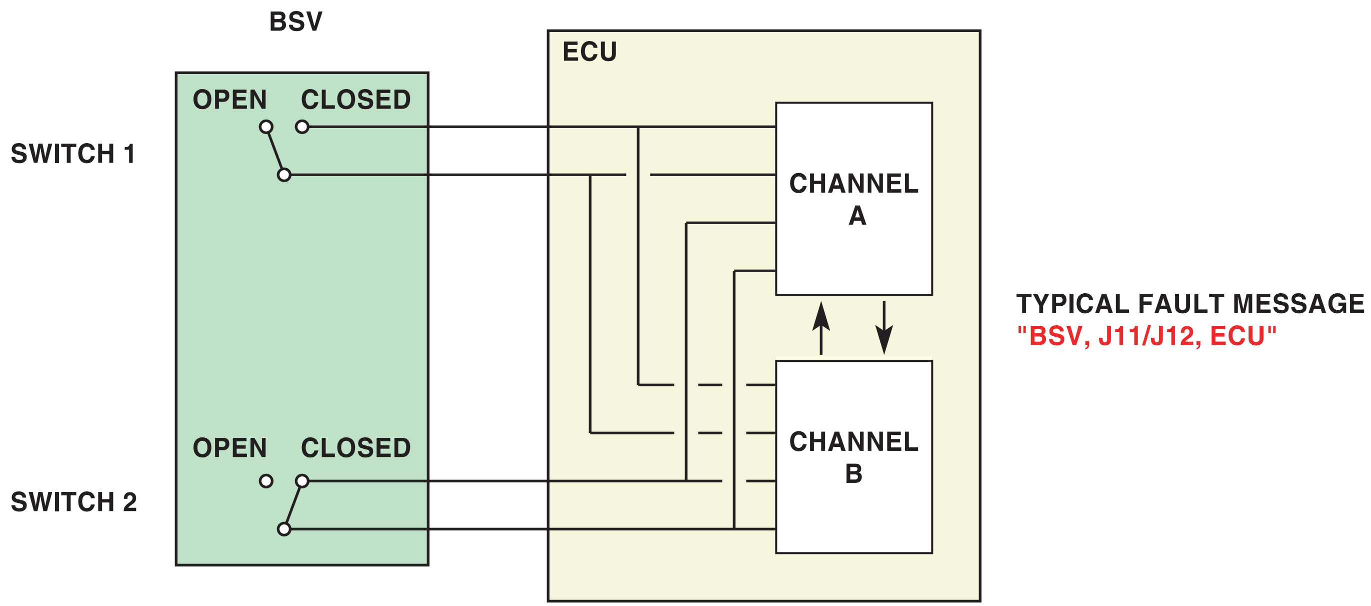
The ECU checks the Burner Staging Valve switch positions for a signals disagree.

A fault message is generated if ;

- Switch 1 signals disagree between channels A & B, or,
- Switch 2 signals disagree between channels A & B, or,
- Switch 1 signals disagree with switch 2 signals.

Typical fault message.

BSV, J11/J12, ECU



CTC-239-029-00

POSITION SIGNALS DISAGREE (BSV)

OUTPUTS

Wraparound.

The ECU uses a current-driver-wraparound test to check correct operation of the torque motors, solenoid drivers and certain relays.

To check the integrity of the circuits, the ECU outputs a calculated current and compares it to the sensed return current (wraparound).

In normal operation, the output current value should be the same as the return current value.

If there is a difference between the output and return current, it must exceed a defined value for a specific time interval in order for a fault to be declared.

On a transition of channel selection state from standby to active, the ECU clears all wraparound faults and sets the fault-delay timers to zero.

A wrap fault is generated if :
-the difference between i1 & i2 is greater than 50mA, or
-i2 > 365mA.

Typical fault messages.

J7, HMU (VSV TM), ECU

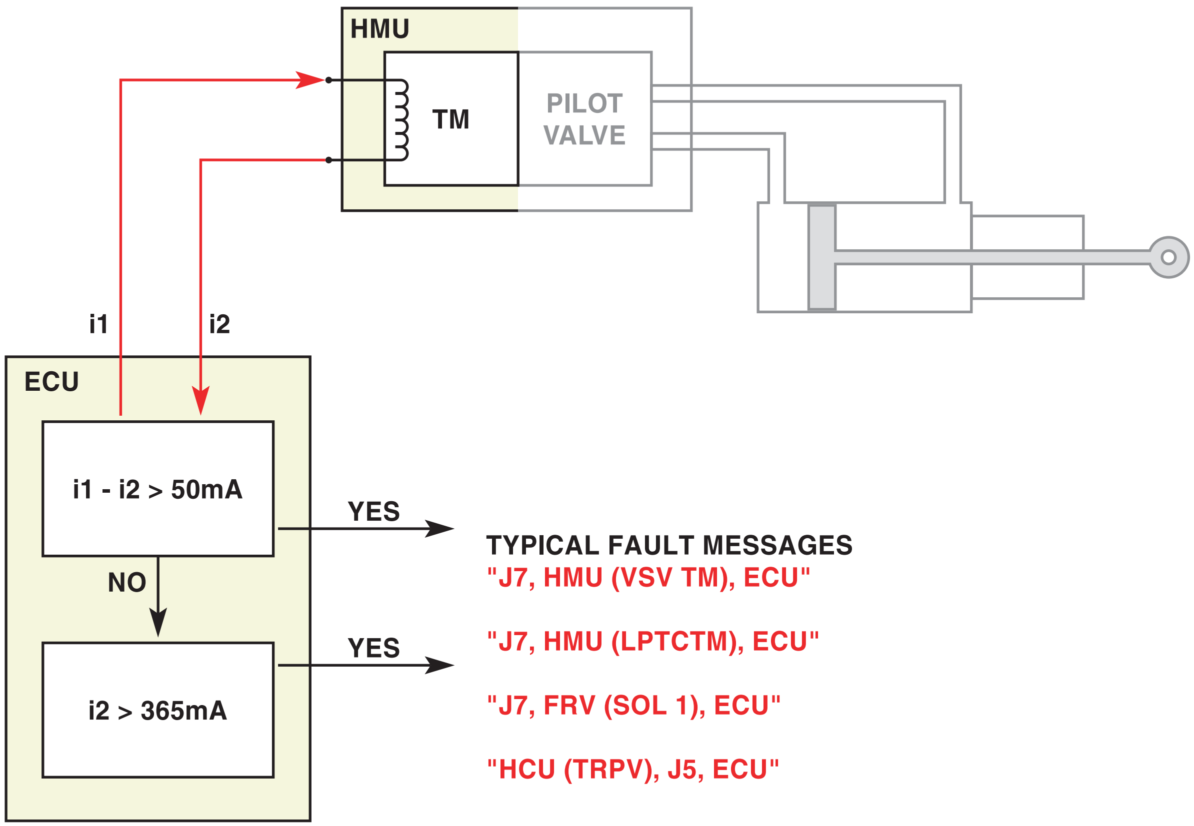
J8, HMU (VBV TM), ECU

J7, HMU (LPTCTM), ECU

J7, FRV (SOL 1), ECU

J7, HMU (BSVSOL), ECU

HCU (TRPV), J5, ECU



CTC-239-030-00

CURRENT DRIVER WRAPAROUND TESTS

OUTPUTS

Wraparound fault detection.

Possible causes.

Example 1 : Short circuit to ground.

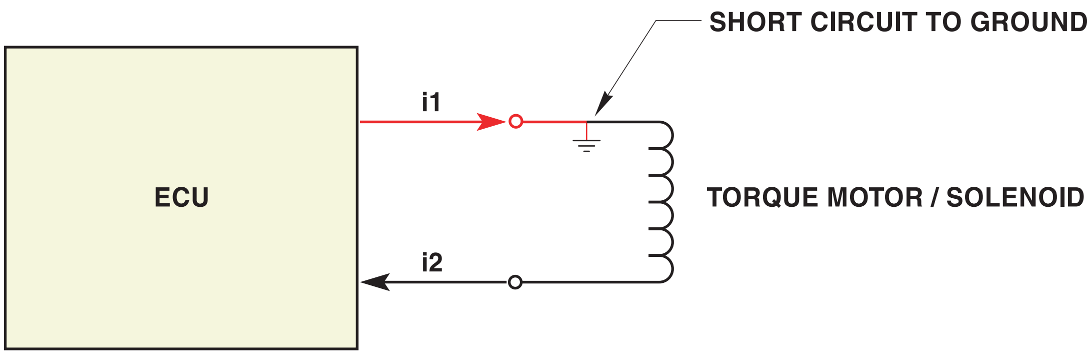
If there is a short circuit to ground, the current flows back to the ECU, through the ground path.

The ECU detects that i1 is not equal to i2 and generates a fault message.

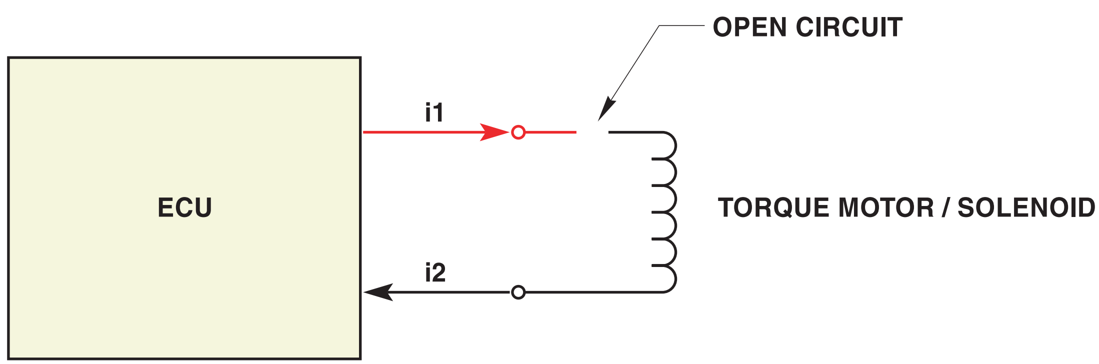
Example 2 : Open circuit.

If there is an open circuit, the ECU generates a current that is unable to loop back to the ECU.

Therefore, i1 and i2 equals zero in all conditions and the ECU generates a fault message.



SHORT CIRCUIT TO GROUND : i1 ≠ i2



OPEN CIRCUIT : i1 AND i2 = 0

CTC-239-031-00

WRAPAROUND FAULT DETECTION

OUTPUTS

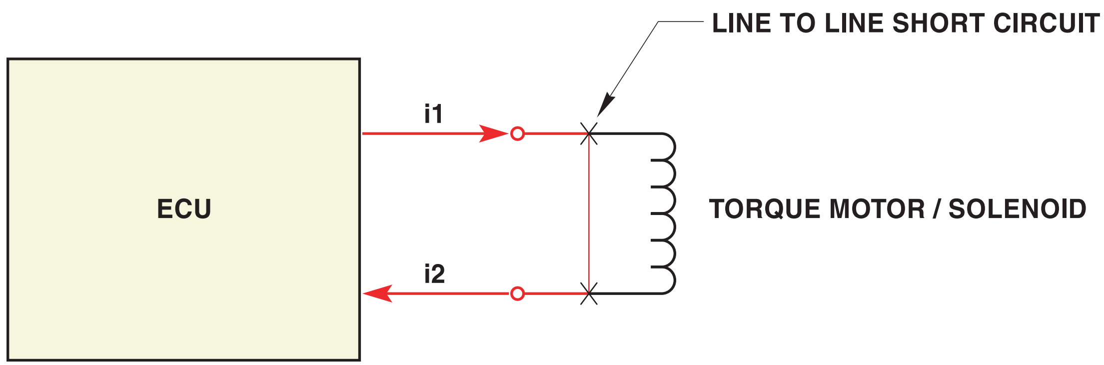
Wraparound fault detection.

Example 3 : Line-to-line short circuit.

In this case, the ECU is unable to detect a short circuit as i1 will be the same as i2.

No wraparound fault is generated and there is no change of channel in control.

However, because of the short circuit, the ECU is no longer able to control the torque motor, or solenoid function and a ‘demand/position disagree’ fault is generated.



NO "SHORT CIRCUIT" DETECTION
NO TORQUE MOTOR CONTROL = "DEMAND / POSITION DISAGREE"

CTC-239-032-00

WRAPAROUND FAULT DETECTION

OUTPUTS

ARINC wraparound test.

Each channel of the ECU has two output ports to interface with the aircraft. ARINC output databus 2 is also used for the Engine Monitoring System for development purposes and aircraft flight test. There are no output differences in the two busses on each channel, unless an ARINC transmitter is faulty, or if databus 2 is in the Engine Monitoring System mode of operation.

In most cases, however, parameter values output by the two separate channels will be slightly different, but within signal tolerance requirements. Data which is specific to a channel, such as fault and maintenance data, may differ from channel to channel.

Each ECU output databus port is driven from a separate transmitter and the databus 1 port is monitored with an individual wraparound test. The ECU verifies for data integrity by looping output databus 1 back to an internal, dedicated input port, within each ECU channel.

Specifically chosen datawords are stored in a source data buffer and continuously transmitted (every 240 msec).

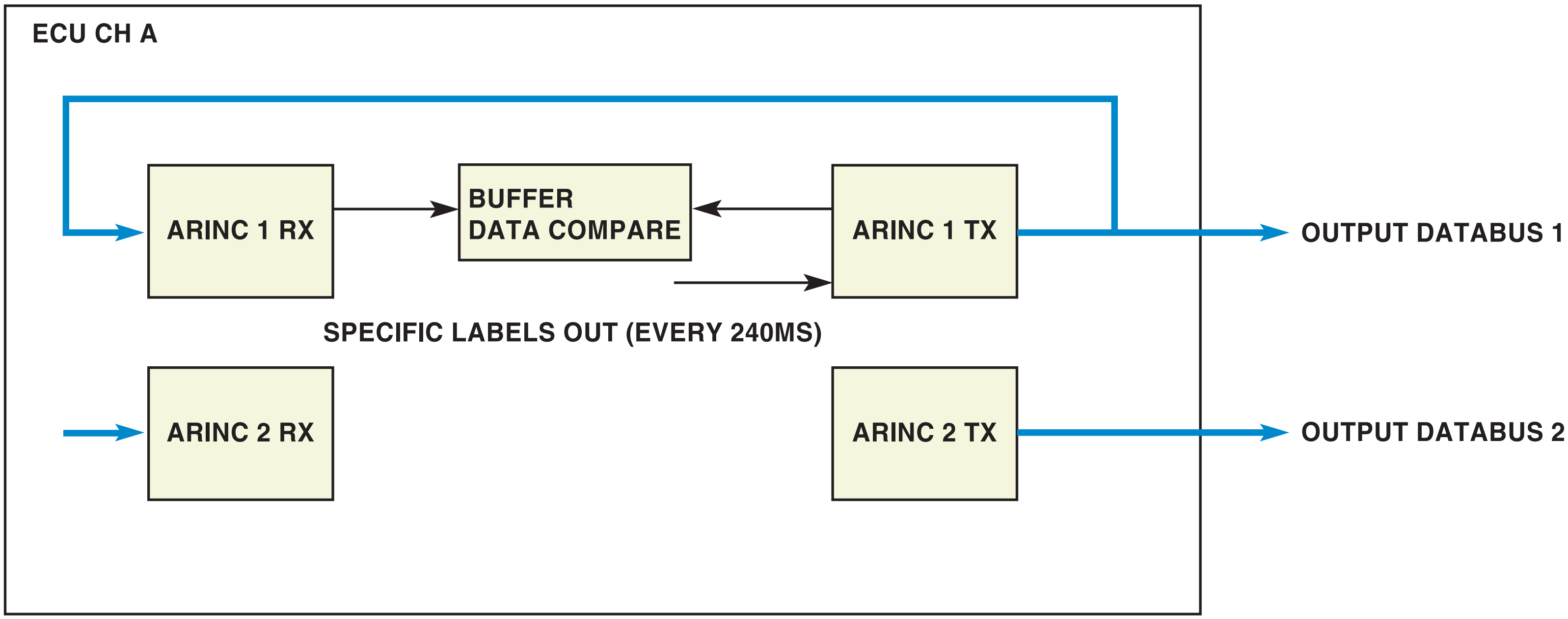
The looped-back datawords pass through an ARINC receiver and the datawords received are compared with the corresponding datawords stored in the source data buffer.

The datawords that are looped back are :

- VSV Demand
- N1 Command
- N1 Target
- Indicated N1 Actual
- Selected FMV position

The ECU confirms the accuracy of the data, SDI, SM and word parity. If the ARINC output databus 1 transmitter fails the wraparound test, all subsequent ARINC parameters output on that bus are flagged with an invalid SM.

No wraparound data verification is performed on output databus 2.



FAULT MESSAGE : "ECU (ARINC OUT)"

* CH A SHOWN ONLY
CH B IDENTICAL

CTC-239-033-00

ARINC WRAPAROUND TEST

CONTROL LOOPS

LPTC, HPTC, TBV & FMV control.

The LPTC, HPTC, TBV and FMV have dual sensors providing feedback of the actuator position.

Only the active channel provides an excitation voltage to drive its torque motor, because the other channel's output drivers are disconnected when in standby mode.

Both channels, active and standby, provide excitation signals for the primary windings of the position sensors.

The secondary windings provide position feedback signals to their respective channels and are subjected to a validation check to make sure they are within range.

The signals input to each channel is also compared across the CCDL to make sure that there is not a position disagree.

Demand and position signals disagree.

The ECU checks if the sensed (measured) actuator position agrees with the demanded position.

A fault message is generated if :

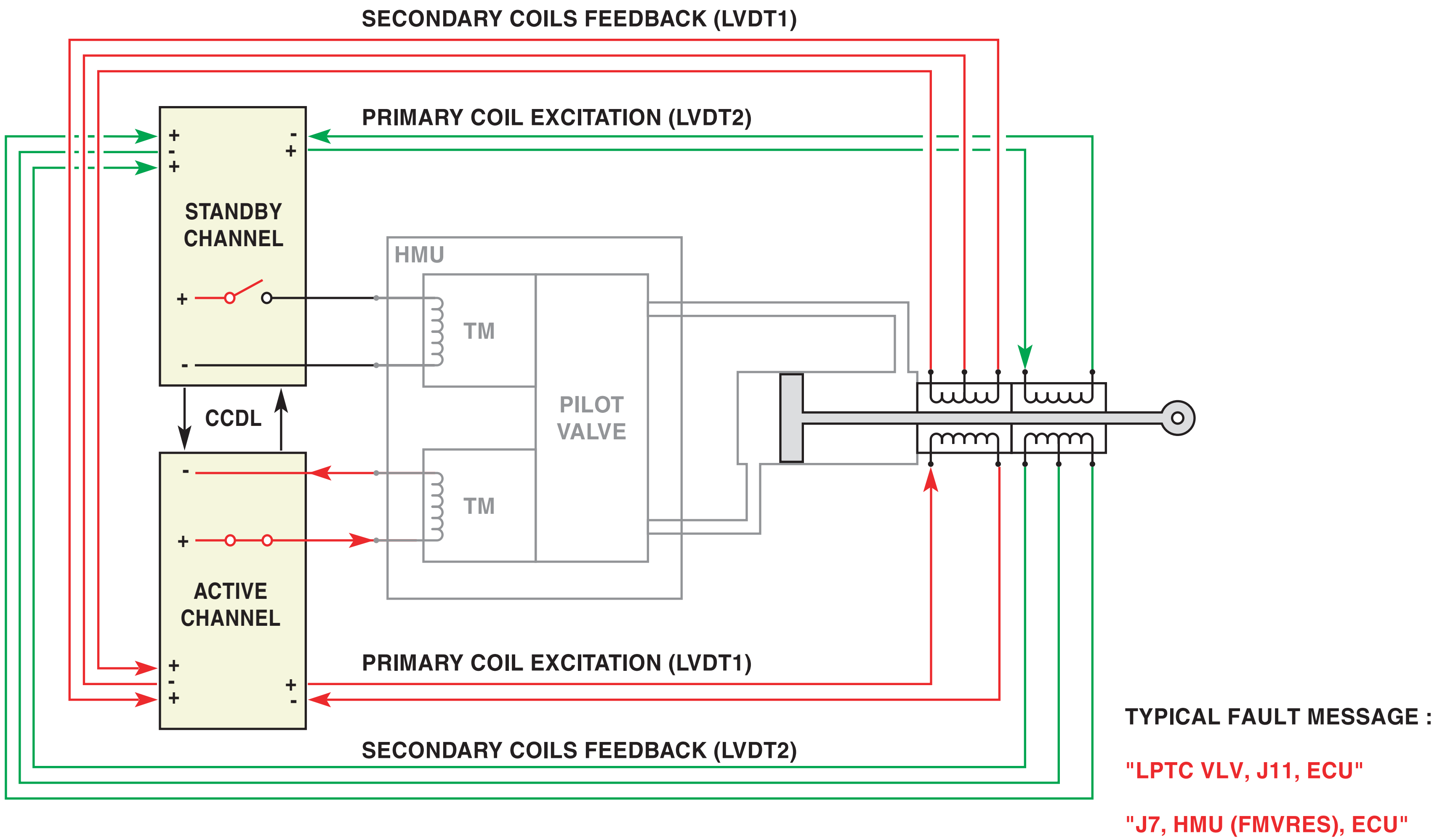
- the absolute value of the difference between the demand and valid position is greater than 5%.
- there is not a wrap fault on the local channel.
- N2 is greater than 22%.
- the channel is active.

Typical fault messages.

LPTC VLV, J11, ECU

HPTC VLV, J12, ECU

J7, HMU (FMVRES), ECU



CTC-239-034-00

LPTC, HPTC, TBV AND FMV CONTROL

CONTROL LOOPS

VSV control.

The VSV system has two actuators, one on either side of the engine. Each actuator contains an LVDT to provide position feedback signals.

One LVDT is connected to ECU channel A and the other LVDT is connected to channel B.

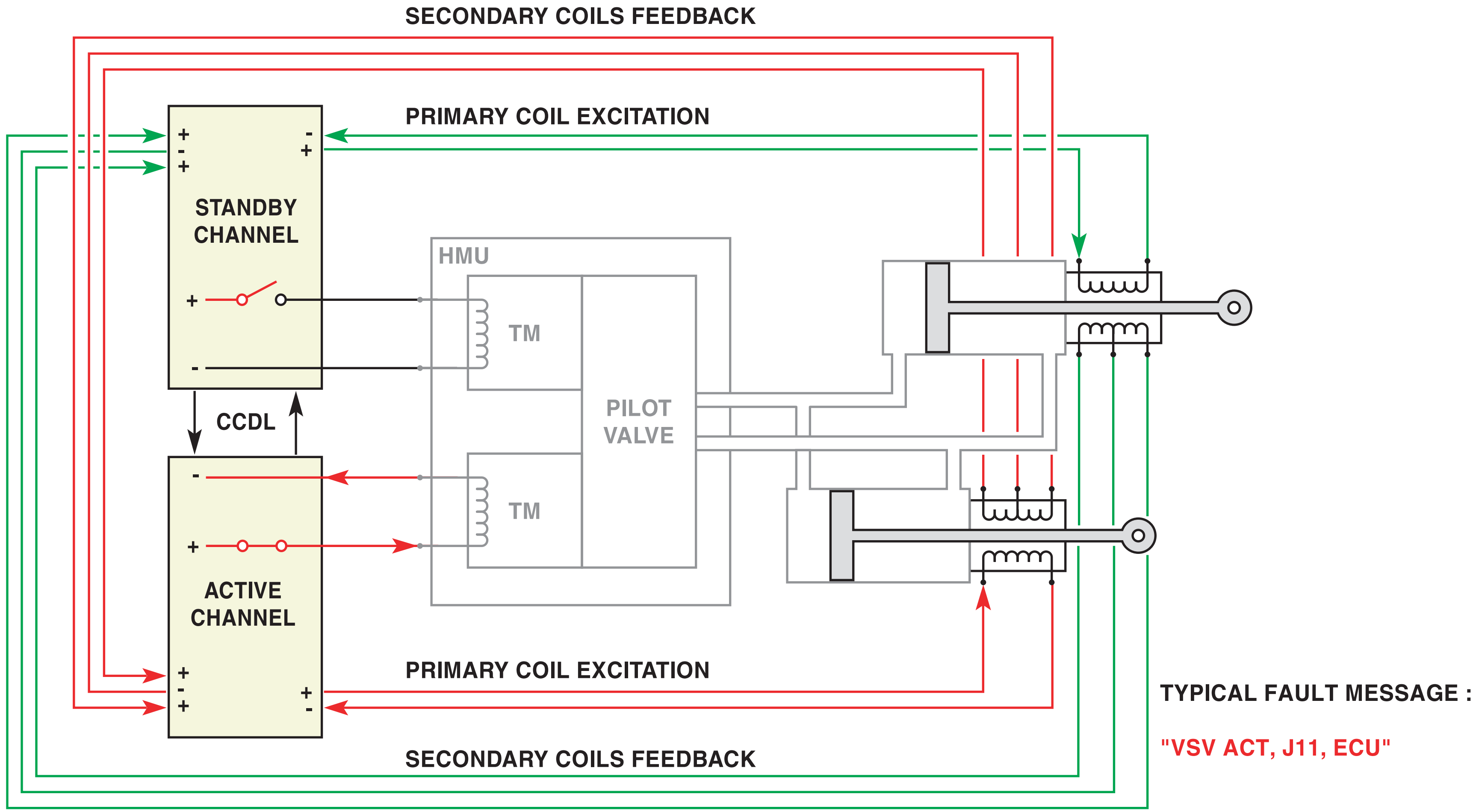
Both channels, active and standby, provide excitation signals for their respective primary windings and the signals induced into the secondary windings provide position feedback signals.

The feedback signals are subjected to validation checks and the inputs to each channel are also compared across the CCDL, to make sure that there is not a position disagree.

A fault message is generated if :
- the absolute value of the difference between the demand and valid position is greater than 5%.
- there is not a wrap fault on the local channel.
- N2 is greater than 22%.
- the channel is active.

Typical fault message.

VSV ACT, J11, ECU



CTC-239-035-00

VSV CONTROL

CONTROL LOOPS

Primary excitation groups.

The LVDT, RVDT and resolver primary excitation windings are wired together in groups.

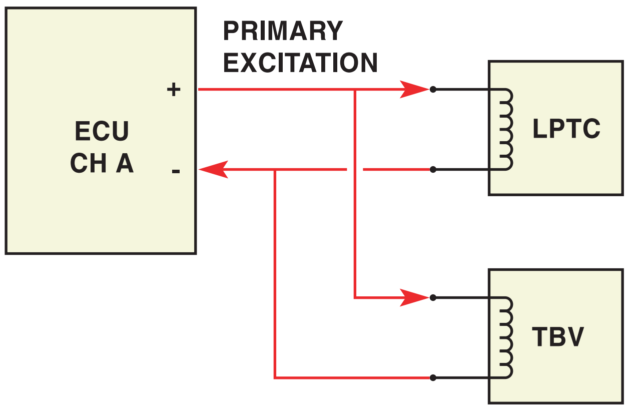
It is possible, therefore, that a fault registered on one primary winding may be caused by a fault on another winding in the same group.

Channel A.

Group 1.	Resolver 1 (TRA)
Group 2.	Resolver 2 (FMV), HPTC
Group 3.	VBV, VSV
Group 4.	LPTC, TBV

Channel B.

Group 1.	Resolver 1 (TRA)
Group 2.	Resolver 2 (FMV), VSV
Group 3.	VBV, LPTC
Group 4.	HPTC, TBV



	CHANNEL A	CHANNEL B
GROUP 1	RESOLVER 1 (TRA),	RESOLVER 1 (TRA),
GROUP 2	RESOLVER 2 (FMV), HPTC	RESOLVER 2 (FMV), VSV
GROUP 3	VSV, VBV	VBV, LPTC
GROUP 4	LPTC, TBV	HPTC, TBV

CTC-239-036-00

PRIMARY EXCITATION GROUPS

IGNITION MONITORING

The ECU has 2 independent 115 Vac inputs from the airframe, one dedicated to each ignition system.

- The Emergency bus supplies System 1 (J1 - Ch A - upper ignition box) Right.
- The Normal bus supplies System 2 (J2 - Ch B - lower ignition box) Left.

The ignition power supply is automatically disconnected by the EIU if the master lever is selected off, or in case of fire emergency procedure.

Ignition power supply is failsafed to ‘ON’, in the case of a failed EIU.

Each ECU channel has a software-operated ignition on/off switch to operate one exciter/ignitor. Each channel can control the operation of both of these switches.

A software monitor in each system keeps both ECU channels informed of the status and messages are generated if faults are detected.

The ECU generates a fault message if :

- there is insufficient voltage on the 115 Vac input.
- the master lever is select ON.
- the fire switch pushbutton is not selected.

Typical fault message.

J1, 115 VAC, ECU

J2, 115 VAC, ECU

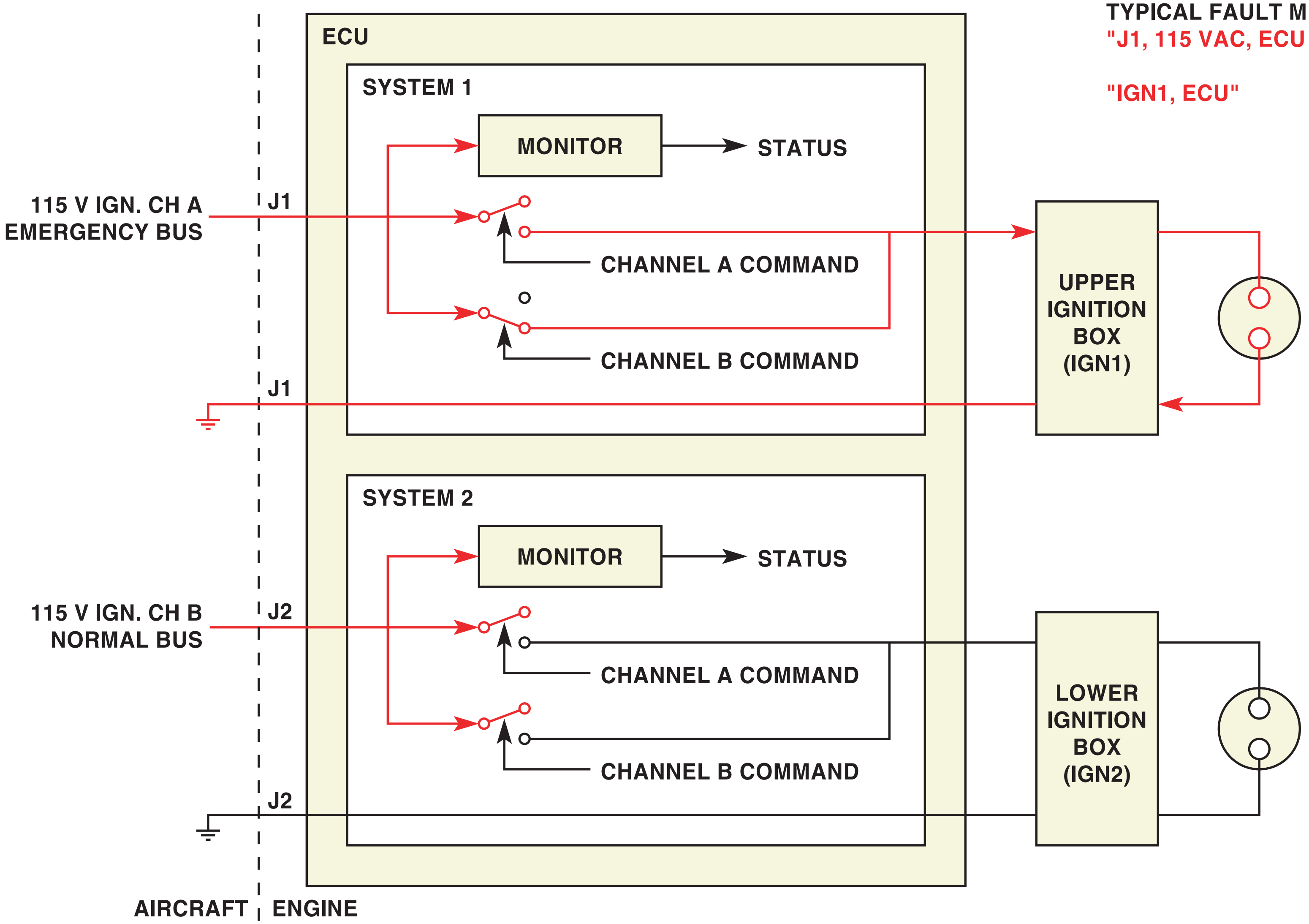
The ECU also generates a fault message if :

- the channel is active,
- no lightoff has been detected,
- 115Vac is available,
- Ignitor switched on.

Typical fault message.

IGN1, ECU

IGN2, ECU



IGNITION MONITORING

CTC-239-037-00

THRUST REVERSER

In response to the throttle resolver setting (TRA), the ECU provides the following functions :

- Control of the thrust reverser deploy and stow.
- Thrust limiting during reverser transition and after a failure has been detected.
- Thrust reverser system monitoring, including the T/R shut-off valve (TRSOV), which isolates the T/R from system pressure.
- Fault identification for accommodation and communication, via ARINC outputs, to the aircraft systems.

The reverser logic is based on throttle lever position, flight/ground status, engine running status, mach number and reverser position.

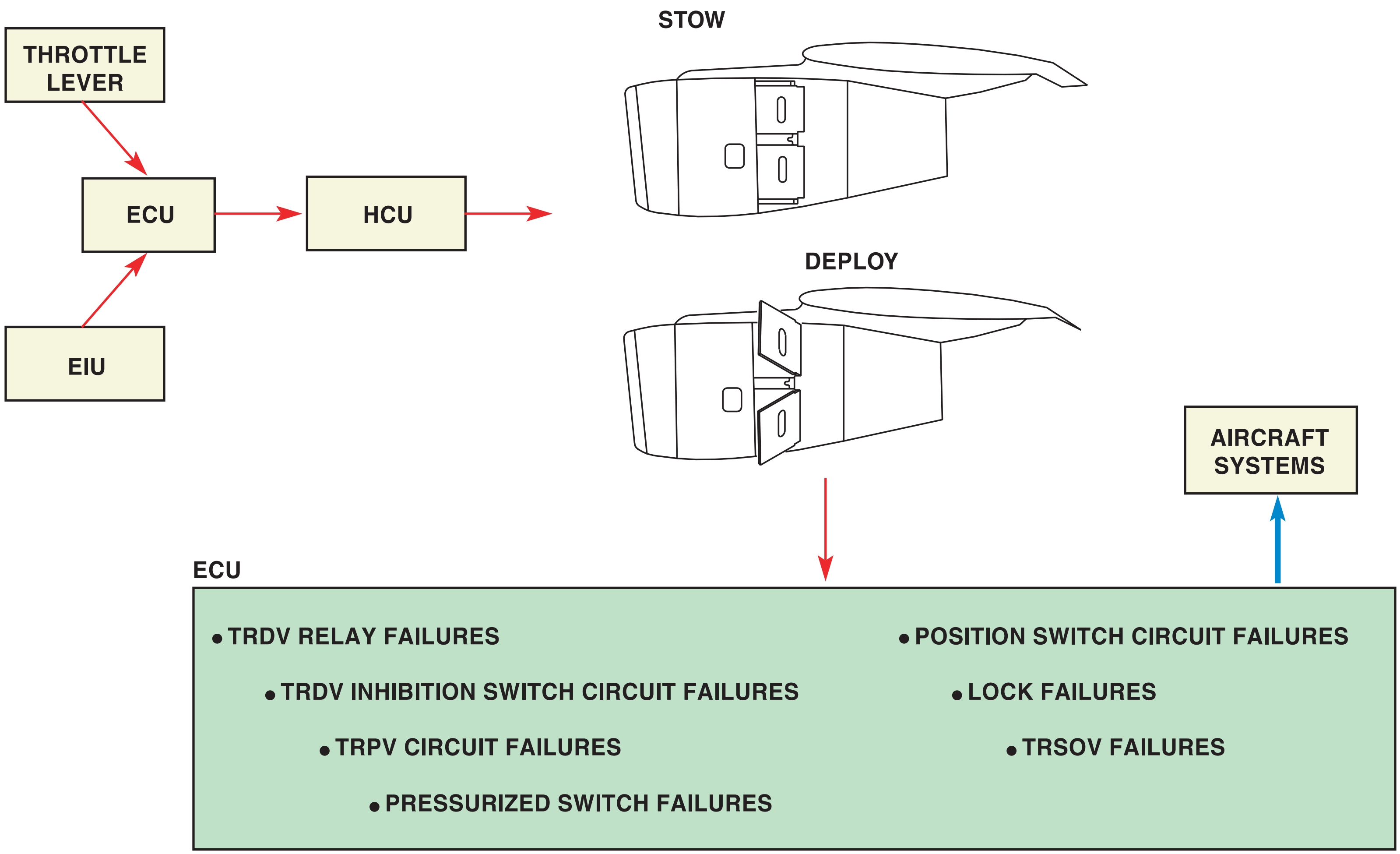
Each ECU channel is able to monitor and control the thrust reverser.

The ECU causes the T/R to deploy by energizing both the T/R Directional Valve (TRDV) solenoid and the T/R Pressurizing Valve (TRPV) solenoid, when the A/C is on ground, the engine is running and the TRA is less than or equal to -4.3 degrees. When all four doors are detected fully deployed, the ECU de-energizes the TRPV solenoid.

The ECU causes the T/R to stow by energizing the TRPV and de-energizing the TRDV, when the A/C is on ground, the engine is running, the TRA becomes greater than -4.3 degrees, N1 is below 71% and either, the reverser position is indeterminate and the reverser system is inadvertently pressurized, or at least one door is detected unstowed.

Failure detection for the T/R control consists of :

- TRDV circuit failures,
- TRDV A/C inhibition switch circuit failures,
- TRPV circuit failures,
- pressurized switch failures,
- position switch circuit failures,
- lock failures,
- TRSOV failure.



CTC-239-038-00

T/R FAILURE DETECTION

THRUST REVERSER

TRDV & TRPV solenoids.

The ECU interfaces with the TRDV solenoid, which contains 2 electrically isolated windings, one to channel A and the other to channel B. Each of the windings is capable of operating the solenoid.

Each TRDV solenoid winding is connected to the ECU via a two-wire cable, wired in series with an aircraft throttle operated inhibition switch. The inhibition switch closes only when the throttle is in the reverse region, supplying 28 Vdc to the TRDV solenoid windings.

The ECU detects failures of the inhibition switch circuit, to the closed state, if 28 Vdc is present when the throttle is in the forward thrust region.

Typical fault message.

J5, TR ACFT SW, ECU

J6, TR ACFT SW, ECU

The ECU also interfaces with the TRPV solenoid, which contains 2 electrically isolated windings, one dedicated to channel A and the other to channel B. The ECU performs current wrap tests on the circuitry of the TRDV and TRPV solenoids to check continuity. This wrap test is continuously done, even if the solenoids are not commanded to be energized.

A fault message is generated if a failure is detected and the ECU will switch to the standby channel when the faulted solenoid is commanded to energize, provided that the standby channel is healthier.

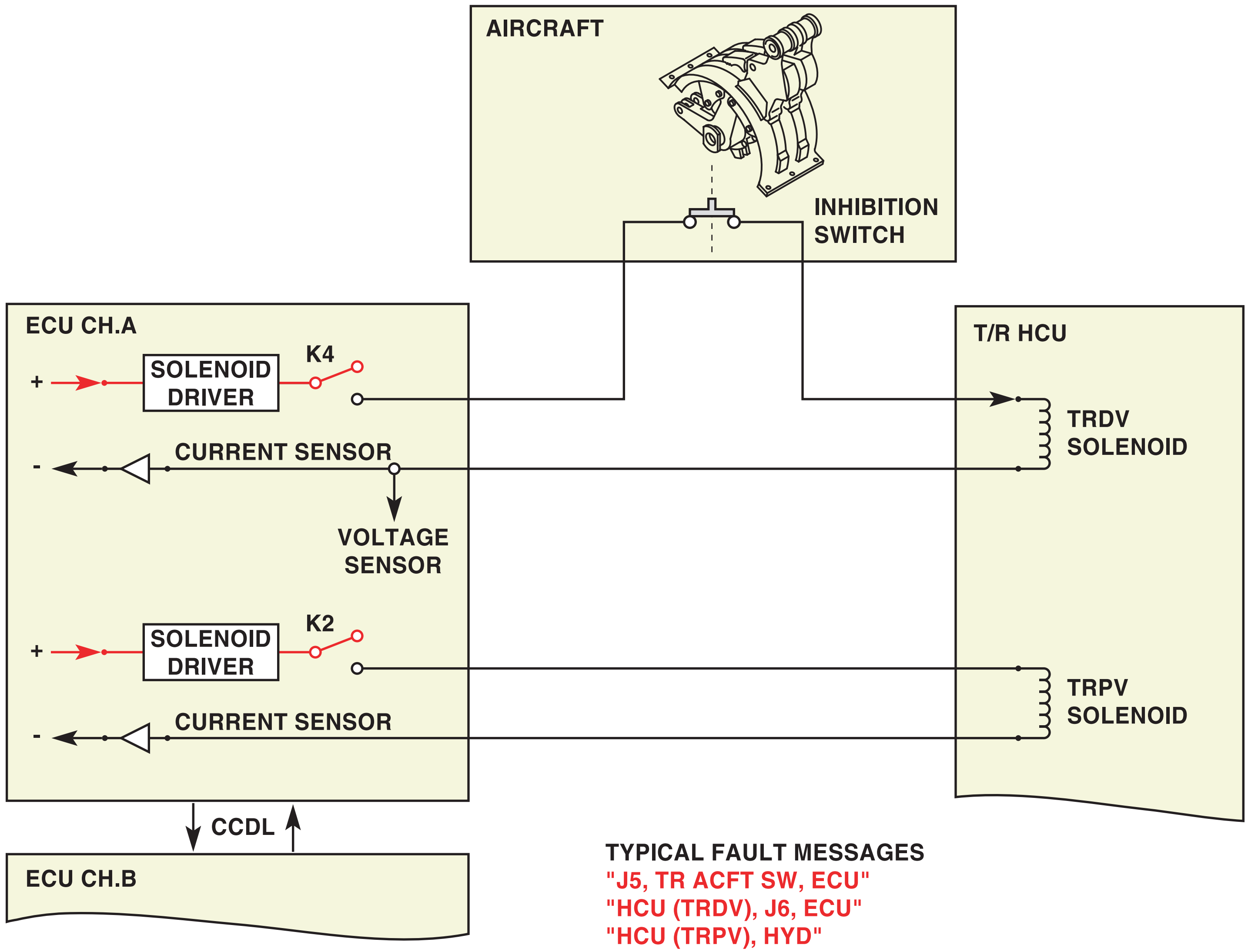
In addition, the ECU detects pressurizing valve position faults by comparing the position command to the system pressure indication given by the T/R pressurized switches. A position fault is generated when the TRPV demand is for ‘pressure on’ and at least one of the two pressure switches indicates ‘not pressurized’.

Typical fault message.

HCU (TRPV), J5, ECU

HCU (TRDV), J6, ECU

HCU (TRPV), HYD



TYPICAL FAULT MESSAGES
"J5, TR ACFT SW, ECU"
"HCU (TRDV), J6, ECU"
"HCU (TRPV), HYD"

CTC-239-039-00

TRDV AND TRPV SOLENOID SUPPLY

Pressure switch failures.

Two pressure switches in the HCU, one dedicated to channel A and the other to channel B, indicate if the system is pressurized.

The state of the switches is as follows :

- Switch open = System pressurized.
- Switch closed = System not pressurized.

The ECU detects failures of the pressure switches by comparing the switches status across the CCDL. If channel A and B switches are both available, but disagree with one another, a pressure switch fault is generated.

The ECU also detects if both pressure switches have failed open. This fault detection is active if the thrust reverser shut-off valve is installed, the reverser is commanded to the stow position and the TRPV is commanded unpressurized.

Typical fault message.

TR PR SW, J5/J6, ECU

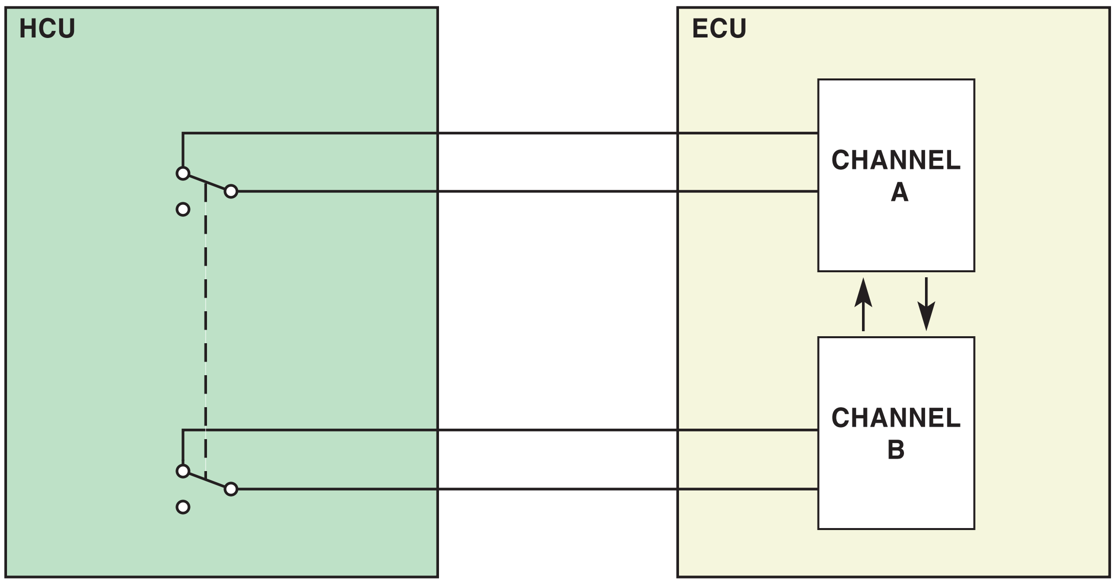
Inadvertent pressurization.

Unless the thrust reverser is detected inhibited, the ECU automatically selects forward idle when in flight, or on ground, for any of the following cases :

- 4 doors detected unstowed.
- At least 1 door detected unstowed and thrust reverser inadvertently pressurized.
- In case of an indeterminate state and thrust reverser inadvertently pressurized.

The thrust reverser is considered inadvertently pressurized when either the local, or cross channel pressure switches indicate that the system is pressurized for at least 360ms and the TRPV and TRDV are both commanded off.

Once inadvertent pressurization has been detected, this state remains latched unless both pressure switches indicate unpressurized, or the TRDV is energized (deploy), or the ECU is reset.



TYPICAL FAULT MESSAGE :

"TR PR SW, J5/J6, ECU"

CTC-239-040-00

HCU PRESSURE SWITCHES

THRUST REVERSER

Stow switches.
The ECU interfaces with 8 stow switches (1 double switch per T/R door), connected in 2 identical parallel circuits of 4 switches. Each parallel circuit of 4 stow switches provides 2 inputs to the ECU. Both ECU channels have direct hardwired access to both parallel circuits inputs. The inputs are designated TRS1 and TRS2.

Deploy switches.
The ECU interfaces with 8 deploy switches (1 double switch per T/R door), connected in 2 identical series circuits of 4 switches. Each circuit of 4 deploy switches provides 1 input to the ECU. Both ECU channels have direct hardwired access to both series circuits inputs. The input is designated TRD.

Detection.
The ECU detects failures in the position switch circuits by comparing the 6 available inputs and identifying inputs which disagree. A position status is assigned based on :
- the 6 inputs (stow and deploy switches), when in reverse, or on ground.
- the 4 stow inputs, when in flight, or forward on ground.

Based on the 6 inputs, a maintenance status is assigned. The ECU detects failures of the position switch circuits by determining the position of the thrust reverser from those inputs that agree.

When a decision cannot be made, the ECU assigns an indeterminate status to the T/R selected position parameter. In this state, the logic will continue its attempts to move the doors to the proper position.

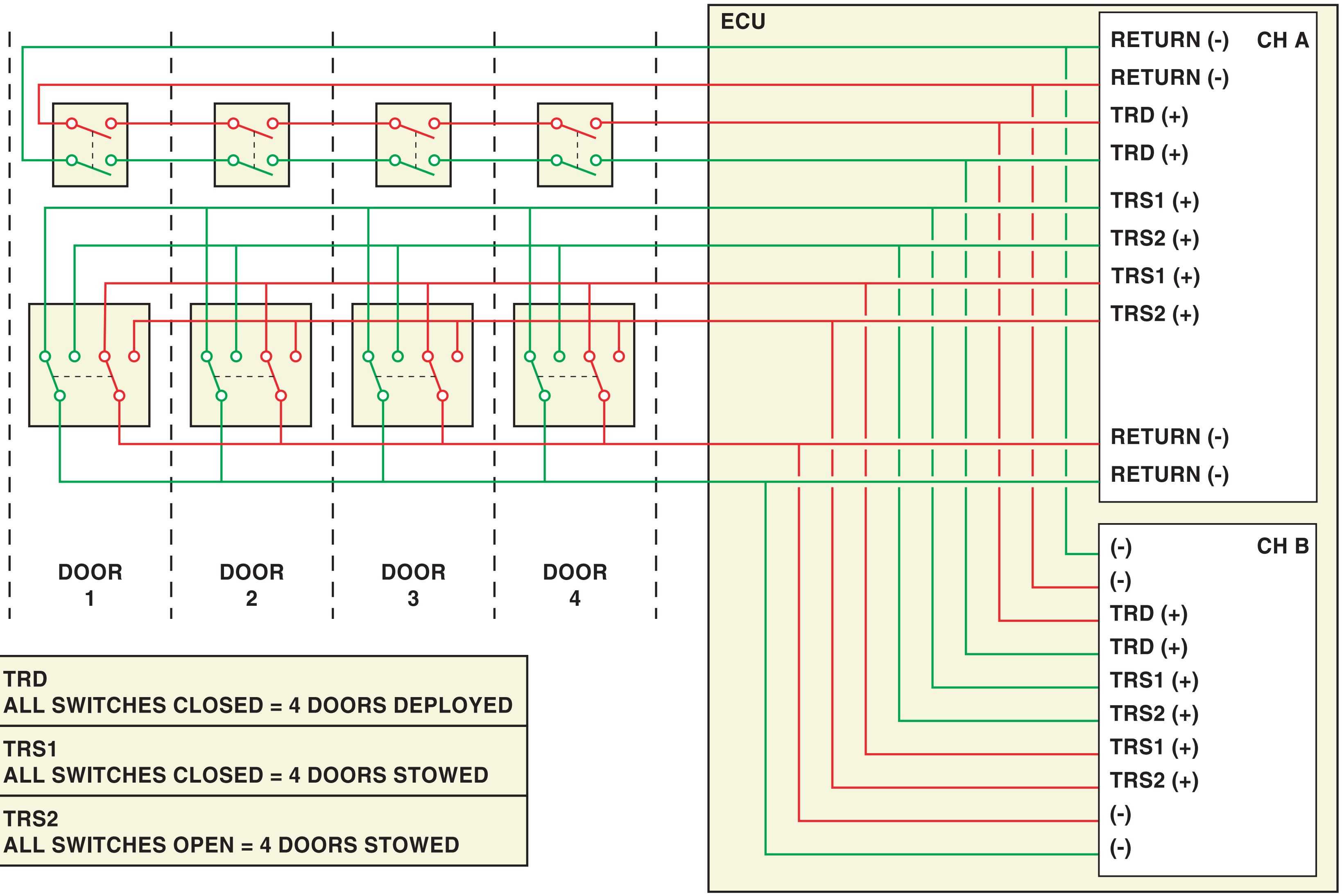
The thrust reverser maintenance status parameter indicates the most probable location of any switch circuit failure.

Typical fault message.

STOW SW, J5/J6, ECU

DEPL SW, J5/J6, ECU

DPLSTW SW, J5/J6, ECU



TRD **ALL SWITCHES CLOSED = 4 DOORS DEPLOYED**
TRS1 **ALL SWITCHES CLOSED = 4 DOORS STOWED**
TRS2 **ALL SWITCHES OPEN = 4 DOORS STOWED**

CTC-239-041-00

STOW/DEPLOY SWITCHES

THRUST REVERSER

Deploy failures.

During a normal thrust reverser deployment cycle, the 4 doors should move from the fully stowed position to fully deployed.

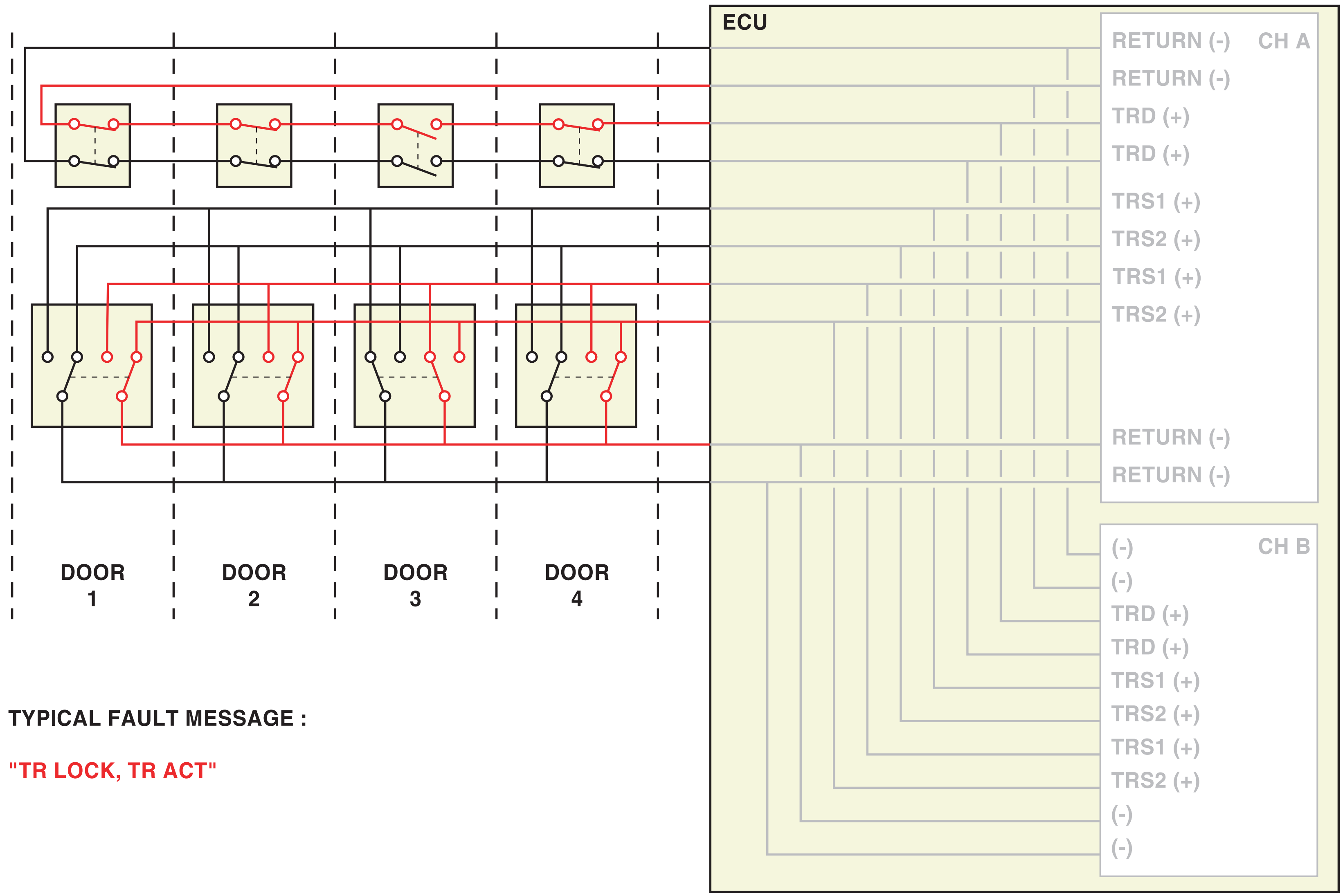
An open circuit in the TRDV 28Vdc supply circuit will prevent the thrust reverser from deploying when commanded.

Likewise, a failure in a door lock, or actuator, may prevent deployment of that door.

Typical fault messages.

TR LOCK, TR ACT

EIU, HCU



TYPICAL FAULT MESSAGE :

"TR LOCK, TR ACT"

CTC-239-042-00

DEPLOY FAULTS

THRUST REVERSER

TRPV position failures and TRSOV failures.

When energized, the TRSOV enables hydraulic pressure to be delivered for thrust reverser operation.

If the TRSOV is installed, TRPV closed position failures and TRSOV closed failures cannot be individually isolated. Consequently, failure detection strategies differ, based on whether the SOV is installed, or not.

The ECU detects TRPV position faults, along with TRSOV failures, by comparing the HCU pressure switches to the TRPV position command that is output by the T/R control logic.

If there is an information disagree, the TRPV position disagree faults will be annunciated for the failure combinations presented in the table.

Typical fault message.

HCU, TRSOV, HYD

HCU (TRPV OPEN)

TR ISOL VALVE, HCU

PHASE (SOV NORMAL POS)	TRPV CMD = DEPLOY	TRPV CMD = PRESSURIZE	PRESSURE SW INDICATION	FAILURE CONDITION	MAINT MESSAGE (ECAM WARNING)
DEPLOY (SOV OPEN)	TRUE	TRUE	BOTH NO PRESSURE	TRPV COMMAND/POSITION DISAGREE	HCU, TRSOV, HYD (ENG X REVERSER FAULT)
END OF DEPLOY T/R FULLY DEPLOYED (SOV OPEN)	TRUE	FALSE	BOTH PRESSURE	TRPV COMMAND/POSITION DISAGREE (FAILED OPEN)	HCU (TRPV OPEN) (ENG X REV PRESSURIZED)
BEGINNING OF STOW PHASE (SOV OPEN)	FALSE	TRUE	BOTH NO PRESSURE	TRPV COMMAND/POSITION DISAGREE	HCU, TRSOV, HYD (ENG X REVERSER FAULT)
AFTER ENGINE START DURING TRSOV TEST (SOV CLOSED)	FALSE	TRUE	EITHER PRESSURE OR BOTH PRESSURE	SOV FAILED OPEN	TR ISOL VALVE, HCU (ENG X REV ISOL FAULT)

CTC-239-043-00

TRSOV FAILURES

CHANNEL SELECTION

Fault processing.

Each channel integrates several fault conditions into a channel-health 32-bit word.

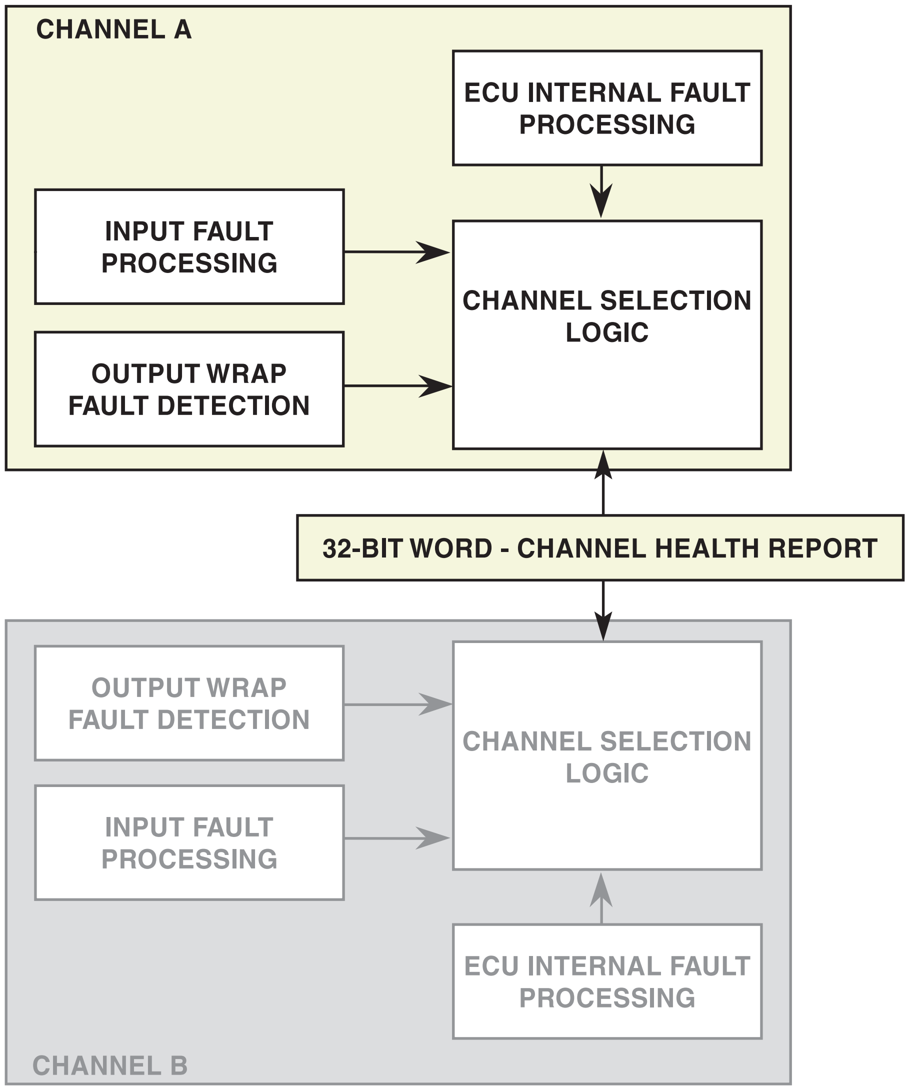
This word can be considered as a ‘health report’, listing the faults for a particular channel. In this way, each channel is able to keep the other constantly informed of its current status.

In the ECU, the fault processing software (logic) for channel selection uses the existing fault conditions to create fault statuses that will then make up the channel health words.

For example, channel selection fault statuses may include:

- Loop faults for FMV, VSV and VBV.
- Loss of cross channel data, on the active channel.
- NVM fault, on the active channel.
- Alternator winding faults, on the active channel.

The complete channel health word is then transmitted, over the serial CCDL, to the cross channel. Furthermore, several of the highest priority status discretes are transmitted over dedicated parallel discrete buses to provide an additional level of redundancy.



CTC-239-044-00

FAULT PROCESSING

CHANNEL SELECTION

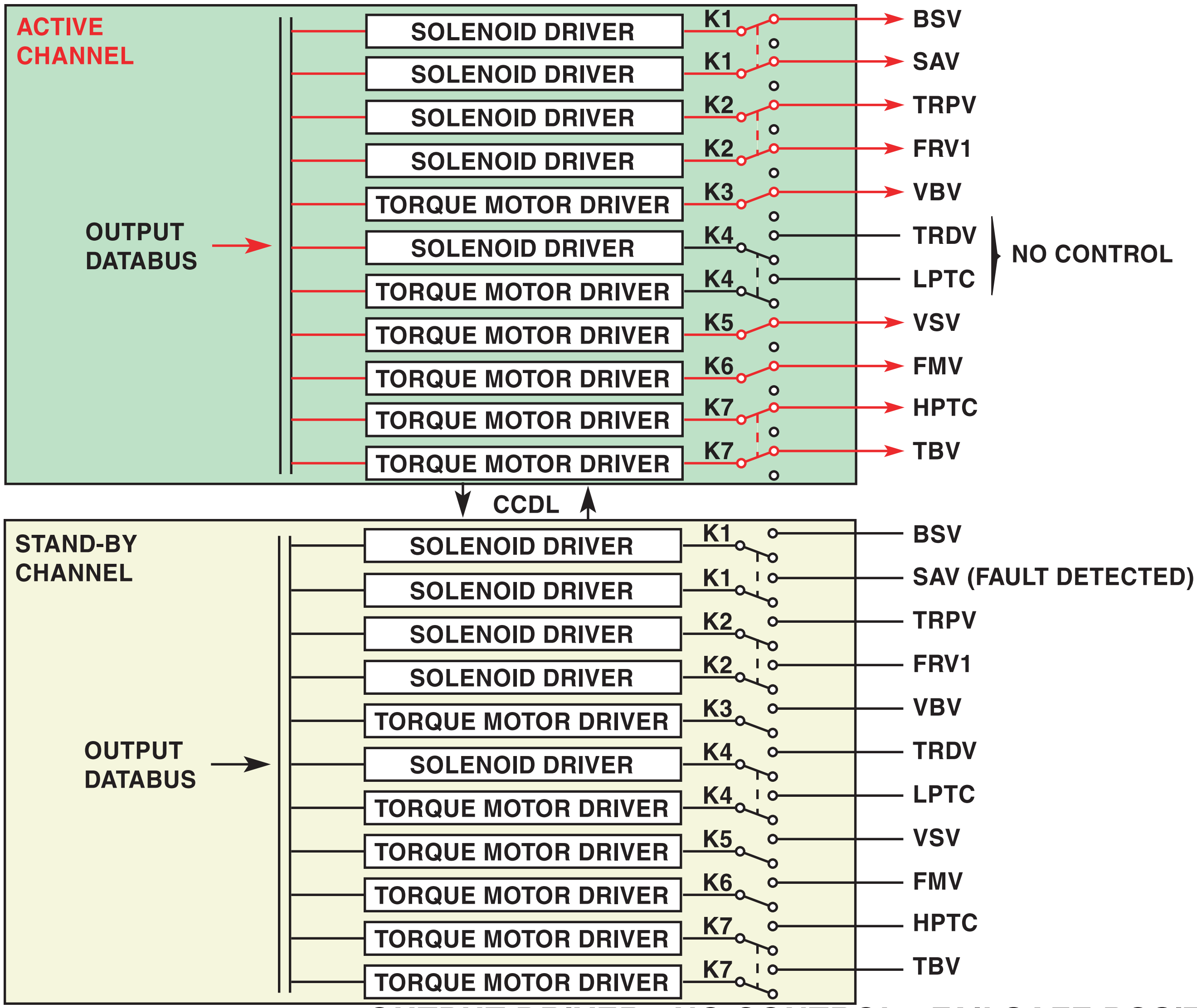
Output driver control.

Each channel's selection logic interrogates the channel-health 32-bit word, received over the CCDL, in order to select the healthiest channel as active.

The output drivers are disconnected in the stand-by channel, but if a fault is detected in the active channel, the ECU changes the channel in control, provided that the other channel has no faults with a higher priority.

If the channel selected as active also has a fault, but of a lower priority, the channel disconnects the corresponding driver output and the ECU loses electronic control of that function.

In this case, a null current is supplied to the torque motor, or solenoid driver of the pilot valve in the HMU. The pilot valve will then hydraulically move the valve (VSV, VBV, HPTC, etc) to a position, which protects the engine.



NO CURRENT FAILSAFE POSITION	
BSV	OPEN
SAV	CLOSED
TRPV	CLOSED
FRV1	CLOSED
VBV	OPEN
TRDV	OPEN
LPTC	CLOSED
VSV	CLOSED
FMV	CLOSED
HPTC	CLOSED
TBV	CLOSED

CTC-239-045-00

OUTPUT DRIVER - NO CONTROL - FAILSAFE POSITION

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WARNING INDICATIONS

WARNING INDICATIONS

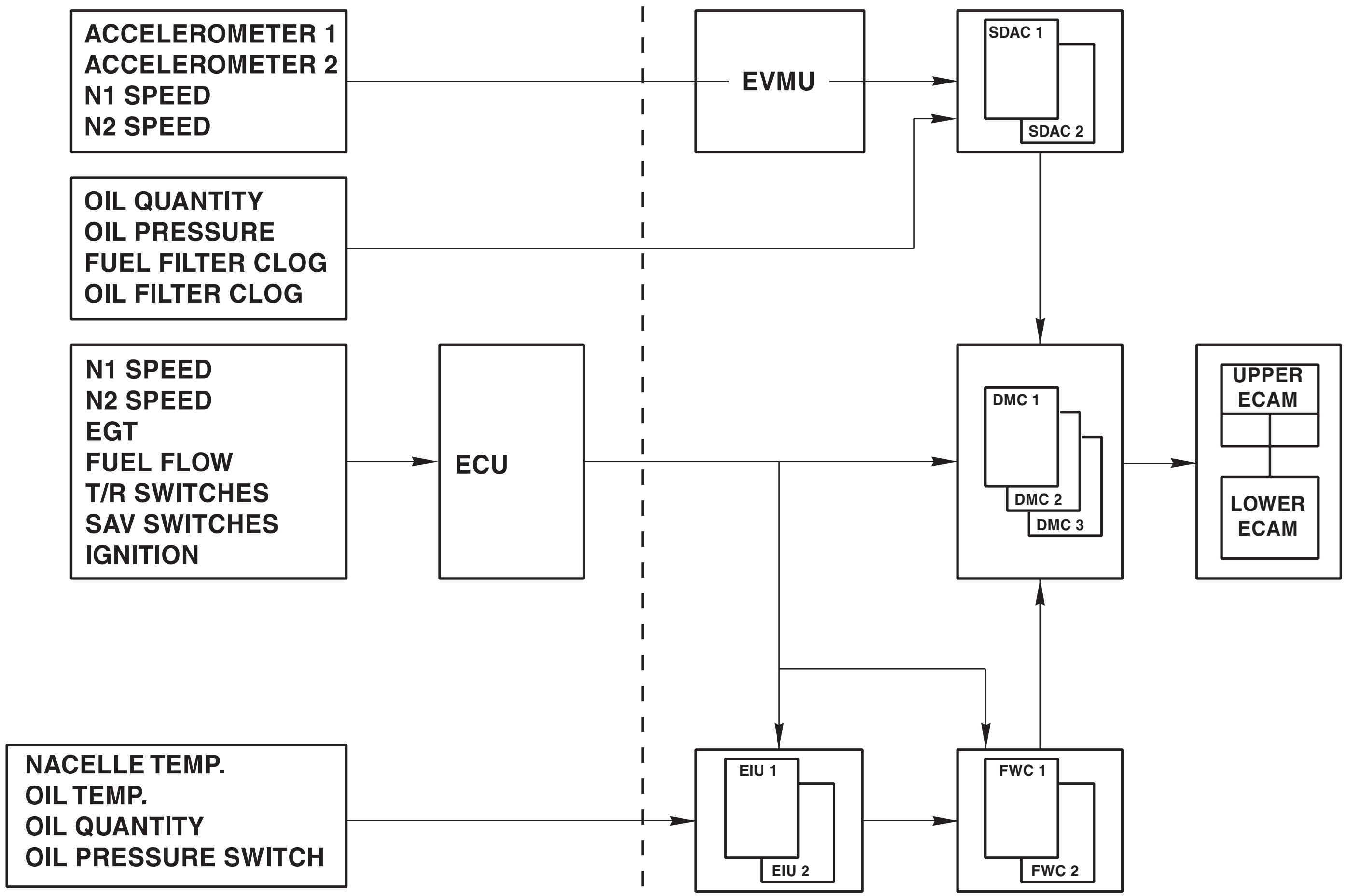
Depending on the data transmitted from the engine, messages are generated on the :

- Upper ECAM : Engine Warning Display (EWD).
- Lower ECAM : Systems Display (SD).
- Master caution, or warning.
- Audible chimes and oral warnings.

These messages are used to run the engine under normal conditions throughout the operating range, or to provide warning messages to the crew and maintenance personnel.

The aircraft computers that impact the engine are :

- 2 System Data Acquisition Concentrators (SDAC).
- 3 Display Monitoring Computers (DMC).
- 2 Flight Warning Computers (FWC).
- 2 Engine Interface Units (EIU).
- 1 Engine Vibration Monitoring Unit (EVMU).



CTC-239-046-00

ENGINE INDICATING SYSTEM

WARNING INDICATIONS

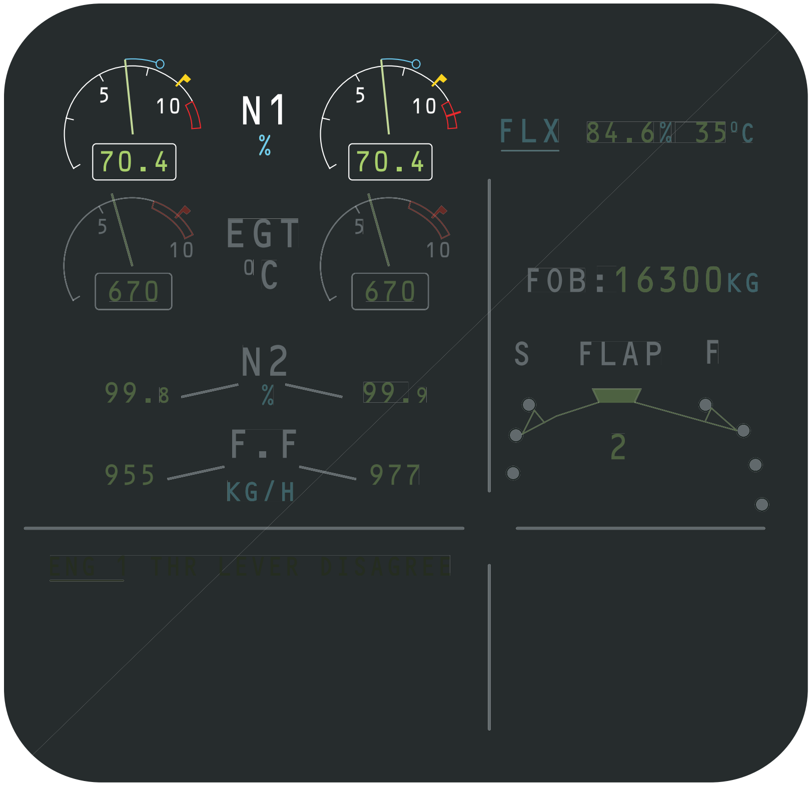
Upper display - N1 indications.

The N1 needle and N1 digital indication are normally green. The needle pulses amber when the actual N1 is above the N1 Max.

Both needle and digital indication pulse red when the actual N1 is above the N1 red line (104%). After an exceedance, a red mark appears at the maximum value achieved. It disappears after a new engine start on ground, of after maintenance action through the MCDU.

If N1 is degraded (N1 dual sensor failure), the last digit of the digital display is amber and dashed.

A blue arc symbolizes the difference between the N1 command and the actual N1. This is not displayed if the A/THR is off.



REDLINE : 104%

N1 INDICATIONS

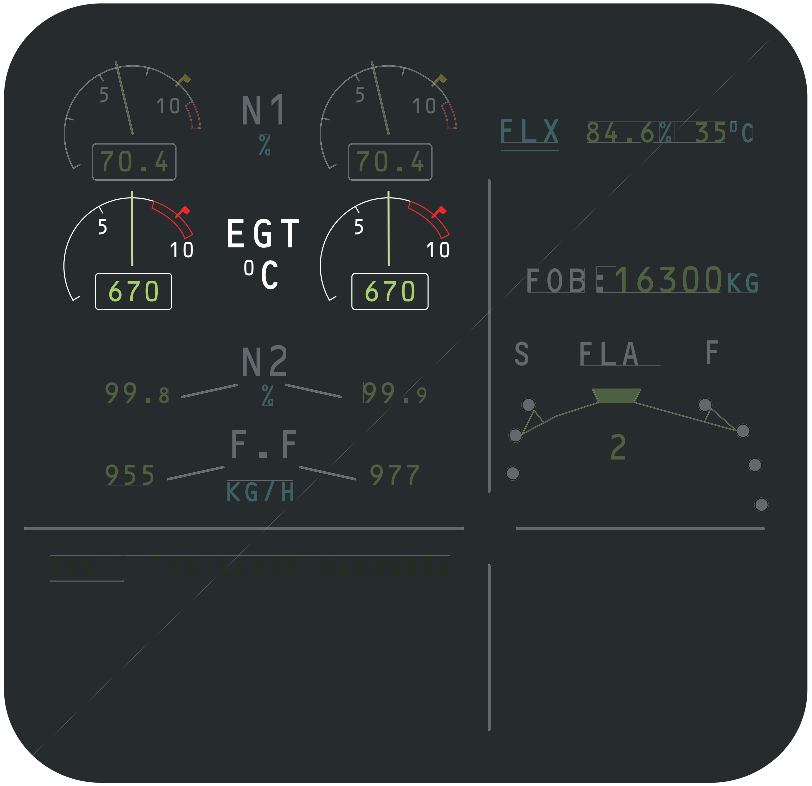
WARNING INDICATIONS

Upper display - EGT indications.

The actual EGT indications are normally green

The index pulses amber above 915°C (or above 725°C during the start sequence). The index and the numerical value pulse red above 950°C.

If 950°C is exceeded, a red mark appears at the maximum value achieved. It disappears after a new take off, or after maintenance action through the MCDU.



AMBER LINE : 725°C DURING START

AMBER LINE : 915°C AFTER START

RED LINE : 950°C

CTC-239-048-00

EGT INDICATIONS

WARNING INDICATIONS

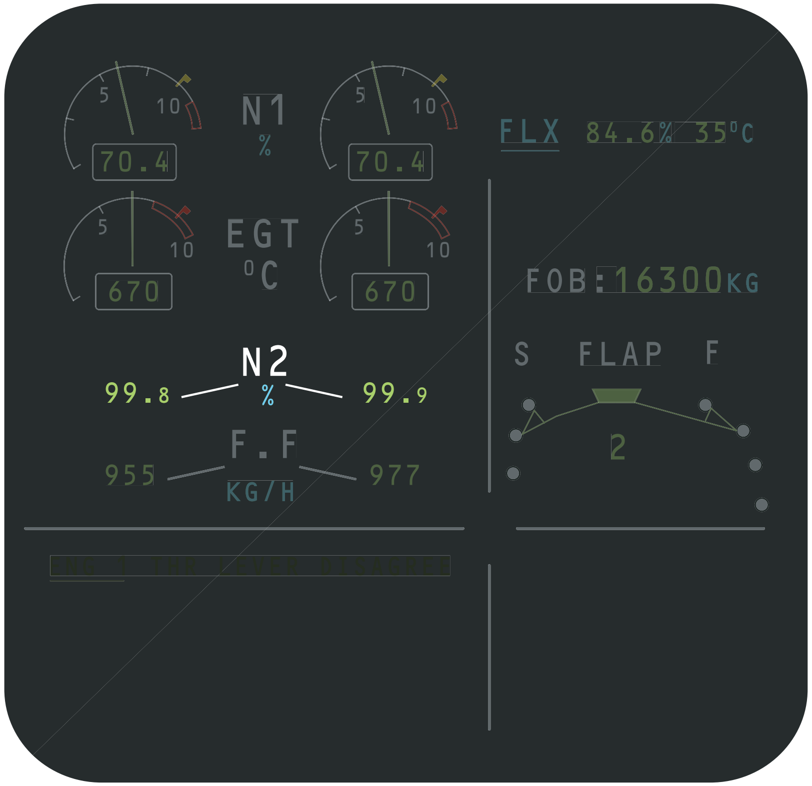
Upper display - N2 indications.

The HP rotor speed digital indication is normally green.

During the start sequence, the indication is green on a grey background.

When N2 is above 105%, the indication becomes red and a red + appears next to the digital indication. It disappears after a new take off, or after a maintenance action through the MCDU.

If the N2 value is degraded (N2 dual sensor failure), the last digit is amber and dashed.



RED LINE : 105%

CTC-239-049-00

N2 INDICATIONS

WARNING INDICATIONS

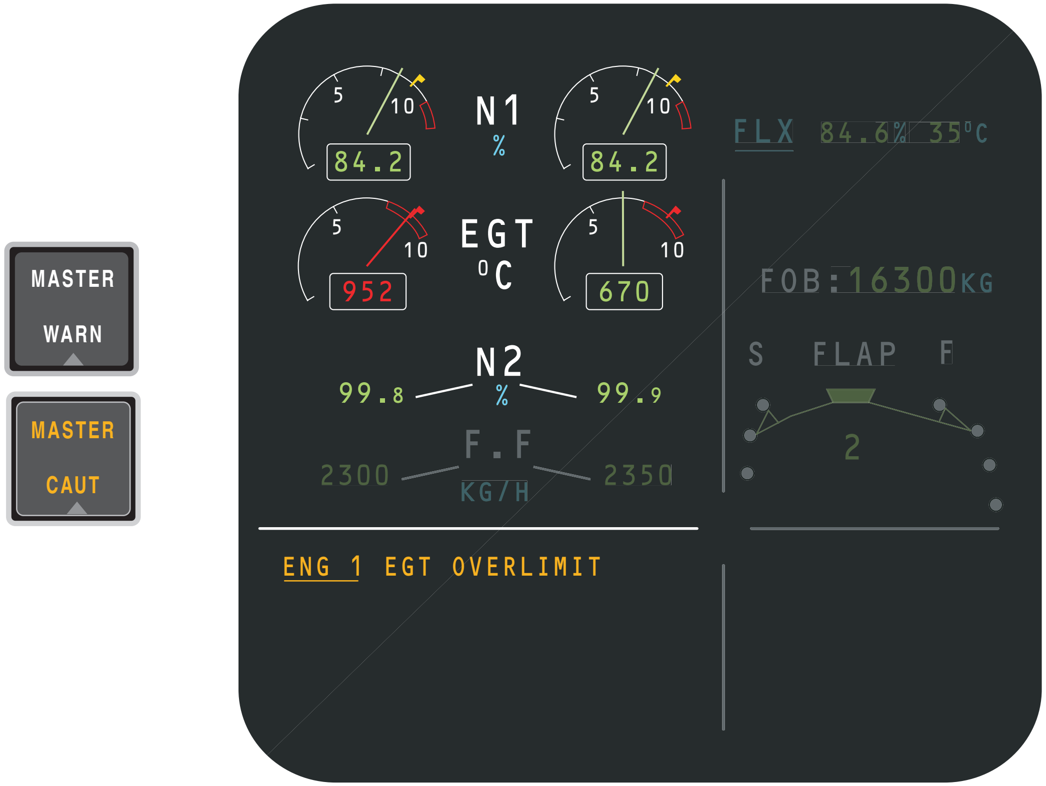
EGT N1 or N2 overlimit.

This warning appears when there are primary parameter limit exceedances.

The over limit for :
- EGT is 950°C.
- N1 is 104%.
- N2 105%.

The master caution comes on and the aural warning (single chime) sounds.

The indication is shown in red and the failure message appears in amber on the upper ECAM display.



THIS WARNING APPEARS WHEN EGT EXCEEDS 950°C.
THE OVERLIMIT FOR :
- **N1 IS 104% AND CORRESPONDING MESSAGE IS "ENG1 (2) N1 OVERLIMIT".**
- **N2 IS 105% AND THE CORRESPONDING MESSAGE IS "ENG1 (2) N2 OVERLIMIT".**

CTC-239-050-00

EGT, N1 OR N2 OVERLIMIT

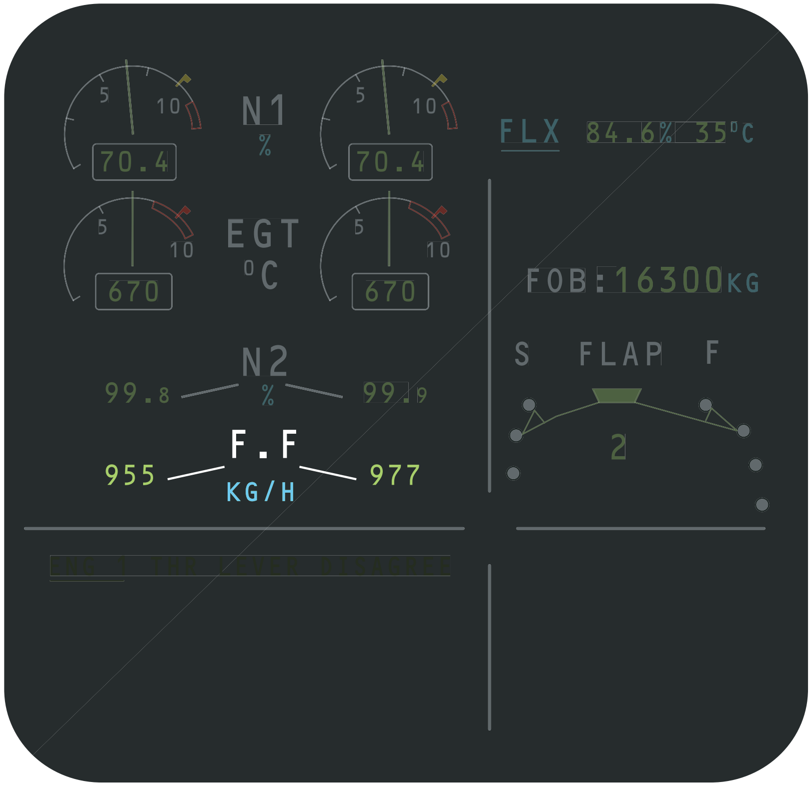
WARNING INDICATIONS

Upper display - Fuel flow indications.

The fuel flow indications are displayed in green.

In case of invalid fuel flow information, the digital indication is replaced by two amber crosses.

This lack of valid data happens when the ECU power is off. This is the case on the ground, five minutes after the last engine shut down.



CTC-239-051-00

FUEL FLOW INDICATIONS

WARNING INDICATIONS

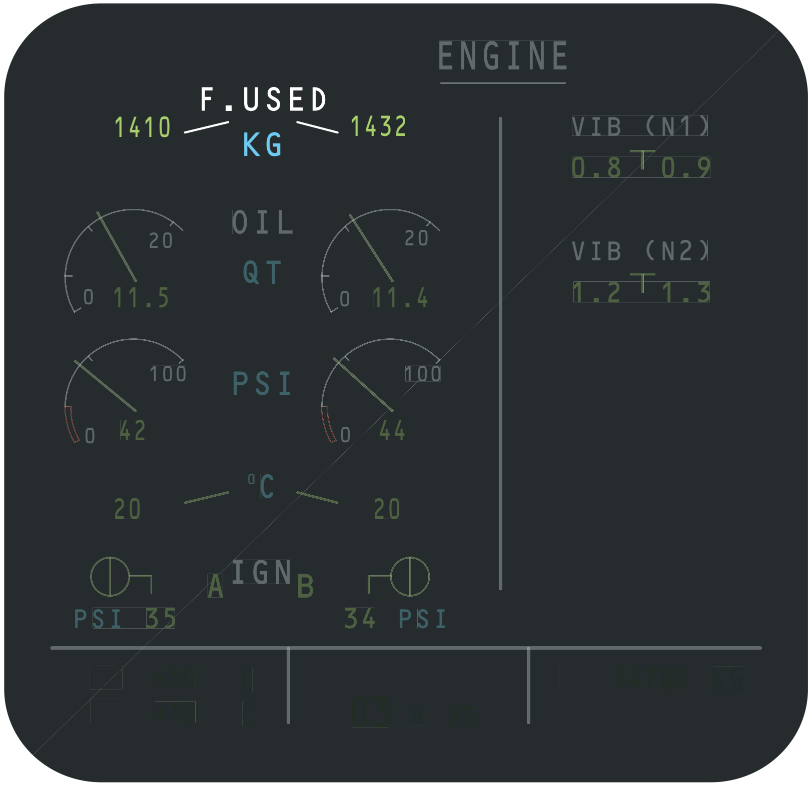
Lower display - Fuel used indications.

The fuel used value, computed by the ECU, is displayed in green.

It is reset at the next engine start (Master switch ON) on ground.

It is frozen at its last value at engine shut down until the next engine start.

The two last digits are dashed if the fuel used indication is inaccurate due to a loss of fuel flow information for more than 1 minute.



CTC-239-052-00

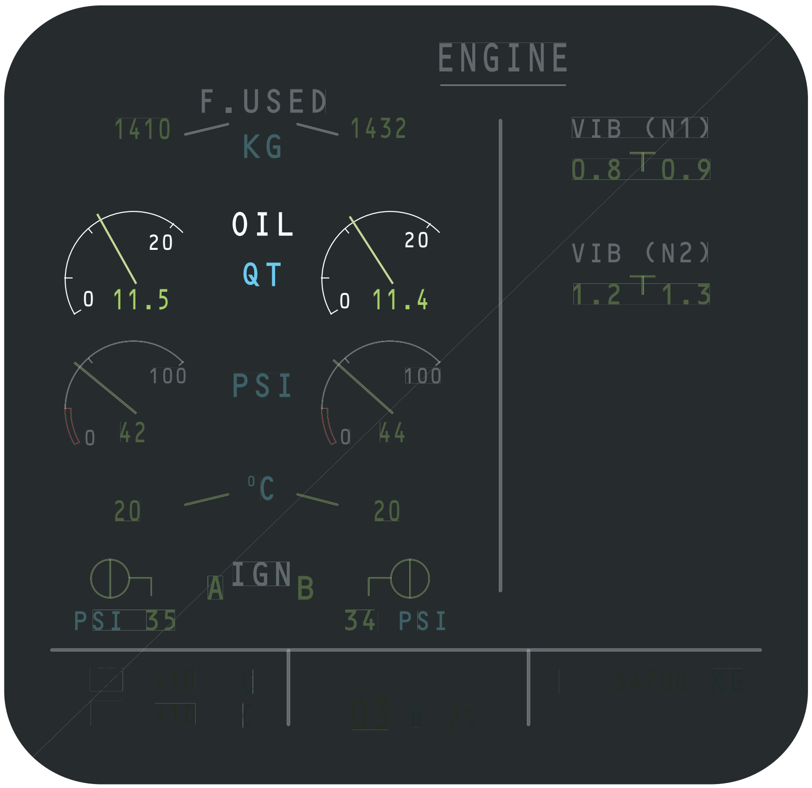
FUEL USED INDICATIONS

WARNING INDICATIONS

Lower display - Oil quantity indications.

The needle and the digital indication are normally green.

The indication pulses below 3 quarts decreasing, or 5 quarts increasing.



NORMAL INDICATION PULSES IF :

- BELOW 3 QUARTS DECREASING.

- BELOW 5 QUARTS INCREASING.

CTC-239-053-00

OIL QUANTITY INDICATIONS

WARNING INDICATIONS

Lower display - Oil pressure indications.

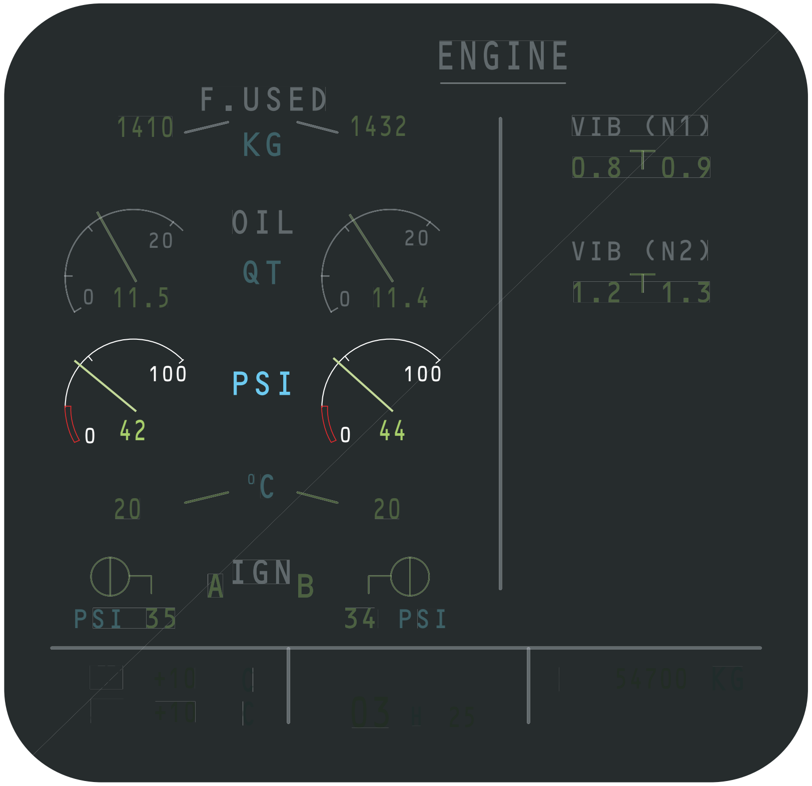
The needle and digital indication are normally in green.

The normal indication pulses if :
- the oil pressure exceeds 90 psi and will continue to pulse until the pressure drops below 85 psi.

- the oil pressure drops below 16 psi and will continue to pulse until the pressure exceeds 20 psi.

The indication is red associated with an ECAM warning if the oil pressure drops below 13 psi.

In case of oil low pressure warning, the master warning flashes and the aural warning (continuous chime) sounds. The failure message is shown in red on the upper ECAM display.



INDICATION PULSES IF :

- PRESSURE EXCEEDS 90 PSI.
  WILL CONTINUE TO PULSE UNTIL
  PRESSURE DROPS BELOW 85 PSI.

- PRESSURE DROPS BELOW 16 PSI.
  WILL CONTINUE TO PULSE UNTIL
  PRESSURE EXCEEDS 20 PSI.

INDICATION RED IF PRESSURE
DROPS BELOW 13 PSI.

CTC-239-054-00

OIL PRESSURE INDICATIONS

WARNING INDICATIONS

Lower display - Oil temperature indications.

The oil temperature indication is normally green.

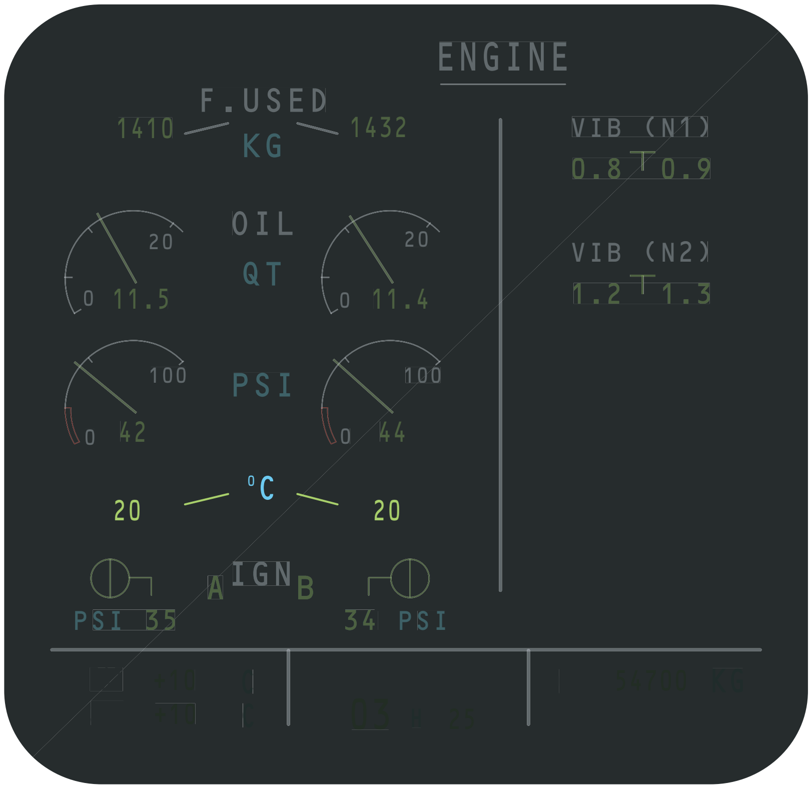
The indication pulses above 140°C increasing and continues to pulse until the temperature drops below 135°C.

The indication becomes amber associated, with an ECAM warning, if the temperature exceeds :

- 140°C for more than 15 minutes,

or

- 155°C without delay.



INDICATION PULSES ABOVE 140°C INCREASING, WILL CONTINUE TO PULSE UNTIL TEMPERATURE DROPS BELOW 135°C.

INDICATION AMBER IF TEMPERATURE EXCEEDS :

- 140°C FOR MORE THAN 15 MINUTES.

OR

- 155°C WITHOUT DELAY.

CTC-239-055-00

OIL TEMPERATURE INDICATIONS

WARNING INDICATIONS

Lower display - Ignition indications.

IGN is displayed in white during the start sequence.

The selected ignitors ‘A’, or ‘B’, or ‘AB’ are displayed in green when supplied during start, or continuous relight.

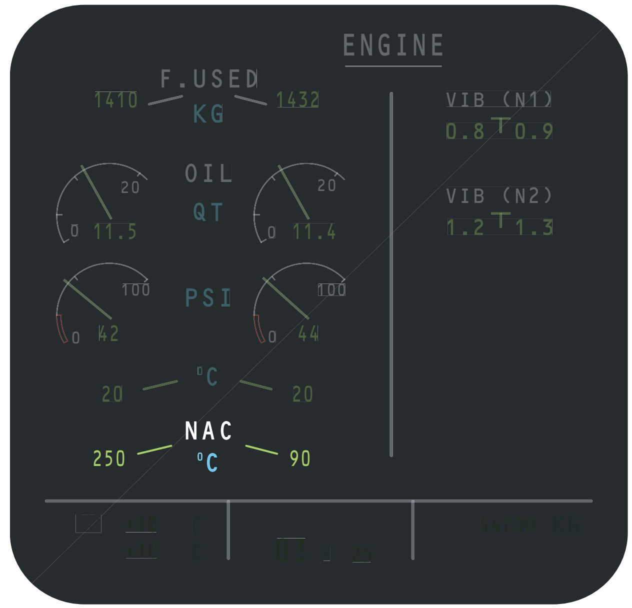
The start valve position is green and displayed only during the start sequence.

The bleed pressure, upstream of the precooler, is displayed normally in green. It becomes amber below 21 psi with N2 greater than 10%, or in the case of overpressure. It is displayed only during the start sequence.

Lower display - Nacelle temperature indications.

This indication is displayed, except during the start sequence, when the nacelle temperature is above 240°C (advisory threshold).

BLEED PRESSURE BECOMES AMBER BELOW 21 PSI WITH N2 GREATER THAN 10%.



INDICATION DISPLAYED (EXCEPT DURING START) WHEN NAC TEMP EXCEEDS 240°C.

CTC-239-056-00

IGNITION AND NACELLE TEMP INDICATIONS

WARNING INDICATIONS

Lower display - Vibration indications.

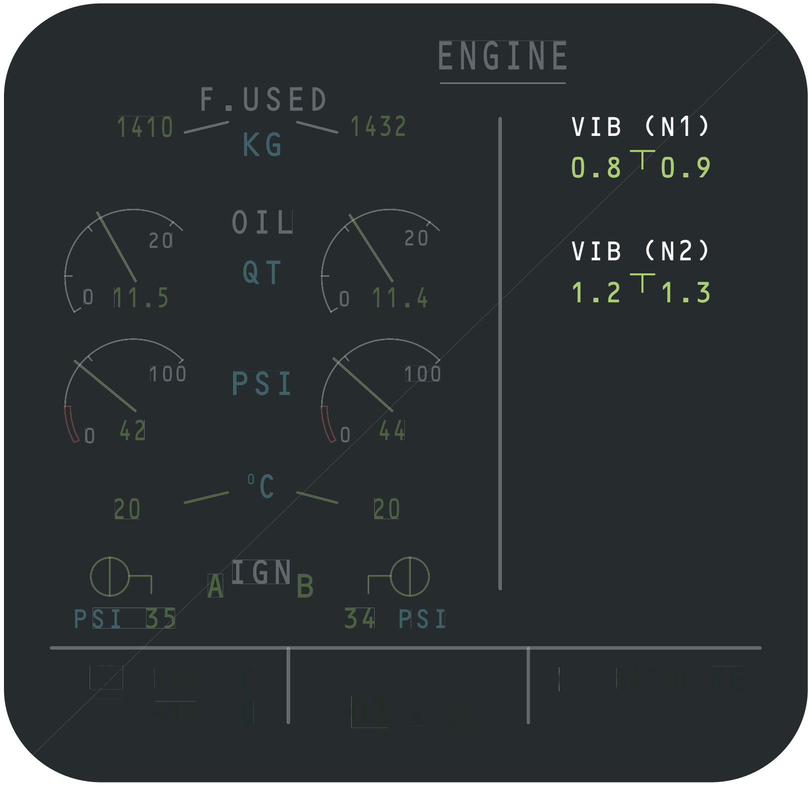
Vibration tracking is theoretically done in Mils for the LP (N1) rotor and IPS for the HP (N2) rotor.

In order to avoid two different types of unit indication being provided to the crew, the two values are transformed and displayed in cockpit units.

The LP rotor indication is green and pulses above 6 units.

The HP rotor indication is green and pulses above 4.2 units.

If an indication is not available, the corresponding indication is replaced by 2 amber crosses.



N1 INDICATION PULSES ABOVE 6 UNITS.

N2 INDICATION PULSES ABOVE 4.2 UNITS.

NOTE : IF INDICATION UNAVAILABLE, THE CORRESPONDING INDICATION IS REPLACED BY 2 AMBER CROSSES.

CTC-239-057-00

VIBRATION INDICATIONS

WARNING INDICATIONS

Lower display - Filter clog indications.

Oil.

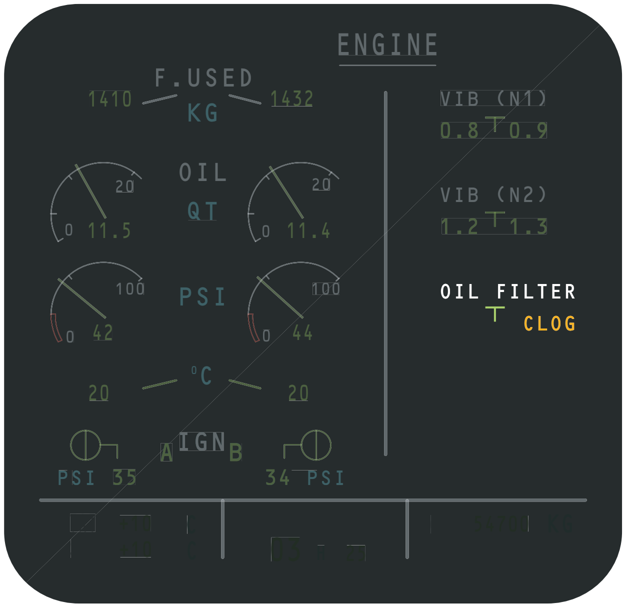
The oil filter clog message appears in amber in case of excessive pressure loss (25.5 psid) across the oil main filter.

When the pressure loss in the oil filter drops below 22 psid, the caution disappears.

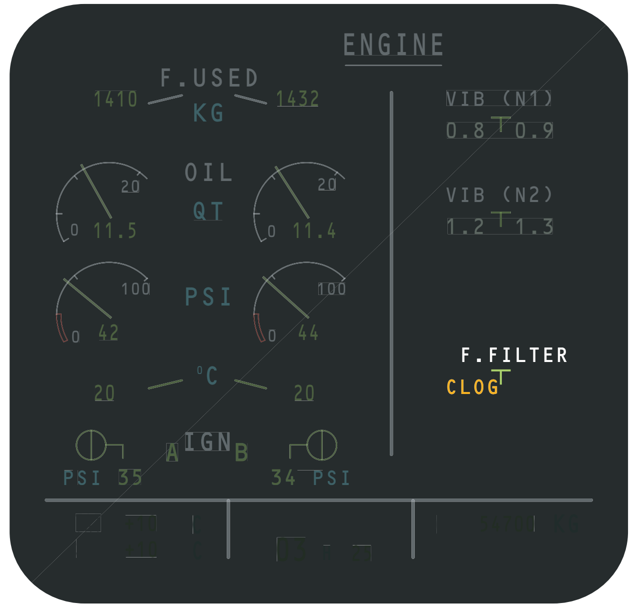
Fuel.

The fuel filter clog message appears in amber in case of excessive pressure loss (11.5 psid) across the fuel filter.

When the pressure loss in the filter drops below 8.5 psid, the pressure switch is de-energized and the caution goes off.



MESSASE APPEARS IF PRESSURE LOSS ACROSS OIL MAIN FILTER EXCEEDS 25.5 PSID.



MESSASE APPEARS IF PRESSURE LOSS ACROSS FUEL FILTER EXCEEDS 11.5 PSID.

FILTER CLOG INDICATIONS

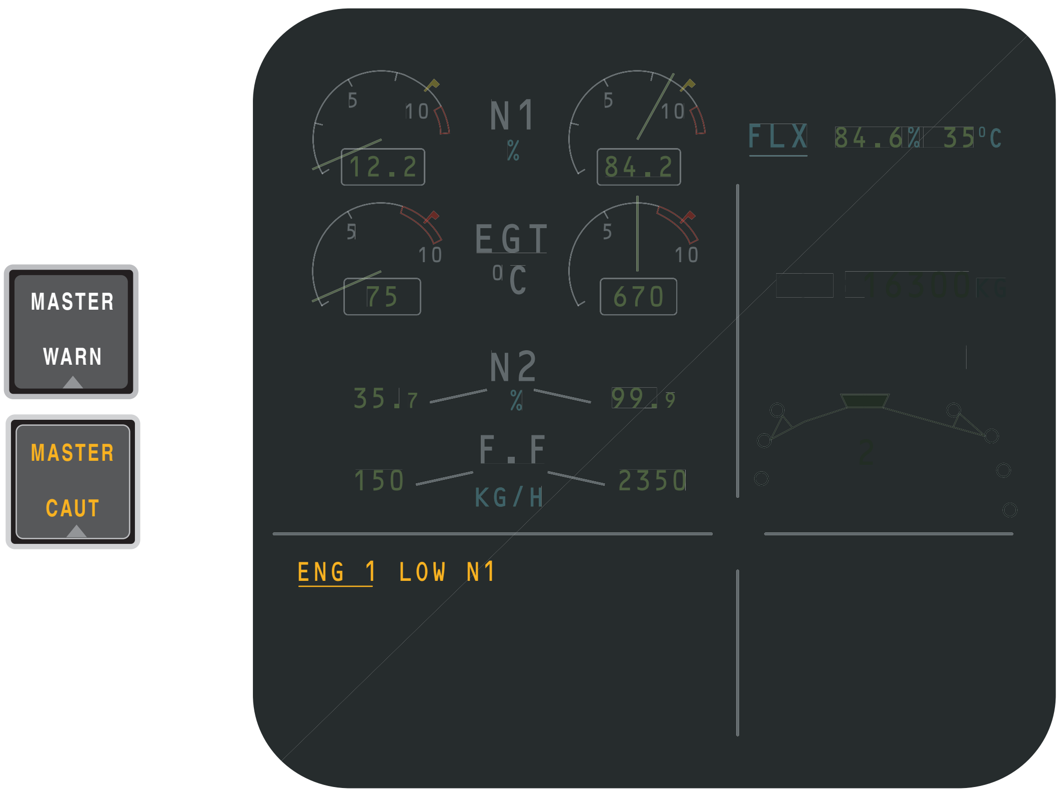
WARNING INDICATIONS

Low N1.

This warning appears when there is a low N1 rotation speed during engine start.

In case of low N1 warning, the master caution comes on and the aural warning (single chime) sounds.

The failure is shown in amber on the upper ECAM display.



MESSAGE APPEARS IF THERE IS A LOW N1 ROTATION SPEED DURING ENGINE START.

CTC-239-059-00

LOW N1 WARNING

WARNING INDICATIONS

Thrust lever disagree.

This warning appears when there is a disagreement between both resolvers of a thrust lever.

The master caution comes on and an aural warning sounds.

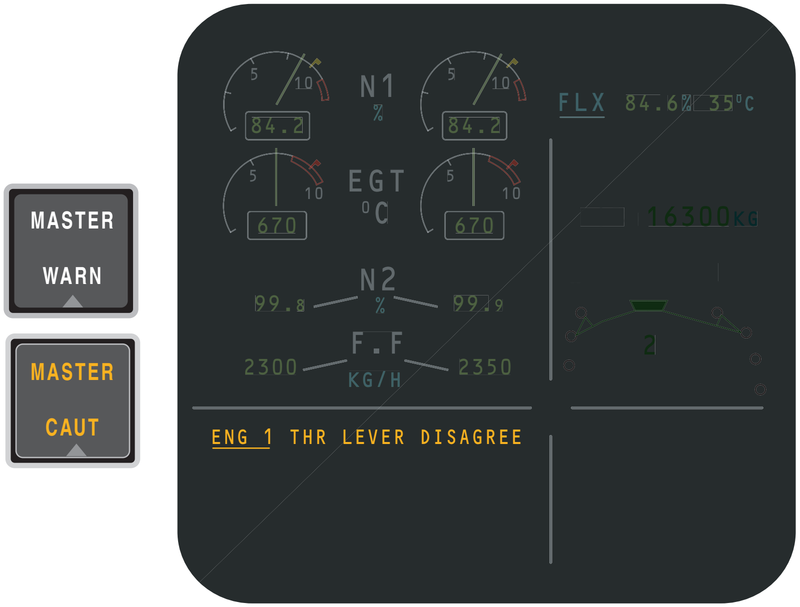
The failure message appears in amber on the upper ECAM display.

Thrust lever fault.

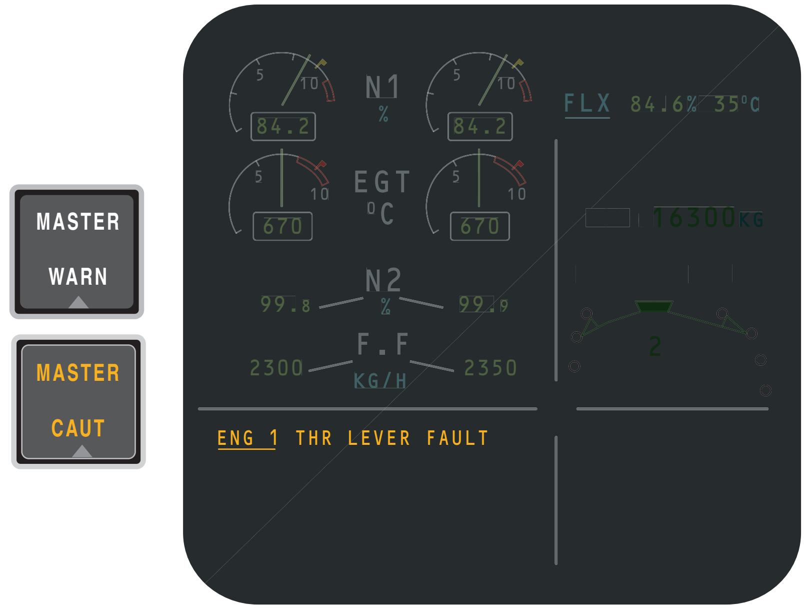
This warning appears when both resolvers on one thrust lever are lost.

The master caution comes on and an aural warning (single chime) sounds.

The failure message appears in amber on the upper ECAM display.



THIS WARNING APPEARS WHEN THERE IS A DISAGREEMENT BETWEEN BOTH RESOLVERS OF A THRUST LEVER.



THIS WARNING APPEARS WHEN BOTH RESOLVERS ON ONE THRUST LEVER ARE LOST.

THRUST LEVER WARNINGS

WARNING INDICATIONS

HP fuel valve not open fault.

If the HP fuel valve does not open an aural warning (single chime) sounds.

The master caution and the engine fault lights come on.

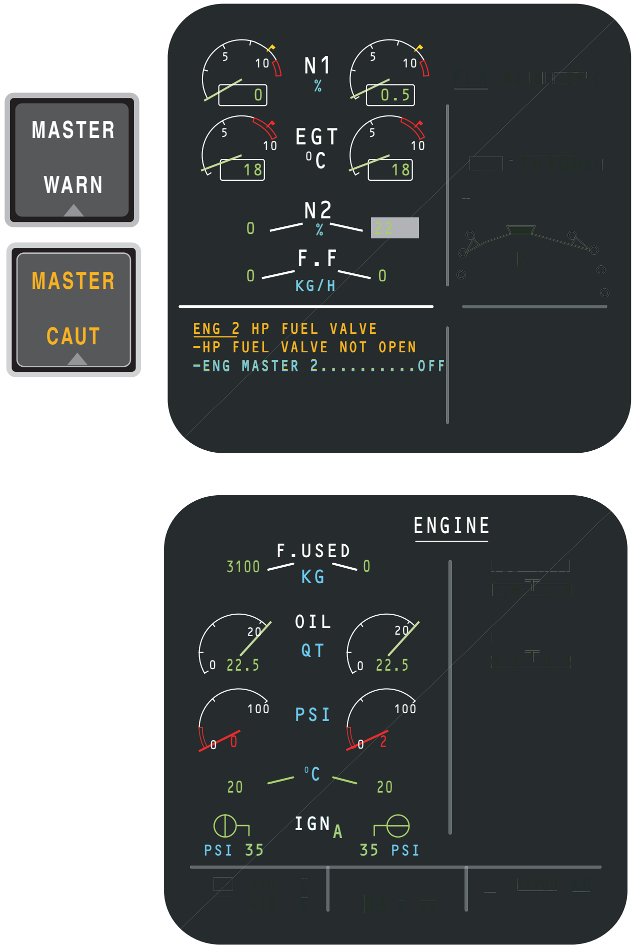
The failure message appears in amber on the upper ECAM display.

Starter time exceeded fault.

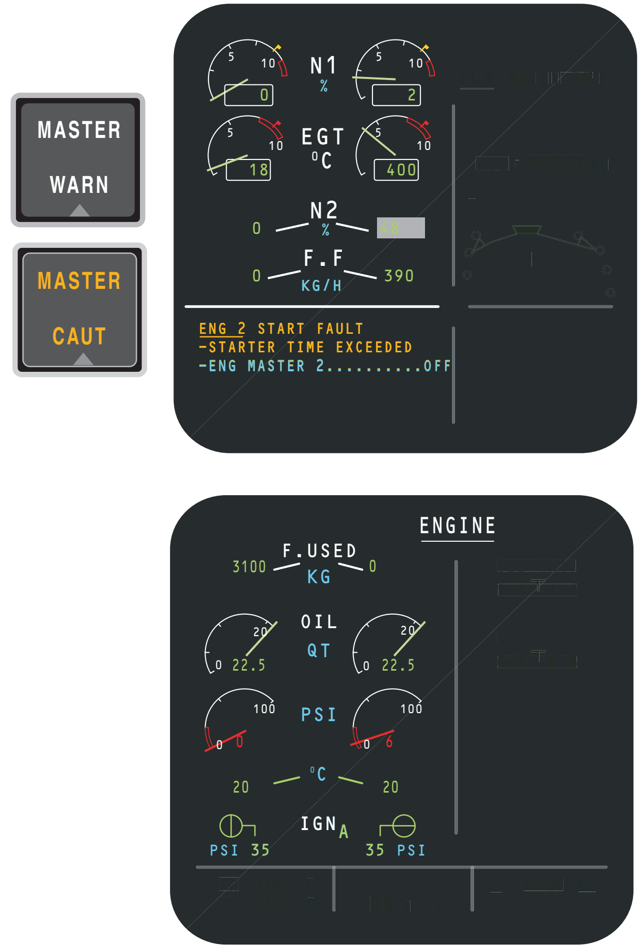
The maximum starter time cycle duration is 2 minutes.

If the starter time limit is exceeded, an aural warning sounds (single chime) and the master caution comes on.

The failure message appears in amber on the upper ECAM display.



HP VALVE NOT OPEN FAULT



MAXIMUM STARTER TIME CYCLE = 2 MINUTES

CTC-239-061-00

START FAILURES

WARNING INDICATIONS

Start valve not open fault.

If the start valve does not open, an aural warning (single chime) sounds.

The master caution and the engine fault light come on.

The failure message appears in amber on the upper ECAM display.

Start valve not closed fault.

If the start valve does not close, an aural warning (single chime) sounds.

The master caution and the engine fault light come on.

The failure message appears in amber on the upper ECAM display.

NOTE THAT IF THIS FAILURE OCCURS ON ENGINE 1, THE APU BLEED MUST BE CUT OFF.

CTC-239-062-00

START FAILURES

WARNING INDICATIONS

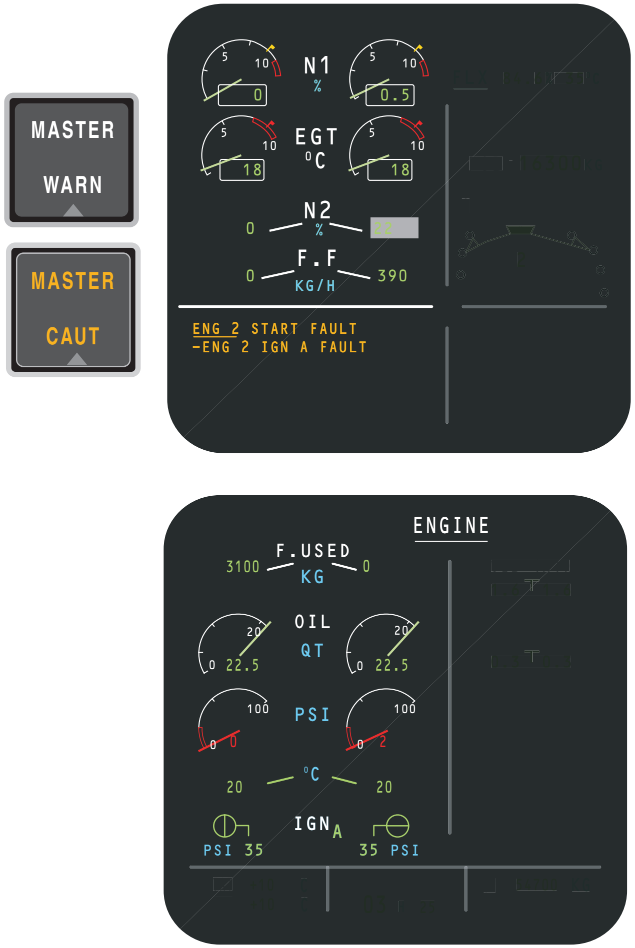
Ignition fault.

If an ignition fault occurs, an aural warning (single chime) sounds.

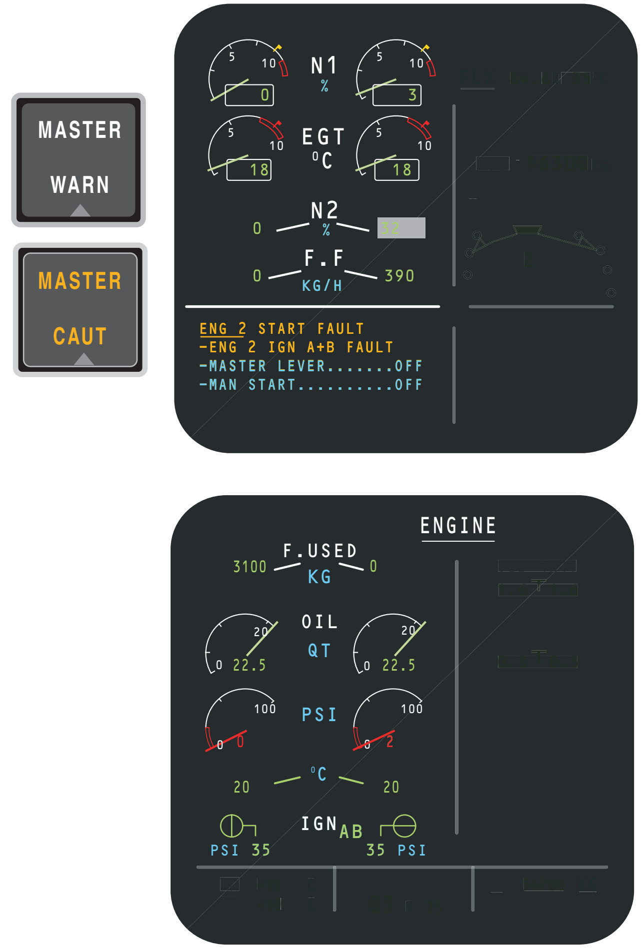
The master caution and engine fault light come on and a failure message appears in amber on the upper ECAM display.

If the FADEC system detects an ignition fault in automatic mode, it will automatically initiate a second attempt.

In manual mode, however, the FADEC system does not abort the start and the operator/pilot must perform the necessary action to shut down the engine.



AUTO MODE



MANUAL MODE

CTC-239-063-00

START FAILURES

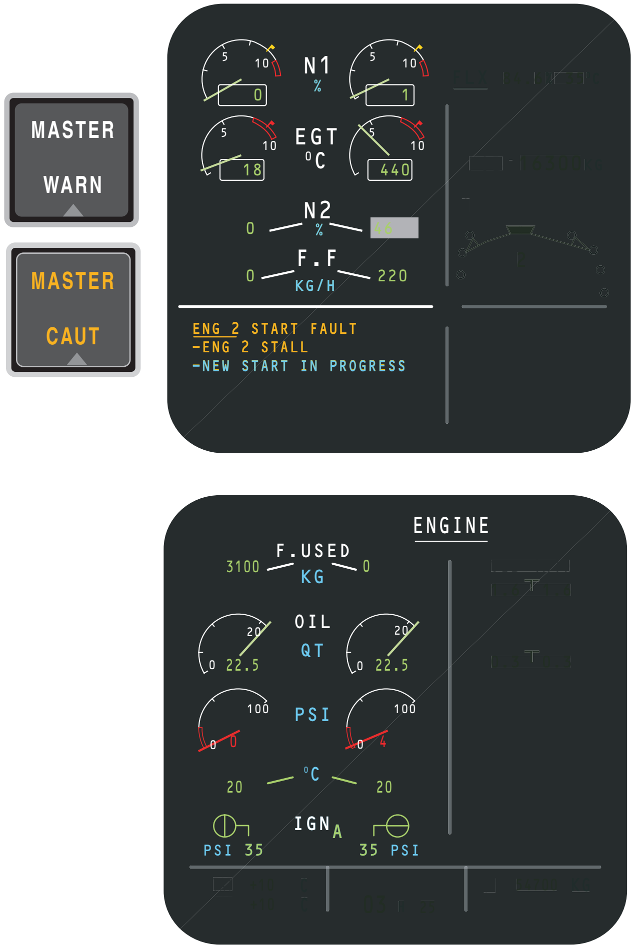
WARNING INDICATIONS

EGT overlimit, or stall fault.

If an EGT overlimit, or stall is detected, an aural warning sounds.

The master caution and engine fault light come on and a failure message appears in amber on the upper ECAM display.

If the FADEC system detects an engine stall in automatic mode, it will automatically initiate a start abort, a crank and a restart sequence.



AUTO MODE

MANUAL MODE

CTC-239-064-00

START FAILURES

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MESSAGE INTERROGATION

**CENTRALIZED FAULT DISPLAY SYSTEM &
AIRCRAFT INTEGRATED DATA SYSTEM.**

The MCDU menu is displayed by selecting the appropriate key on the keypad. The menu provides access to various systems, including the Centralized Fault Display System (CFDS) and, if installed, the Aircraft Integrated Data System (AIDS).

The CFDS enables maintenance personnel to perform system operational tests, functional checks and readout of BITE memory information, through the MCDU. The CFDS enables memorization and display of fault messages and ECAM warnings and also enables BITE interrogation and system tests.

The CFDS operates in 2 modes : Normal and Menu.

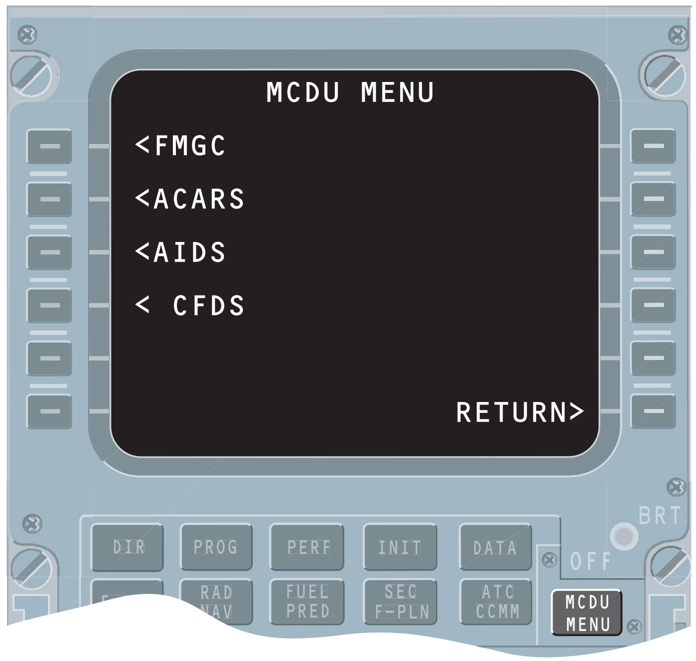
- Normal mode : The CFDS records fault messages.
- Menu mode : The CFDS allows the operator to obtain troubleshooting data from the systems and initiate self tests. This mode is available on ground only.

Most CFDS reports can be printed on board, or transmitted to the ground, manually or automatically, through the ACARS, if installed, or dumped on the MDDU floppy disk, if installed.

The AIDS enables the data stored and processed in the Data Management Unit (DMU) to be read in the form of printed reports. A report is a set of data related to a specific event (e.g. Limit exceedance of engine parameters).

The reports can also be sent to the ground through the ACARS, if installed, or dumped on the MDDU floppy disk, if installed.

The AIDS also enables the operator to view, in real time, the values of aircraft and engine parameters and also the labels transmitted on the ARINC buses.



CTC-239-065-00

MCDU MENU

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CENTRALIZED FAULT DISPLAY SYSTEM

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
FAULT CLASSIFICATION - AIRCRAFT.

Failures are classified by the aircraft according to three classes : Class 1, 2 and 3.

Class 1 failures.

Class 1 failures may have operational consequences on the current flight, or on subsequent ones. These failures are normally displayed in real time on the upper ECAM warning display. In some cases, the FWC applies inhibitions and failures are displayed in delayed time during critical flight phases when crew disruptions are not desired.

Class 1 failure warning messages are displayed in 3 levels, according to their severity and the required crew corrective action. Warning messages may also be associated with specific sounds.

- Display level 3 : Red warning. This corresponds to an emergency situation and the crew will have to take immediate corrective actions.
- Display level 2 : Amber caution. This corresponds to an abnormal situation and corrective action is not immediately required.
- Display level 1 : Caution. This level corresponds to an alert situation and the affected system must be monitored by the crew.

Class 2 failures.

Class 2 failures have no immediate operational consequences on the current flight, or on subsequent ones, but should be repaired when the aircraft is back at its main base (first opportunity). They are indicated to the crew by means of an STS indication, pulsing after the 2nd engine shutdown, on ground. They can be displayed, on request, on the ECAM status page under the MAINTENANCE title.

Class 3 failures.

Class 3 failures have no operational consequences on the current flight, or on subsequent ones. They are not presented to the flight crew, either in flight, or on ground. They are only available for maintenance crews, on manual request, through the MCDU.

Advisory mode.

The value of some critical system parameters is monitored by an Advisory mode. When the value drifts from its normal range, the corresponding System page is displayed automatically and the affected parameter pulses. An Advisory may, or may not, lead to a failure.

FAILURE	CLASS 1	CLASS 2	CLASS 3
INDICATION TO THE FLIGHT CREW	MESSAGE DISPLAYED IN FLIGHT - WARNING, CAUTION ON EWD - FLAGS - LOCAL WARNINGS	STATUS LIGHT FLASHING AT THE END OF THE FLIGHT	NO INDICATION TO THE FLIGHT CREW
DISPATCH CONSEQUENCES	MEL ENTRY : "GO", "GO IF" OR "NO GO"	MEL PREAMBLE : "GO"	MEL NOT APPLICABLE
MAINTENANCE INFORMATION	HAVE TO BE REPORTED BY THE PILOTS IN THE LOG BOOK. FAILURES INDICATED AT THE END OF EACH FLIGHT LEG. MEL ENTRY REQUIRED		PRESENTED ON REQUEST, WHEN NEEDED. NO FIXED TIME FOR CORRECTION

CTC-239-066-00

AIRCRAFT FAULT CLASS ASSIGNMENTS

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS). MAINTENANCE MENU.

From the MCDU menu, selecting CFDS will display the first page of two maintenance menu pages. The first page provides access to :

- **The Last Leg Report** : This displays up to 40 failures (Class 1 & 2), which occurred during the last flight.

- **Last Leg ECAM Report** : This report displays a list of ECAM warning messages sent to the CFDIU, by the FWC's. It can store up to 40 warnings, which occurred during the last flight.

- **Previous Legs Report** : At each new flight leg, the contents of the last leg report are transferred to the Previous Legs Report. It can store up to 200 failures recorded over the last 63 flights.

- **Avionics Status** : This presents a list of the systems currently affected by a failure. The information is permanently updated.

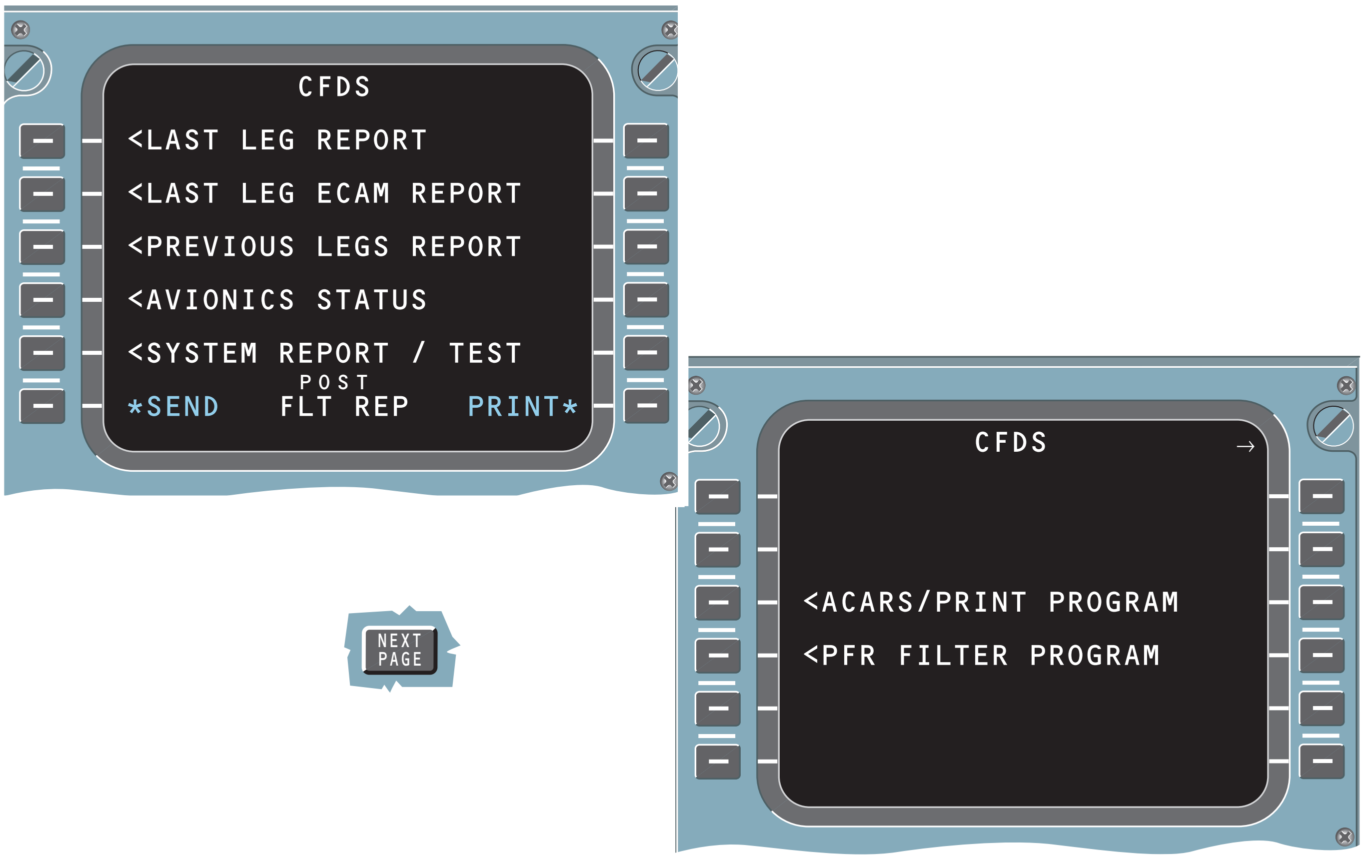
- **System Report/Test** : This presents a list of all the systems connected to the CFDIU.

- **Post Flight Report** : This is the sum of the Last Leg Report and the Last Leg ECAM Report. It is only available on the printer.

The second page of the maintenance menu provides access to:

- **ACARS/Print Program** : This selection provides access to a menu in order to program automatic transmission, or print-out of the Post Flight Report at the end of the flight, or failures and warnings in real time.

- **PFR Filter Program** : The purpose of this function is to improve the operational use of the Post Flight Report by filtering all spurious, or unjustified failures, or messages.



CTC-239-067-00

THE MAINTENANCE MENU

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
THE SYSTEM REPORT/TEST.

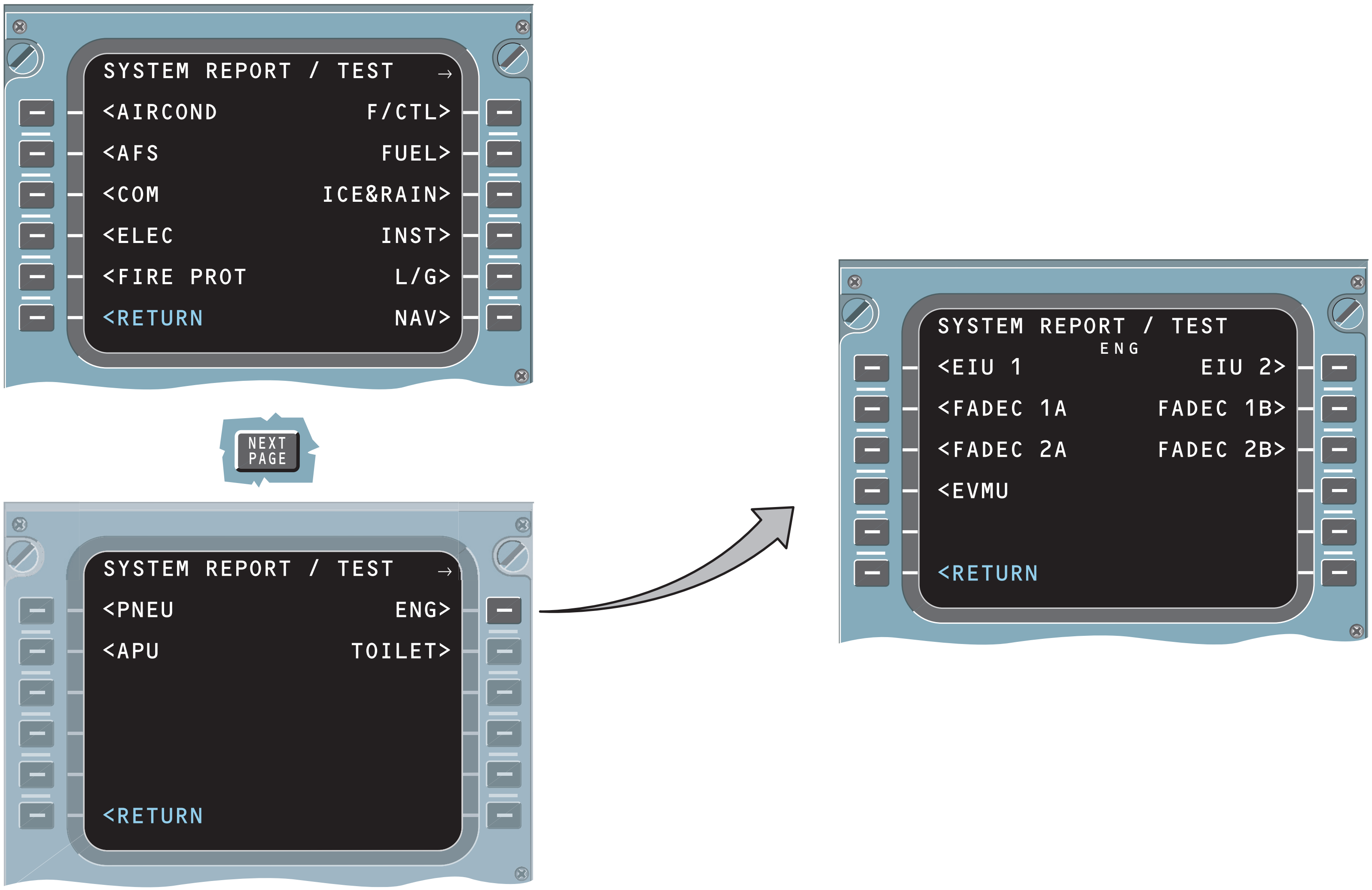
This function is available only on ground. Selection of the System Report/Test provides access to a list of all the systems connected to the CFDIU.

The System Report/Test function allows interactive dialogue between the MCDU and one system computer.

The systems are displayed in ATA chapter order and the list is displayed on 2 pages, which can be accessed using the NEXT PAGE key.

Selecting ENG on page 2 of the System Report/Test will display a menu for engine related systems.

- **EIU 1 & EIU 2** : allows access to the main menus for Engine Interface Units 1 & 2.
- **FADEC 1A & FADEC 1B** : allows access to the main menus for ECU 1 channels A & B.
- **FADEC 2A & FADEC 2B** : allows access to the main menus for ECU 2 channels A & B.
- **EVMU** : allows access to the main menu for the Engine Vibration Monitoring Unit. This menu has 2 pages.



CTC-239-068-00

SYSTEM REPORT/TEST

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
THE ENGINE INTERFACE UNIT (EIU).

The Engine Interface Unit (EIU) is an interface concentrator between the FADEC system and the aircraft systems. There is one EIU for each engine.

Each EIU main menu provides access to :

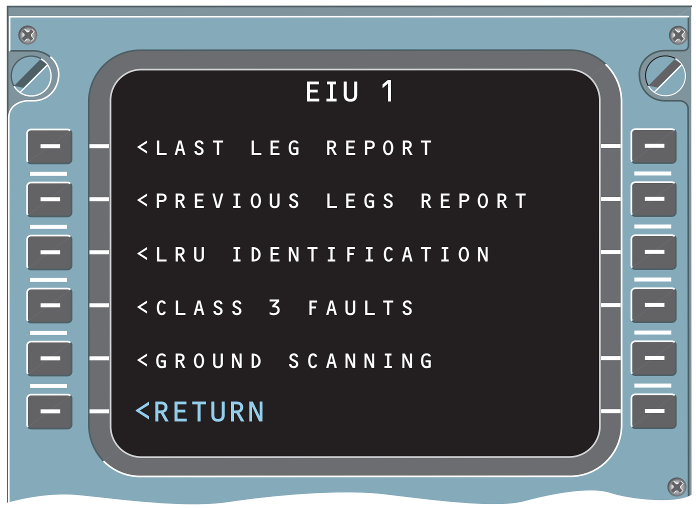
- **Last leg report** : Presents any internal, or external EIU failures, which occurred during the last flight.

- **Previous legs report** : Any internal, or external EIU failures, which occurred during the previous 64 flights are displayed in this report.

- **LRU identification** : Presents the EIU serial number.

- **Class 3 faults** : This report presents any class 3 failure messages that appeared during previous flights.

- **Ground scanning** : This presents any internal, or external failures which are present when a ground scanning request is made. This report is established by forcing operation of the BITE into normal mode (same BITE operation as in flight).



CTC-239-069-00

EIU MAIN MENU

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

Data retrieval.

The ECU interfaces with the CFDIU over ARINC429 databuses, through the EIU, for all fault reporting and maintenance operations.

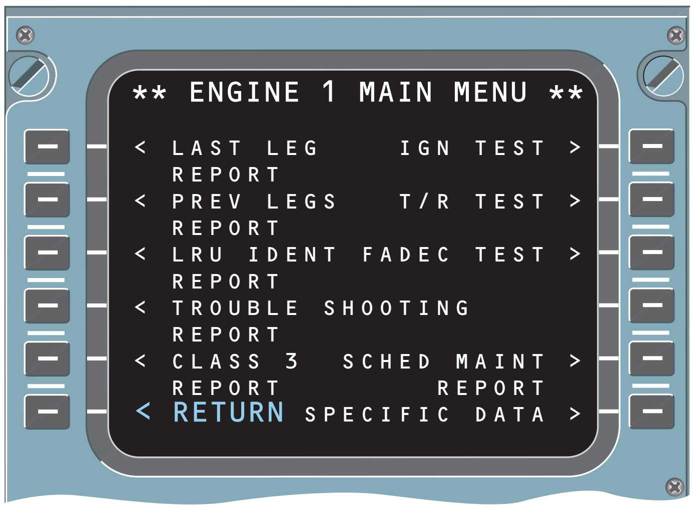
When using the MCDU to interrogate the Last Leg Report, the data displayed is retrieved from the CFDIU memory.

When using the MCDU to interrogate the System Report/ Test- FADEC 1 A/B & FADEC 2 A/B, the data displayed is retrieved from the respective ECU memory.

ECU Menu.

The ECU main menu provides access to various sub-menus :

- Last leg report (leg 00).
- Previous legs report (legs 01 - 63).
- LRU identification report.
- Troubleshooting report.
- Class 3 report.
- Ignition tests.
- Thrust reverser tests.
- FADEC test (motoring / non-motoring).
- Scheduled maintenance report.
- Specific data (PWR setting max values).



CTC-239-070-00

ECU MAIN MENU

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

ECU fault class assignments.

The ECU automatically determines the criticality level of the fault, or combination of faults to establish the dispatch state of the control/indication system, to comply with the engine and aircraft safety objectives.

The ECU assigns different fault classes to those of the aircraft. The ECU fault classes are :

- Class 1 'NO GO'.
- Class 2 ' TIME LIMITED'.
- Class 3 'UNLIMITED'.
- Class SM (Scheduled Maintenance) 'LONG TIME'.

Class 1 NO GO faults.

This condition does not satisfy dispatch criteria and should be corrected prior to aircraft dispatch. However, there may be possible maintenance, or operational procedures that allow dispatch with the fault(s) and the maintenance manual refers to these particular cases.

Class 2 TIME LIMITED faults.

These conditions are system faults that have no immediate direct impact on the loss of thrust control and satisfy the engine and aircraft safety objectives during the time limitation. The aircraft can be dispatched with these faults, but they should be cleared at an interval that is not greater than the time limitation specified in the Aircraft Maintenance Manual.

Class 3 UNLIMITED faults.

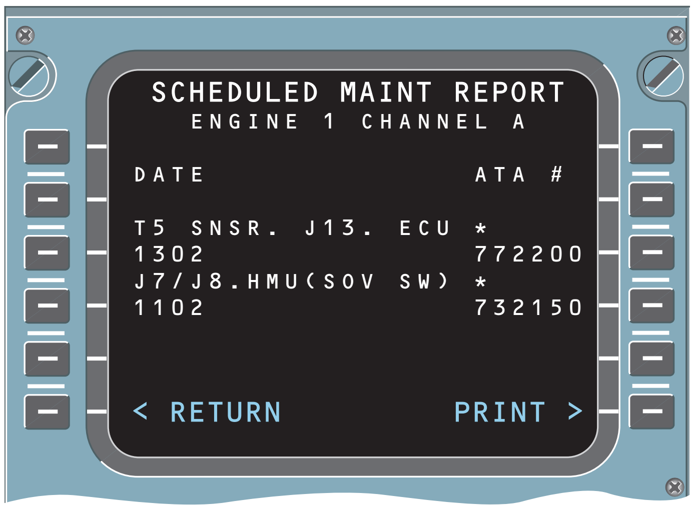
These faults have 'UNLIMITED' conditions and do not have any impact on the dispatch of the aircraft. They may remain unrepaired during the entire aircraft life.

Class SM LONG TIME faults.

These faults are 'time limited' conditions and may be hidden from the flight crews up to the next 'A' check. 'LONG TIME', or Scheduled Maintenance (SM) conditions are system faults that have an indirect impact on the loss of thrust control and the aircraft can be dispatched with these faults. All long time faults must be cleared at an interval that is no longer than the 'A' check maintenance interval.

Note : The ECU may re-evaluate a particular fault and change its priority to a higher class level depending on the health state of the 2 ECU channels.

For example, if there is a Class 2 fault set on the active channel and the standby channel becomes inoperative or,
the same fault is set on both active and standby channels, the ECU will re-evaluate the situation and change the fault level to a Class 1 condition.



CLASS 1 NO GO. **CONDITION DOES NOT SATISFY DISPATCH CRITERIA.** **SHOULD BE CORRECTED PRIOR TO AIRCRAFT DISPATCH.**
CLASS 2 TIME LIMITED. **AIRCRAFT CAN BE DISPATCHED, BUT SHOULD BE CORRECTED BEFORE TIME LIMITS SPECIFIED IN AIRCRAFT MAINTENANCE MANUAL.**
CLASS SM LONG TIME. **TIME LIMITED CONDITION.** **MUST BE CORRECTED AT NEXT A CHECK.**
CLASS 3 UNLIMITED. **MAY REMAIN UNREPAIRED DURING THE ENTIRE AIRCRAFT LIFE.**

CTC-239-071-00

ECU FAULT CLASS ASSIGNMENTS

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

ECU BITE memory structure & fault storage.

Internal and external class 1, 2, 3 and SM faults data isolated during Normal Mode operation is stored in BITE memory and the entire contents can be retrieved by shop maintenance test equipment.

The BITE memory structure is divided into five zones and each zone is treated as a circular buffer. The oldest data is overwritten by incoming data. Data from one zone will not be stored in another zone. Class 1 and 2 fault data is divided between zones 1 and 2.

Zone 1 : NVM - Contains failure identification of the 12 most recent class 1, or 2 isolated faults that occurred during the previous 64 flights. This zone contains the fault number, flight leg (0-63) and number of fault occurrences (up to 4).

Zone 2 : NVM - Contains snapshot data corresponding to the 12 class 1 and 2 faults stored in zone 1.

Zone 3 : Reserved RAM - contains failure identification of the 12 most recent class 1, 2, 3, or SM isolated faults that occurred during the ECU test, or thrust reverser test. This zone contains the fault number, flight leg (0), number of occurrences (up to 4), the GMT and date data.

Zone 4 : NVM - Contains information required for troubleshooting the ECU, while in the repair shop. The data is only accessible in the repair shop and display of this information on the aircraft is inhibited.

Zone 5 : NVM - Contains failure identification of the 12 most recent class 3 and class SM isolated faults that occurred during the previous 64 flights. This zone contains the fault number, flight leg (0-63), number of fault occurrences (up to 4), the GMT and date data.

Note : This zone is shared between class 3 and class SM faults. The sum total of faults saved in the zone is 12, therefore, if there are several SM faults, less than 12 class 3 faults can be reported.

ZONE 1 : NVM (FAULT IDENTIFICATION).		
12 MOST RECENT CLASS 1, OR 2 ISOLATED FAULTS DETECTED DURING THE PREVIOUS 64 FLIGHTS.		
FAULT NUMBER.	**FLIGHT LEG (0-63).**	**NUMBER OF OCCURRENCES (UP TO 4).**
ZONE 2 : NVM (ADDITIONAL FAULT DATA).		
SNAPSHOT DATA CORRESPONDING TO THE 12 MOST RECENT CLASS 1, OR 2 ISOLATED FAULTS DETECTED DURING THE PREVIOUS 64 FLIGHTS AND STORED IN ZONE 1.		

ZONE 3 : RESERVED RAM (FAULT IDENTIFICATION).		
12 MOST RECENT CLASS 1, 2, 3, OR SM ISOLATED FAULTS DETECTED DURING THE ECU TEST, OR THRUST REVERSER TEST		
FAULT NUMBER.	**FLIGHT LEG (0)**	**NUMBER OF OCCURRENCES (UP TO 4).**
TIME AND DATE DATA.		

ZONE 4 : NVM (SHOP DATA).
INFORMATION REQUIRED FOR TROUBLESHOOTING THE ECU AND ONLY ACCESSIBLE IN THE REPAIR SHOP.

ZONE 5 : NVM (CLASS 3 & SM FAULTS).		
12 MOST RECENT CLASS 3 AND SM ISOLATED FAULTS DETECTED DURING THE PREVIOUS 64 FLIGHTS.		
FAULT NUMBER.	**FLIGHT LEG (0-63)**	**NUMBER OF OCCURRENCES (UP TO 4).**
TIME AND DATE DATA.		

CTC-239-072-00

ECU BITE MEMORY STRUCTURE

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

Aircraft status - ECU memory.

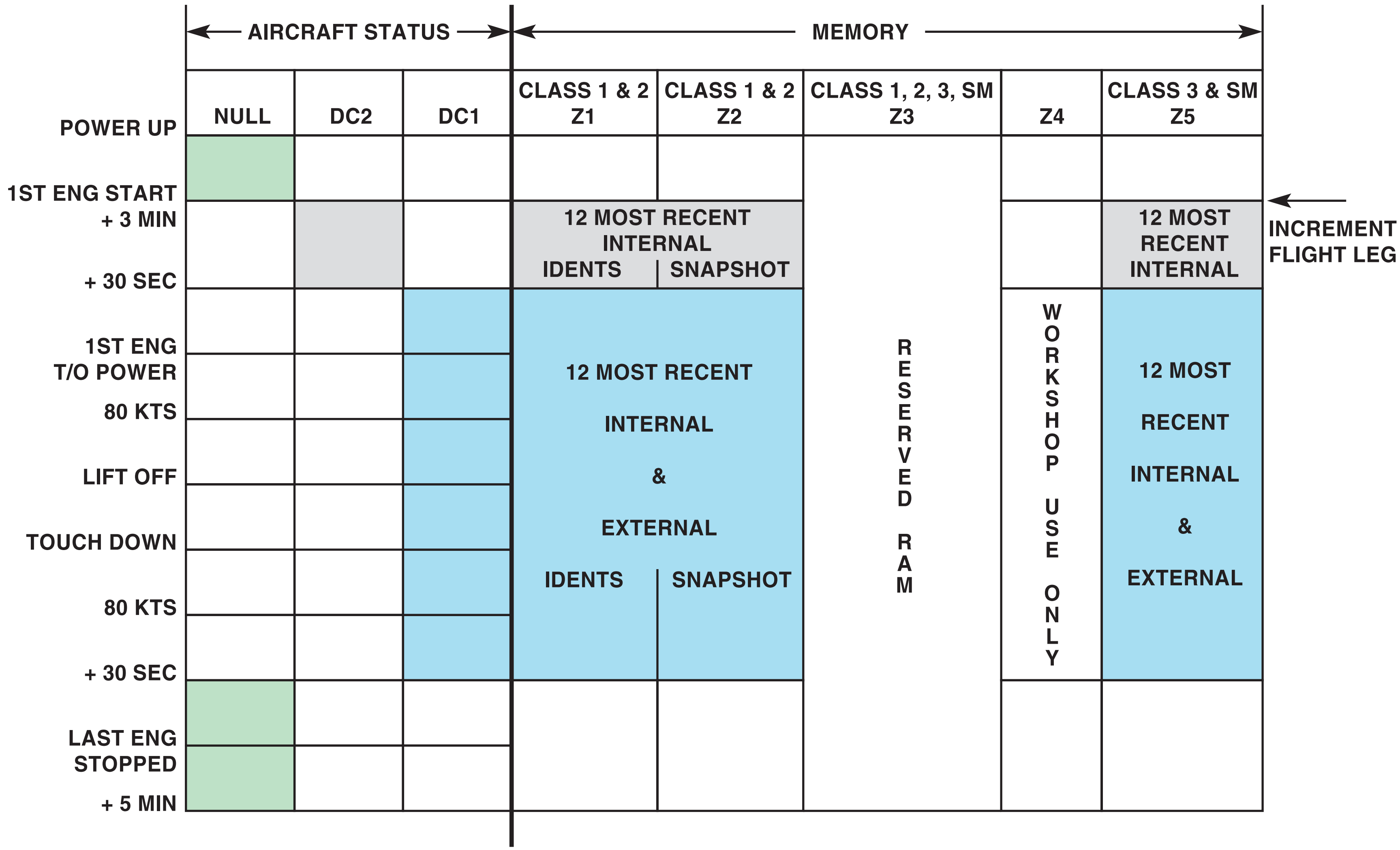
Storage of internal and external fault data in BITE memory is a function of aircraft status.

NULL : No data is stored.

DC2 : Data for all internal faults only will be stored in appropriate areas.

DC1 : Data for all internal and external faults will be stored in appropriate areas.

Flight leg counting and storage processing is done at the start of the flight at the NULL to DC2 transition. The current flight leg (or, last leg if on ground) is identified by 00 on the menu mode display. The previous flight legs increment from 01 to 63.



CTC-239-073-00

A/C STATUS - ECU MEMORY FAULT STORAGE

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

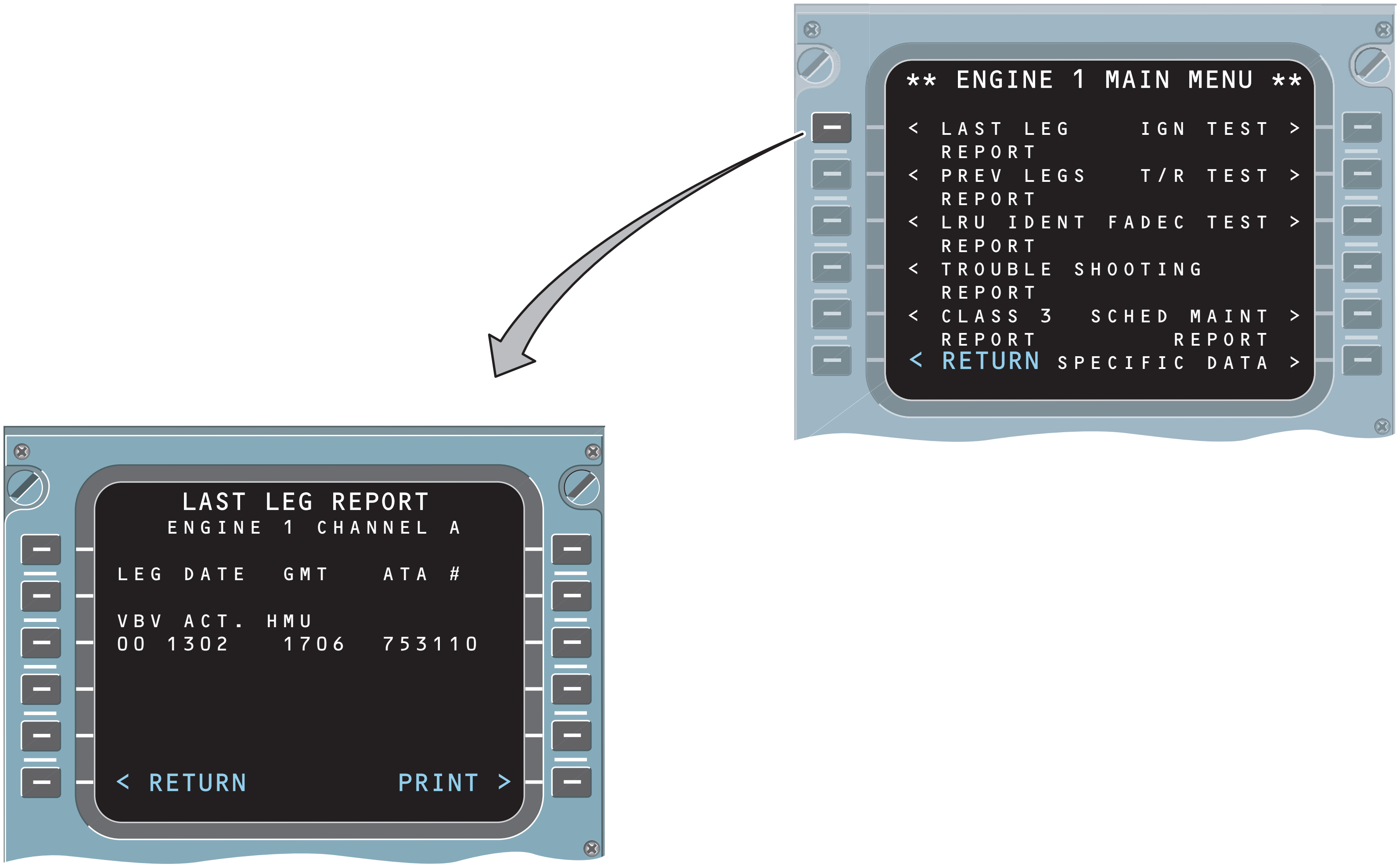
Last leg report (Leg 00).

The last leg report format (class 1 and 2 faults only) contains the identity of each faulty LRU, the flight leg (always 00), the date and time at which the fault occurred and the ATA reference number.

A maximum of three faults are displayed per page and the faults are displayed in chronological order with the oldest fault first.

If no faults were recorded during the last flight, a ‘NO FAULTS RECORDED’ message is displayed.

When there is an NVM failure, the ECU will display a ‘DATA NOT RETRIEVABLE’ message.



CTC-239-074-00

LAST LEG REPORT (00)

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

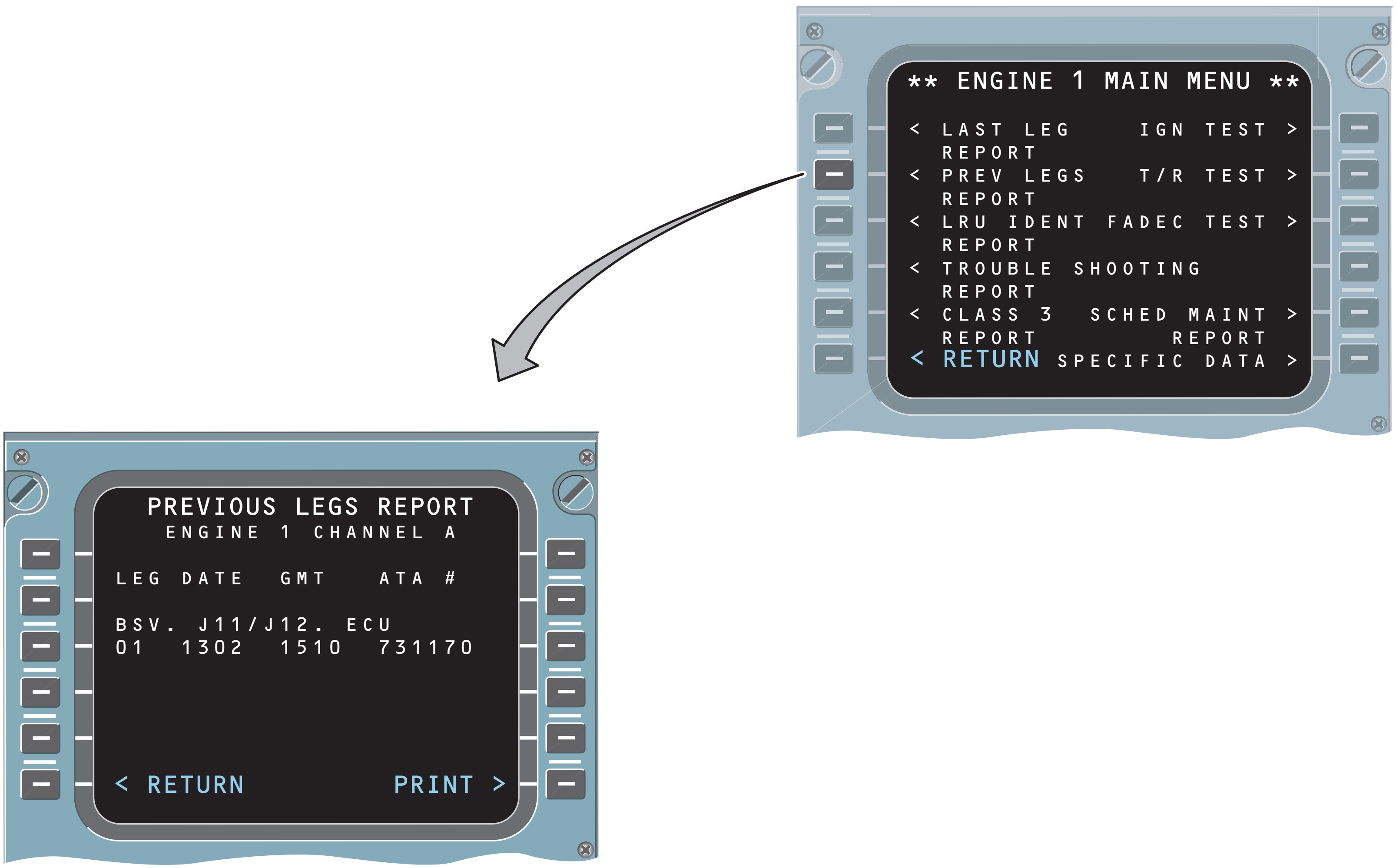
Previous legs report (Legs 01 to 63).

The previous legs report format (class 1 and 2 faults only) is the same as the last leg report, except that for each fault, the flight leg number at which the fault occurred is added.

Flight leg numbers are displayed in reverse chronological order with the most recent flight leg first and the faults within each leg are displayed in chronological order with the oldest fault first.

If no faults were recorded during previous flights, a ‘NO FAULTS RECORDED’ message is displayed.

When there is an NVM failure, the ECU will display a ‘DATA NOT RETRIEVABLE’ message.



CTC-239-075-00

PREVIOUS LEGS REPORT (01-63)

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

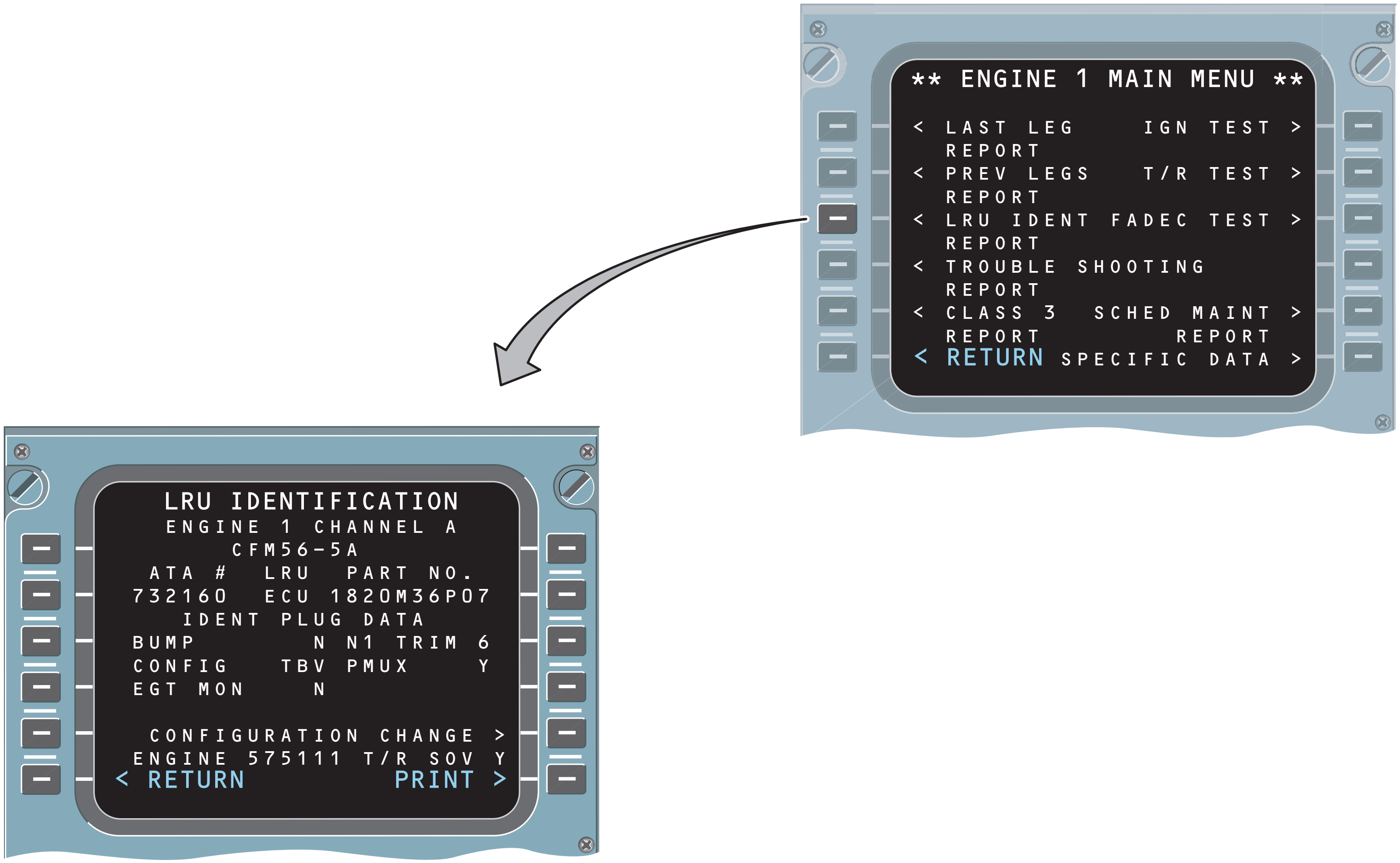
LRU identification.

The LRU identification page provides information on engine configuration.

The page displays :

- ECU ATA number
- ECU part number
- Engine rating
- Bump availability
- N1 Trim (0 - 7)
- PMUX inhibited status
- EGT monitoring status
- Engine configuration (RACSB valve, or TBV valve)
- TR SOV status
- Engine serial number

A menu selection is also provided to change the engine serial number if the ECU is moved from one engine to another and also to change the TRSOV installation status.



CTC-239-076-00

LRU IDENTIFICATION

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

LRU identification - S/N & TRSOV status change.

If the ECU has been changed, or moved to another engine, the engine serial number may be changed through the MCDU. The S/N must correspond to that engraved on the Engine Dataplate, riveted on the fan frame.

When 'CONFIGURATION CHANGE' is selected from the LRU identification page, a sub-menu appears that allows the operator to select either engine S/N change, or TRSOV status change.

If the operator selects 'ENGINE S/N CHANGE', a new sub-menu is displayed that allows the operator to enter six digits from the keypad. When the new S/N has been entered, the operator presses the corresponding line select key and a new screen appears informing the operator that the S/N entry has been accepted.

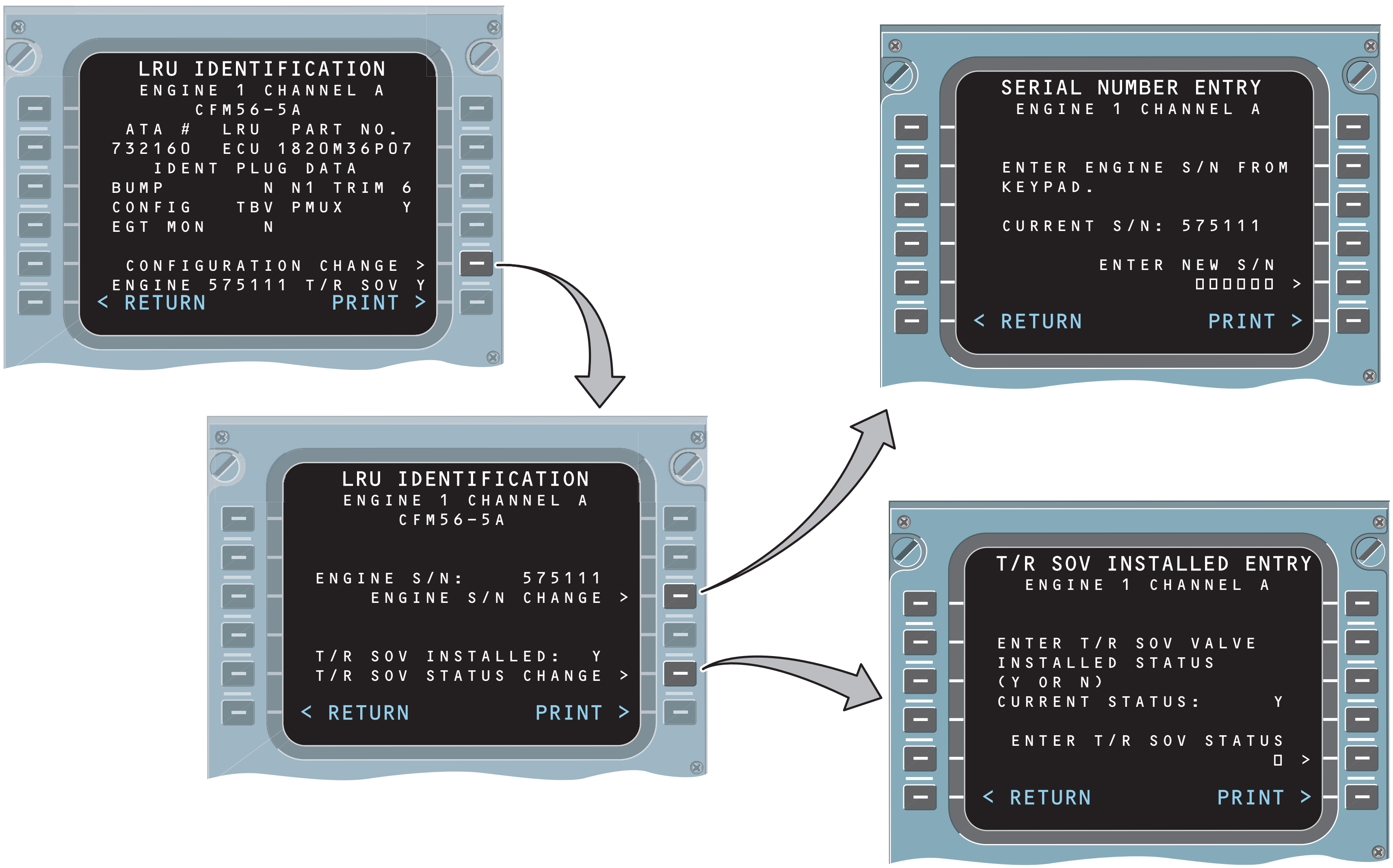
If the number was wrongly entered (incorrect number of digits, or a letter accidentally keyed), a different screen will be displayed informing the operator that a mistake was made and allowing the correct number to be re-entered. Once the correct number has been entered, the ECU stores it in both channels. The LRU identification menu will then display the new S/N.

If the operator selects 'T/R SOV STATUS CHANGE', a new sub-menu is displayed that allows the operator to change the status. The current status is displayed and the operator can key 'Y', or 'N' using the keypad.

When the new status has been entered, the operator presses the corresponding line select key and a new screen appears informing the operator that the new status has been accepted.

If the entry was incorrect (any character other than 'Y', or 'N'), a different screen will be displayed informing the operator that a mistake was made and allowing the correct status to be re-entered.

Once the correct status has been entered, the ECU stores it in both channels. The LRU identification menu will then display the new status.



CTC-239-077-00

S/N AND TRSOV STATUS CHANGE

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS). ENGINE SYSTEMS - ECU.

Troubleshooting report.

This report provides a snapshot of certain parameters recorded at the time the fault first appeared and is used as an aid in troubleshooting.

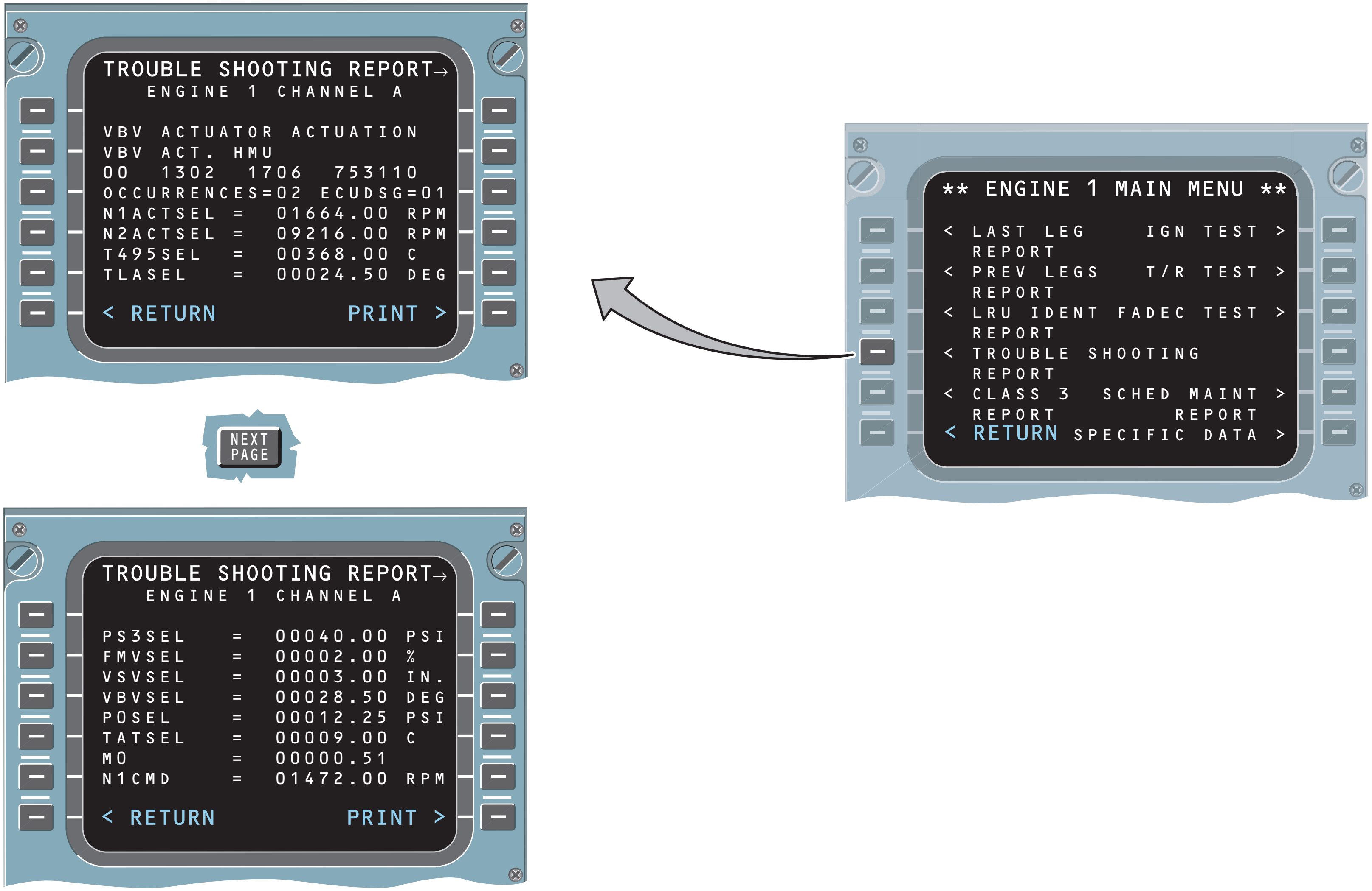
Each report has 2 pages and data for a maximum of 12 class 1 & 2 faults recorded over the last 64 flight legs may be displayed.

Troubleshooting data is displayed in reverse chronological order, i.e. last event first.

The display shows the fault message and the normal mode message, followed by the flight leg number, date, time, and ATA number.

The number of occurrences (1 to 4) and the ECU designation are shown followed by the values of selected parameters.

If no troubleshooting data is available, a 'NO FAULTS RECORDED' message is displayed.



CTC-239-078-00

TROUBLESHOOTING REPORT

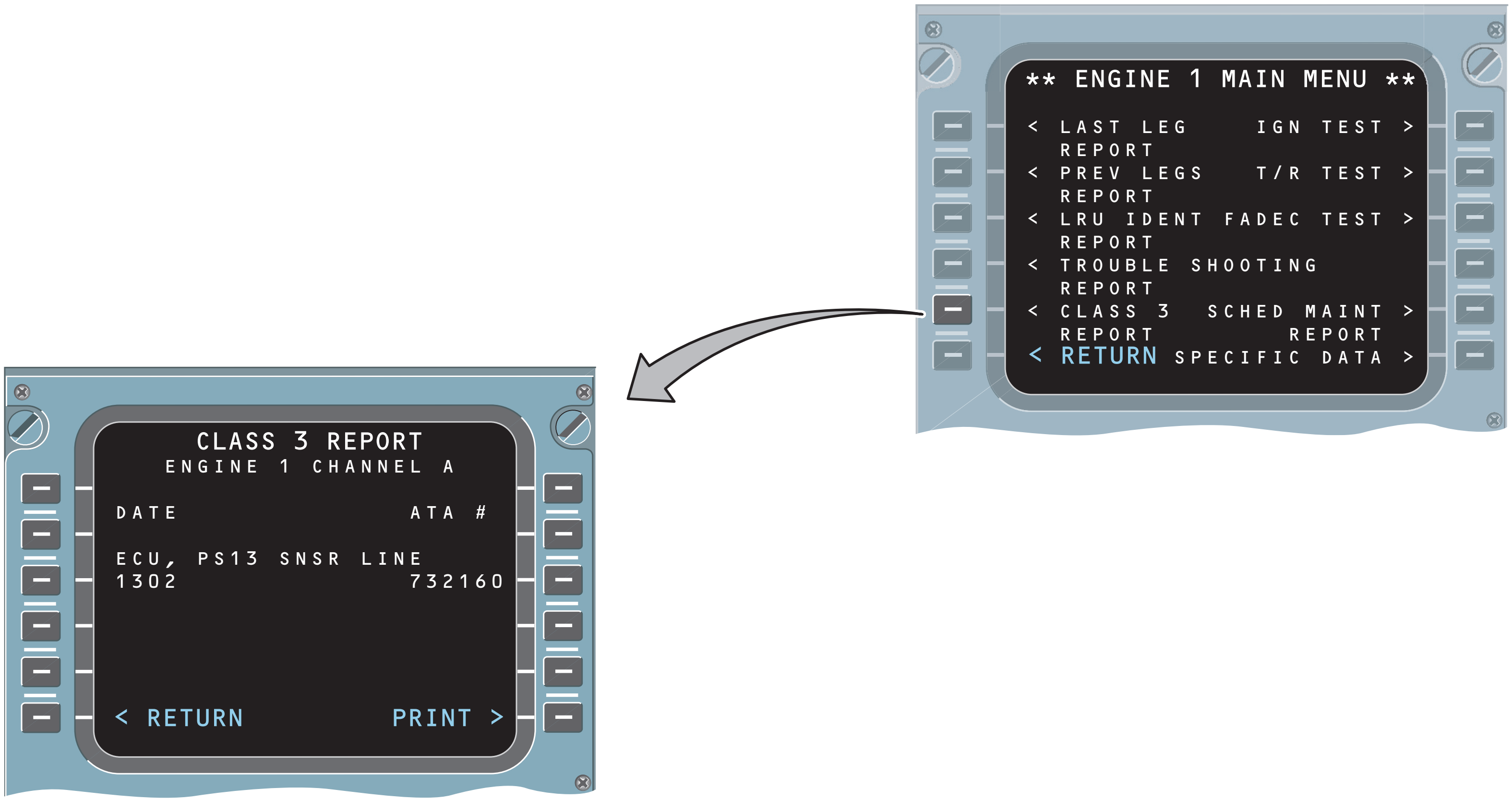
CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

Class 3 report.

The Class 3 report has the same format as the 'Last leg report', except that there is no flight leg, or date information.

Troubleshooting data is not available for class 3 faults.

If no class 3 faults have been recorded during the last 64 flights, a 'NO FAULTS RECORDED' message is displayed.



CTC-239-079-00

CLASS 3 REPORT

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

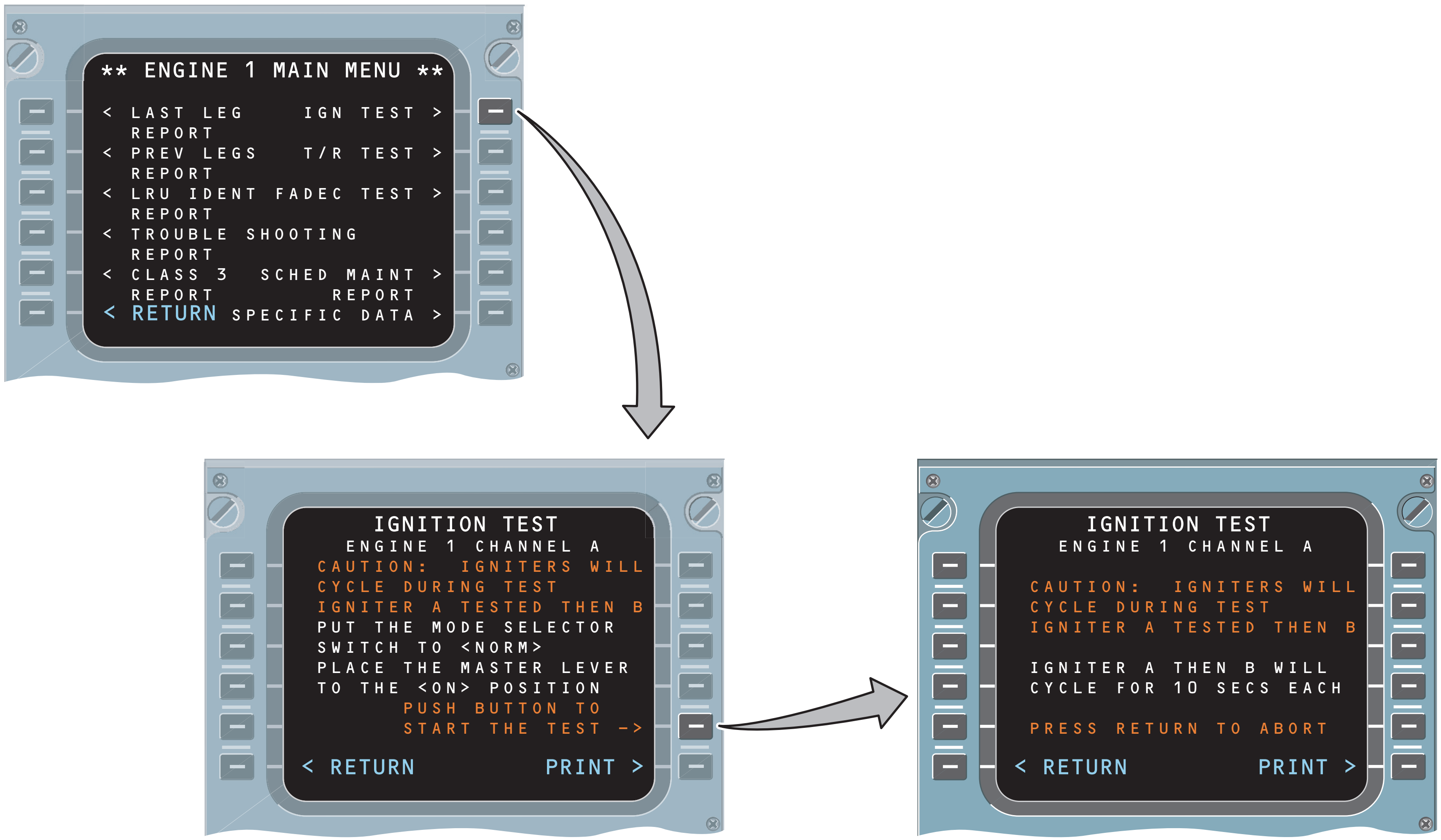
Ignition test.

The ignition test consists of cycling ignitor A for 10 seconds, waiting 2 seconds, then cycling ignitor B for 10 seconds.

Selecting 'IGN TEST' from the main menu will display a screen with initial aircraft setup conditions. The operator is prompted to place the mode selector switch to the 'NORM' position and place the master lever to 'ON'. The operator must then press the appropriate line select key to start the test.

While the test is active, a page is displayed warning the operator the ignitors are cycling and that pressing the 'RETURN' key will abort the test.

Upon completion of the test, a test 'close up' screen is displayed to ensure that the function is exited with the master lever returned to the 'OFF' position.



CTC-239-080-00

IGNITION TEST

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

Thrust reverser test.

During this test, hydraulic pressure must be available for supply to the thrust reverser system. By moving the throttle in the reverse and forward regions, the T/R will deploy and stow under controlled conditions.

Thrust reverser position switch faults, pressurizing valve and directional valve solenoid electrical checks, aircraft inhibition switch failures and pressurizing valve position faults are announced, if detected.

Only thrust reverser system faults are announced during the test and the general FADEC test may be selected to determine if any other faults are present.

Selecting 'T/R TEST' from the main menu will display a screen with initial setup conditions and caution information. The operator must press the appropriate line select key to start the test.

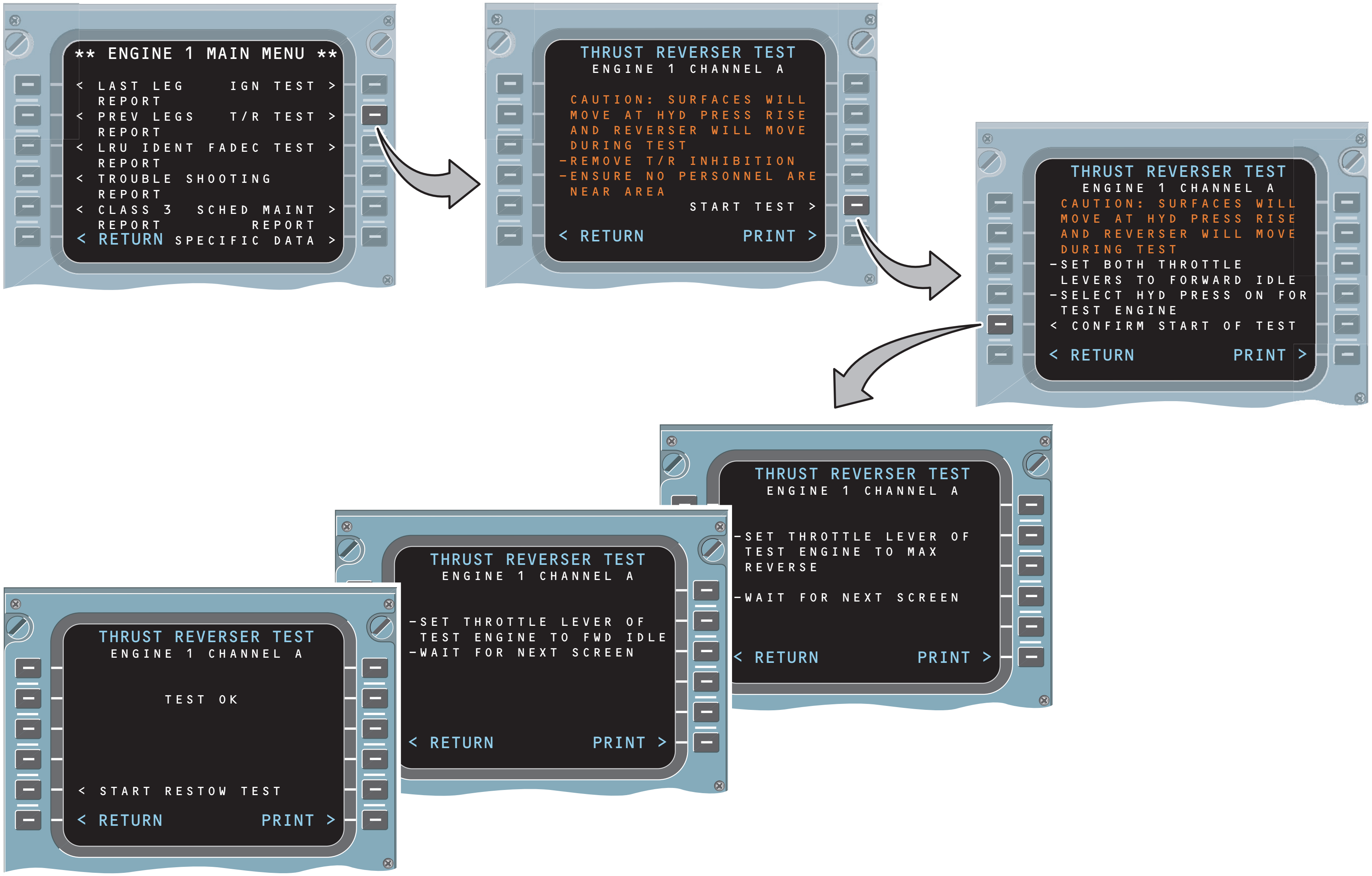
Selecting 'START TEST' displays another screen with more caution information and setup conditions. The operator must confirm the start of the test by pressing the appropriate line select key.

If the TRSOV is not installed, a screen is displayed to ask the operator to set the throttle lever to max reverse and this screen is displayed until a timer times out, or the T/R is fully deployed.

If the TRSOV is installed, a 'PERFORMING TR SHUTOFF VALVE TEST' screen is displayed, which times out after about 8 seconds. The next display asks the operator to set the throttle lever to max reverse and this screen is displayed until a timer times out, or the T/R is fully deployed.

The next display asks the operator to set the throttle lever to fwd idle and, when the doors are fully stowed, the test results screen is displayed.

If no faults were found, a 'TEST OK' message is displayed and the operator is also given the opportunity of performing a restow test. This checks for possible restrictions in the hydraulic return lines from the HCU. To the operator, the test is identical to the previous test. There is no limit to the number of times the operator may perform the restow test.



CTC-239-081-00

THRUST REVERSER TEST

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS). ENGINE SYSTEMS - ECU.

FADEC test.

The FADEC test is divided into two parts. If starter air is available at the beginning of the test, a motoring test is performed. Otherwise, a non-motoring test is performed.

The non-motoring test will complete automatically in about two minutes. After the operator has pressed the line select key to start the test, a screen appears prompting the operator to place the mode selector switch to 'NORM' and the master lever to 'ON'. When the conditions are met, a 'TEST ACTIVE' screen is displayed.

When the test is complete, a display reports that a non-motoring test was performed and prompts the operator to either press a key to display the test results, or return to the main menu.

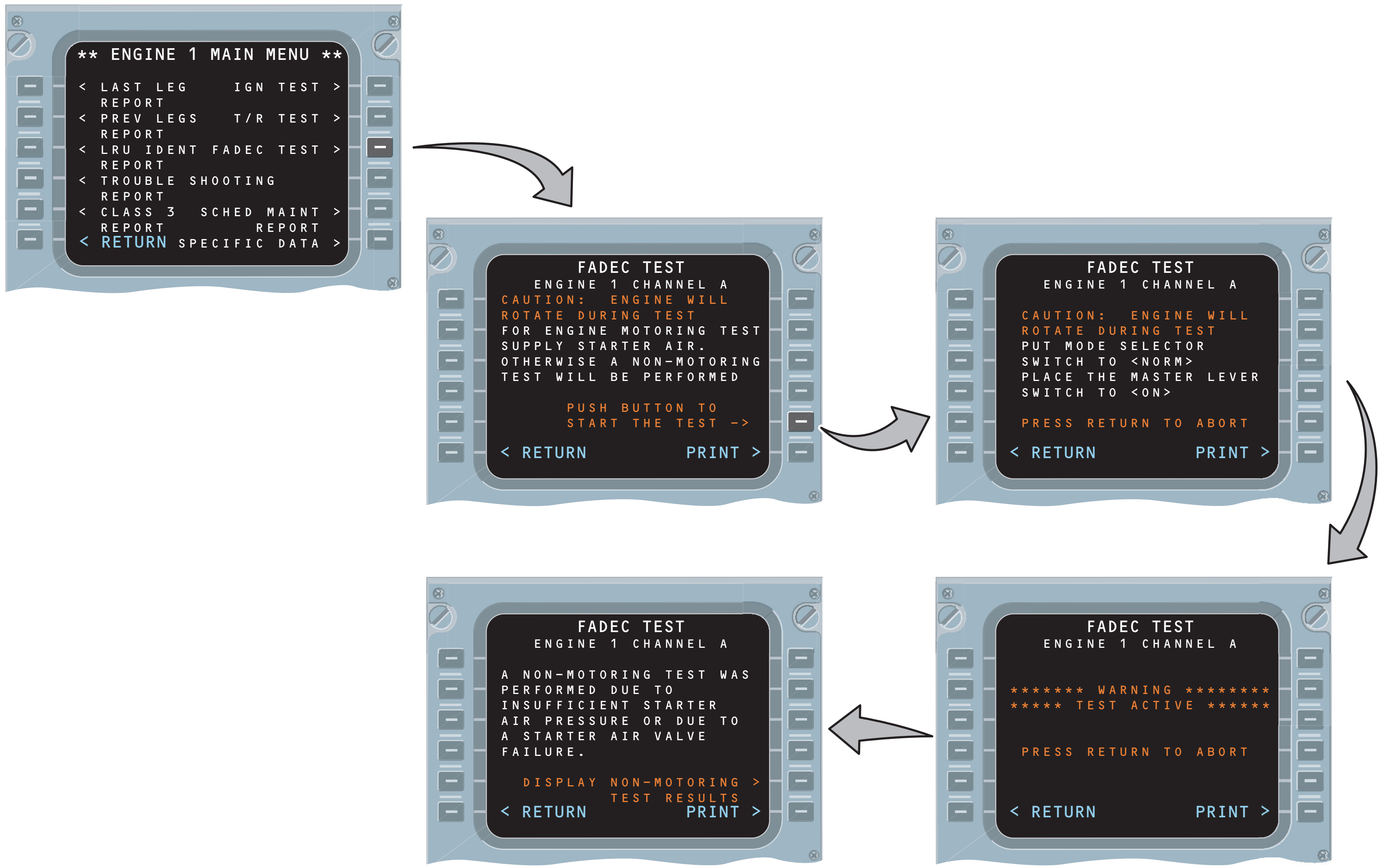
If a fault is detected, the fault report page contains the identity of the 3 most likely failed LRU's for the fault. A maximum of 3 faults per page are displayed with a maximum of 12 faults recorded.

If starter air is supplied, the engine is dry cranked and the various actuators and valves (except FMV, HPSOV and FRV valves) are commanded to move to certain positions. The test will complete automatically in less than one minute.

As in the non-motoring test, after the operator has pressed the line select key to start the test, a screen appears prompting the operator to place the mode selector switch to 'NORM' and the master lever to 'ON'. When the conditions are met, a 'TEST ACTIVE' screen is displayed.

If the test is positive, a 'NO FAULTS RECORDED' message is displayed.

Before exiting either the non-motoring, or motoring tests, a 'TEST COMPLETE' screen is displayed that prompts the operator to place the master lever to the 'OFF' position.



CTC-239-082-00

FADEC TEST

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

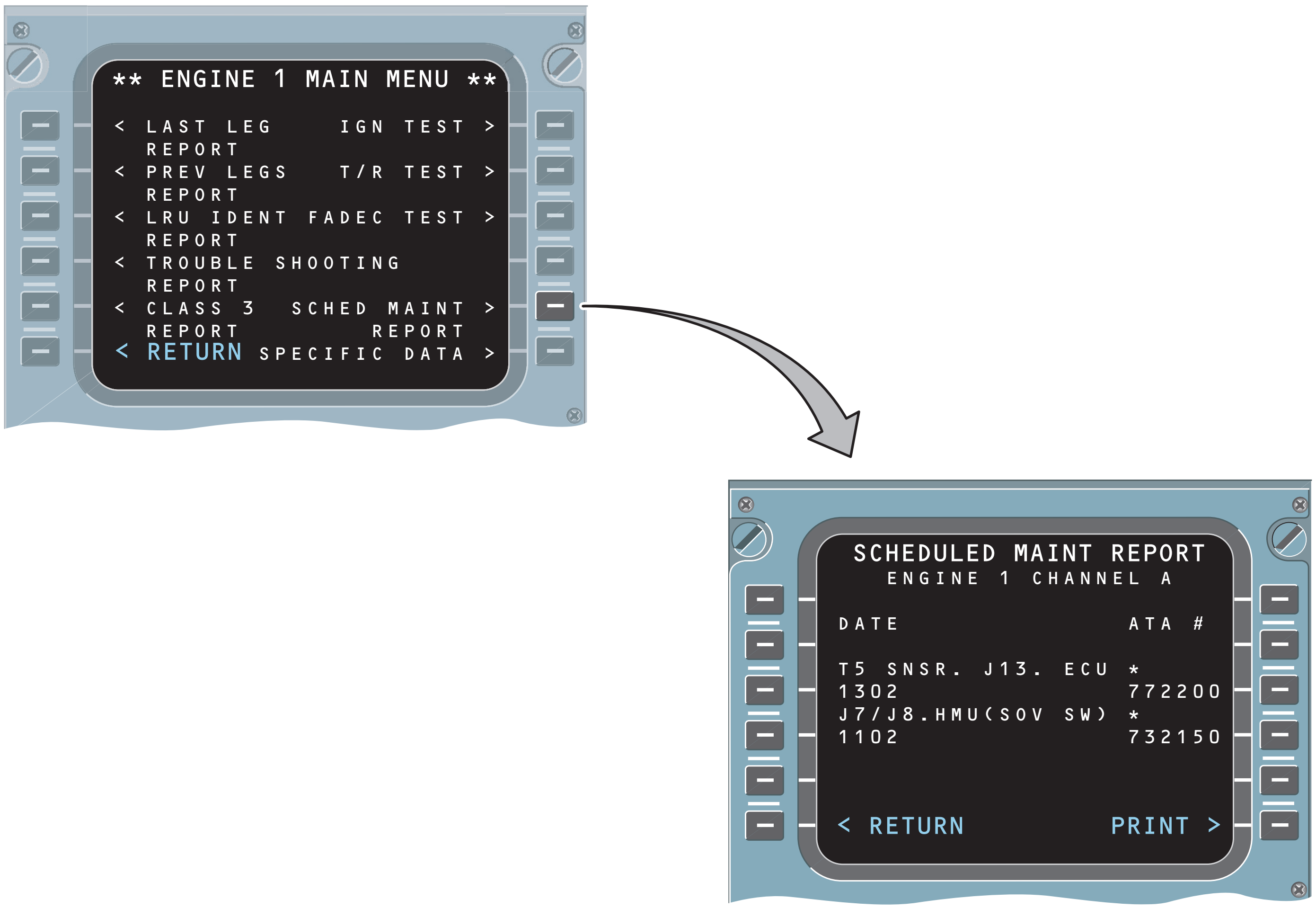
Scheduled maintenance report.

The report format is the same as the ‘Last leg report’, except that there is no flight leg or data information.

When no SM faults are recorded during the last 64 flight legs, a ‘NO FAULTS RECORDED’ message is displayed.

Troubleshooting data is not available for scheduled maintenance faults.

Note : Some (not all) single channel SM faults may be upgraded by the ECU to class 2, or even class 1, if they become dual channel faults.



CTC-239-083-00

SCHEDULED MAINTENANCE REPORT

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - ECU.

Specific data.

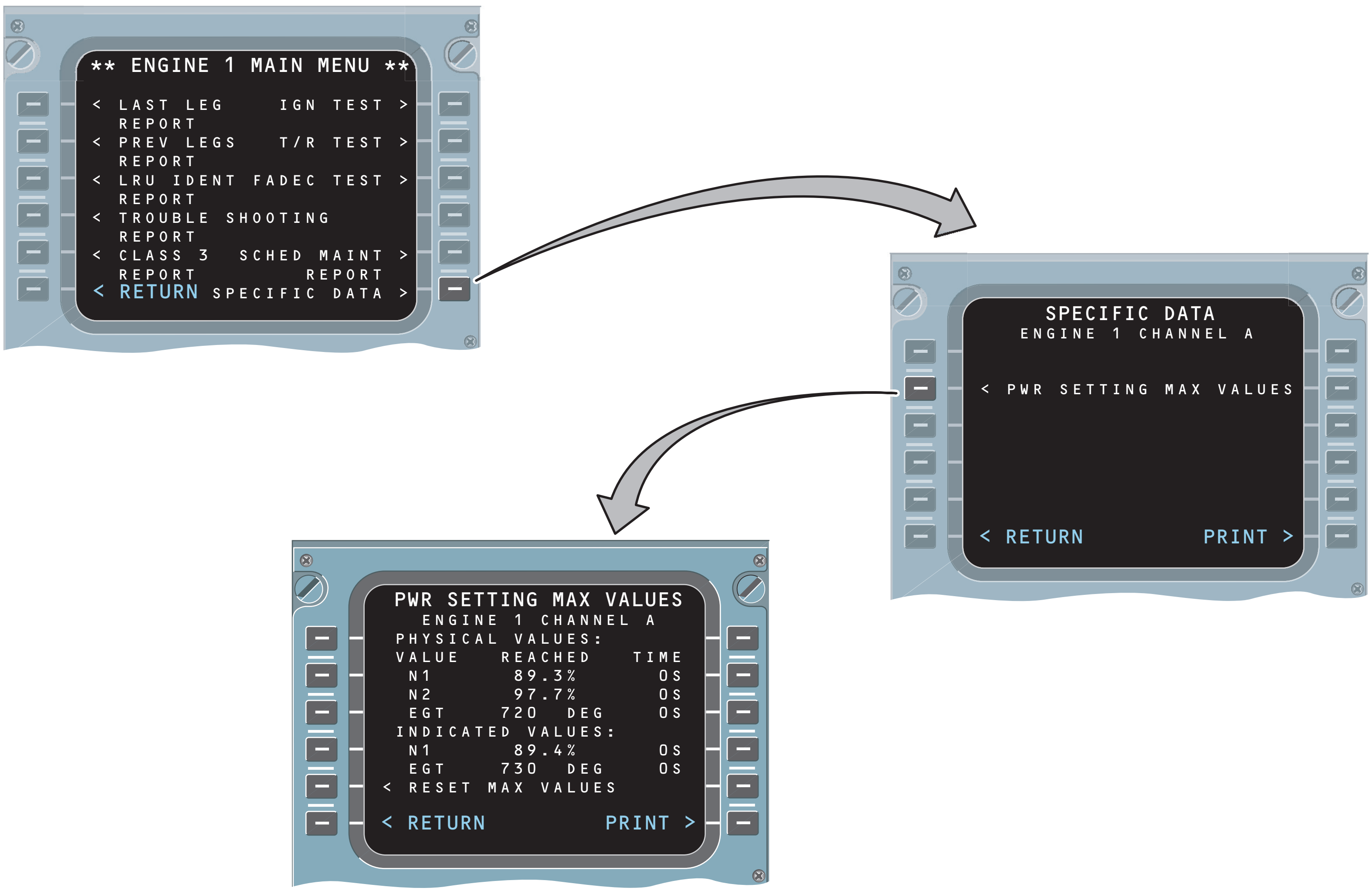
The specific data report is a sub-menu that currently has only one selection available :
PWR SETTING MAX VALUES

This displays the maximum values of N1, N2 and EGT reached the last time the engine was operated. The time, in seconds, logged at these maximum values is also displayed.

Both indicated and physical N1 and EGT values are displayed. There is no separate indicated value for N2.

These maximum values and the duration of any limit exceedance are reset during engine ground start, or they may be reset by an option in menu mode.

When the reset option is selected by the operator, a confirmation screen is displayed. If the operator presses the line select key to confirm, then the reset values (all zeros) are displayed.



CTC-239-084-00

SPECIFIC DATA

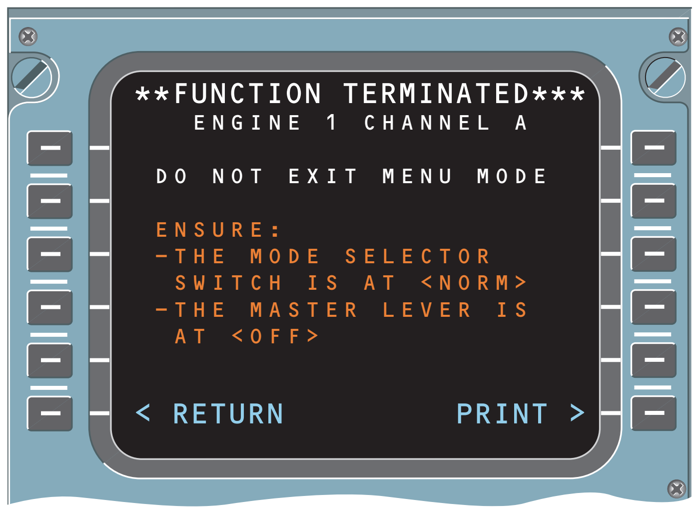
CENTRALIZED FAULT DISPLAY SYSTEM (CFDS). ENGINE SYSTEMS - ECU.

Function terminated report.

If the cockpit rotary selector is turned to ‘IGN/START’, at any time, menu mode will terminate the current function and display the function terminated report screen.

If the master lever is set to ‘ON’, (except during the ignition test, or FADEC test), menu mode will also terminate the current function and display the function terminated report screen.

The purpose is to prompt the operator to return cockpit switches to safe positions. The page is displayed until the operator does so and then, when the return key is pressed, the screen displays the main menu.



CTC-239-085-00

FUNCTION TERMINATED REPORT

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - EVMU.

Engine vibration measurement consists of :
- 2 transducers (piezo-electric accelerometers).
- an Engine Vibration Monitoring Unit (EVMU).
- 2 vibration indications.

The No1 bearing vibration sensor permanently monitors vibrations from the No1 bearing. It also senses vibrations in the LPT and HPT shafts. This sensor is also used for trim balance operations.

The Turbine Rear Frame (TRF) vibration sensor is used in conjunction with the No1 bearing vibration sensor to monitor and, if necessary, reduce engine vibration levels using the trim balance procedure.

The EVMU computes the position and the amplitude of the unbalance and is capable of on-board fan trim balancing.

The EVMU does not interface directly with the ECU.

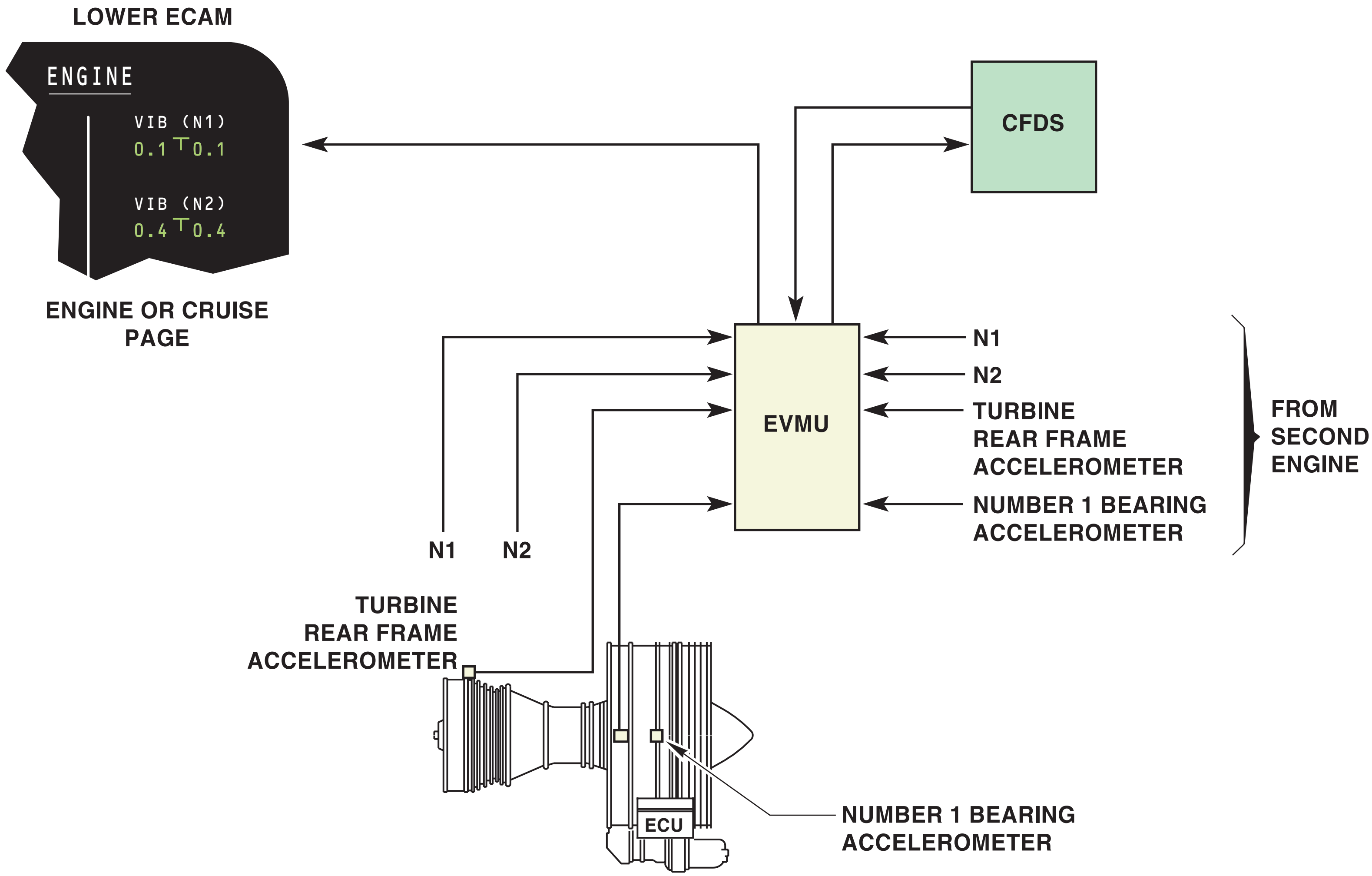
The EVMU receives analog signals from the 4 engine accelerometers (2 per engine) and the N1 and N2 speed sensors of each engine.

The EVMU interfaces with the CFDS, through ARINC429 databuses, for maintenance fault messages and vibration data analysis.

The EVMU also sends signals to SDAC1, SDAC2 and the DMU over ARINC429 databuses.

The ECAM receives information via SDAC1 and SDAC 2. The vibration indications are displayed in green on the lower ECAM display, in the engine and cruise pages.

The maximum value that can be displayed is 10 units.
- 10 units for the N1 rotor corresponds to 10 MILS (MILS = Milli-Inch).
- 10 units for the N2 rotor corresponds to 4 IPS (IPS = Inch per second).



CTC-239-086-00

ENGINE SYSTEMS - EVMU

CENTRALIZED FAULT DISPLAY SYSTEM (CFDS).
ENGINE SYSTEMS - EVMU.

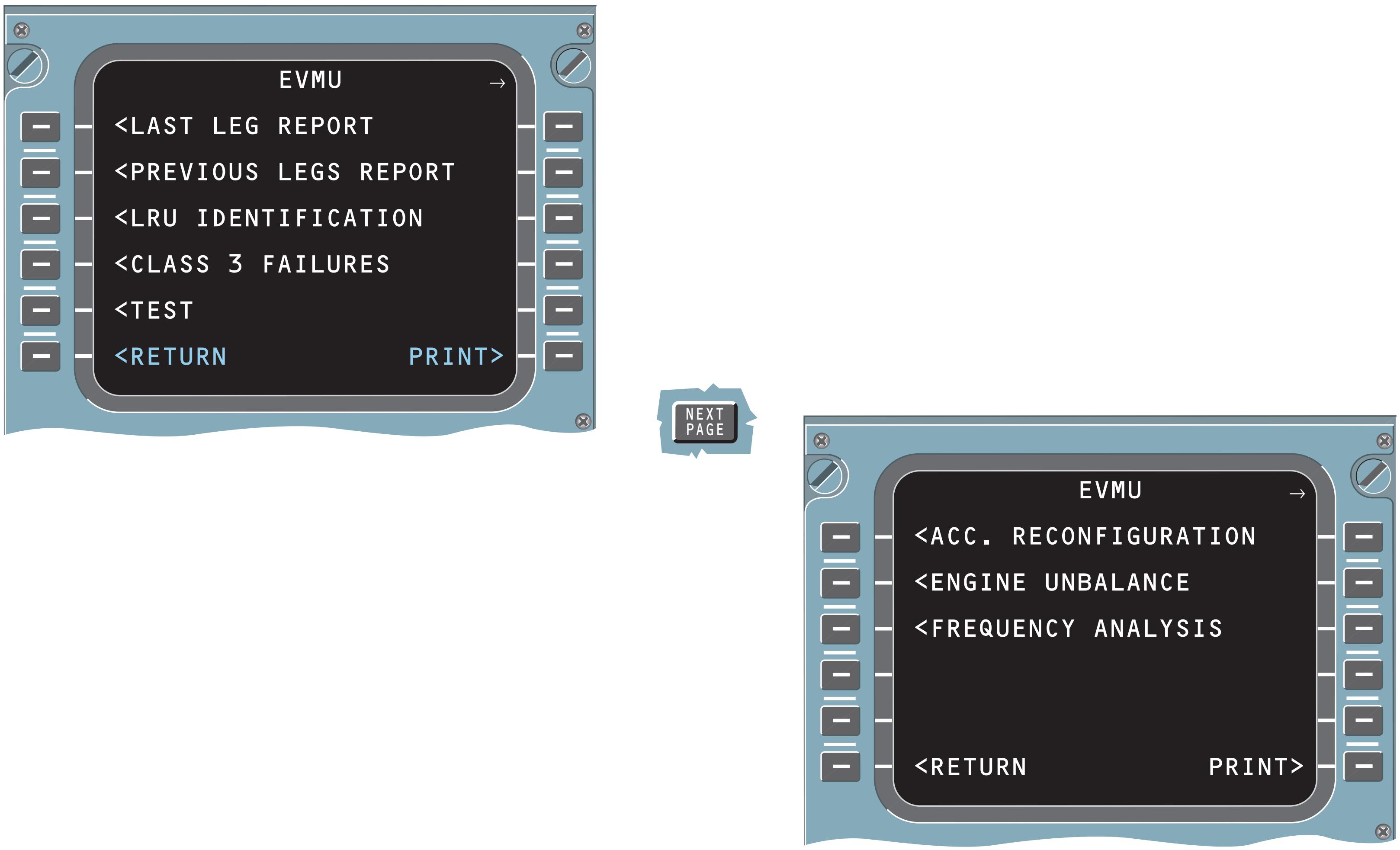
The EVMU main menu is on 2 pages and provides access to various sub-menus.

The first page provides access to :

- **Last leg report** : Internal and external class 1 & 2 faults recorded during the last flight leg.
- **Previous legs report** : Internal and external class 1 & 2 faults recorded during the previous 63 flight legs, excluding the last flight.
- **LRU identification** : Provides part and serial number information.
- **Class 3 failures** : Provides a list of LRU's detected faulty during a ground test. Only the last 3 detected failures are displayed.
- **Test** : Allows user to initiate a complete check of the EVM system and view the results.

The second page provides access to :

- **Acc. reconfiguration** : Allows selection of the accelerometer (Fan No1 bearing, or TRF) to be used for the next flight. The EVMU also indicates which accelerometer is in operation.
- **Engine unbalance** : Allows selection, per engine, of 5 different engine speeds (from 50% to 100% N1) at which unbalance data will be stored. Unbalance data acquired during the previous command can be read and trim balancing (one shot, or vectorial method) for both engines with both accelerometers can be performed.
- **Frequency analysis** : With this menu, the operator can set aquisition conditions for an in-flight frequency analysis. This menu also provides lines for comments (up to 3) that the operator considers necessary for the frequency analysis printout that will be made after the next flight.



CTC-239-087-00

EVMU MAIN MENU

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AIRCRAFT INTEGRATED DATA SYSTEM

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

The AIDS is an option that is organized around the Data Management Unit (DMU), which is reconfigurable via Ground Support Equipment (GSE). The DMU is connected to various aircraft systems and receives data from them over ARINC429 databuses.

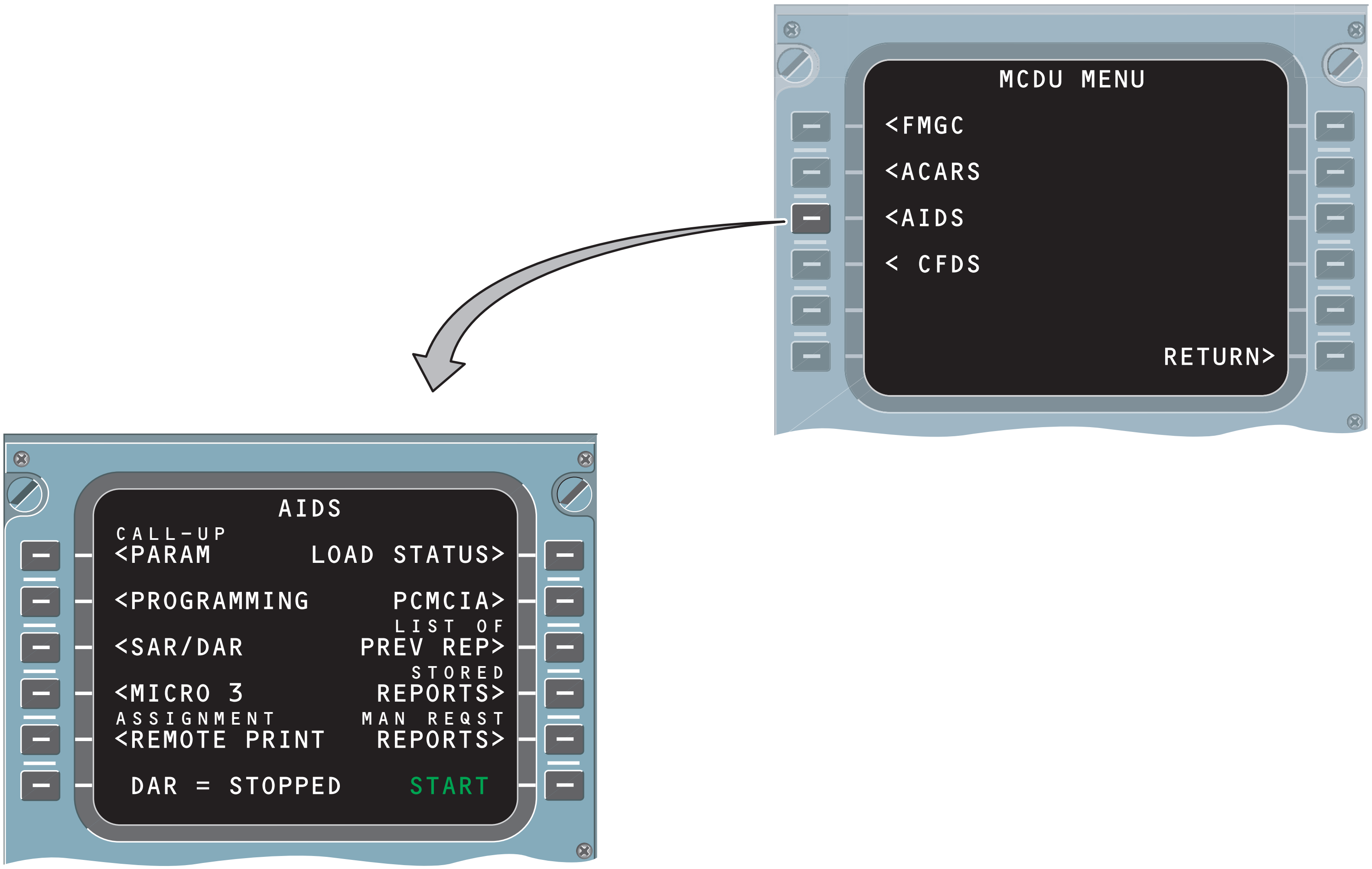
One of the functions of the DMU is the generation of reports as a result of specific events defined by trigger conditions. The DMU is able to record data either by the use of an optional Digital Aids Recorder (DAR), optional Smart Access Recorder (SAR), or integrated PCMCIA interface. The storage medium of the DAR is a magnetic tape cartridge, or optical disk, while the SAR stores data in a solid state mass memory. The PCMCIA interface can accept disks to store SAR data, DAR data, or standard AIDS reports.

While the CFDS is intended to assist line maintenance in isolating faults detected by the BITE functions of the aircraft systems, the main objective of AIDS is preventative. Long term trend monitoring of the engines avoids expensive unscheduled maintenance. Continuous monitoring of the engine is also intended to substitute fixed interval inspections with on-demand maintenance.

In addition, AIDS is used for various tasks such as hard landing detection, special investigations and troubleshooting on a system level.

From the MCDU menu, selecting AIDS will display the main menu, which provides access to 10 specific functions :

- **Call-up parameter** : This selection provides access to Label call-up, Alpha call-up and Parameters menus (programmed through GSE).
- **Programming** : This displays identification information and allows reconfiguration of limits, counters and reports inhibition.
- **SAR/DAR** : This displays the state of the SAR memory and allows access to the DAR function.
- **Micro 3** : This is used to access either additional menus, or customer menus. This line is only displayed if a third CPU board is present.
- **Assignment remote print** : Displays a list of reports triggered by the remote print button.
- **Load status** : Displays the status of all airborne data loader operations.
- **PCMCIA** : Used to access PCMCIA disk management and display functions.
- **List of previous reports** : Displays a list of the last stored reports.
- **Stored reports** : Displays a list of all stored reports.
- **Manual request reports** : Provides all the report names and associated numbers.



CTC-239-088-00

AIDS MAIN MENU

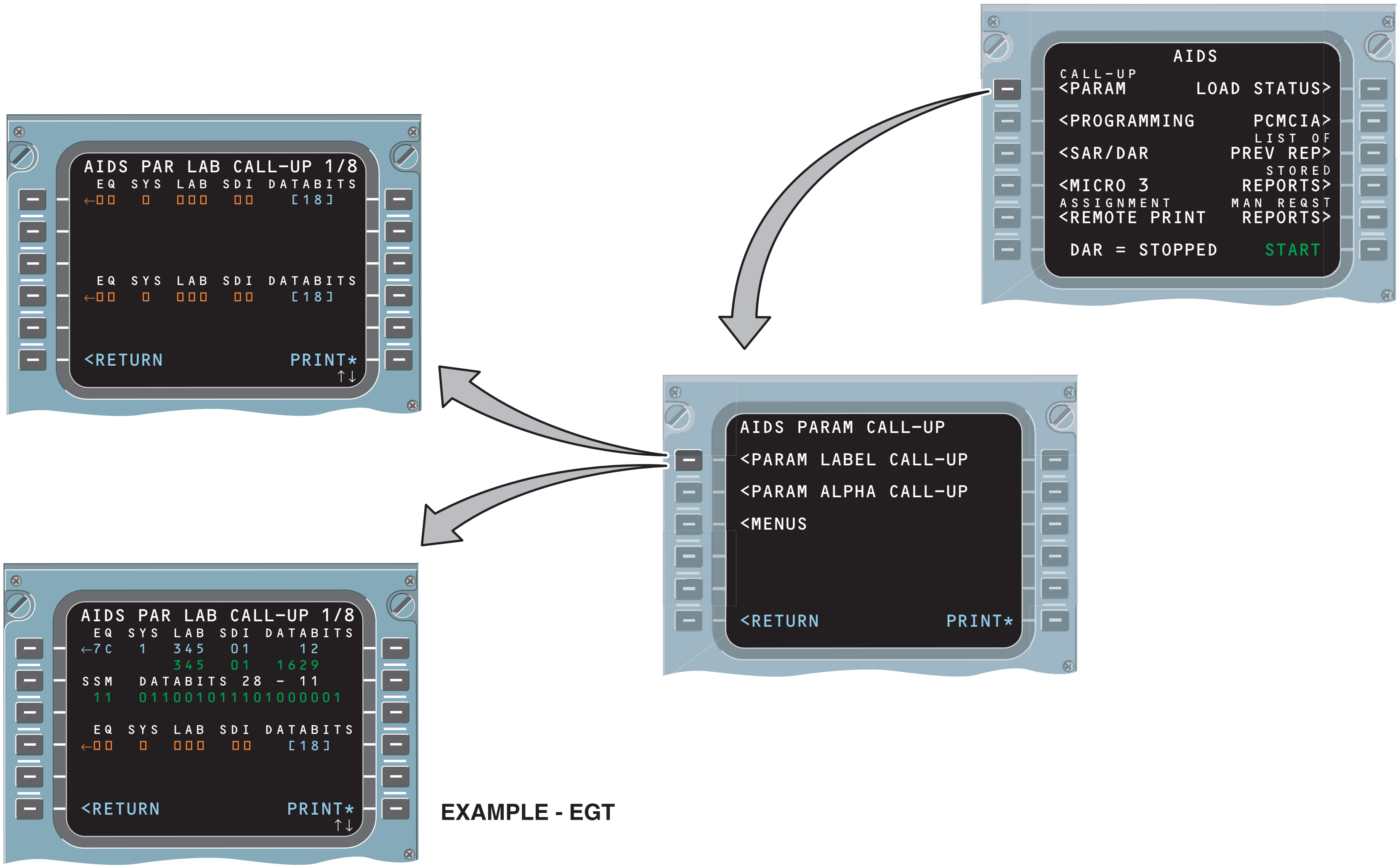
THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).
PARAMETER CALL-UP.

From the AIDS main menu, selection of Call-up parameter will display a sub-menu with three selections :
- Parameter label call-up.
- Parameter alpha call-up.
- Menus.

Label call-up.

This function enables direct access to all parameters transmitted on the ARINC429 databuses, connected to the DMU, for on-line display. The values displayed are in real time and refreshed once per second.

To display a label call-up, the operator enters the following parameters, separated by a slash(/) :
- EQ : Equipment number entered by 2 characters.
- SYS : System number (1, 2, 3, or 4).
- LAB : Parameter label entered in octal (001 to 377).
- SDI : Source destination identifier (00, 01, 10, or 11).
- Databits : Number of databits to be used for decimal conversion (1 to 18). 18 is the default value.



LABEL CALL-UP

CTC-239-089-00

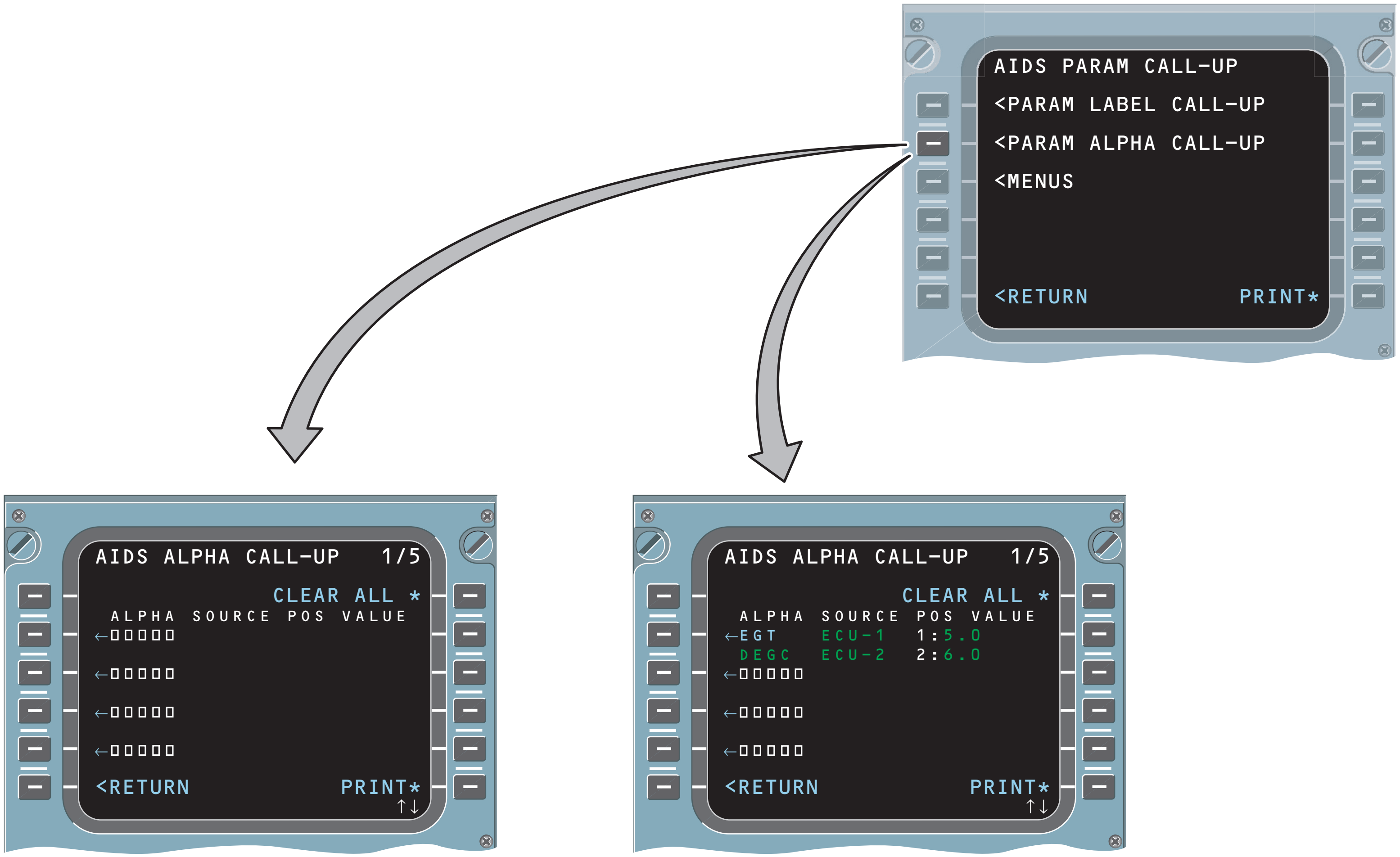
THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).
PARAMETER CALL-UP.

Alpha call-up.

This function enables the operator to read out parameter values in real time.

Every alpha call-up defined in the set-up database may be selected to visualize parameters in engineering units. The values are refreshed once per second.

Up to 20 alpha call-ups can be displayed (5 pages). If parameters from 2 systems are available, both parameters are displayed upon a single alpha call-up code entry.



CTC-239-090-00

ALPHA CALL-UP

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).
PARAMETER CALL-UP.

Menus.
This page provides a list of the menu titles, programmed through Ground Support Equipment (GSE) and available to the operator. Up to 20 menus can be programmed through GSE.

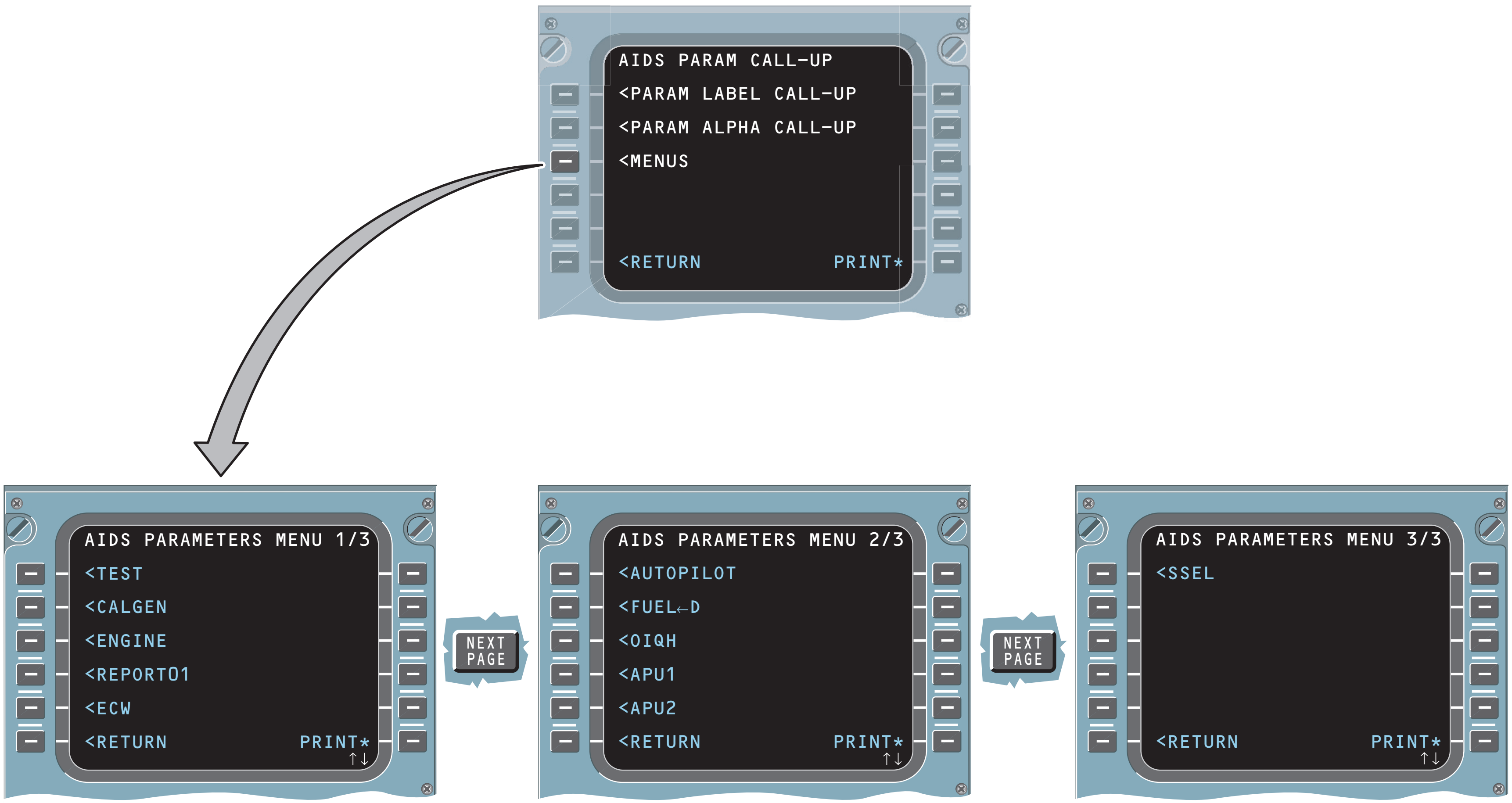
AIDS is supplied with 11 standard menus, spread over three pages. Airlines can choose to add other menus, or change the name of existing menus through GSE.

The 11 standard menus are :

Page 1 :
- Test.
- Calgen.
- Engine.
- Report01.
- ECW.

Page 2 :
- Autopilot.
- Fuel_D.
- OIQH.
- APU1.
- APU2.

Page 3 :
- SSEL.



CTC-239-091-00

PARAMETER MENUS

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Reports.

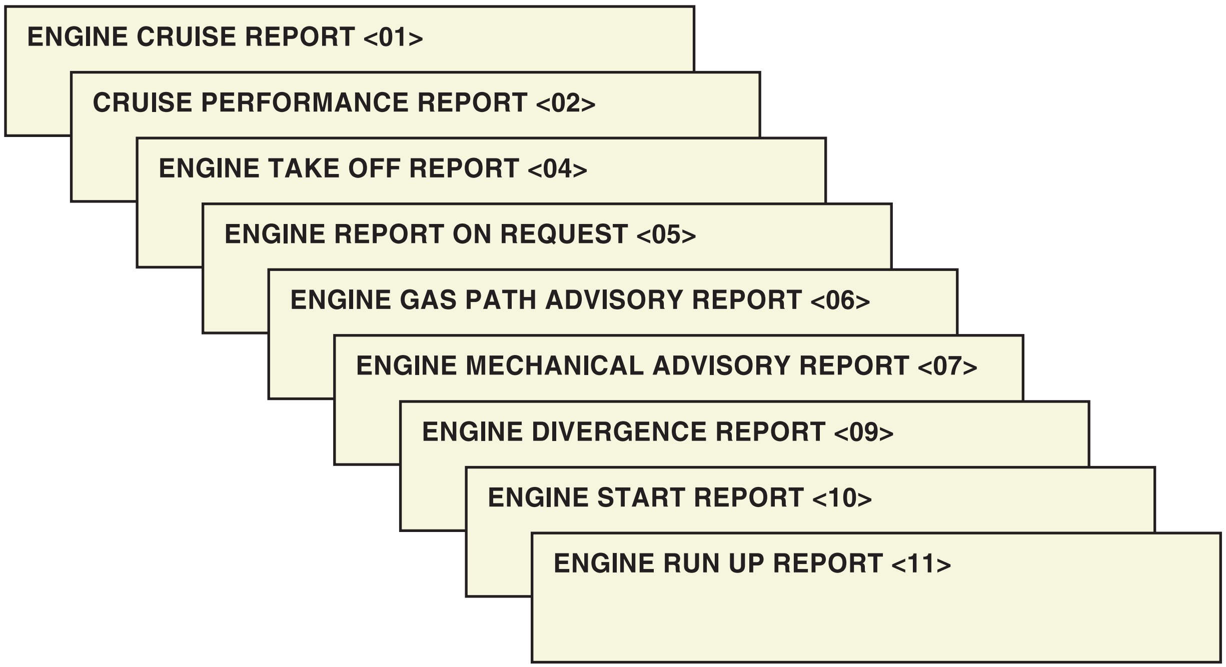
The data stored and processed in the DMU can be read in the form of printed reports, which are triggered and generated when specific conditions are met.

A report is a comprehensive set of data related to a specific event (e.g. limit exceedance of engine parameters).

The reports are used in routine follow-up (Trend monitoring) and to provide information in the case of specific events.

Below, is a list of the reports which concern the engine :

- Engine cruise report <01>
- Cruise performance report <02>
- Engine take off report <04>
- Engine report on request <05>
- Engine gas path advisory report <06>
- Engine mechanical advisory report <07>
- Engine divergence report <09>
- Engine start report <10>
- Engine run up report <11>



CTC-239-092-00

AIDS REPORTS

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Engine cruise report <01>.

This report is a collection of data over a period of time in which the aircraft met the appropriate stability criteria.
The required stability period is 100 seconds (programmable value). Whatever the number of times the stability is detected, only one report is generated per flight leg.

If no stability is detected, then a report is generated with the following message in its last line :

NO STABLE FRAME CONDITION

The report mainly contains operating data of both engines, including vibration data.
All the data is an average over the required stability period, except :

- serial number, flight hours, running time, cycle.
- Autopilot status.
- Engine quality number used as stability indicator.
- Oil consumption from the previous flight.
- Engine vibration status word, engine control word, status of FADEC sensors.
- Data lines V3, V4, which are the averaged values taken from the last stable descent (last leg).
- Data lines V5, V6, which are the averaged values taken from the last stable climb (current leg).

Cruise performance report <02>.

This report is similar to the engine cruise report, except that the data is sampled for longer periods and more information is provided about the aircraft.

The following data is added :

- Aircraft quality number used as stability indicator.
- Inner cell fuel quantity.
- Elevator position.
- Corrected angle of attack and side slip angle.
- Last DMU calculated flight path acceleration and inertial vertical speed.
- Roll angle and body axis yaw rate (average).
- True heading, longitude and latitude positions.
- Wind speed and direction (average).
- Fuel temperature and density (average).
- Flight controls positions (average).

In addition, the trigger logic for this report differs from the engine cruise report and is performed independently (e.g. the required stability period can be different).

ENGINE 1 DATA LINE

ENGINE 2 DATA LINE

```
A320 ENGINE CRUISE REPORT <01>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC OCT26 172639 EGLL LFPG 0903

   PH CNT   CODE BLEED STATUS      APU
C1 06 01604 5000 48 0010 0 0100 45 X

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE N162 31027 298 801 5962 295 C31000
   ESN    EHRS  ERT   ECYC  AP QE
EC 779253 07856 08800 03625 73 22
EE 779254 07854 03766 03626 73
   N1   N1C  N2   EGT  FF   PS13
N1 0824 0824 0923 5852 1366 XXXXX
N2 0824 0824 0923 5949 1375 XXXXX

   P25   T25  P3   T3   T5   VSV VBV
S1 XXXXX 0694 1446 4247 XXXX 023 028
S2 XXXXX 0700 1464 4298 XXXX 024 029

   HPT LPT GLE PD TN  PT2   OIQH
T1 099 096 029 39 068 06351 0178
T2 099 096 019 44 050 06295 0180

   VN VL PHA PHT VC VH EVM
V1 07 04 156 233 01 00 0000C
V2 05 08 120 214 03 00 0000C

  STABLE DESCENT

   VN VL PHA PHT N1
V3 XX XX XXX XXX XXXX
V4 XX XX XXX XXX XXXX

   STABLE CLIMB

V5 XX XX XXX XXX XXXX
V6 XX XX XXX XXX XXXX

   OIP OIT ECW1  SSEL
V7 044 083 00061 2222222222511
V8 043 083 00081 2222222222111
```

ENGINE QUALITY NUMBER

```
A320 CRUISE PERFORMANCE REPORT <02>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC OCT26 172701 EGLL LFPG 0903

   PH CNT   CODE BLEED STATUS      APU
C1 06 01701 5000 48 0010 0 0100 45 X

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE N164 31033 298 802 5963 295 C31000
CN N165 31015 298 801 5963 295

   ESN    EHRS  ERT   ECYC  AP QA QE
EC 779253 07856 08800 03625 73 21 16
EE 779254 07854 03766 03626 73
   N1   N1C  N2   EGT  FF   PS13
N1 0823 0823 0922 5841 1361 XXXXX
N2 0823 0823 0923 5936 1370 XXXXX

   P25   T25  P3   T3   T5   VSV VBV
S1 XXXXX 0692 1442 4240 XXXX 023 029
S2 XXXXX 0698 1461 4291 XXXX 024 029

   HPT LPT GLE PD TN  PT2   OIQH
T1 099 096 029 39 068 06351 0178
T2 099 096 020 44 050 06294 0180

   VN VL PHA PHT VC VH EVM
V1 07 05 155 231 01 00 0000C
V2 05 08 119 215 03 00 0000C

  STABLE DESCENT

   VN VL PHA PHT N1
V3 XX XX XXX XXX XXXX
V4 XX XX XXX XXX XXXX

   STABLE CLIMB

V5 XX XX XXX XXX XXXX
V6 XX XX XXX XXX XXXX

   OIP OIT ECW1  SSEL
V7 044 083 00061 2222222222511
V8 043 083 00081 2222222222111

   WFQ   ELEV AOA  SLP  CFPG  CIVV
X1 02287 N001 0012 0000 N0008 N010
X2 02320 N004 0010 0000 N0008 N010

   RUDD RUDT AILL AILR STAB ROLL YAW
X3 0001 0013 N010 N006 N005 0003 N000

   RSP2 RSP3 RSP4 RSP5 FLAP SLAT
X4 0000 0000 0000 0000 0000 0000
X5 0000 0000 0000 0000 0000 0000

   THDG LONP  LATP WS  WD  FT   FD
X6 2825 E0131 N486 139 256 0141 XXXX
X7 2825 E0131 N486 138 256 0148 XXXX
```

A/C QUALITY NUMBER

A/C AND FLIGHT CONTROLS INFORMATION

CTC-239-093-00

ENGINE CRUISE REPORT - CRUISE PERFORMANCE REPORT

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Engine take off report <04>.

This report is generated while in the take off flight phase when the sum of the EGT for both engines is maximum. It is used to check the trend and the stress of the engines during take off.

One report is generated per leg (programmable frequency).

The report mainly contains data from both engines, including the maximum EGT (EGTM). The radio height (RALT), provided by radio altimeters 1 & 2, is also printed.

T/O delta N1 summary data.

The history of the difference between the maximum value of N1 (N1MX) and the actual N1 during previous take offs is provided for both engines. This data is calculated a few seconds after entry into the take off flight phase, independently from the report trigger.

Engine report on request <05>.

This report provides a snapshot of the engine parameters and is only generated on manual request.

Parameters for both engines are recorded at 1 second intervals, from 5 seconds before the request to 5 seconds after.

```
A320 ENGINE TAKE OFF REPORT <04>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC OCT26 170203 EGLL LFPG 0903

   PH CNT   CODE BLEED STATUS      APU
C1 05 01513 4000 54 0010 0 0100 53 X

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE 0192 01890 162 254 6143 289 C31000

   ESN    EHRS  ERT   ECYC  AP
EC 779253 07855 08799 03625 23
EE 779254 07854 03765 03626 23

   T/O DELTA N1 SUMMARY    EGTM
N1 02 00 00 01 00 01 00 00 7110
N1 02 00 00 01 00 01 00 00 7160

   N1   N1C  N2   EGT  FF   P3   N1MX
S1 0850 0850 0968 7110 3285 3117 0925
S2 0851 0851 0968 7160 3322 3155 0925

   T3   T25  T12 PO  T5   VSV VBV
T1 5075 1103 210 137 .... 015 023
T2 5130 1111 211 136 .... 015 024

   VN VL PHA PHT VC VH EVM
V1 .. 09 ... 252 .. 00 0000C
V2 .. 09 ... 224 .. 00 0000C

   OIP OIT O/F ECW1  ECW2  PSEL
V3 051 072 1 1 00060 00010 2225
V4 051 073 1 1 00080 00010 2221

   PT2   FT   HPT LPT RALT
X1 14578 0155 099 037 1530
X2 14593 0157 100 037 1528
```

TAKE-OFF DELTA N1 SUMMARY DATA

MAXIMUM EGT

MAXIMUM N1

RADIO HEIGHT

```
A320 ENGINE REPORT O/R <05>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC OCT04 161521 EGLL LFQQ 0819

   PH CNT   CODE BLEED STATUS      APU
C1 06 84904 2000 14 0010 0 0100 43 X

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE N247 35023 272 801 6635 327 C31000

   ESN    EHRS  ERT   ECYC  AP
EC 779253 07717 08642 03551 73
EE 779254 07716 03608 03552 73
   ECW2  ECW5  EVM
N1 00000 08000 0000C
N2 00000 08000 0000C

      PRE EVENT, 1 SEC INTERVALS

   N1   N1C  N2   EGT  FF   VN VC VH VL
S1 0845 0845 0924 6060 1284 07 01 00 03
T1 0846 0845 0925 6150 1317 06 02 00 06

S2 0845 0845 0923 6050 1305 06 01 00 04
T2 0845 0845 0925 6150 1322 06 02 00 06

S3 0845 0844 0923 6050 1288 06 01 00 04
T3 0845 0845 0925 6150 1314 06 02 00 06

S4 0844 0843 0923 6040 1292 07 01 00 04
T4 0844 0844 0924 6140 1311 06 02 00 06

S5 0843 0843 0923 6040 1294 06 01 00 04
T5 0843 0844 0924 6140 1315 06 02 00 07

  AT AND POST EVENT, 1 SEC INTERVALS

   N1   N1C  N2   EGT  FF   VN VC VH VL
S6 0843 0843 0923 6040 1289 06 01 00 04
T6 0843 0844 0924 6140 1307 06 02 00 07

S7 0843 0843 0923 6040 1278 07 01 00 04
T7 0843 0844 0924 6140 1314 06 02 00 07

S8 0843 0843 0923 6040 1292 07 01 00 04
T8 0843 0843 0924 6140 1311 06 02 00 07

S9 0842 0842 0922 6030 1285 06 01 00 04
T9 0843 0843 0923 6130 1307 06 02 00 07

S0 0842 0842 0922 6030 1284 06 01 00 04
T0 0842 0843 0923 6130 1308 06 02 00 07

V1 0843 0842 0922 6030 1285 07 01 00 04
X1 0843 0843 0923 6120 1302 06 02 00 07

   TAT  ALT   MN  BLEED STATUS      APU
C2 N247 35015 801 14 0010 0 0100 43 X
U
```

T - 5SEC

T - 4SEC

T - 3SEC

T - 2SEC

T - 1SEC

T = EVENT

T + 1SEC

T + 2SEC

T + 3SEC

T + 4SEC

T + 5SEC

CTC-239-094-00

ENGINE TAKE-OFF REPORT - ENGINE REPORT ON REQUEST

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Engine gas path advisory report <06>.

This report is generated by any of the following trigger conditions :

- Stall condition detected on one engine.
- Exceedance of one of the primary engine parameters (EGT, N1, N2) detected on one engine.
- Fuel shut-off valve closed in flight for at least 4 seconds on one engine.

3 sets of parameters for both engines are recorded at 6 second intervals before the event, 1 set at the event and 5 sets at 5 second intervals after the event.

Limit exceedance summary.

The following data provides a summary on the exceedance that occurred :

- E : Engine (1 or 2) on which the exceedance occurred.
- MAX : Maximum value (peak) of the exceeded parameter.
- LIM : Programmable limit that was exceeded.
- REF : N2 at stall detection (for all other exceedance, zeros are printed).
- TOL : Time over limit during report generation.
- TTP : Time to peak during report generation.

Engine mechanical advisory report <07>.

This report is generated when an exceedance of one of the following secondary engine parameters is detected on one engine :

- Engine oil temperature (OIT).
- Engine oil pressure (OIP).
- Vibrations of the engine LP rotor.
- Vibrations of the engine HP rotor.

The reason for the exceedance is displayed.

5 sets of parameters for one engine are recorded at 4 second intervals before the event, 12 sets at the event and 4 sets at 5 second intervals after the event.

The length of the pre-event and post-event intervals is programmable.

```
A320 ENGINE GAS PATH ADV REPORT <06>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC JUL26 122110 BGLL LFPG 0000

   PH CNT   CODE BLEED STATUS      APU
C1 07 12202 6000 45 0000 1 0000 53 1

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE 0470 00236 ... ... .... ... C31000

   ESN    EHRS  ERT   ECYC  AP TR
EC XXXXXX 07010 XXXXX 03235 00 10
EE 779254 07008 02807 03236 00 10

     LIMIT EXCEEDANCE SUMMARY

   E MAX  LIM  REF  TOL TTP Y1 Y2 PSEL
N1 1 0000 0000 0000 000 000 06 05 2225

 REASON: SHUT DOWN

       PRE EVENT, 06 SEC INTERVALS
   N1   N1C  N2   EGT  FF   P3   T3
S1 XXXX XXXX XXXX XXXX XXXX XXXX XXXX
T1 0000 0174 0000 1160 0000 0145 1085
   T5   P25   T25  PT2   ECW1  VSV VBV
V1 XXXX XXXXX XXXX XXXXX ..... XXX XXX
X1 .... ..... 0412 14562 00040 N56 N00

S2 XXXX XXXX XXXX XXXX XXXX XXXX XXXX
T2 0000 0174 0000 1160 0000 0145 1085
V2 XXXX XXXXX XXXX XXXXX ..... XXX XXX
X2 .... ..... 0416 14562 00040 N56 N00

S3 XXXX XXXX XXXX XXXX XXXX XXXX XXXX
T3 0000 0174 0000 1160 0000 0145 1085
V3 XXXX XXXXX XXXX XXXXX ..... XXX XXX
X3 .... ..... 0417 14562 00040 N56 N00
  AT AND POST EVENT, 05 SEC INTERVALS

S4 0000 0171 0000 0990 0000 0147 1185
T4 0000 0174 0000 1160 0000 0145 1085
V4 .... ..... 0283 14562 00040 N57 N02
X4 .... ..... 0418 14562 00040 N56 N00

S5 0000 0174 0000 0990 0000 0147 1180
T5 0000 0174 0000 1160 0000 0145 1085
V5 .... ..... 0425 14562 00040 N57 N02
X5 .... ..... 0418 14546 00040 N56 N00

S6 0000 0174 0000 0990 0000 0147 1185
T6 0000 0175 0000 1160 0000 0145 1080
V6 .... ..... 0500 14562 00040 N57 N02
X6 .... ..... 0420 14562 00040 N56 N00

S7 0000 0174 0000 0980 0000 0147 1180
T7 0000 0175 0000 1150 0000 0147 1085
V7 .... ..... 0543 14562 00040 N57 N02
X7 .... ..... 0426 14562 00040 N56 N00

S8 XXXX XXXX XXXX XXXX XXXX XXXX XXXX
T8 0000 0175 0000 1140 0000 0145 1085
V8 XXXX XXXXX XXXX XXXXX ..... XXX XXX
X8 .... ..... 0417 14562 00040 N56 N00

S9 XXXX XXXX XXXX XXXX XXXX XXXX XXXX
T9 0000 0175 0000 1150 0000 0147 1080
V9 XXXX XXXXX XXXX XXXXX ..... XXX XXX
X9 .... ..... 0420 14562 00040 N56 N00
```

T - 18SEC
T - 12SEC
T - 6SEC
T = EVENT
T + 5SEC
T + 10SEC
T + 15SEC
T + 20SEC
T + 25SEC

```
A320 ENGINE MECH ADV REPORT <07>
   A/C ID DATE  UTC    FROM TO   FLT
CC F-MISC MAY20 170242 LFPG EGLL 0725

   PH CNT   CODE BLEED STATUS      APU
C1 01 00000 1000 48 0000 1 0000 54 1

   TAT  ALT   CAS MN  GW   CG  DMU/SW
CE 0235 N0094 ... ... .... ... C31000

   ESN    EHRS  ERT   ECYC  AP ECW1
EC XXXXXX 06366 XXXXX 02973 00 .....
EE XXXXXX 06364 XXXXX 02974 00 .....

     LIMIT EXCEEDANCE SUMMARY

   E MAX LIM REF  TOL TTP EVM
N1 1 000 000 0000 000 000 0000C

 REASON:

       PRE EVENT, 04 SEC INTERVALS

   N1   N2   VN VC VH VL PHA PHT OIT OIP
S1 XXXX XXXX .. .. 00 00 ... 000 062 000
S2 XXXX XXXX .. .. 00 00 ... 000 062 000
S3 XXXX XXXX .. .. 00 00 ... 000 062 000
S4 XXXX XXXX .. .. 00 00 ... 000 062 000
S5 XXXX XXXX .. .. 00 00 ... 000 062 000

  AT AND POST EVENT, 05 SEC INTERVALS

   N1   N2   VN VC VH VL PHF PHT OIT OIP
S6 XXXX XXXX .. .. 00 00 ... 000 062 000
S7 XXXX XXXX .. .. 00 00 ... 000 062 000
S8 XXXX XXXX .. .. 00 00 ... 000 062 000
S9 XXXX XXXX .. .. 00 00 ... 000 062 000
S0 XXXX XXXX .. .. 00 00 ... 000 062 000
T1 XXXX XXXX .. .. 00 00 ... 000 062 000
T2 XXXX XXXX .. .. 00 00 ... 000 062 000
T3 XXXX XXXX .. .. 00 00 ... 000 062 000
T4 XXXX XXXX .. .. 00 00 ... 000 062 000
T5 XXXX XXXX .. .. 00 00 ... 000 062 000
T6 XXXX XXXX .. .. 00 00 ... 000 062 000
```

T - 20SEC
T - 16SEC
T - 12SEC
T - 8SEC
T - 4SEC
T = EVENT
T + 5SEC
T + 10SEC
T + 15SEC
T + 20SEC

CTC-239-095-00

ENGINE GAS PATH ADV REPORT - ENGINE MECH ADV REPORT

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Engine divergence report <09>.

This report is generated while in the climb, or cruise phases when, under stabilized conditions, any of the following engine divergence conditions is detected :

- EGT divergence exceeding a programmed threshold.
- Nacelle temperature (TN) divergence exceeding a programmed threshold.

The reason for the divergence is displayed (EGT, TN).

This report is intended to detect quick degradation in engine performance.

3 sets of parameters for both engines are recorded at 2 second intervals before the event, 1 set at the event and 3 sets at 2 second intervals after the event.

In addition, the following data is provided :

- E : Divergent engine (1 or 2).
- DIV : Absolute divergence value of EGT, or TN.
- REF : Reference delta value of EGT, or TN.

Engine start report <10>.

This report is generated in case of aborted engine start, or EGT exceedance.

The possible aborted start reasons are :

- Starter air valve, HP shut-off valve demand/position disagree.
- EGT overtemperature.
- Stall.
- No engine light off.
- Hung start.
- Illegal start sequence.
- Slow start.

3 sets of parameters for one engine are recorded at 5 second intervals before the event, 1 set at the event and 3 sets at 2 second intervals after the event.

The length of the pre-event and post-event intervals is programmable.

Note : The engine start report is also generated :

- every 25 engine cycles (programmable frequency).
- every flight leg for 5 consecutive flight legs from initialization (programmable number up to 9).

```
A320 ENGINE DIVERGENCE REPORT <09>
   A/C ID DATE  UTC     FROM TO    FLT
CC F-MISC MAY20 170250 LFPG EGLL 0725

   PH CNT   CODE BLEED STATUS       APU
C1 01 00000 1000 48 0000 1 0000 54 1

   TAT  ALT    CAS MN  GW    CG  DMU/SW
CE 0235 N0096 ... ... .... ... C31000

   ESN     EHRS  ERT   ECYC  AP VSV VBV
EC XXXXXX 06366 XXXXX 02973 00 XXX XXX
EE XXXXXX 06364 XXXXX 02974 00 XXX XXX

   E DIV  REF  K  ECW1  ECW2  PARA
N1 1 0000 0000 00 ..... ..... 000

 REASON:

     PRE EVENT, 2 SEC INTERVALS

   N1   N1C  N2   EGT  FF   TN
S1 XXXX XXXX XXXX XXXX XXXX 106      T - 6SEC
T1 XXXX XXXX XXXX XXXX XXXX 104

S2 XXXX XXXX XXXX XXXX XXXX 106      T - 4SEC
T2 XXXX XXXX XXXX XXXX XXXX 104

S3 XXXX XXXX XXXX XXXX XXXX 106      T - 2SEC
T3 XXXX XXXX XXXX XXXX XXXX 105

  AT AND POST EVENT, 2 SEC INTERVALS

   N1   N1C  N2   EGT  FF   TN
S4 XXXX XXXX XXXX XXXX XXXX 106      T = EVENT
T4 XXXX XXXX XXXX XXXX XXXX 105

S5 XXXX XXXX XXXX XXXX XXXX 106      T + 2SEC
T5 XXXX XXXX XXXX XXXX XXXX 105

S6 XXXX XXXX XXXX XXXX XXXX 106      T + 4SEC
T6 XXXX XXXX XXXX XXXX XXXX 105

S7 XXXX XXXX XXXX XXXX XXXX 106      T + 6SEC
T7 XXXX XXXX XXXX XXXX XXXX 105
```

```
A320 ENGINE START REPORT <10>
   A/C ID DATE  UTC     FROM TO    FLT
CC F-MISC OCT22 202009 EGLL LFBO 0807

   PH CNT   CODE BLEED STATUS       APU
C1 11 98910 6000 00 0000 1 0000 00 1

   TAT  ALT    CAS MN  GW   CG  DMU/SW
CE 0297 00093 ... ... 7698 319 C31000

   ESN    EHRS  ERT   ECYC  AP Y1 Y2
EC 779253 07824 08764 03613 00 05 02
EE 779254 07823 03731 03614 00

    LIMIT EXCEEDANCE SUMMARY

   E MAX  LIM  TOL TTP TTF FF   PD SM
N1 1 4110 0000 031 035 018 0181 19 0

 REASON:

       PRE EVENT, 05 SEC INTERVALS

   N1   N2   EGT  FF   FMV T25  PD
S1 0000 0149 0800 0000 999 0567 28        T - 15SEC

   P3   T3   VSV VBV T5   OIT ECW5
T1 0152 1120 386 390 .... 052 0000D

S2 0010 0206 0820 0000 999 0513 28        T - 10SEC
T2 0155 1050 386 390 .... 053 0000D

S3 0023 0253 0990 0181 030 0473 29        T - 5SEC
T3 0170 1000 386 389 .... 052 00005

S4 0053 0330 2000 0248 064 0445 30        T = EVENT
T4 0195 1005 386 389 .... 053 00005

  AT AND POST EVENT, 02 SEC INTERVALS

S5 0091 0415 3180 0342 088 0420 30        T + 2SEC
T5 0230 1045 373 389 .... 054 00005

S6 0106 0451 3590 0370 100 0410 29        T + 4SEC
T6 0247 1070 370 389 .... 055 00005

S7 0121 0490 3940 0402 112 0403 29        T + 6SEC
T7 0277 1115 359 389 .... 055 00005

S8 0140 0528 4250 0427 121 0398 25
T8 0307 1180 347 385 .... 055 00001

S9 0160 0563 4500 0451 132 0396 20
T9 0342 1255 336 383 .... 055 00001

S0 0180 0603 4690 0479 138 0393 22
T0 0387 1335 324 382 .... 055 00001

U1 0194 0626 4630 0358 078 0390 24
V1 0385 1415 315 382 .... 055 00000

U2 0191 0620 4390 0288 065 0383 26
V2 0372 1445 317 382 .... 056 00000

 0372 1445 317 382 .... 056 00000
```

CTC-239-096-00

ENGINE DIVERGENCE REPORT - ENGINE START REPORT

THE AIRCRAFT INTEGRATED DATA SYSTEM (AIDS).

Engine run up report <11>.

This report is primarily generated on manual request. It contains the same data as the engine cruise report <01>, plus corrected parameters for the ambient temperature.

The data is an average over 20 seconds with the exception of :

- A/C serial number.
- Flight hours with dedicated engine, cycles, control word and vibration status.
- A/C running time with dedicated engine.
- Status of FADEC sensors.
- Oil quantity.

```
A320 ENGINE RUN UP REPORT <11>

   A/C ID DATE  UTC     FROM TO    FLT
CC F-MISC SEP04 131016 LFBO LFBO 2924

   PH CNT   CODE BLEED STATUS      APU
C1 02 00000 1000 56 0000 1 0000 56 1

   TAT  ALT    CAS MN   GW    CG  DMU/SW
CE 0217 00277 ... ... 4838 201 C33057

   ESN     EHRS  ERT    ECYC  AP
EC 779805 00006 00009 00006 00
EE 779806 00006 00009 00006 00

   N1   N1C  N2   EGT  FF    PS13
N1 0737 0737 0928 6034 2312 .....
N2 0600 0600 0881 5644 1606 .....

   P25    T25  P3    T3   T5    VSV VBV
S1 ..... 0883 2462 4543 .... 037 042
S2 ..... 0636 1786 3853 .... 018 013

   HPT LPT GLE PD TN  PT2
T1 099 036 000 20 093 14621
T2 082 037 000 18 088 14550

   VN VL PHA PHT VC VH EVM
V1 08 06 091 158 02 00 00000
V2 06 09 142 266 01 00 00000

   OIP OIT ECW1  SSEL
V3 046 075 00060 22222222222111
V4 047 079 00080 22222222222111

   EGTK N1K  N2K  FFK
X1 5881 0728 0916 2288
X2 5500 0592 0870 1589
```

CORRECTED PARAMETER

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ENGINE RUN UP REPORT

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