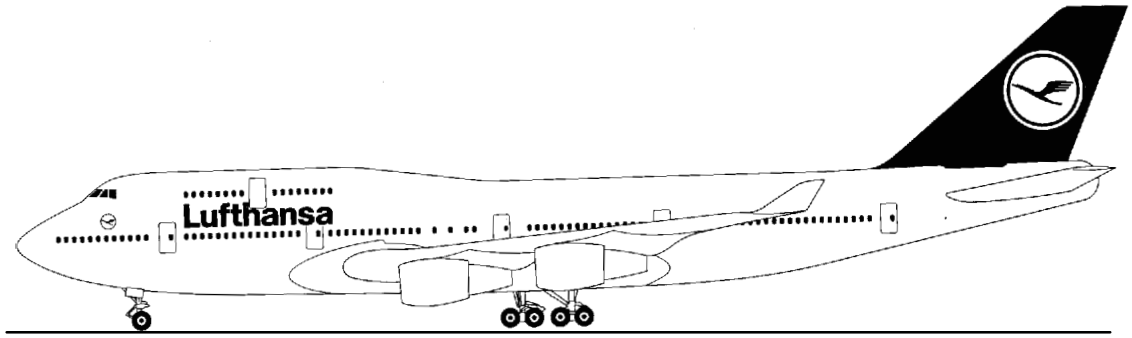
Lufthansa Technical Training

Training Manual B 747-400



ATA 34-61 FMCS

ATA Spec. 104 Level 3

Book No:

Lufthansa
Technical Training GmbH
Lufthansa Base

Issue: May 2001

Lufthansa Technical Training

Lufthansa Technical Training GmbH

Lufthansa Base Frankfurt

D-60546 Frankfurt/Main

Tel. +49 69 / 696 41 78

Fax +49 69 / 696 63 84

Lufthansa Base Hamburg

Weg beim Jäger 193

D-22335 Hamburg

Tel. +49 40 / 5070 24 13

Fax +49 40 / 5070 47 46

ATA 34-61 FLIGHT MANAGEMENT COMPUTER SYSTEM

FMCS - INTRODUCTION

General

The flight management computer system (FMCS) does many functions and calculations which reduce crew workload. The major functions are:

- Flight plan map display
- Automatic navigation/radio tuning
- Thrust Management
- Lateral guidance (LNAV)
- Vertical guidance (VNAV)

Flight Plan Map Display

The FMCS does calculations which allow the flight crew to monitor airplane movement along the flight plan. The FMCS shows this data on the ND in the map and plan formats. The FMCS can also show additional data from the navigation data base on the map displays.

Automatic Navigation/Radio Tuning

The FMCS automatically tunes navigation radios (VOR, DME, ILS) along the route.

The FMCS calculates airplane position with inertial and radio data.

ADF receivers are tuned manually through the CDU.

Thrust Management

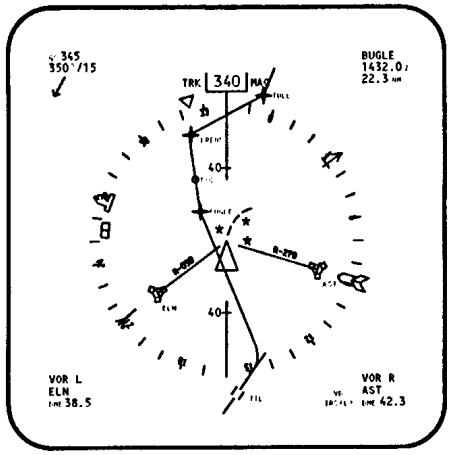
The FMCS moves the thrust levers to control the thrust of the engines. The FMCS also computes thrust limits and sends engine trim equalization commands to the electronic engine controls.

Lateral Guidance

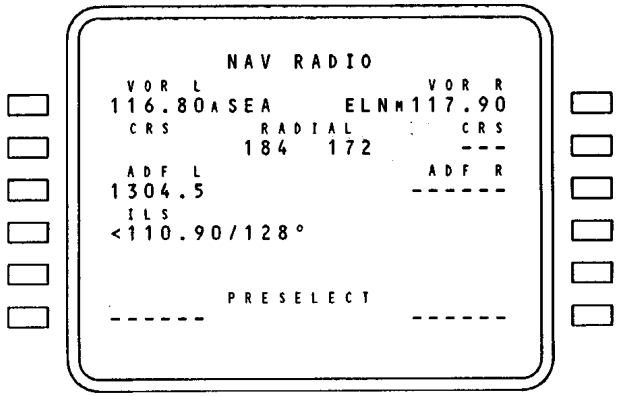
The FMCS gives lateral guidance to fly the airplane from point to point along the route.

Vertical Guidance/Performance

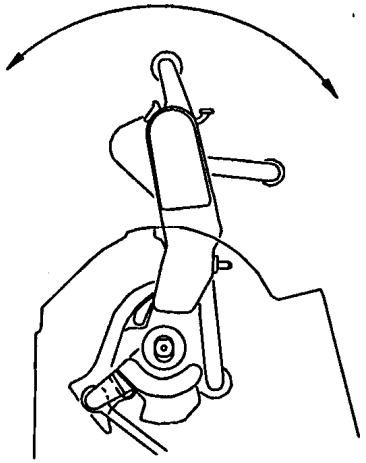
The FMCS gives vertical guidance to fly the airplane on the most economical path. Performance calculations provide predictions of flight data along the route.



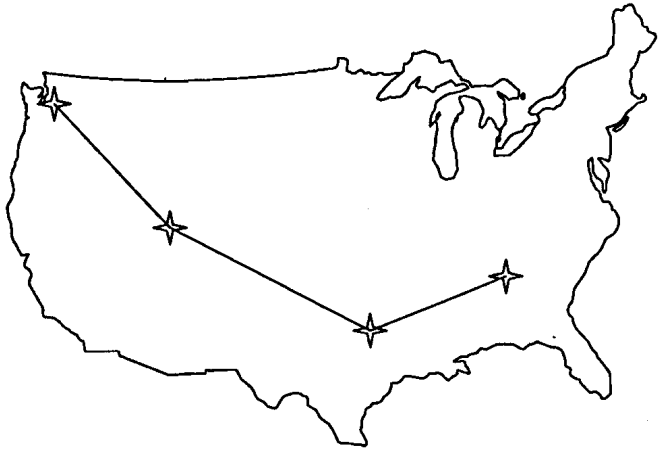
FLIGHT PLAN
MAP DISPLAY



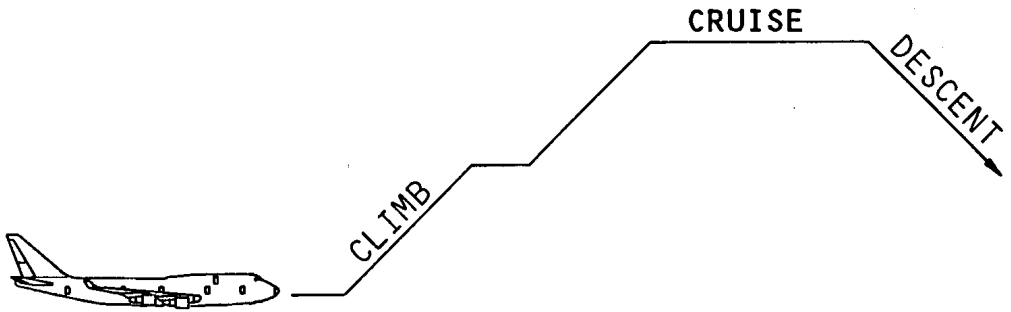
AUTOMATIC NAVIGATION/
RADIO TUNING



THRUST MANAGEMENT



LATERAL GUIDANCE
(LNAV)



VERTICAL GUIDANCE/PERFORMANCE
(VNAV)

Figure 1 FMCS - INTRODUCTION

FANS 1 - INTRODUCTION

The flight management computer system (FMCS) has been upgraded to install the first stage of the future air navigation system (FANS1). FANS 1 adds these new features to the 747-400:

- Air traffic control data link
- Air traffic services facilities notification
- Airline operational communications
- Printer interface
- Automatic dependent surveillance
- Required time of arrival
- Global positioning system
- Required navigation performance

FANS 1 can improve en-route operations in non-radar surveillance areas. Benefits of this system are:

- Reduced separation requirements
- Flexible tracks
- Improved response for altitude and route change requests
- Avoidance of altitude loss for crossing tracks
- Improved availability of alternate airports

The improved communications capability of the FMCS is based on an ARINC communications addressing and reporting system (ACARS) and a satelite communications system (SATCOM). This lets the flight crew use the air traffic services facilities notification function (AFN) to logon to an ATC center. Messages can be sent or received for clearance data. Airline operational communications (AOC) messages can be sent to or received from airline operations for flight and route data.

Automatic dependent surveillance (ADS) lets ATC or the airline contract for flight data reports without the need for flight crew action.

The required time of arrival (RTA) gives ATC better control of aircraft.

Improved navigational capability, and possible additional alternate airports, are gained with the installation of a Global positioning system (GPS). Required/actual navigation performance calculations ensure the accuracy of the total navigation system.

- AIR TRAFFIC CONTROL DATA LINK
- AIR TRAFFIC SERVICES FACILITIES NOTIFICATION
- AIRLINE OPERATIONAL COMMUNICATION DATA LINK
- AUTOMATIC DEPENDENT SURVEILLANCE
- REQUIRED TIME OF ARRIVAL
- GLOBAL POSITIONING SYSTEM
- PRINTER INTERFACE
- REQUIRED NAVIGATION PERFORMANCE

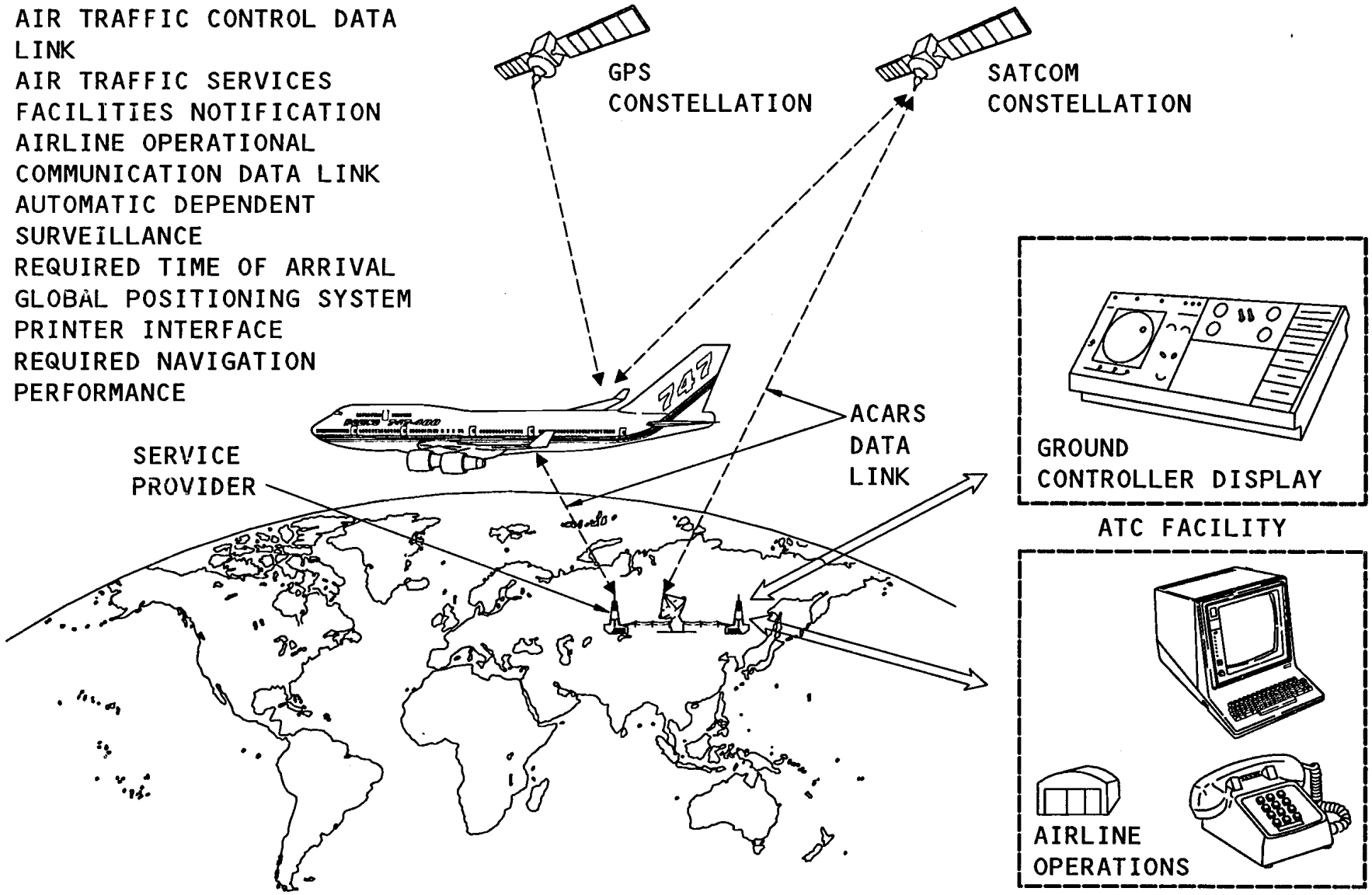


Figure 2 FANS 1 - INTRODUCTION

FLIGHT MANAGEMENT COMPUTER SYSTEM

General

The dual FMCS performs these major functions based on inputs from the flight crew through the CDU and data from external sensors:

- Performance calculations
- Guidance (LNAV and VNAV steering commands)
- Thrust management (autothrottle, thrust limits, and engine trim)
- Navigation/radio tuning
- EFIS map display
- Data link
- BITE

The FMC also uses stored data to assist in calculation of lateral, vertical and thrust commands that control the airplane along the active route. The airborne data loader interfaces with the FMCS to update the stored data.

CDU

The control display unit (CDU) is the primary interface between the flight crew and the FMC. If both of the FMCS fail, the CDU performs these backup functions:

- Alternate navigation-using inputs from the IRUs
- Alternate navigation radio tuning

The CDU may also be selected as the source for the map displays. This map is based on the last FMC update and can be selected at any time.

The CDU performs alternate EFIS/EICAS control panel functions when the EFIS control panel input fails.

Other systems also use the CDU as an interface to the flight and maintenance crews.

FMC

The FMC stores the following data:

A navigation (NAV) data base which contains data on items such as airports, procedures, waypoints and navaids. From this data base the FMC selects reference data to assist in calculations of present position and lateral guidance to the flight plan. This data base is updated every 28 days.

A performance data base which contains models of the airplane and engine characteristics. From this data base the FMC selects reference data to assist in calculation of flight path projection and vertical guidance to the flight plan.

An operational program that determines which sensors are used for calculations and how the calculations are done.

An airline policy file (APF) which sets customer options for the FMCS. The APF is loaded along with the NAV data base.

Autothrottle Servomotor Generator

The autothrottle servomotor receives commands from the FMC to move the thrust levers. The generator and EECs provide feedback.

FMC Master Relays

A switch in the flight deck controls the FMC master relays. The position of the relays determine which FMC sends outputs to the:

- Engine electronic controllers (EEC) for the engine trim function
- Flight control computers (FCC) for autopilot/flight director commands
- Mode control panel (MCP) for mode status and speed data
- Nav Radios for radio tuning

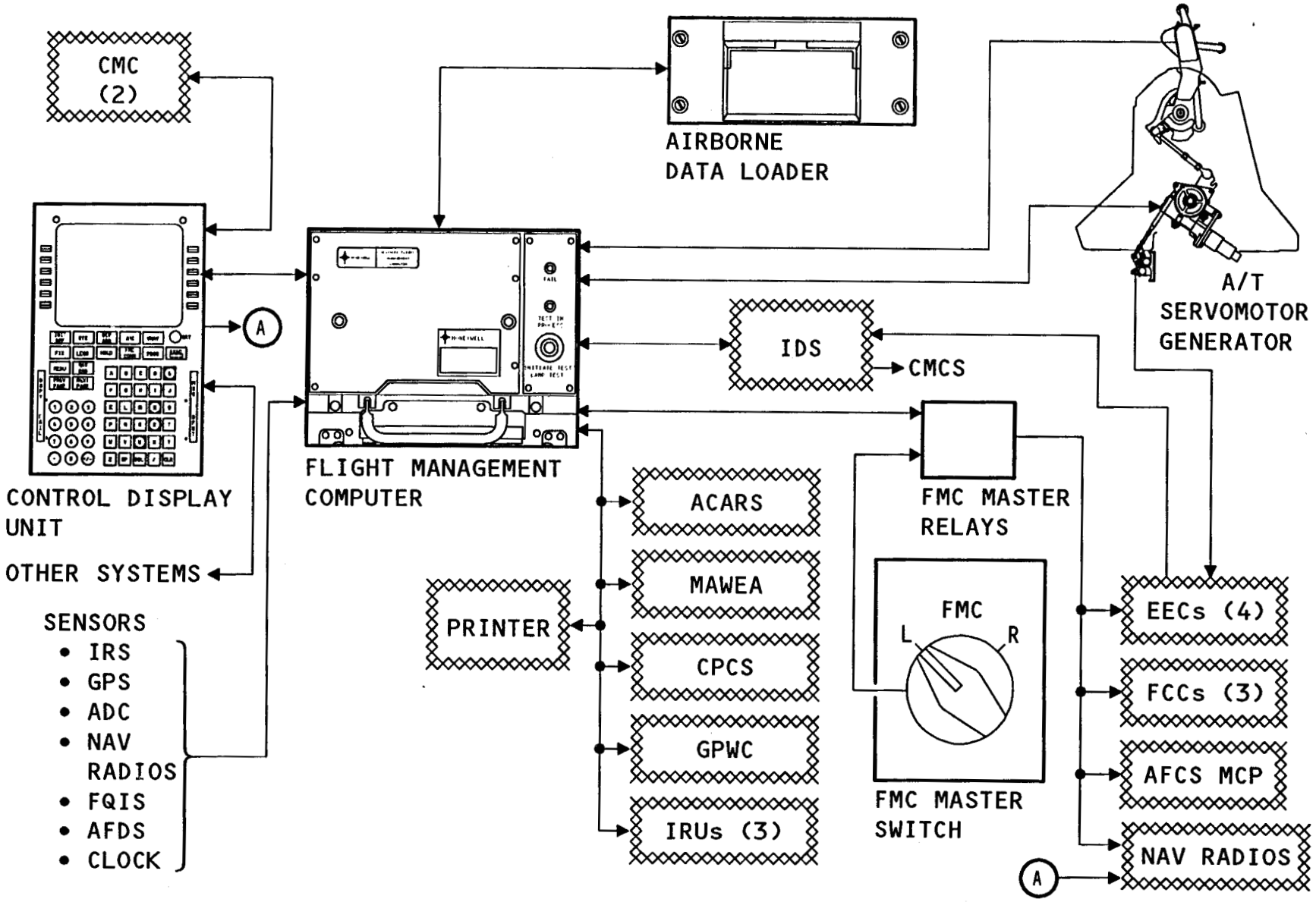


Figure 3 FLIGHT MANAGEMENT COMPUTER SYSTEM

FLIGHT DECK COMPONENT LOCATIONS - 1

Captain's Main Instrument Panel (P1)

These are the components on P1:

- Left inboard IDU (ND)
- Left outboard IDU (PFD)
- Captain's instrument source select switches
- CDU active port select isolation diode (behind panel)

Forward Electronics Panel (P9)

These are the components on P9:

- Right CDU
- Lower IDU (EICAS/ND)
- Left CDU

Aft Electronics Panel (P8)

The center CDU is on P8.

First Officer's Main Instrument Panel (P3)

These are the components on P3:

- Right inboard IDU (ND)
- Right outboard IDU (PFD)
- First officer's instrument source select switches
- CDU active port select isolation diode (behind panel)

Autoflight Control Panel (P10)

These are the components on P10:

- Left EFIS control panel
- Right EFIS control panel
- AFCS mode control panel

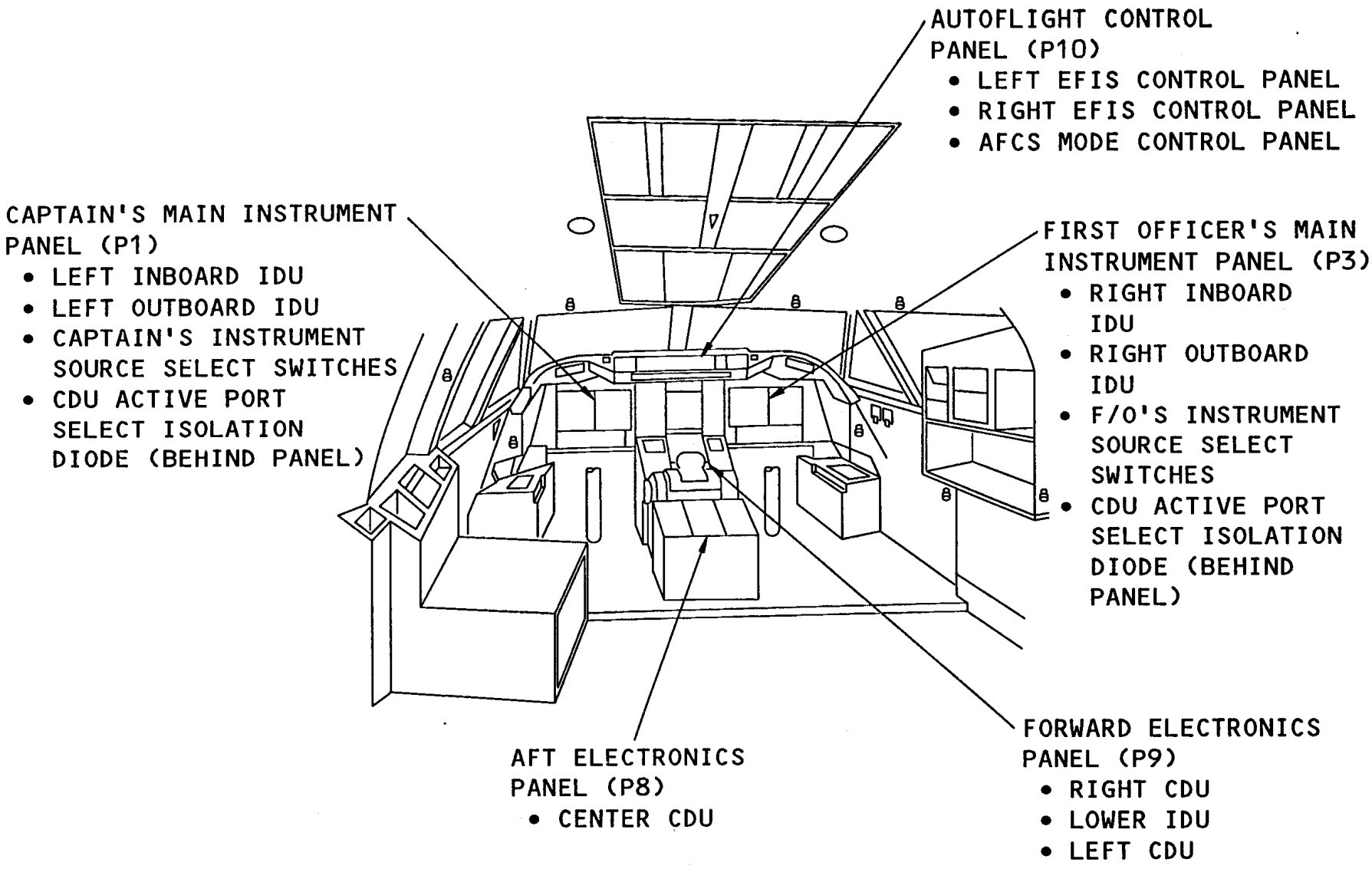


Figure 4 FLIGHT DECK COMPONENT LOCATIONS - 1

FLIGHT DECK COMPONENT LOCATIONS -2

Control Stand

The autothrottle servomotor generator is below the control stand and accessible from the right side. The thrust levers have switches for autothrottle disconnect/reset and go-around (TO/GA).

First Observer's Console Panel (P11)

These are the components on P11:

- Data loader control panel
- Airborne data loader
- Diskette storage case

Pilots' Center Instrument Panel (P2)

These are the components on P2:

- FMC master switch
- HEADING REF switch
- Upper IDU (EICAS)

Main Power Distribution panel (P6)

The data loader circuit breaker is on P64.

Overhead Circuit Breaker Panel (P7)

These FMCS circuit breakers are on P7:

- FMC left
- CDU left
- CDU center
- A/T servo excitation
- Auto flight warning
- FMC right
- CDU right
- A/T servo right
- FMC master switch

Aft Electronics Panel (P8)

The printer is on the P8.

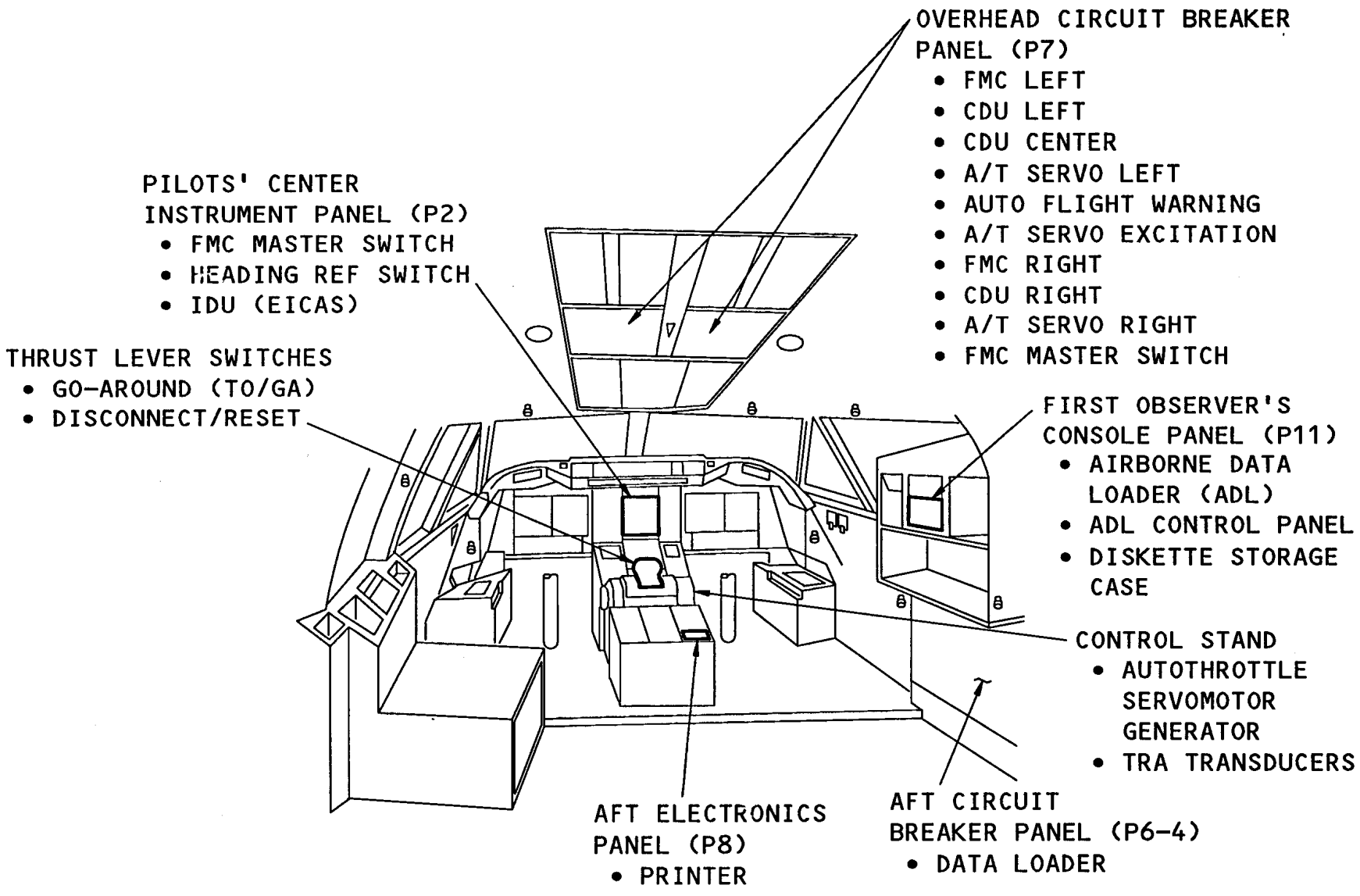


Figure 5 FLIGHT DECK COMPONENT LOCATIONS -2

MEC COMPONENT LOCATIONS

These are the FMCS components in the main equipment center (MEC):

- Left and right FMC
- Numbers 1, 2, and 3 FMC master relays

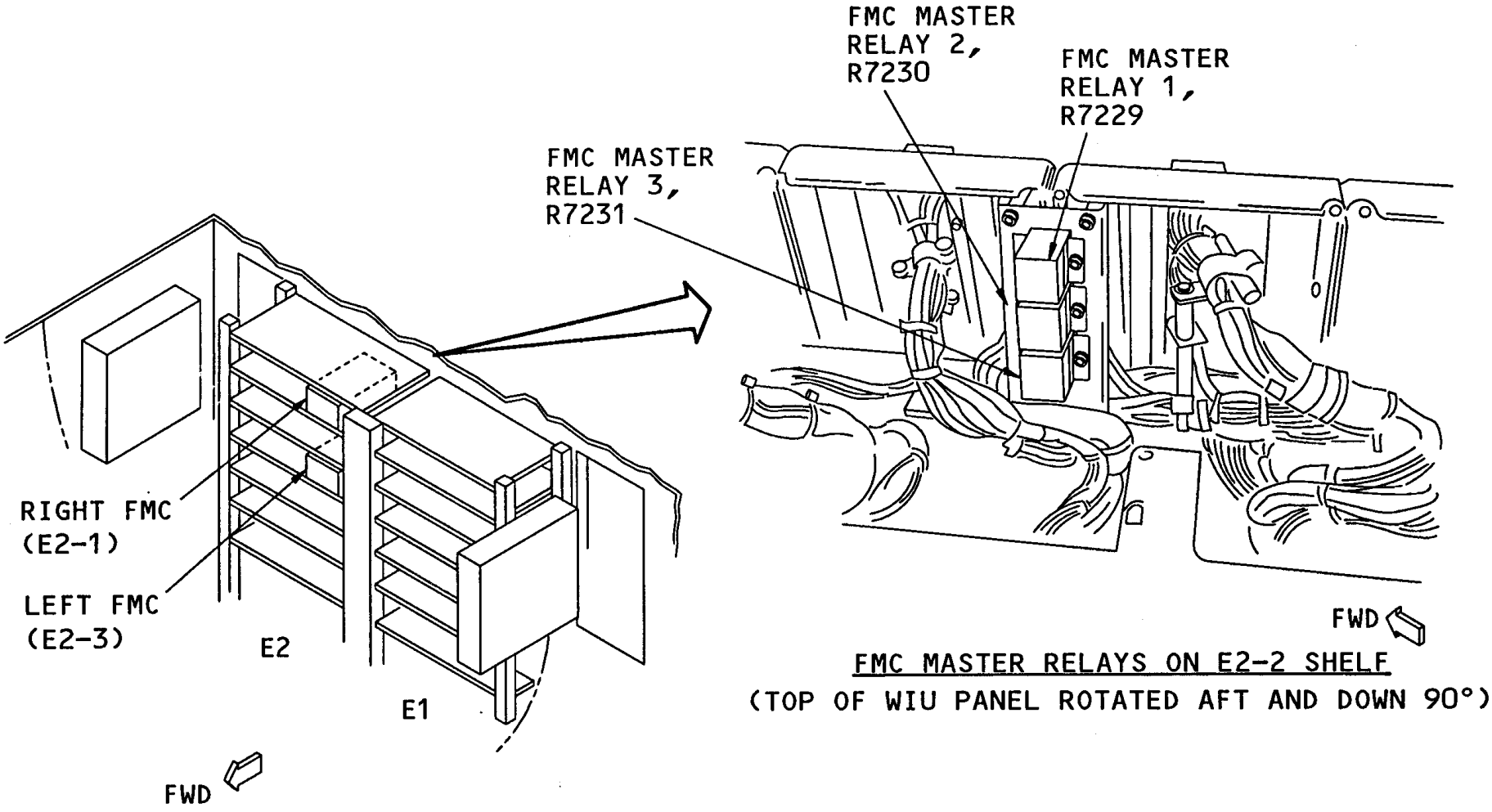


Figure 6 MEC COMPONENT LOCATIONS

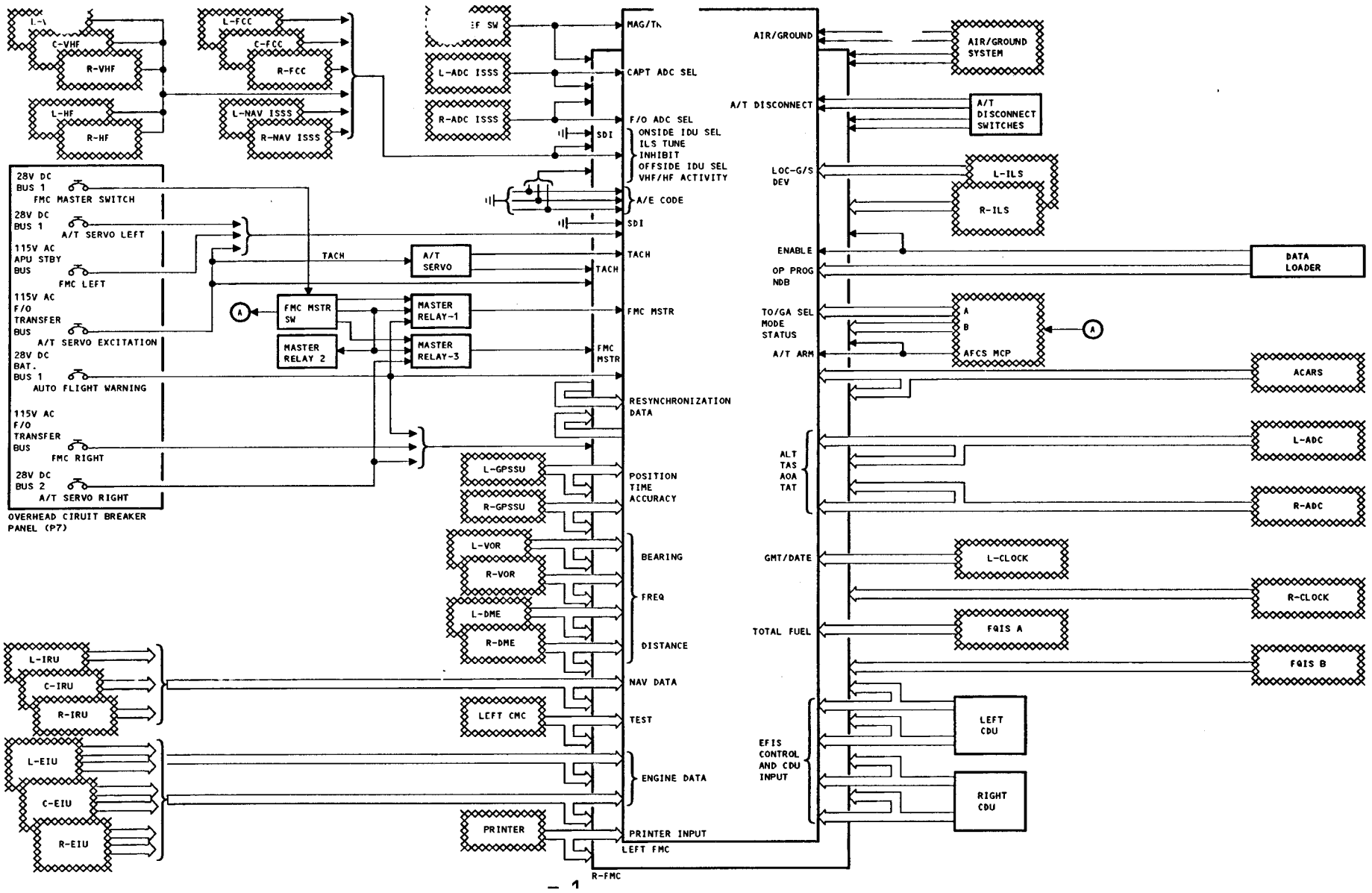


Figure 7 FMC INPUTS INTERFACE DIAGRAM - 1

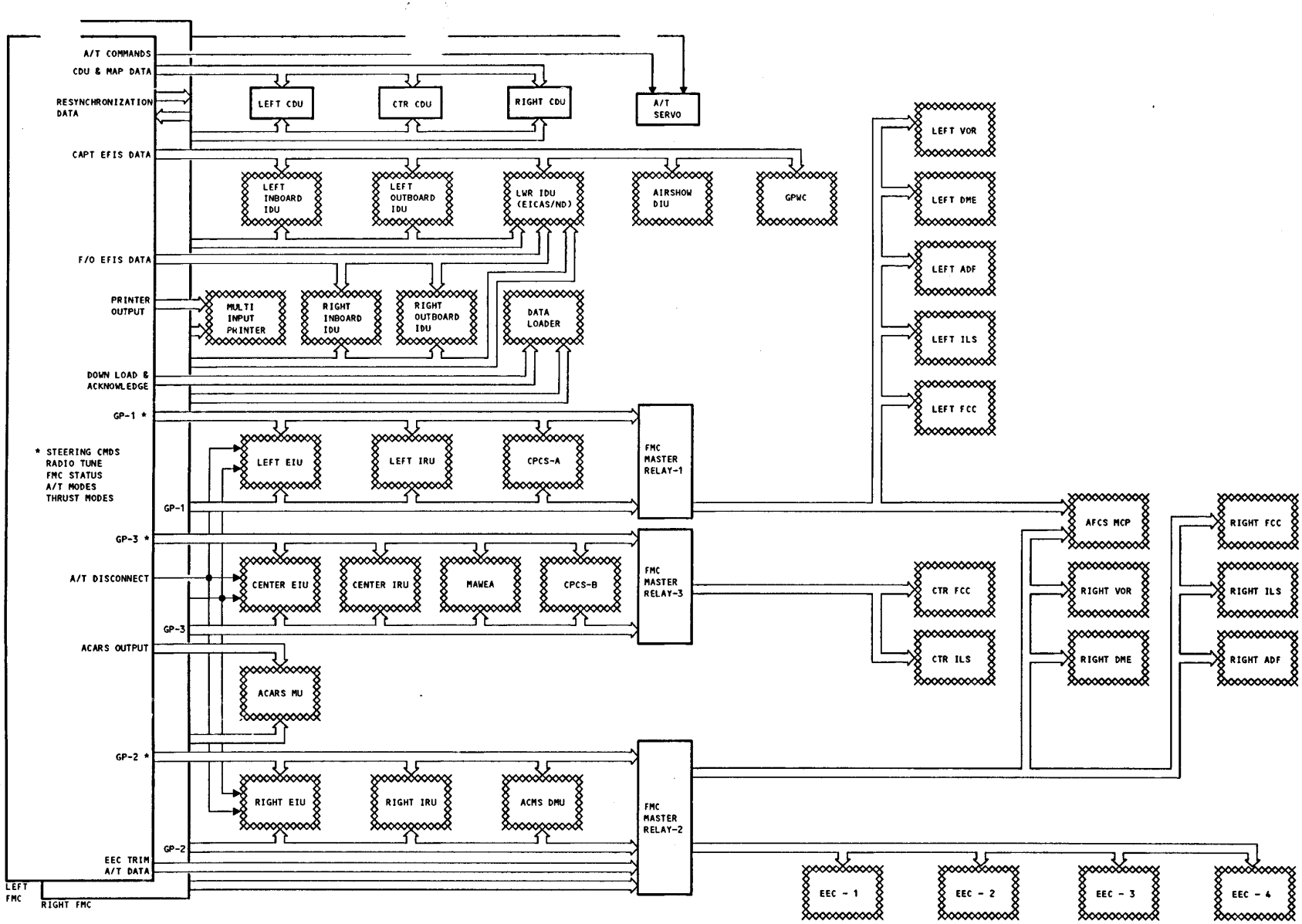


Figure 8 FMC OUTPUTS INTERFACE DIAGRAM - 2

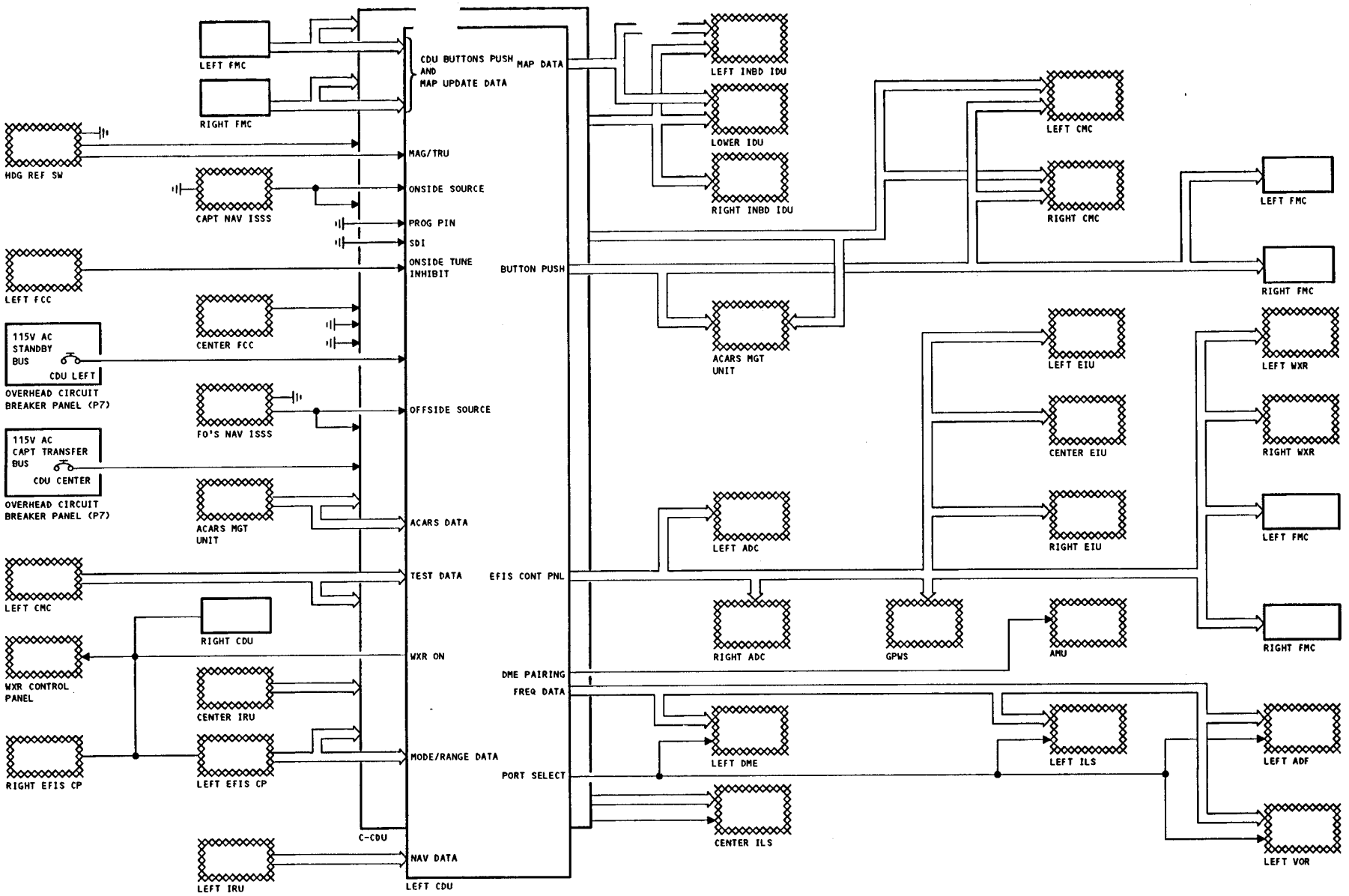


Figure 9 CDU INPUT/OUTPUTS - INTERFACE DIAGRAM - 1

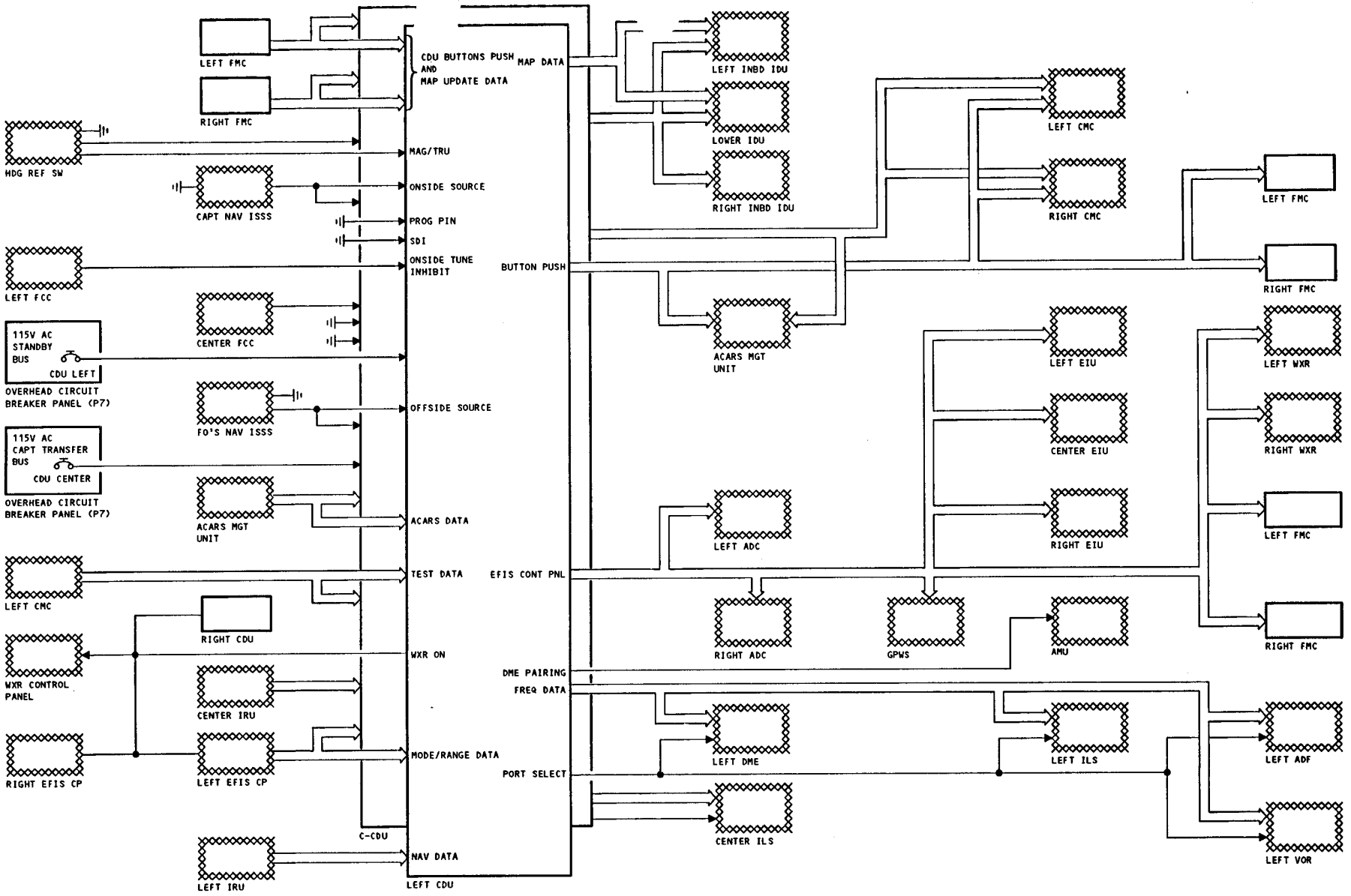


Figure 10 CDU INPUT/OUTPUTS - INTERFACE DIAGRAM - 1

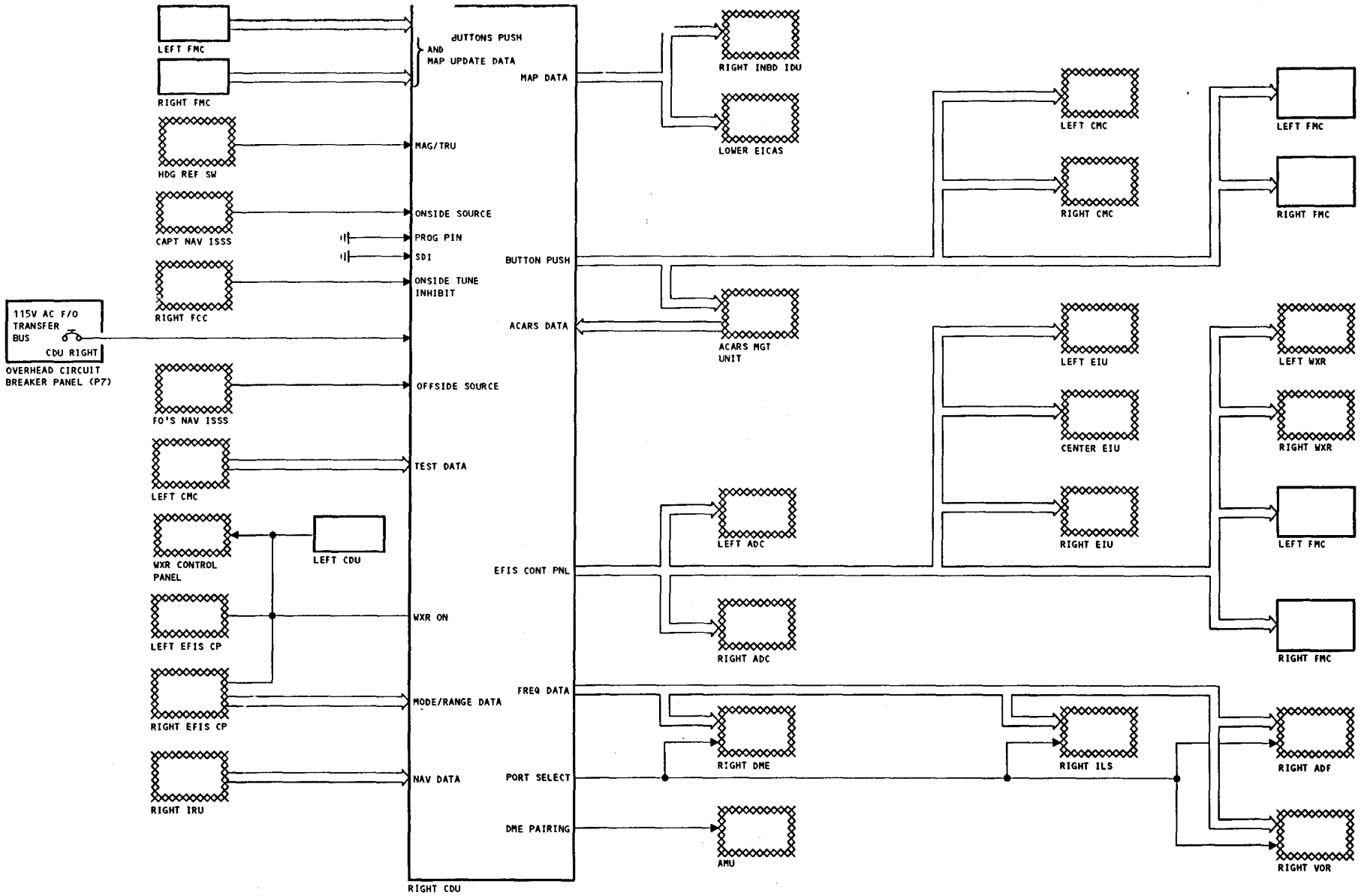


Figure 11 CDU INPUT / OUTPUTS - INTERFACE DIAGRAM - 2

FMCS - POWER

The APU standby bus (115v ac) sends power to the left FMC and the first officer's transfer bus sends power to the right FMC. From this, the FMC power supply produces the power needed for calculation, logic, and control.

Servo tachometer excitation comes directly from the first officer's transfer bus. Servo motor excitation comes from the same bus but through the FMC selected as master.

Bus 1 and bus 2, 28v dc provide autothrottle drive power. The 28v dc from the battery bus supplies power for the warning circuits in the FMCs.

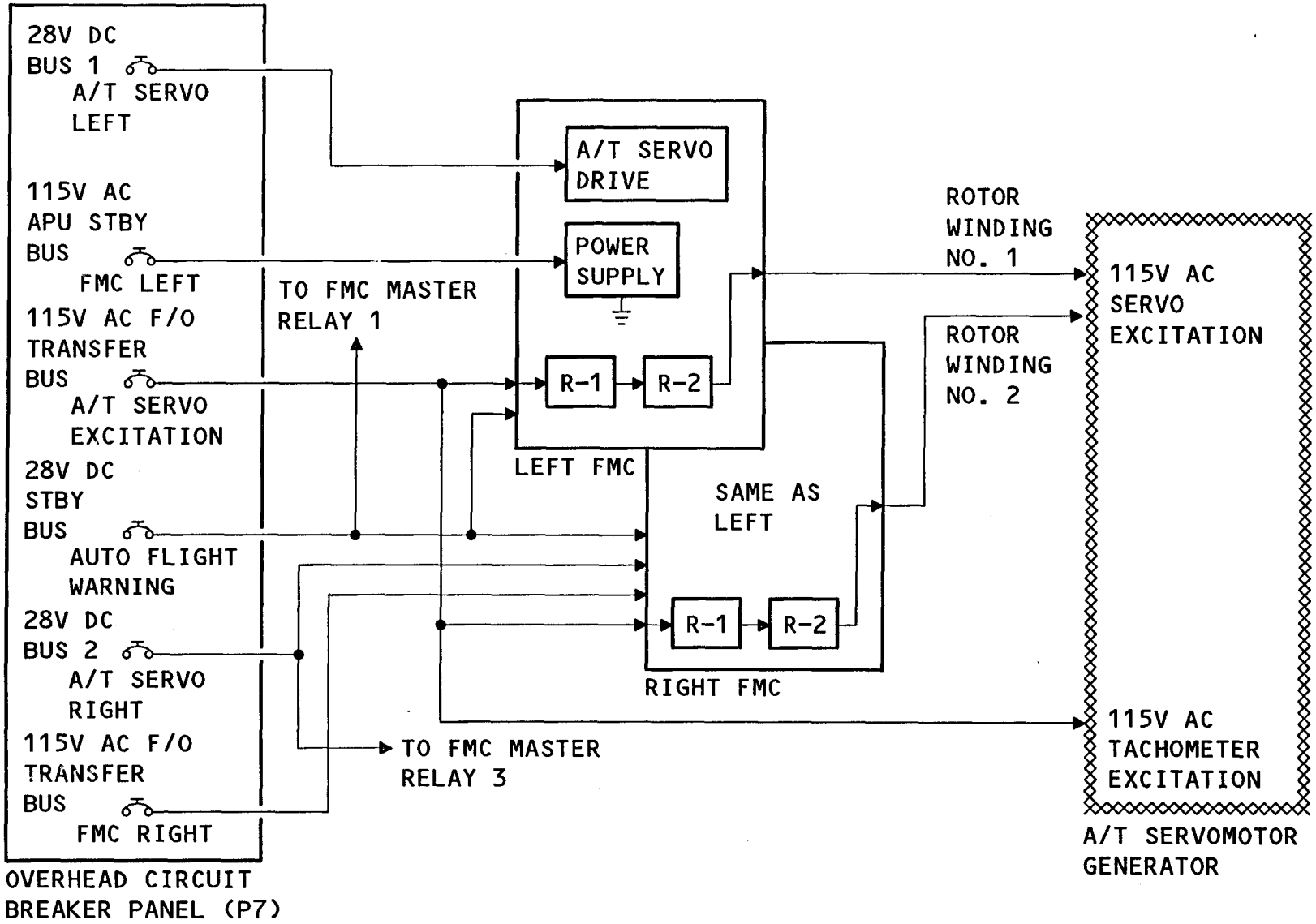


Figure 12 FMCS - POWER

MASTER RELAY & A/T ARM POWER

The FMC master relays are energized by the FMC master switch from 28v dc bus 1, if the FMC master switch is in the R position.

The autothrottle arm voltage goes through both the FMC master switch and master relay. This is to make sure that the switch and relay are in the same position. If the associated master relay is not in the same position as the master switch, the autothrottle can not be armed.

The L-FMC master logic power is through the deenergized closed contacts of master relay 1. The R-FMC master logic is through the deenergized open contacts of master relay 3. When the right FMC is selected as master the master relays are energized. The L-FMC loses 28v dc (master logic) and the R-FMC gets 28v dc (master logic) through the main energized-contacts of master relay 3.

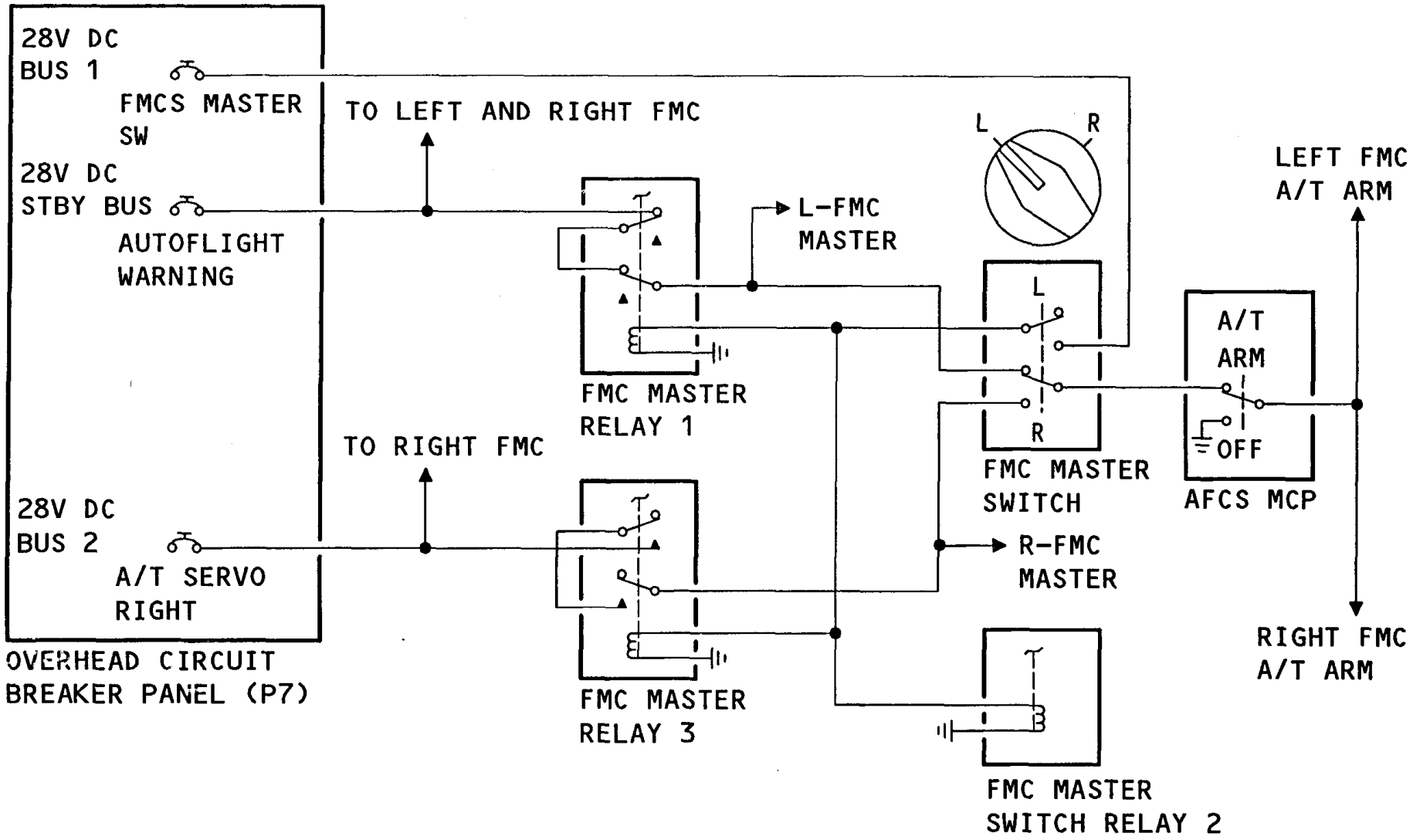


Figure 13 MASTER RELAY & A/T ARM POWER

CDU AND DATA LOADER POWER

The standby bus, captain's AC transfer bus and the first officer's transfer bus supply power to the three control display units.

Bus-1 sends power to the airborne data loader. The power line goes through the data loader control panel.

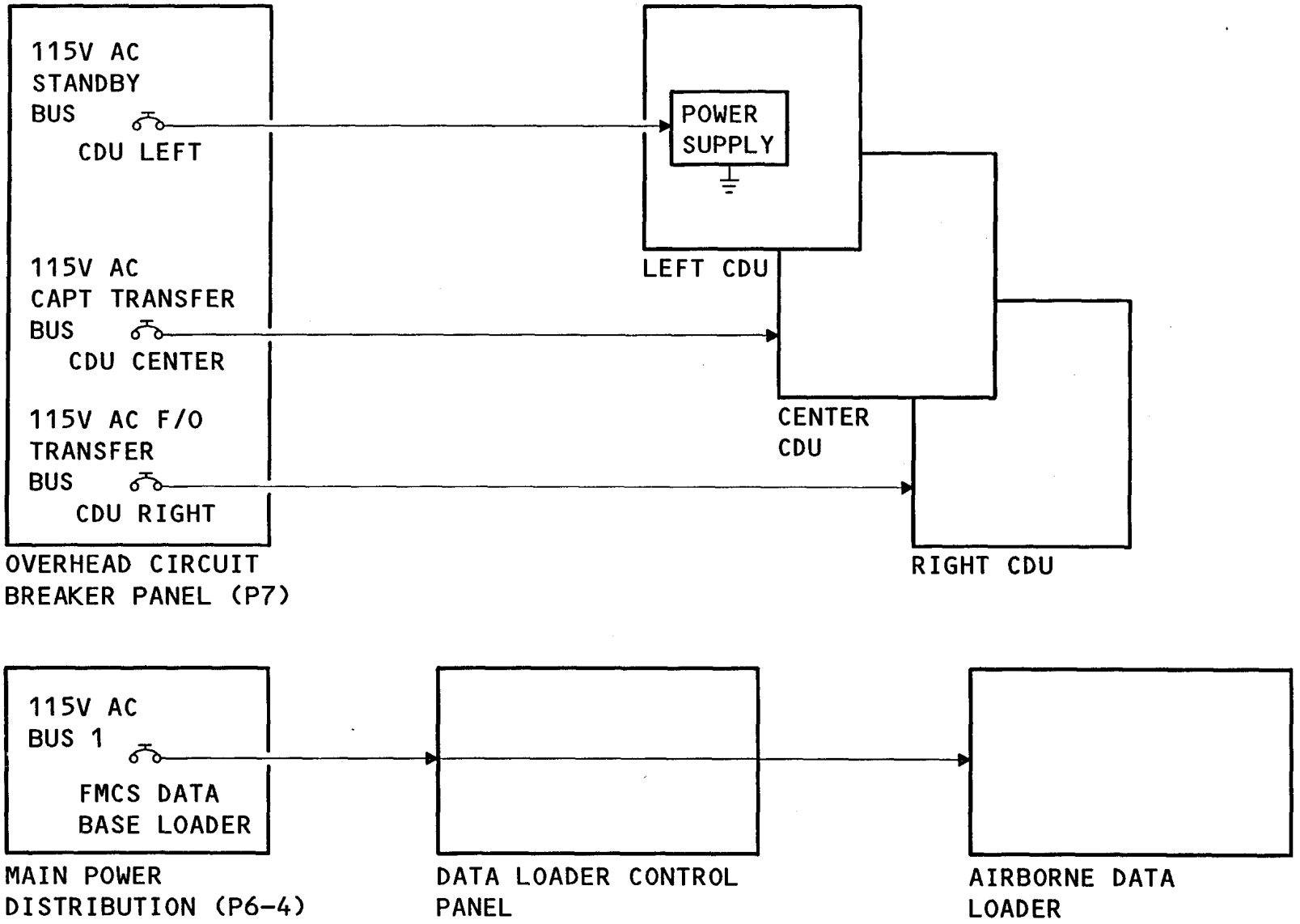


Figure 14 CDU AND DATA LOADER POWER

INTERSYSTEM DATA

General

The basic FMCS consists of two flight management computers (FMCs) and three control display units (CDU). The two FMCs process data sequentially as it is received from the CDUs. The left and right CDUs are independent and can display different pages at the same time. The center CDU receives data from the FMCs, but cannot send data to the FMCs.

Button Push Master

Button pushes from the CDUs to the FMCs are processed in such a way as to prevent the FMCs from duplicating certain computations. In a normal dual system configuration, the left FMC is the button push master. All button pushes from either the left or right CDU are first processed by the left FMC. The left FMC passes the button push data through the intersystem bus to the right FMC. Button pushes that cause a change to the left CDU display are output by the left FMC, while button pushes that cause a change to the right CDU display are output by the right FMC.

CDU Alternate FMC Input Select

The NAV instrument source select switch controls which FMC input is used by a CDU for display control. The normal input to the left and center CDUs is the left FMC. The normal input to the right CDU is the right FMC. The onside NAV switch selects the offside FMC input. If one FMC fails, the CDUs can still display different pages when selected to the same FMC.

Intersystem Data

The intersystem bus is used to maintain synchronization of the two FMCs. Information is compared between the two computers. Resynchronization can result from data comparison that exceeds normal tolerances. During resynchronization one FMC sends data to the other to allow normal operation to resume. If resynchronization is not successful a shutdown command can be sent by one FMC to the other. Resynchronization can be done by either FMC.

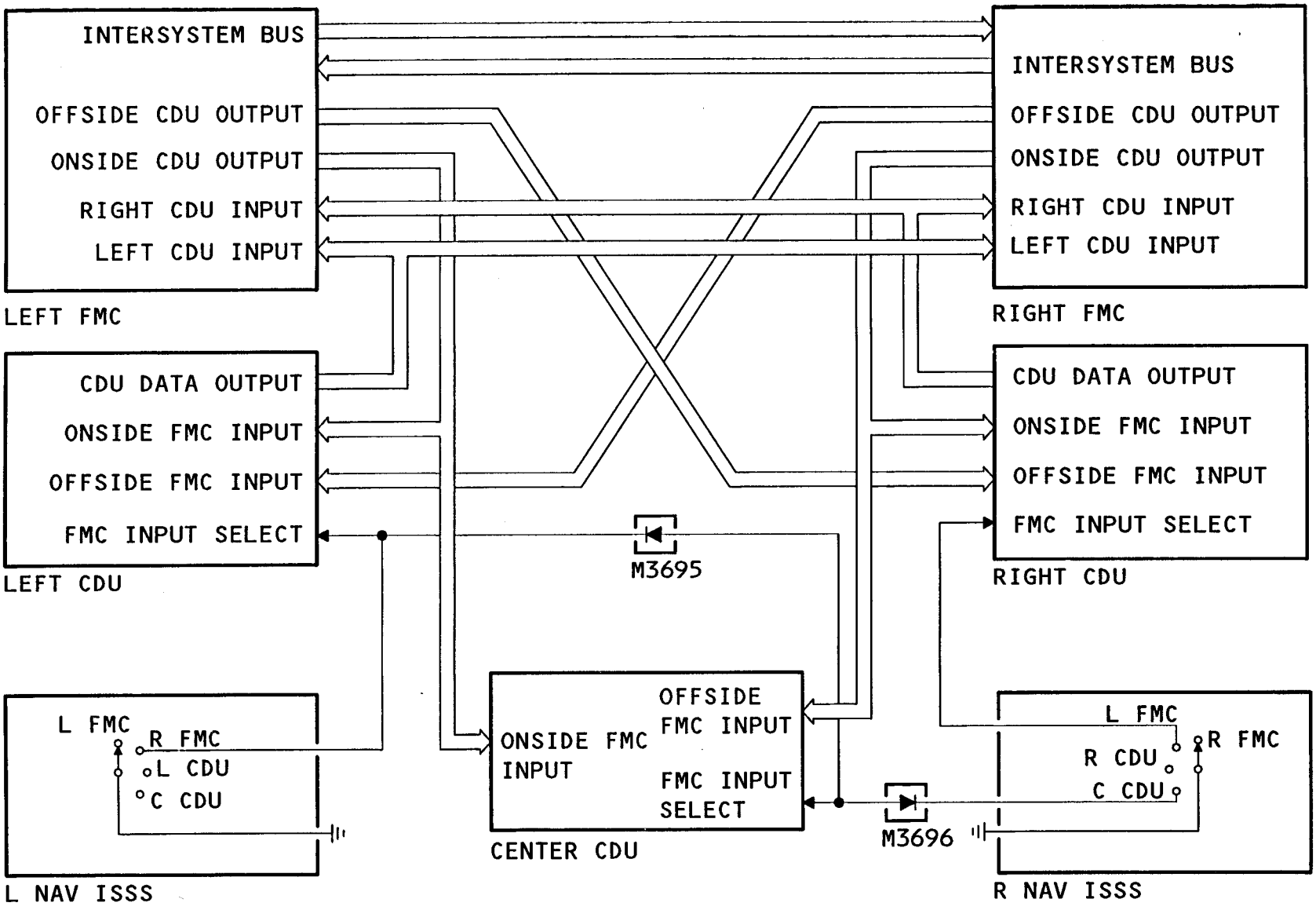


Figure 15 INTERSYSTEM DATA

DIGITAL SENSOR DATA

General

Sensor data provides the FMCS with the data required to support the many calculations. The FMCS receives data from the following sensors:

- Fuel quantity indicating system
- Navigation radios
- Clocks
- Inertial reference units
- Air data computers

Fuel Quantity Indicating Svstem

The fuel quantity processor unit provides the FMCs with total fuel quantity. This data is used to compute the airplane gross weight.- The left FMC uses output A, while the right FMC uses output B.

Navigation Radios.

The navigation radios provide the FMCS with radio position data. This data is used to compute airplane position. VOR receivers provide bearing and frequency data. ILS receivers provide localizer deviation and frequency data. DME interrogators provide distance and frequency data. The left FMC normally uses the left and right VOR, the left DME and the left ILS receiver, while the right FMC uses the right and left VOR, right DME and right ILS receiver. The FMCs switch to the offside DME input if the normal input is not valid.

Clocks

The clocks provide the FMCS with date and time. This data is used for the nav data base validity check and a UTC reference for time at waypoint and destination data. The FMCs normally use time from the left GPS sensor unit (GPSSU). If the left GPSSU is not valid the FMCs use time from the right GPSSU. If neither GPSSU is valid, the FMCs use the captain's clock. If the captain's clock is not valid, the FMCs use the first officer's clock.

Inertial Reference Units

The inertial reference units provide the FMCs with position, vertical speed, heading, track, and velocity data. The data is used in navigation and guidance computations. For position and velocity data the FMCs each use data from all three IRUs. If one IRU is not valid, the FMCs switch to the onside or center input. For data other than position or velocities, the IRU source selection is as follows:

- The left IRU is used when no autopilot or flight director is engaged, only the left autopilot channel is engaged, only the captain's flight director is engaged, or the left autopilot channel is first in command during multi-channel operations.
- The right IRU is used when only the right autopilot channel is engaged, only the first officer's flight director is engaged, or the right autopilot channel is first in command during multichannel operation.
- The center IRU is used when only the center autopilot channel is engaged, or the center autopilot channel is first in command during multi-channel operation.

Air Data Computers

The air data computers provide the FMCs with altitude, airspeed, temperature, and pressure data. This data is used in navigation and guidance computations. The FMC selection of air data inputs is selected as follows:

- If no autopilot or flight director is engaged, or only the left or center autopilot channel is engaged, the FMCs select the ADC source based on the left ADC selected discrete.
- If only the right autopilot channel is engaged, the FMCs select the ADC source based on the right ADC select discrete.
- If the autopilot is in multichannel operation, the FMCs select the ADC source based on the channel that is first in command.

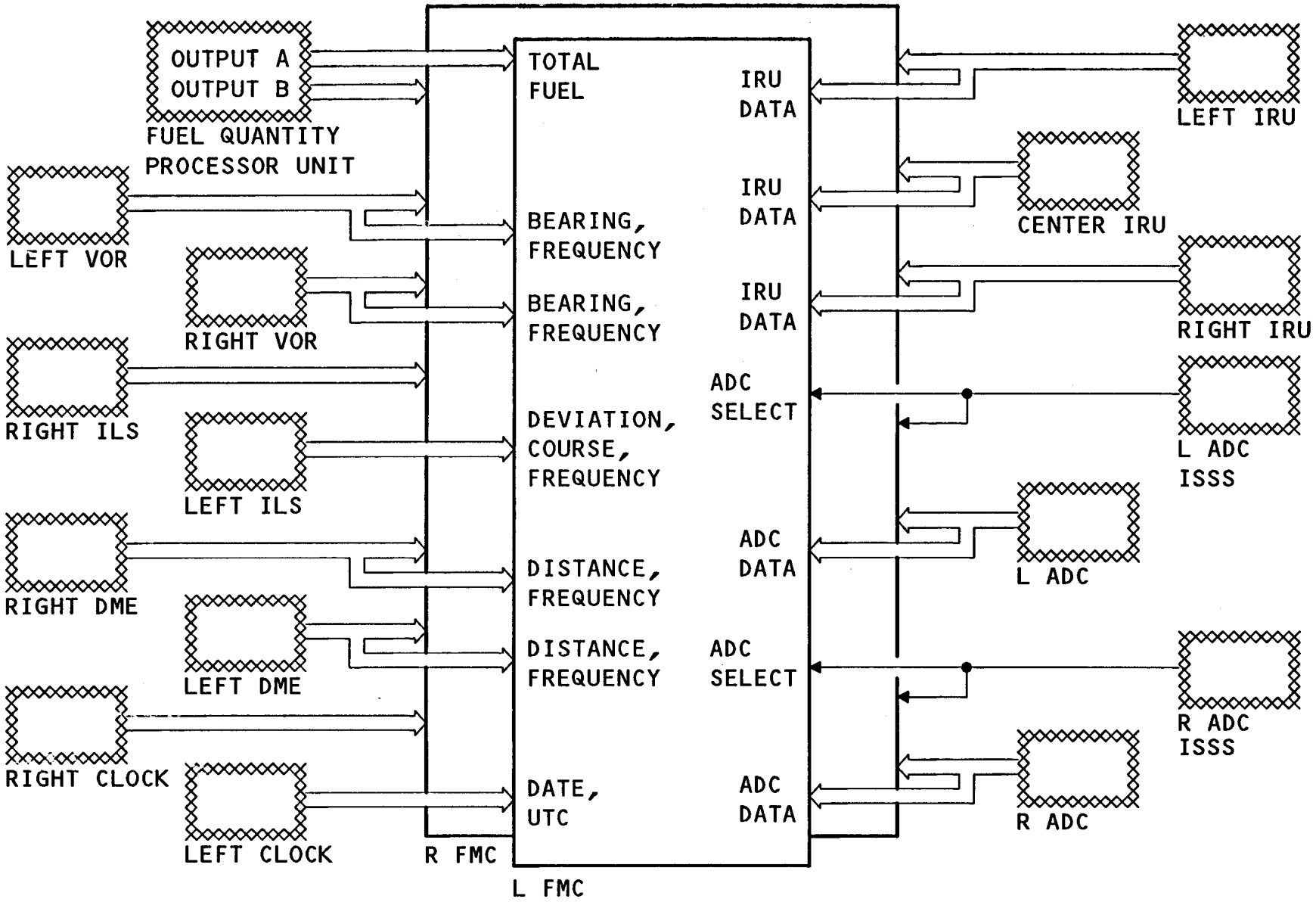


Figure 16 DIGITAL SENSOR DATA

FANS - 1 INTERFACES

General

Interfaces with the FMCs that support the future air navigation system (FANS 1) are:

- Global positioning system sensor units (GPSSUs)
- ARINC communications addressing and reporting system (ACARS)
- Printer
- Modular avionics and warning electronics assembly (MAWEA)

GPSSU Interface

The GPSSUs send position to the FMCs. The FMCs use this data along with the other sensors to compute airplane position. Horizontal figure of merit (HFOM) and horizontal integrity limit (HIL) are measures of GPS accuracy. Satellite fail (SAT FAIL) indicates that the GPS is not properly updating, and to use HIL rather than HFOM. These values of actual navigation performance (ANP) are compared with the required navigation performance (RNP). The time input gives the airplane and air traffic control (ATC) a common time reference.

ACARS Interface

ACARS lets the FMCs communicate with ATC and airline operations. Some of the received data can be loaded directly to the FMCs, which reduces the possiblity of the crew making entry errors. The flight crew can make specific requests to ATC for flight plan changes. The flight crew can also communicate with airline operations for flight and route data.

Printer

Messages that come from ATC may be sent to the printer for hard copies. Printer status messages such as BUSY or FAIL come from the printer to show during print operations.

MAWEA

The FMCs sends a signal to the MAWEA to alert (CHIME) the flight crew that an ATC uplink message has been received.

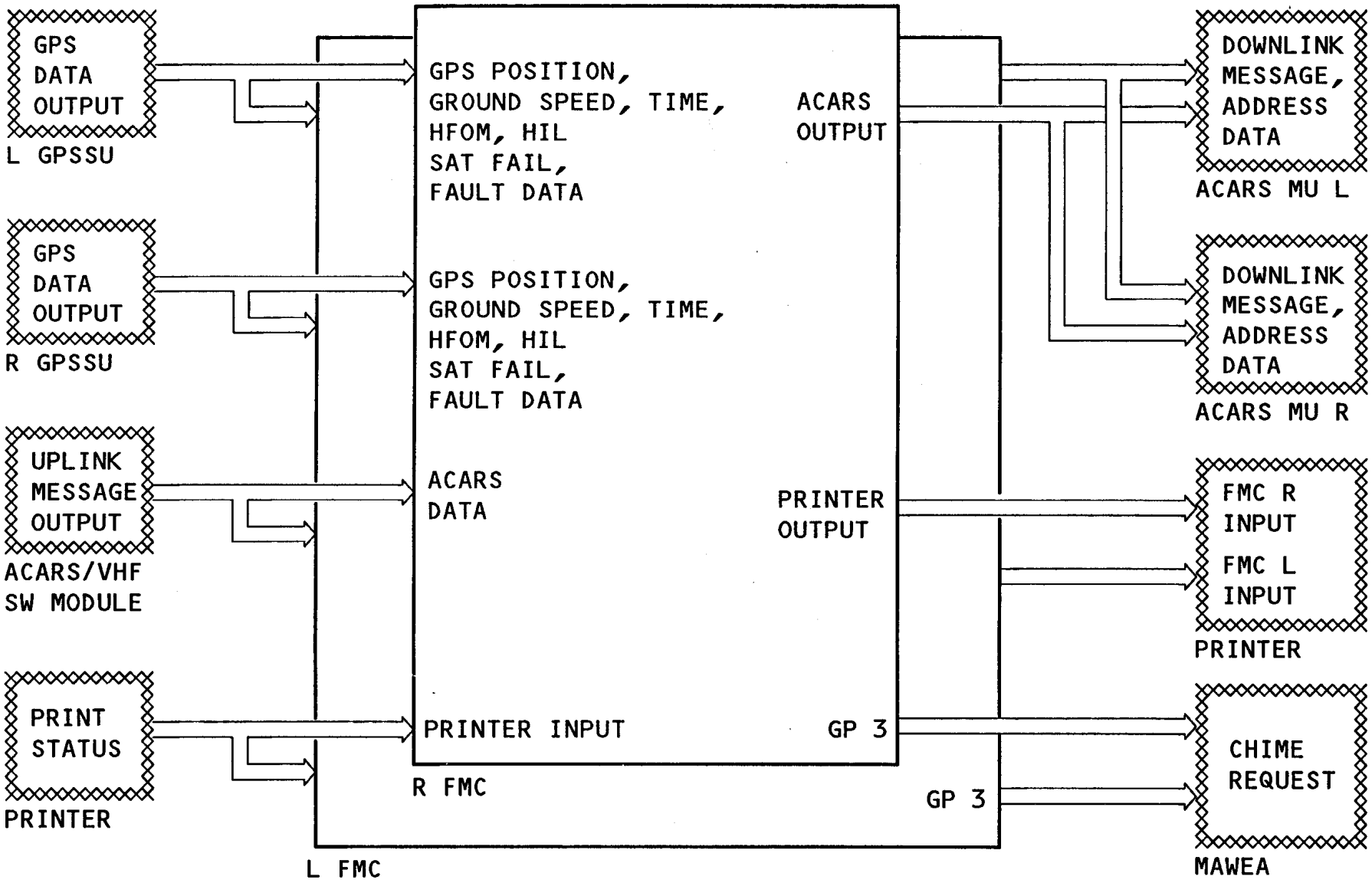


Figure 17 FANS 1 INTERFACES

EIU AND EFIS C. P. INTERFACE

The EIUs provide sensor data to the FMCS. The data is used for many different calculations. The following is a list of EIU low speed data to the FMCs:

- Fuel flow
- Fuel jettison data
- Vmin and Vmax
- Flap position
- Landing gear position
- Engine speed
- Bleed discretes
- Radio altitude
- Wing gear tilt

The EIUs provide this high speed engine data to the FMCs:

- Engine pressure ratios
- Engine speed (N1, N2, N3)
- Exhaust gas temperatures
- Engine oil temperatures
- Engine rating
- Trim data

For low speed data the EIU source is based on presence and validity monitoring. The priority of selection is left, center, and then right. The FMCs use all valid sources of high speed data simultaneously.

The FMCs calculate parameters for display and control. The FMCs send this general purpose data to the EIUs:

- Thrust management data
- Navigation radio frequencies
- Speed tape data
- Stabilizer trim data
- Gross weight
- Flight plan data
- Miscellaneous data
- BITE data

The FMCs send an A/T disconnect discrete to the EIUs. This signal alerts the flight crew of an autothrottle disconnect.

The EFIS control panel sends this information to each FMC and CDU:

- Navigation display mode selection
- Map range
- Map data selector switches

The information is used to control the separate map displays for the captain and first officer. The data goes through the onside CDUs and then to the FMCs. If an EFIS control panel fails, the CDU transmits the data and may be used as a back-up EIFS control panel.

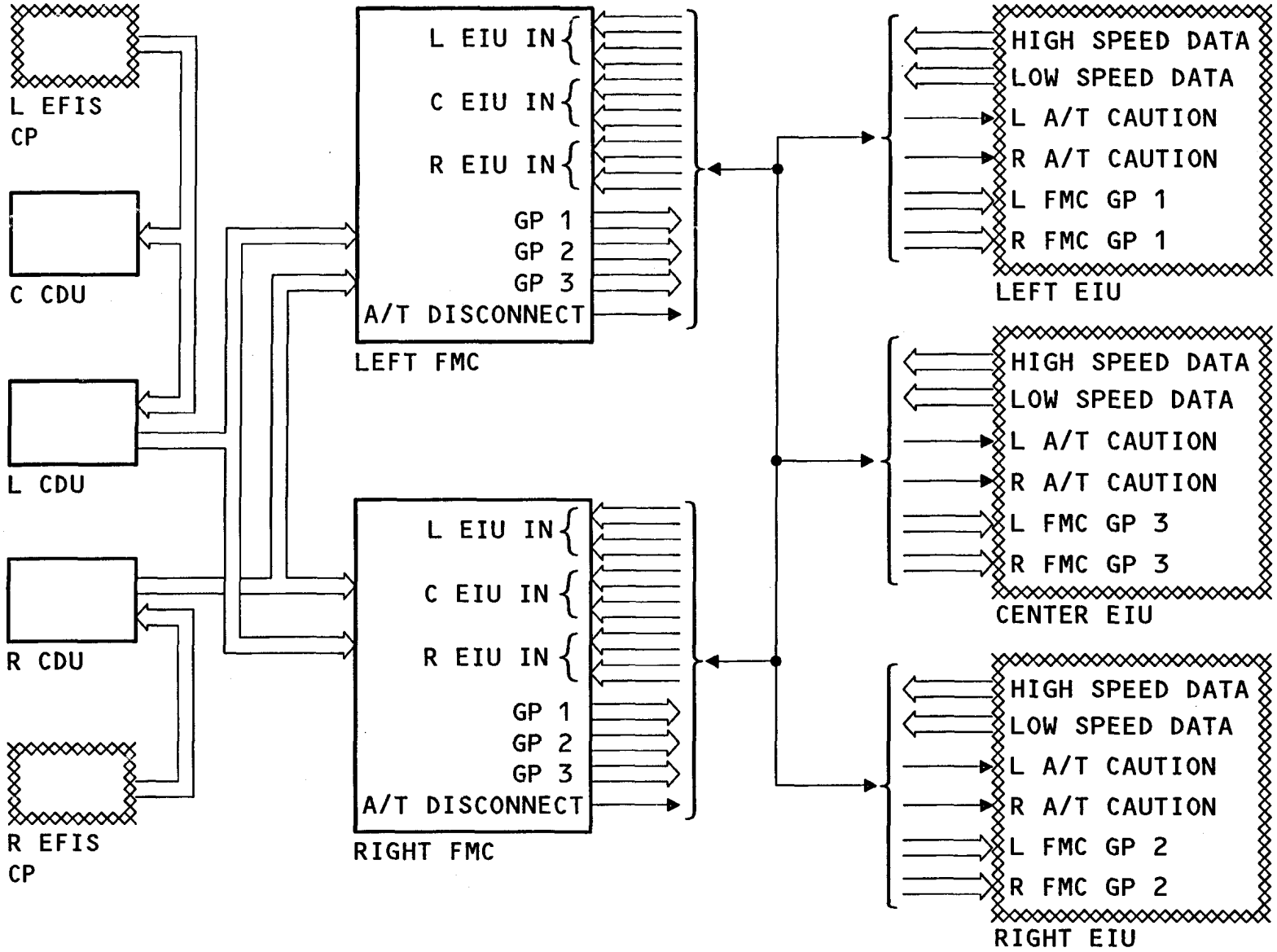


Figure 18 EIU AND EFIS CP INTERFACE

IDU INTERFACE

The FMCs and CDUs send high speed map display data directly to the IDUs. Each FMC can produce a separate map display for the captain and first officer. The left output bus contains captain's map data, while the right bus contains first officer's data. The CDU can only produce one map display. The left CDU produces a captain's map display. The right CDU produces a first officer's map display. The center CDU can produce either a captain's or first officer's map display.

Each IDU selects a map input bus based on the IDU position operating as a captain's or first officer's display and the position of the NAV instrument source select switches. Captain's displays use the left NAV switch, while first officer's displays use the right NAV switch.

The outboard IDUs use the high speed data bus as their source of track and ground speed data.

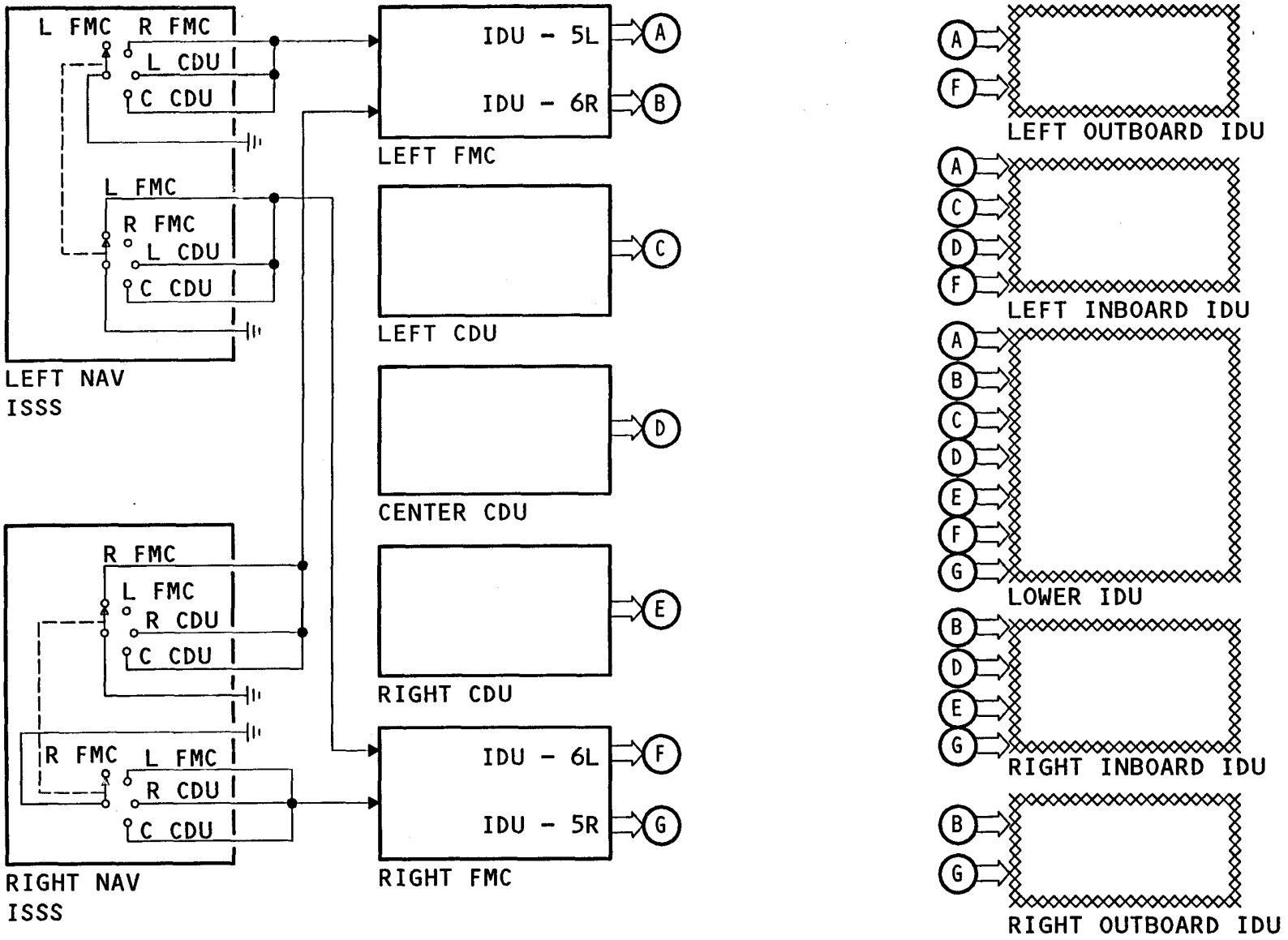


Figure 19 IDU INTERFACE

NAV SWITCH TO IDS INTERFACE

The captain's and first officer's NAV switches send source select discretes to all three EIU's.

The source select discretes are used by the EIU's to send source select commands to the IDU's. The inboard and lower IDU's use the source select commands to select the map display source from either of the FMCs or the onside or center CDUs. The outboard IDU's use the source select commands to select the source of track data from either of the FMCs.

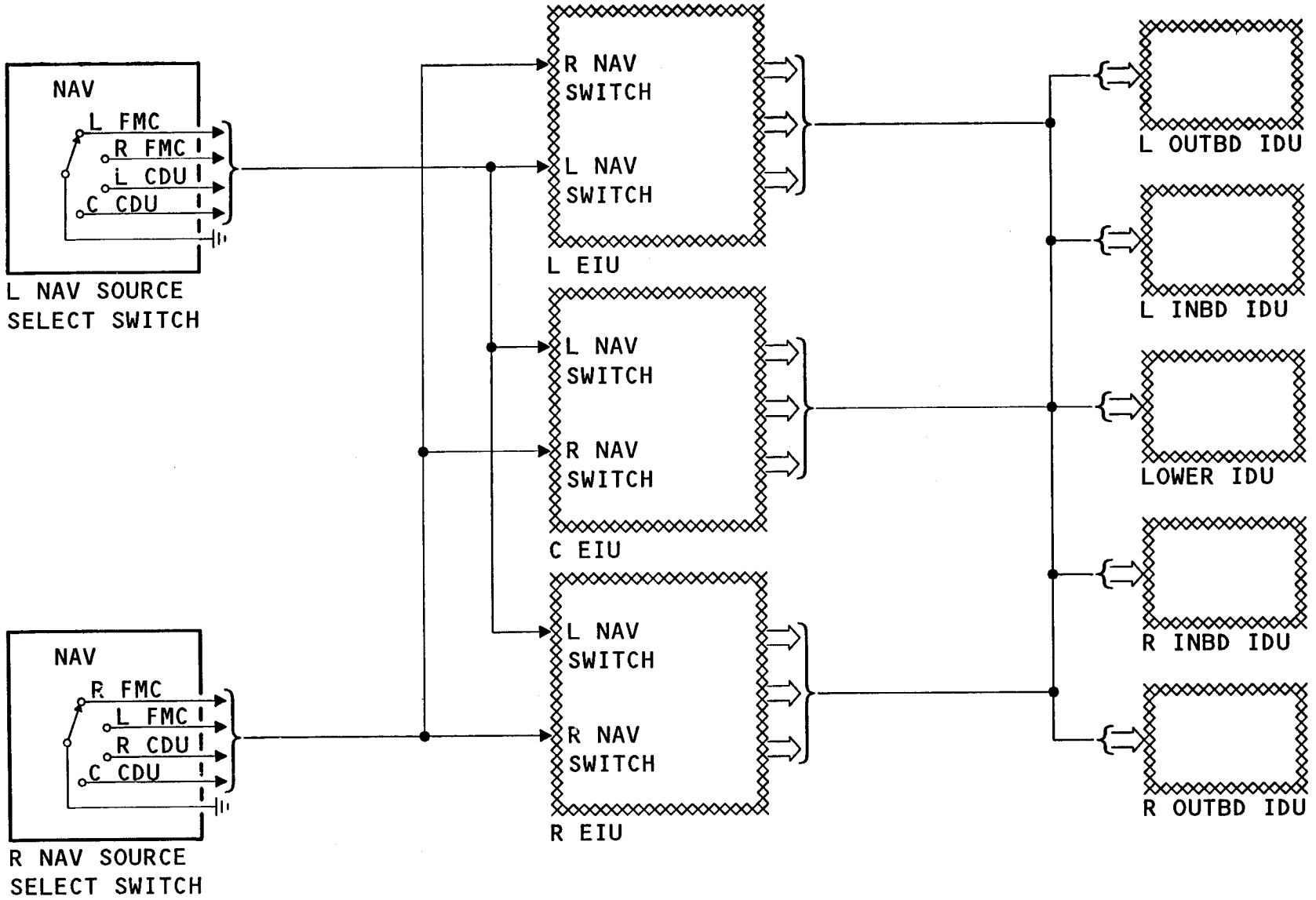


Figure 20 NAV SWITCH TO IDS INTERFACE

NAVIGATION RADIO TUNING

The master FMC normally sends frequency tuning data to the navigation radios. Tuning data is based on manual inputs from the CDUs or automatic selection done by the FMCS navigation function. Course entries by the flight crew are sent to the VOR receivers during certain modes of operation. Selected runway heading goes to the ILS receivers along with ILS frequency. The ILS receivers are parked by the FMCS when no auto or manual tuning is active. The DME interrogators receive up to five frequencies for directed scan operation along with audio and display bit assignment. The left and right ADF receivers get frequency and mode data based on CDU manual entries.

If the master FMC fails in the air or both FMCs fail on the ground, the CDUs send a source select discrete to the navigation radios. This source select discrete allows manual tuning data from the CDU to tune the onside navigation radios.

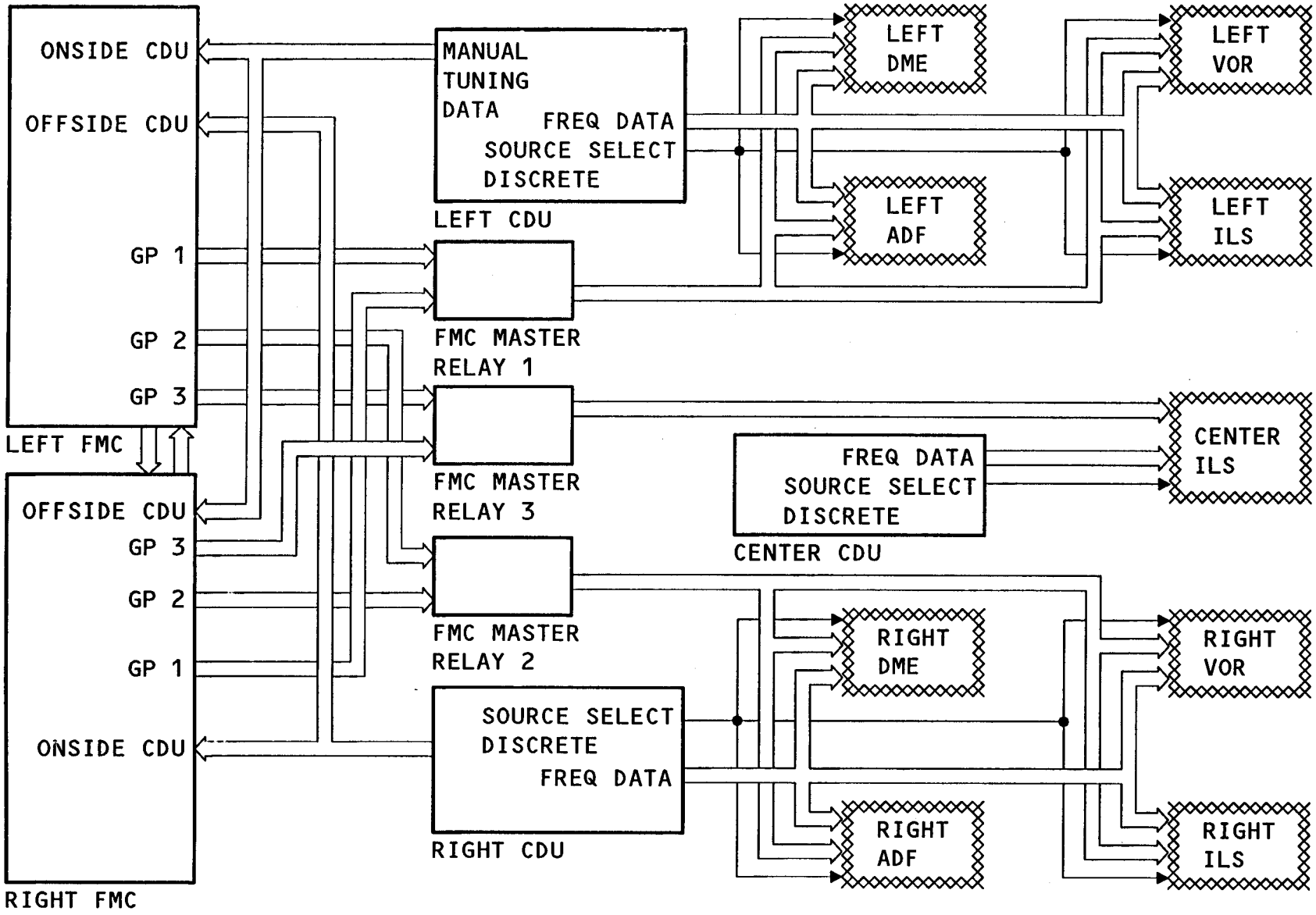


Figure 21 NAV RADIO TUNING

AFDS INTERFACE

The AFCS MCP sends the following digital data to the FMCs:

- Selected altitude
- Selected heading
- Selected airspeed/Mach
- Flap position
- Stabilizer position
- Speed brake position
- MCP pushbutton status
- Altitude and speed intervention selection
- TO/GA select

The AFCS MCP sends an analog autothrottle arm discrete signal to each FMC. The AFCS MCP sends the system A bus to the left FMC and the system B bus to the right FMC.

The data from the AFCS MCP is used to control the autothrottle and for selection of the LNAV and VNAV modes.

The master FMC sends the following data to the AFCS MCP:

- Mode status
- Speed data

This data is used by the AFCS MCP to light autothrottle mode buttons and to blank or display certain speeds in the selected airspeed window.

The master FMC sends the following data to the FCCs:

- LNAV steering commands
- VNAV steering commands
- Vertical speed commands
- Airspeed limits

The FCCs use the FMC data to control the airplane when the LNAV and VNAV modes are selected.

The FCCs send a tune inhibit discrete to the FMCs and CDUs to prevent tuning of the ILS when any of these conditions exits:

- A/P engaged and LOC or GIS capture
- Below 500, during F/D only approach
- During takeoff acceleration through 40 knots until in air.

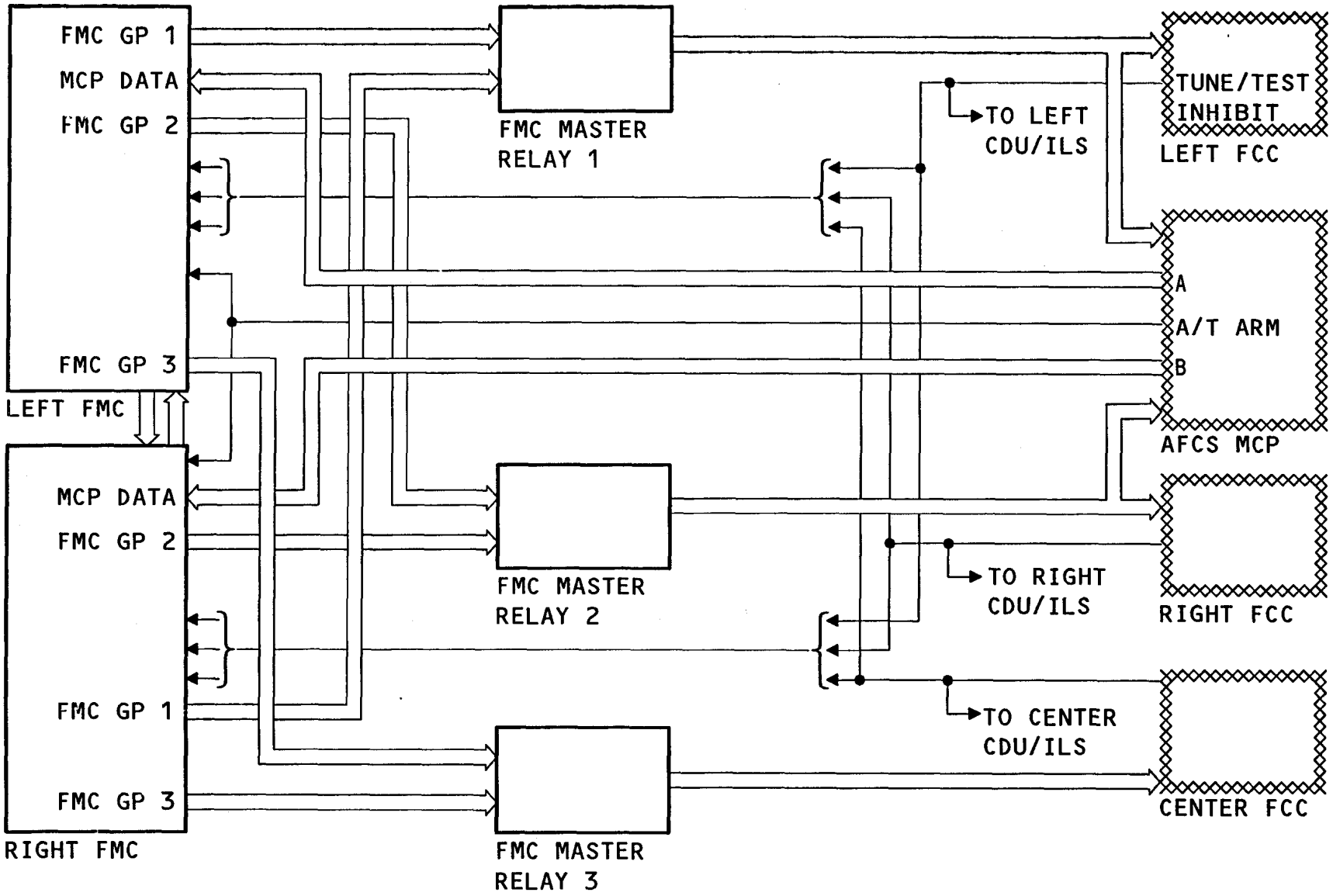


Figure 22 AFDS INTERFACE

AUTOTHROTTLE INTERFACE

The autothrottle servomotor generator receives forward and reverse commands and an excitation voltage from each FMC. The FMCs can drive the autothrottle servomotor generator in an operating range from 0 to 10 degrees per second. The drive signal is an AC voltage developed by the FMC from the 28v dc servo power input. The excitation voltage is 115v ac. The autothrottle servomotor generator has dual windings, one for each FMC.

The single tachometer feedback signal provides a rate feedback signal to each FMC.

The FMCs receive an autothrottle disconnect discrete input and a reset discrete input from switches in thrust levers 1 and 4.

The FMCs receive a go-around select discrete from switches in thrust levers 2 and 3. These switches are not used in favor of the voted go-around status provided by AFDS.

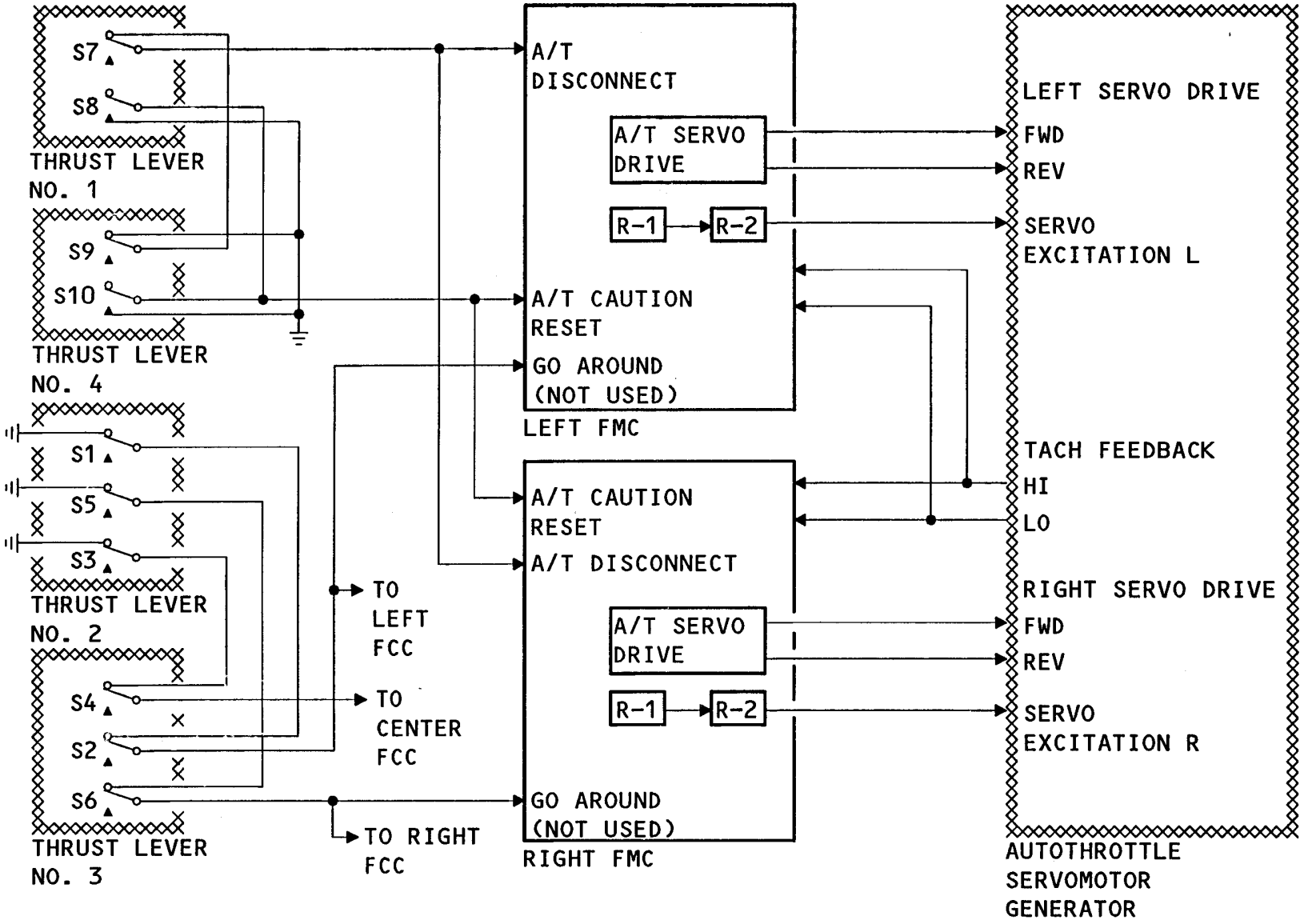


Figure 23 AUTOTHROTTLE INTERFACE

ENGINE TRIM INTERFACE

The master FMC sends the following data to the electronic engine controls:

- EPR/N1 trim command
- Bleed correction

Engine trim is enabled at the FMCs by the autothrottle arm discrete from the AFCS MCP. The autothrottle arm discrete also controls the trim enable relay. This relay sends a trim enable discrete to the electronic engine controls.

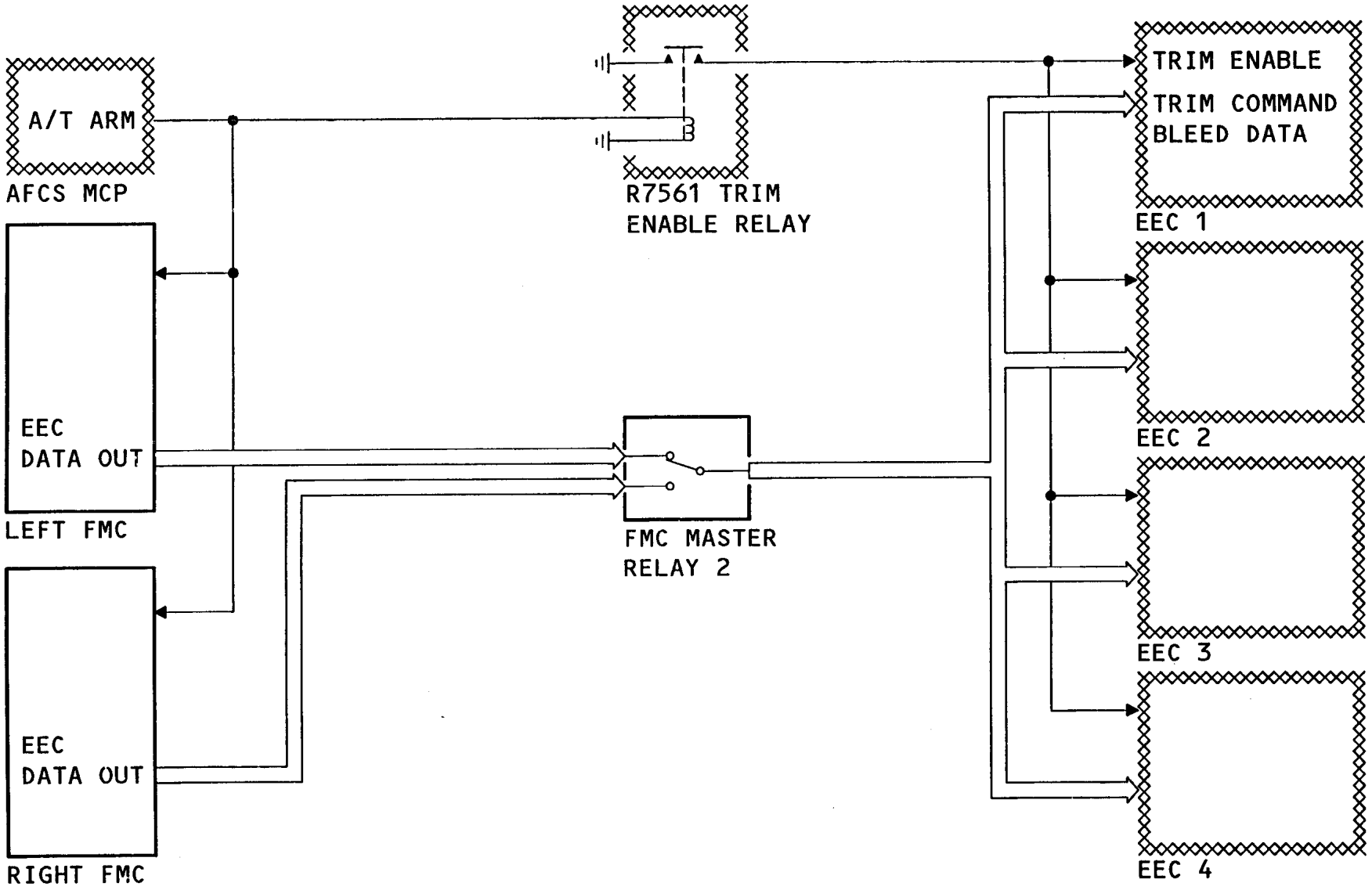


Figure 24 ENGINE TRIM INTERFACE

MISCELLANEOUS INTERFACES

General

The FMCs have the interfaces with the following to support various functions:

- Heading reference switch
- FMC master relays
- Central maintenance computer
- Air ground relay
- Cabin pressure controllers
- Modular avionics and warning electronics assembly
- Airborne data loader
- Inertial reference units
- Ground proximity warning computer

Heading Reference Switch

The heading reference switch allows selection of magnetic or true reference for the map displays and guidance function.

FMC Master Relays

The FMC master relays send an analog discrete to enable one FMC to perform the master functions of radio tuning, thrust management, and guidance.

Air/Ground Relays

The air/ground relays send an analog discrete to enable data base loading, and is also used in flight phase determination.

Cabin Pressure Controllers

The cabin pressure controllers get active flight plan landing altitude and vertical profile data.

Modular Avionics and Warning Electronics Assembly (MAWEA)

The stall warning management computers in the MAWEA get gross weight and center of gravity data from the FMCs.

Airborne Data Loader

The airborne data loader allows the navigation data base or operational program to be updated on the airplane. The airborne data loader can also be used to record the FMC BITE report. The data goes through the data loader control panel, which also sends data base load enable discretes to the FMCs when selected by the data loader selector switch.

Inertial Reference Units

Inertial reference units get present position latitude and longitude for position initialization during alignment. The inertial reference units also get reference heading when operating in the attitude mode.

Ground Proximity Warning Computer

The ground proximity warning computer gets present position and track data from the left FMC.

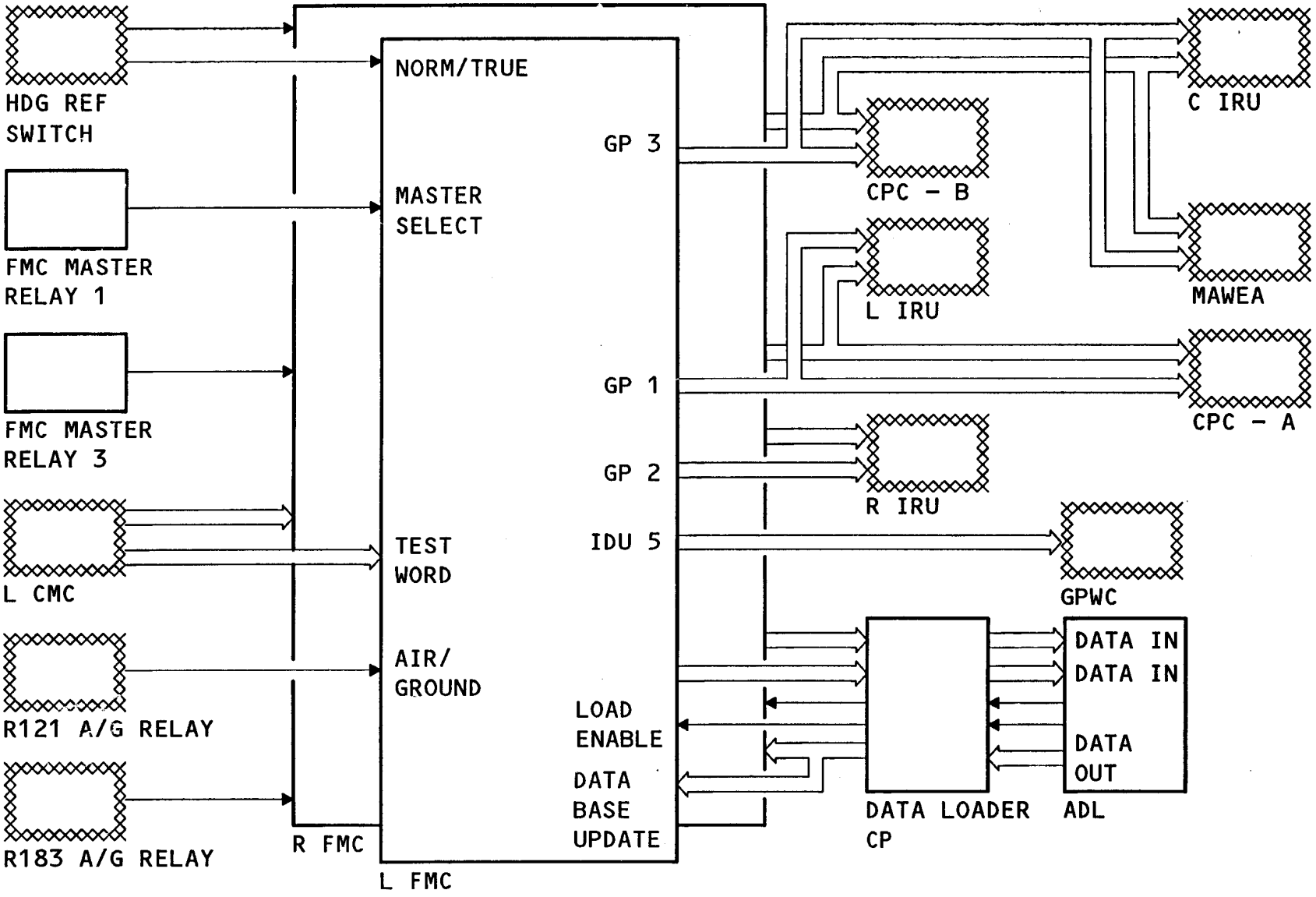


Figure 25 MISCELLANEOUS INTERFACES

CDU INTERFACES

General

The CDUs receive data from these:

- Left, center, and right IRUs
- Left, center, and right FCCs
- Heading reference switch

IRU

Each CDU receives present position, accelerations, ground speed, inertial altitude and vertical speed, attitude and heading. This data is used for the alternate navigation function of the CDU.

FCC

The FCCs send an analog input to the CDU to inhibit ILS tuning.

Heading Reference Switch

The normal or true heading discrete selection is sent to the CDUs for navigation display orientation.

Outputs

The CDU sends a DME audio pairing discrete to the audio management unit (AMU). The AMU uses this discrete to pair DME audio with either ILS or VOR audio.

The CDU also sends a weather radar (WXR) on discrete to the WXR control panel . This discrete responds to selections made on the alternate EFIS control panel function of the CDU.

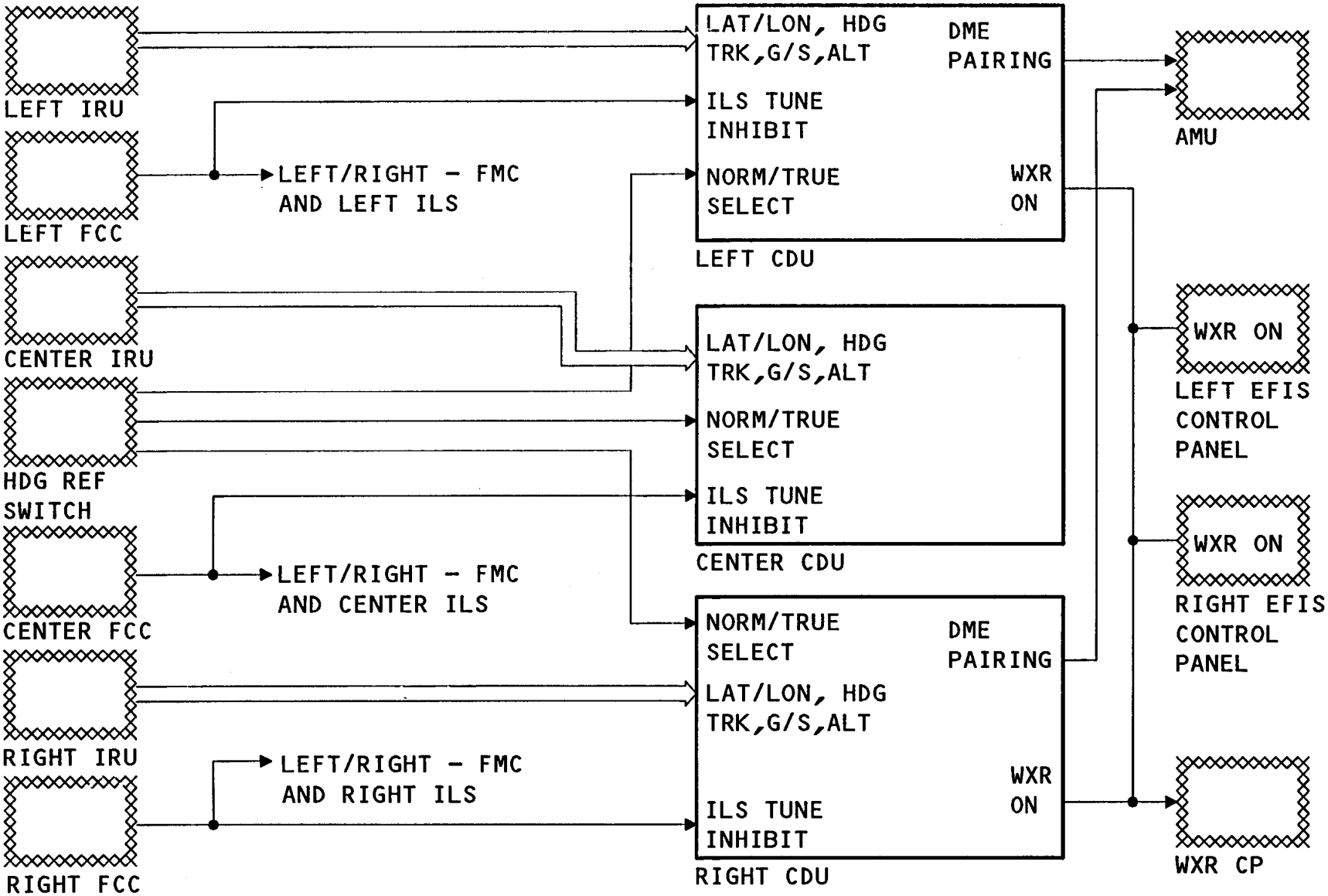


Figure 26 FMCS - CDU INTERFACES

FLIGHT MANAGEMENT COMPUTER

Purpose

The FMC processes requests from the crew and sensor data to navigate along the selected route, supply display data, and provide guidance outputs.

General

The FMC contains hardware and software to support the processing of data. The FMC contains:

- Two SDP-185 processors to do calculations and data processing.
- Nonvolatile memory for storage of programs and data bases.
- Receiver subsystem to receive data from external systems.
- Transmitter subsystem to transmit data to the external systems.
- One autothrottle (A/T) servo card to perform the autothrottle I/0 interfaces.
- Two relays supply excitation power to the A/T servomotor.
- A power supply to support internal processing.

Front Panel

The front panel has these features:

- An INITIATE TEST/LAMP TEST switch starts the self-test.
- An FMC FAIL red LED fault annunciator.
- A TEST IN PROCESS yellow LED annunciator that is on during test.

BITE/Monitor

The FMC contains hardware and software to do power-up and continuous BITE to monitor operation and store faults.

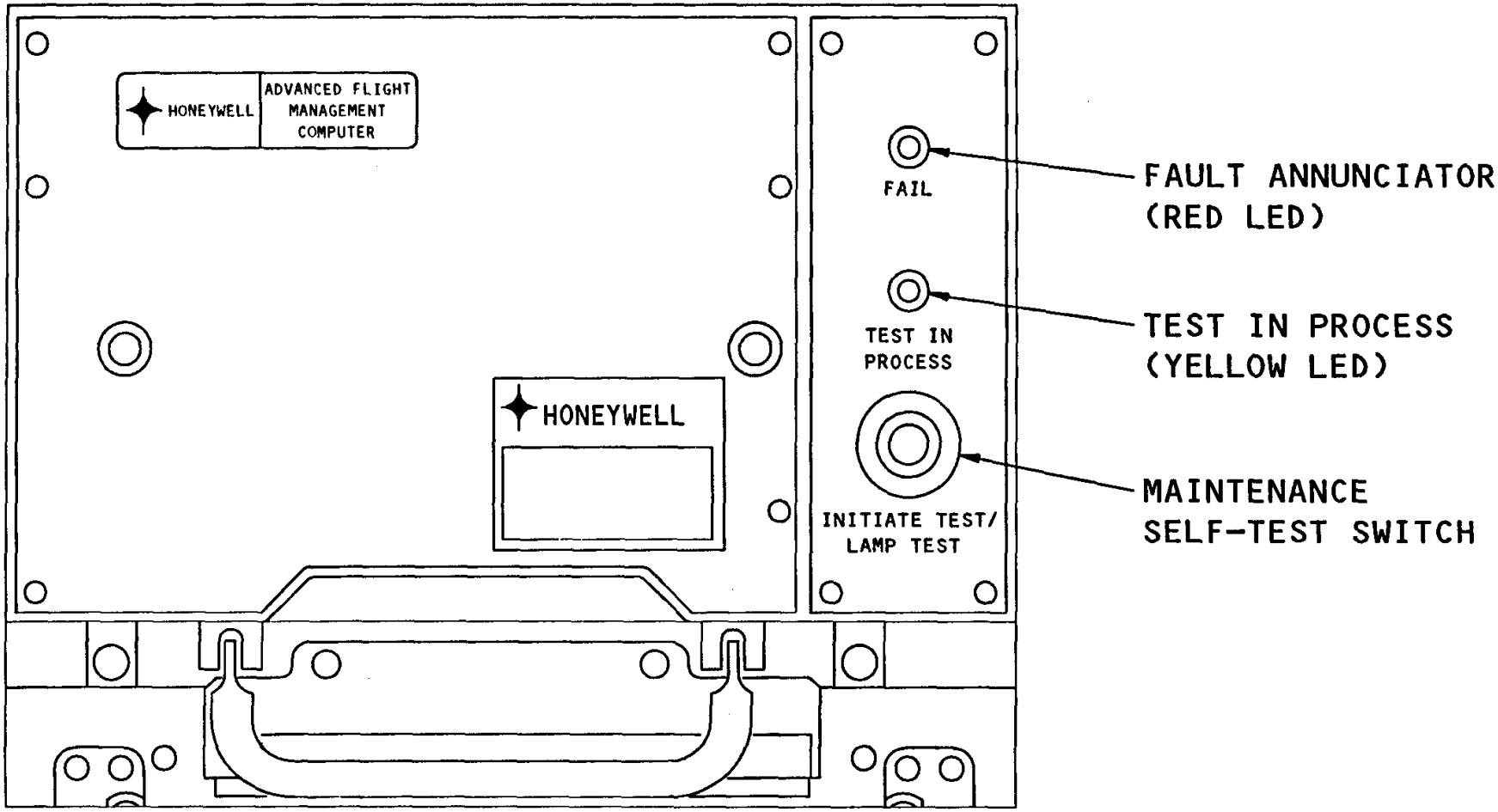


Figure 27 FLIGHT MANAGEMENT COMPUTER

CONTROL DISPLAY UNIT

Purpose

The control display unit (CDU) has an interface with the crew, external sensors, external systems and the FMC. The CDU controls and shows FMCS data.

General

The CDU contains:

- Keyboard for data entry or display selection
- Cathode ray tube (CRT) to show data
- SDP-185 processor to control the operation of the CDU
- ARINC receivers to receive data from the FMC and other sources
- ARINC transmitters to send data to the FMC and other users
- Annunciators to show mode key status
- Brightness adjustment for manual CRT brightness control
- Photocells for automatic CRT brightness control

The primary control interface to the CDU is the keyboard. There are four types of keys:

- Function keys
- Mode keys
- Line select keys
- Alpha-numeric keys

Function Keys

The function keys are:

- Execute (EXEC) is used to execute (make active) a function or change a function. The key has a light that comes on when the execute command is needed.
- NEXT PAGE is used to look at the next page among many pages
- Previous page (PREV PAGE) is used to look at the last among many pages

Mode Keys

The mode keys select the first page of a desired function. The mode keys are:

- Initialization/reference (INIT REF)
- Route (RTE)
- Departure/arrival (DEP ARR)
- Vertical navigation (VNAV)
- FIX
- LEGS
- HOLD
- Progress (PROG)
- MENU
- Navigation radio (NAV RAD)
- Air Traffic Control (ATC)
- FMC Communication (FMC COMM)

The function and operation of the modes and pages will be discussed later.

Line Select Keys

The line select keys (1L - 6L and 1R - 6R) are used to insert data from the scratch pad, to select data into the scratch pad or to select a function.

Alpha-numeric Keys

The alpha-numeric keys provide the means to enter data into the FMC. In addition to the letters and numbers, there are:

- Slash (/) key
- Change sign (+/-) key
- Delete (DEL) key
- Clear (CLR) key
- Space (SP) key

The CLR key is used to clear (remove data from) all or part of the scratch pad. The DEL key enters the word DELETE in the scratch pad. A line select key then deletes (removes) the selected field.

Display Format

There are 14 lines of data which can be shown. Each line is 24 characters long. The top line is always the title of the page or function, the page number and the number of pages in that function. The bottom line is for the scratch pad. The scratch pad is used for data entry or transfer and for messages to be shown.

Annunciators

The annunciators come on to show status annunciations that require crew attention. These are:

- Message (MSG) shows when an FMCS message is in the scratch pad
- Display (DSPY) shows that the current page is not related to the active flight plan leg or present active mode. The DSPY light comes on, as an example, when the route page 2 of 3 (2/3) shows on the CDU and the aircraft is at the departure runway.
- FAIL shows when either the master FMC fails in the air or the navigation instrument source selected FMC fails.

NOTE: CDU CONSIDERS IN AIR WHEN GROUND SPEED GREATER THAN 100 KNOTS OR GROUND SPEED IS INVALID.

- Offset (OFST) shows that an offset route is in use when in the air.

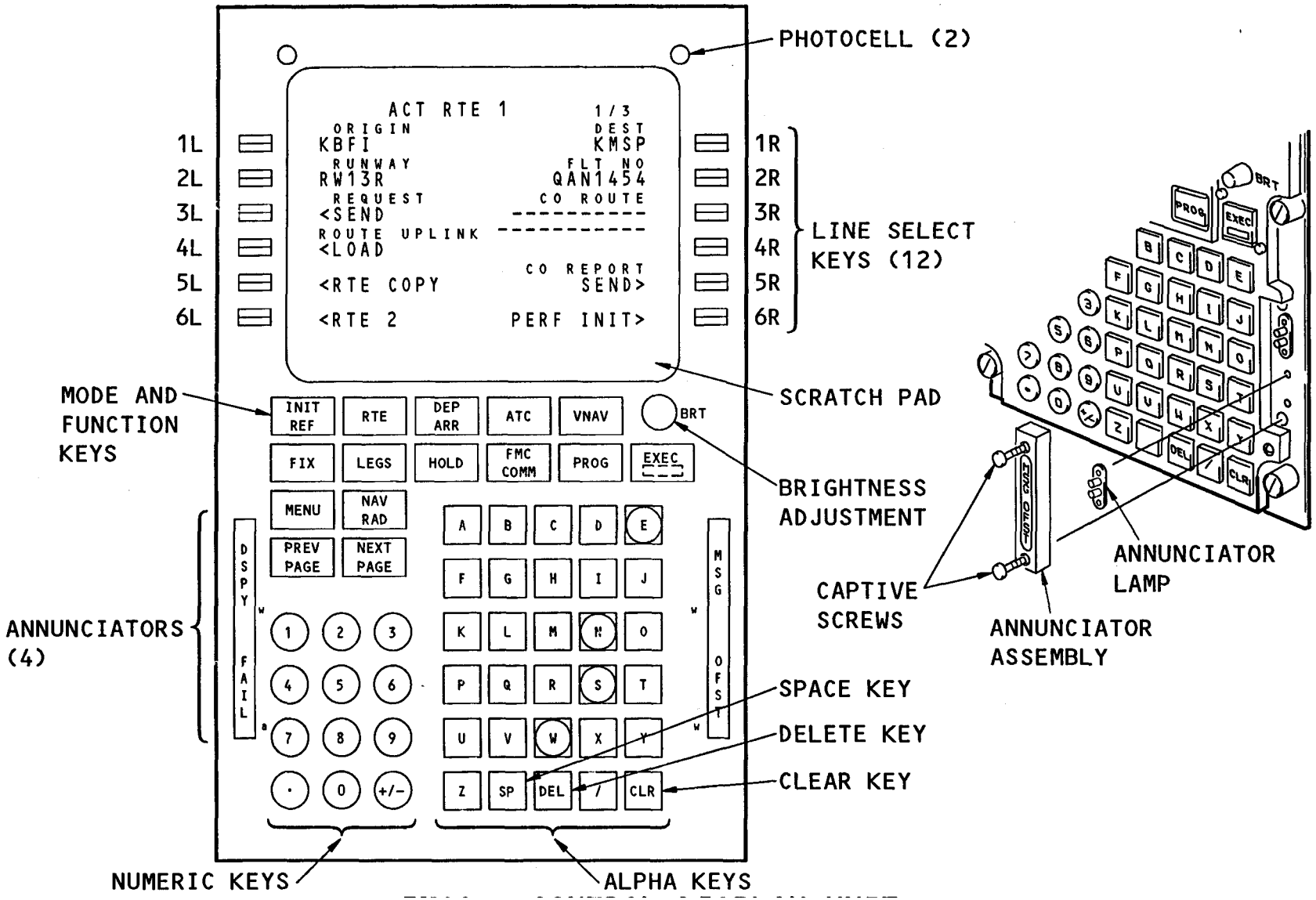


Figure 28 CONTROL DISPLAY UNIT

AUTOTHROTTLE SERVOMOTOR GENERATOR

General

The autothrottle servomotor generator is under the control stand. The FMC sends commands to the autothrottle servomotor to drive the throttles forward or aft through a gearbox assembly.

Operations

Power to the autothrottle servomotor generator is 115 volts ac excitation and a variable ac signal derived from 28 volts dc for drive control. The generator also uses 115 volts ac for servomotor rate feedback to the flight management computer (FMC). The servomotor moves at 10 degrees/second maximum throttle rate when commanded.

Access

Access to the autothrottle servomotor generator is through the access panel on the first officer's side of the control stand. The assembly is at the floor level below the control stand.

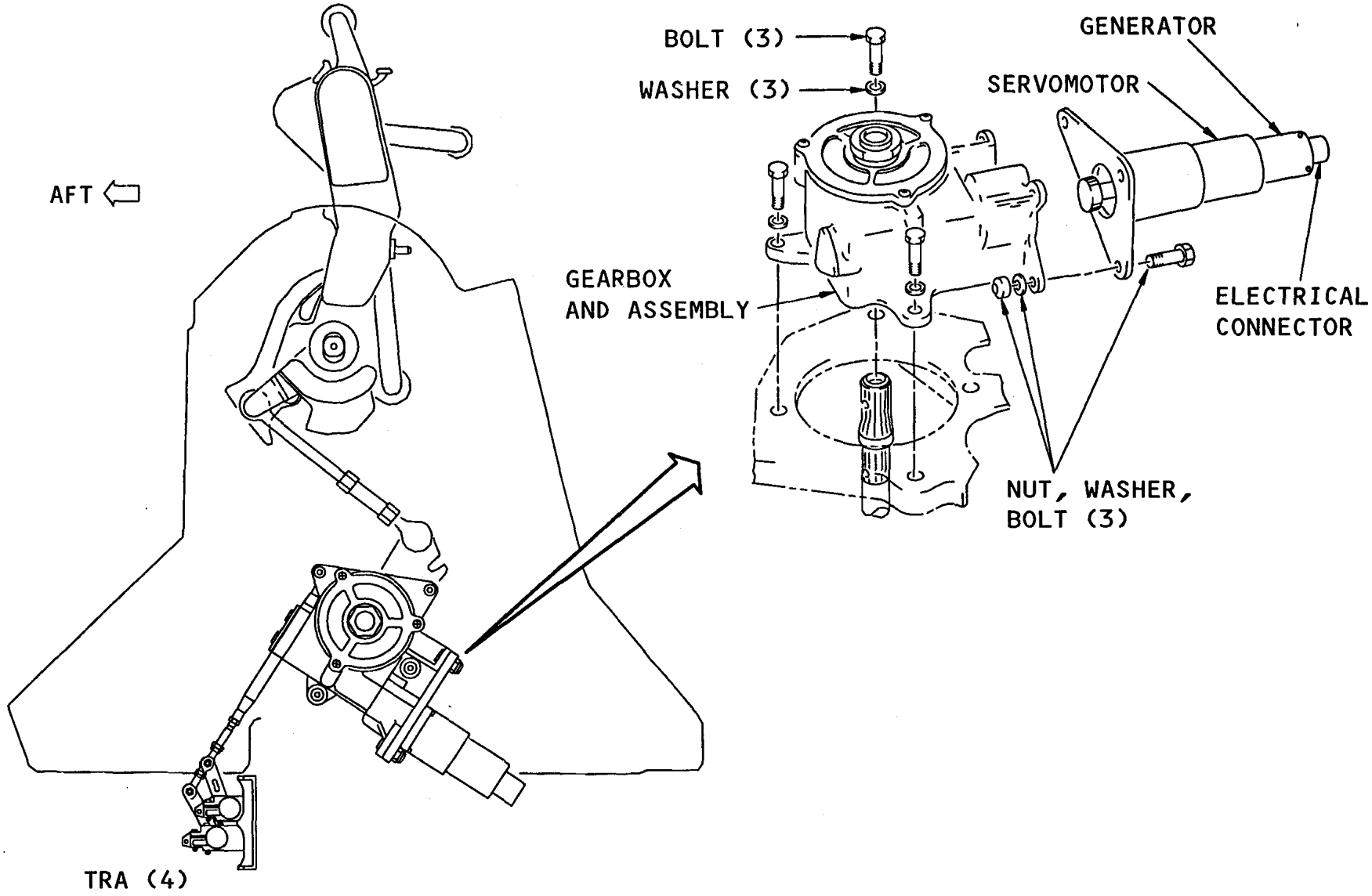


Figure 29 AUTOTHROTTLE SERVOMOTOR GENERATOR

AUTOTHROTTLE DISCONNECT SWITCHES

General

The autothrottle disconnect levers are on thrust levers No. 1 and No. 4.

Operation

The autothrottle disconnect switches (S7 and S9) disconnects the autothrottle servomotor if it is engaged. The autothrottle reset switches (S8 and S10) reset the EICAS caution message when a disconnect occurs.

Access

Access to autothrottle disconnect switches is through a cover plate on the thrust levers.

Removal/Installation

The autothrottle disconnect and reset switches are identical and installed in the same manner. The electrical connections are soldered. After replacement, rigging of the switches is required for the switches to activate

at the lever middle position. Rigging is accomplished by adjusting the switch position with the mounting screws loosened.

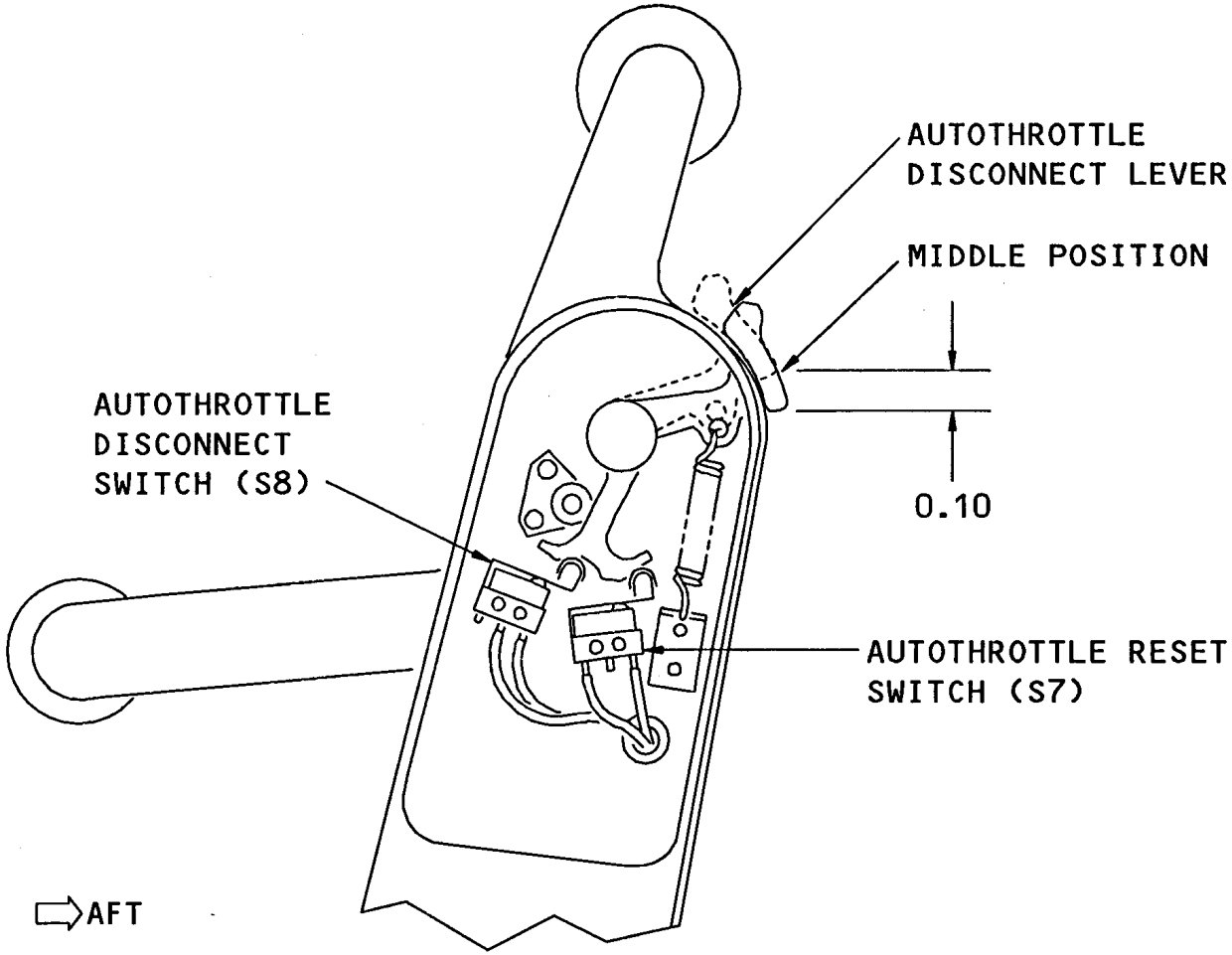


Figure 30 AUTOTHROTTLE DISCONNECT SWITCHES

FMC GO-AROUND SWITCHES

General

The go-around levers are on thrust levers No. 2 and No. 3.

Operation

These six switches (S1 through S6) are used to select the takeoff mode or the go-around mode for both the autothrottle and the autopilot.

Access

Access to the go-around switches is through a cover plate on the thrust levers.

Removal/Installation

The go-around switches are all identical and installed in the same manner. The electrical connections are soldered. After replacement, rigging of the switches is required for the switches to activate at the lever middle position. Rigging is accomplished by adjusting the switch position with the mounting screws loosened.

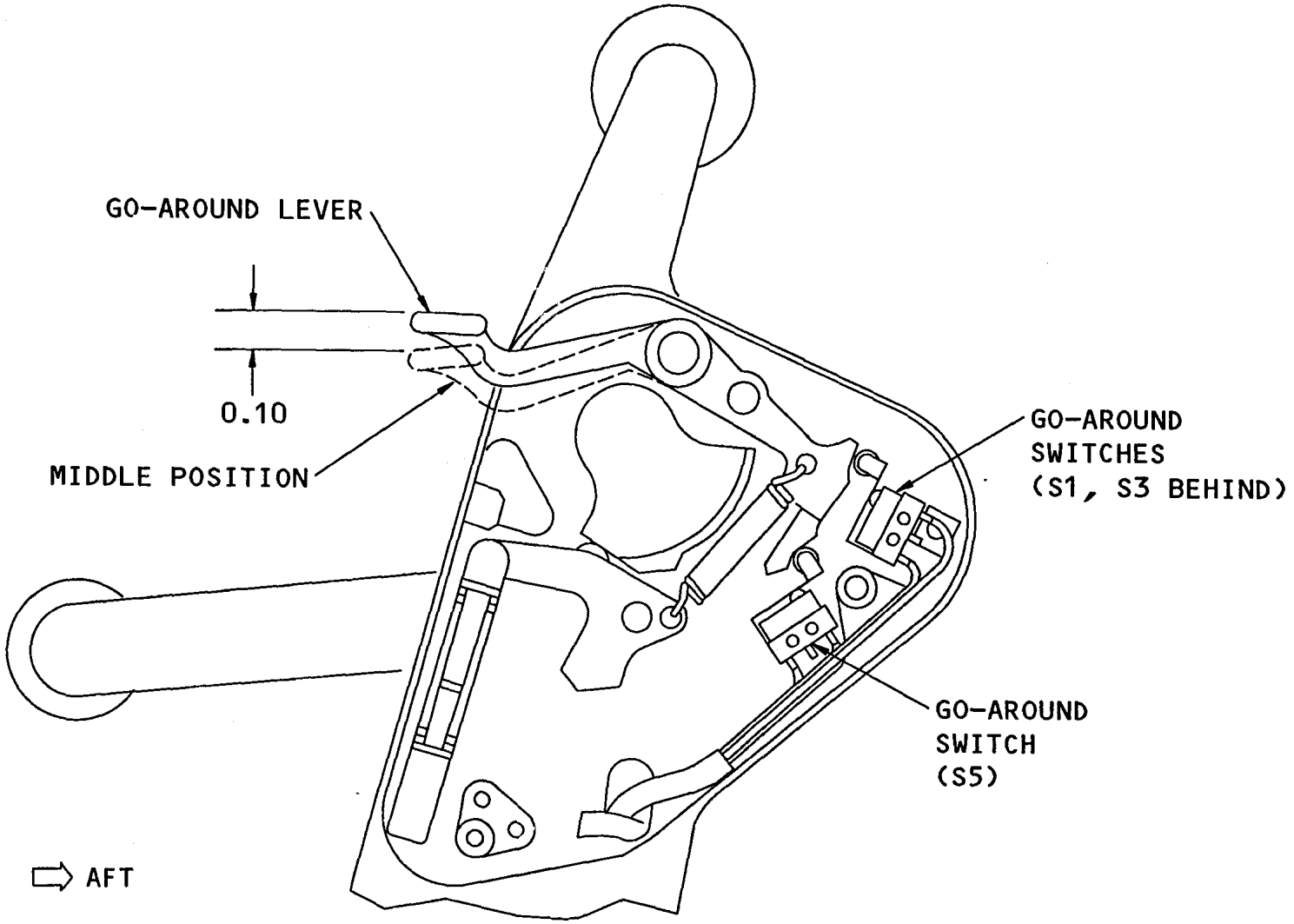


Figure 31 GO-AROUND SWITCHES

FMC MASTER SWITCH & NAV ISSS

General

The master switch determines which FMC provides:

- Steering commands to the autopilot
- Frequency commands to the NAV radios
- Engine trim commands to the engine electronic computers (EECs)
- Mode control panel (MCP) data
- Autothrottle (A/T) commands to the A/T servo

NAV ISSS - selects the onside EFIS (electronic flight instrument system) navigation source. The FMC provides navigation data to the PFD (primary flight display) and ND (navigation display). The CDU provides navigation data to the ND only.

The NAV ISSSs also select the FMC for CDU map and display update.

Operation

The master switch - in the left FMC position causes the master relays to deenergize and connects the left FMC outputs to the FCCs, EECs, NAV radios and MCP. When the switch is in the right position the master relays energize and connects the right FMC outputs.

NAV ISSS - sends discretes to the FMC, CDU, EFIS and EIU (EFIS/EICAS interface unit) for navigation source selection. The captain and first officer may select the same NAV source.

Access

Master switch - the master switch is on the P2 instrument panel.

NAV ISSSs - the NAV ISSSs are on the instrument source select modules (ISSM) which are then located on the P1 (captain) and P3 (first officer) panels.

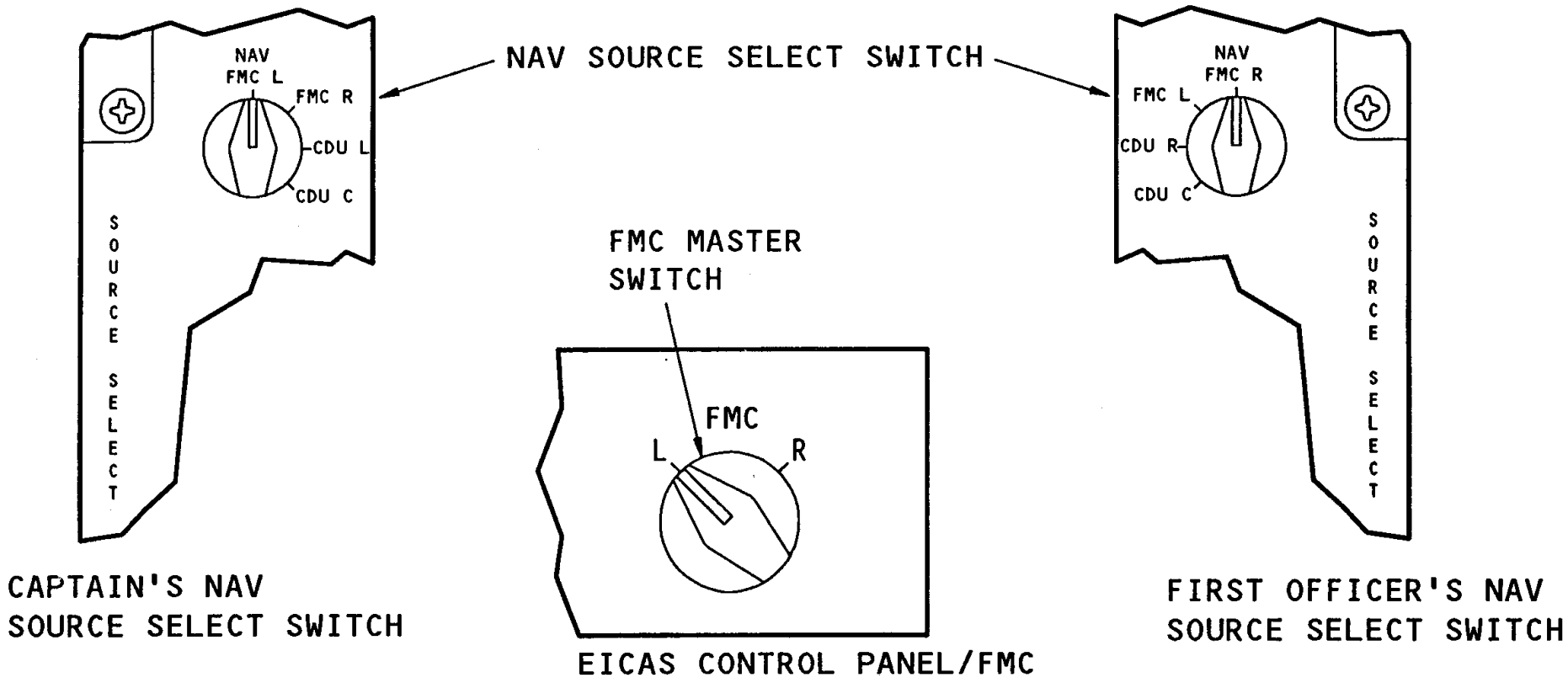


Figure 32 FMC MASTER SWITCH & NAV ISSS

AIRBORNE DATA LOADER

General

Data bases and operational programs can be loaded in many of the systems in the airplane. This is done with the installed airborne data loader (ADL) and the ADL control panel (on P11 behind the first officer). A diskette storage case is used to store preloaded and future loadable programs.

ADL Control

Power input is 115v ac BUS 1. Control is with the data loader interface panel switch. Power is supplied from the FMCS data base loader circuit breaker on P64.

ADL Physical Description

The ADL is installed in the P11 panel below the data loader control panel. It has a front cover panel that covers the alphanumeric display and the 3.5 inch diskette slot.

Diskette Storage Case

The diskette storage case is mounted above the ADL control panel in the P11 book case. The storage case provides storage capability for up to fourteen 3.5 inch diskettes. The unit door is hinged, transparent and made of a plastic material.

ADL Control Panel.

The ADL control panel is installed on the P11 book case below the diskette storage case and above the ADL unit. The unit houses a rotary switch that allows LRU selection for software enabling and loading from the ADL.

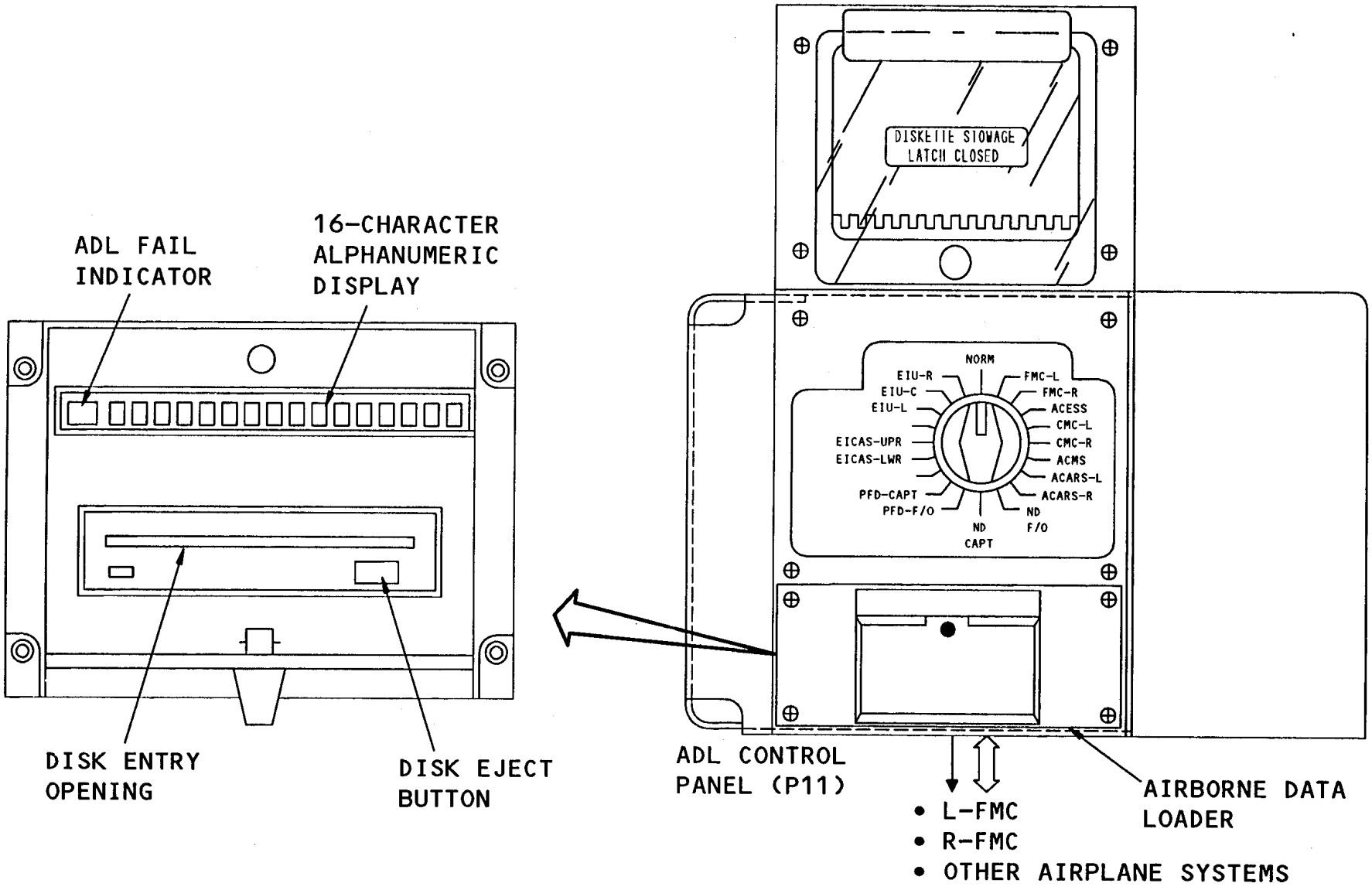


Figure 33 AIRBORNE DATA LOADER

PRIMARY FLIGHT DISPLAY DATA

General

The FMCS sends speed tape data, autothrottle mode, and drift angle to the PFD.

Speed Tape Data

The following FMCS data shows on the airspeed tape:

- Minimum Manuever Speed shows as an amber line which begins at the minimum manuever speed on the tape and extends to the stick shaker speed. minimum manuever speed is the lowest speed the FMC may use for control signals.
- High Speed Buffet Speed shows as an amber line which begins at the high speed buffet speed on the tape and extends to the maximum operating speed. High speed buffet speed is the maximum speed the FMC may use for control signals.
- Decision Speed (V1) shows as a green 'Vi' and digital readout at the top of the tape when the value of V1 is offscale. When the value of V1 is within the range of the scale, 'V1' shows next to the decision speed.
- Rotation Speed (VR) shows as a green 'VR' next to the rotation speed, or as 'R' when closer than four knots to -the decision speed.
- Landing Speed (V REF) shows as a green 'REF' next to the landing speed.
- Flap Manuever Speeds show as green digits next to the speed at which a flap setting applies. Flap retraction to zero units shows as 'UP'.
- Selected Target Speed shows as a magenta readout at the top of the tape and a magenta cursor on the tape. This data normally comes from the AFDS, but comes from the FMCS when VNAV is engaged. Selected target speed is set to the V2 value for takeoff.

Autothrottle Mode Annunciation

The autothrottle mode shows in green on the PFD in the upper left corner when the autothrottle is engaged. A green box shows around the mode for ten seconds after a mode change occurs.

Heading

The source of heading is normally selected by the onside IRS instrument source select switch, but can be changed based on data from the FMCS. At high latitudes, the FMCs each use a single IRU source. Track from one IRU may be poorly correlated with heading from a different IRU when close to the pole, if the IRU positions differ by a few miles. The PFD and ND always use heading data from the same source which the FMC is using for track.

Landing Altitude

Landing altitude shows as an amber band on the altitude tape. Landing altitude alert and caution bars extend upwards five hundred feet respectivly from the landing altitude.

Drift Angle Pointer (Track)

The source of track data is normally the selected FMC. Below 80 knots, heading data is substituded for track data. If the selected FMC is invalid, the source of track defaults to the selected IRU.

PFD Data Source Selection

Source selection of PFD data is as follows:

- Speed tape data is normally supplied by the onside FMC and the secondary source is the offside FMC
- Autothrottle mode data is supplied by the master FMC
- Drift angle data is normally supplied by the selected FMC and the selected IRU as secondary
- Landing altitude data is normally supplied by the master FMC. If the master FMC is not valid, the data comes from the cabin pressure control system.

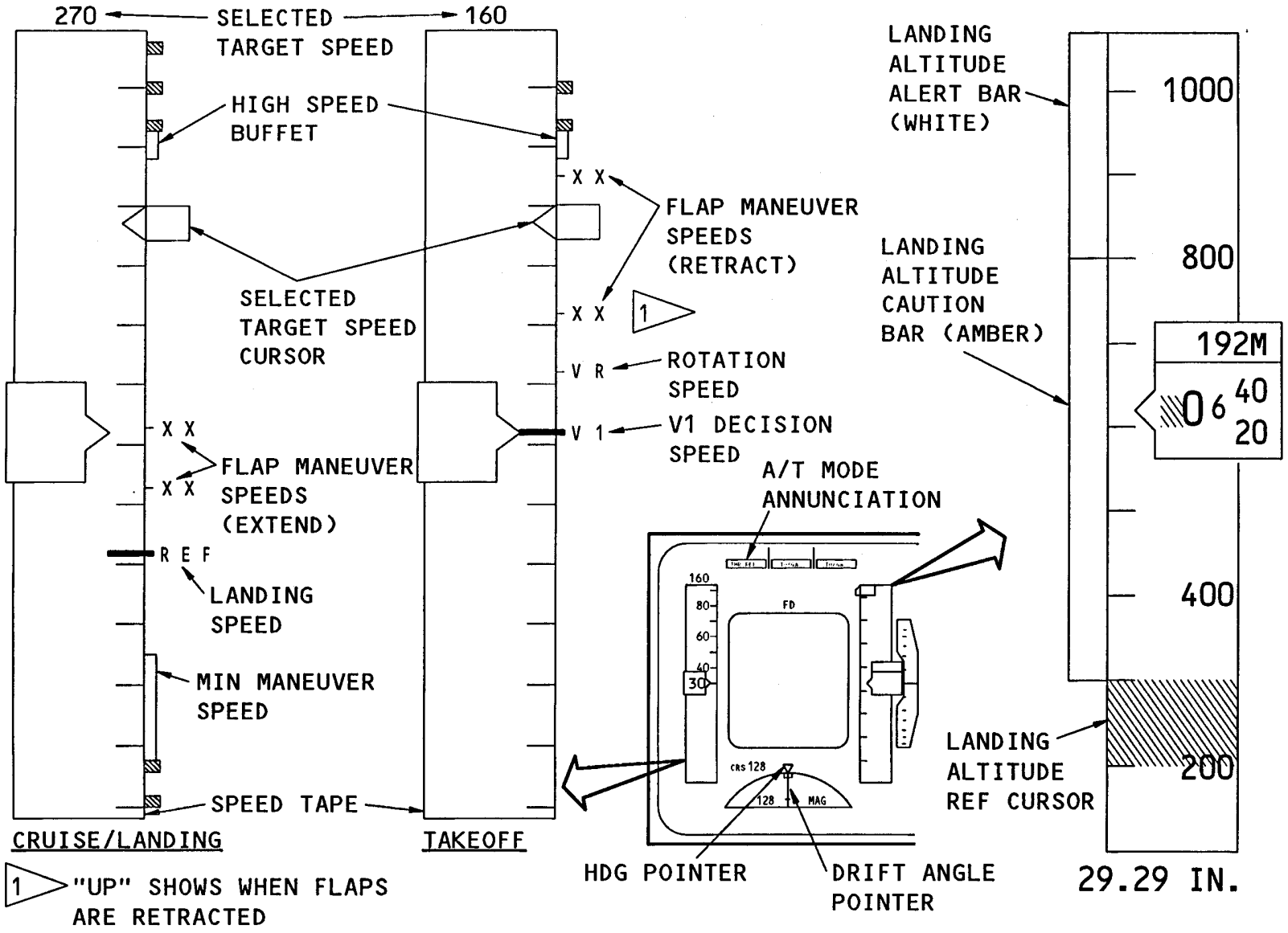


Figure 34 PFD DATA

NAVIGATION DISPLAY DATA

General

The selected FMC/CDU sends map and display data to the ND.

Track (MAG/TRU)

The source of track data is normally the selected FMC. Below 80 knots, IRS heading data is substituded for track data. If the selected FMC is invalid, the source of track defaults to the selected IRU.

The source of heading is normally selected by the onside IRS instrument source select switch, but can be changed based on data from the FMCS. At high latitudes, the FMCs each use a single IRU source. Track from one IRU may be poorly correlated with heading from a different IRU when close to the pole if the IRU positions differ by a few miles. The PFD and ND will always use heading data from the same source which the FMC is using for track.

Ground Speed

The selected FMC normally supplies this data. The selected IRU supplies this data when the selected FMC is not valid.

Wind Data

Wind data (direction, speed and angle) shows when true air speed (TAS) is greater than 100 knots and wind speed is greater than 5 knots. The selected FMC normally supplies this data. The selected IRU supplies this data when the selected FMC is not valid.

Active Waypoint

The magenta active waypoint symbol is the waypoint the airplane is flying to. When the airplane passes over the active waypoint it becomes white and the next flight plan waypoint goes from white to magenta. The source for this data is the selected FMC or the selected CDU.

Range to Altitude,

The range to altitude arc shows as the airplane approaches the mode control panel (MCP) selected altitude. The arc position is based on present flight path angle.

Vertical Deviation

The vertical path deviation scale and magenta pointer show on the right side of the ND when the airplane passes the top of descent altitude profile point. The vertical deviation scale has a full scale range of +/- 420 feet. The deviation also shows as a digital readout calibrated in 50-foot increments to a maximum of 9999 feet when the pointer is at the upper limit of the scale.

Estimated Time of Arrival (ETA)

The time that shows is when the airplane will reach the active waypoint. When a CDU is selected as the display source it shows time-to-go.

Distance To Go

The distance to the active waypoint, in nautical miles, shows below the ETA.

Altitude Profile Points

Altitude profile points are along the flight plan where the flight mode or vertical path changes. These are:

- Top of climb (TIC)
- Top of descent (T/D)
- Step climb (SIC)
- End of descent (E/D)
- Acceleration/Deceleration point

The points show as green circles.

Flight Plan

The flight plan shows in three ways:

- Active flight plan - solid magenta line
- Inactive flight plan - dashed cyan line
- Flight plan modifications - dashed white lines

Radio Update

The radio position update display shows one of these radio position update modes:

- LOC GPS (LOCALIZER GPS)
- LOC DD (LOCALIZER DME DME)
- LOC VD (LOCALIZER VOR DME)
- LOC (LOCALIZER)
- GPS (GLOBAL POSITIONING SYSTEM)
- DD (DME/DME)
- VD (VOR/DME)

IRS Position update

The IRS position update mode shows how many valid IRU inputs the FMC uses to calculate airplane position and velocity. The possible FMC IRS position update modes are:

- IRS (3)
- IRS (L)
- IRS (C)
- IRS (R)

A change to/from IRS (3) to any of the other modes causes a green (box) to show around the display for ten seconds.

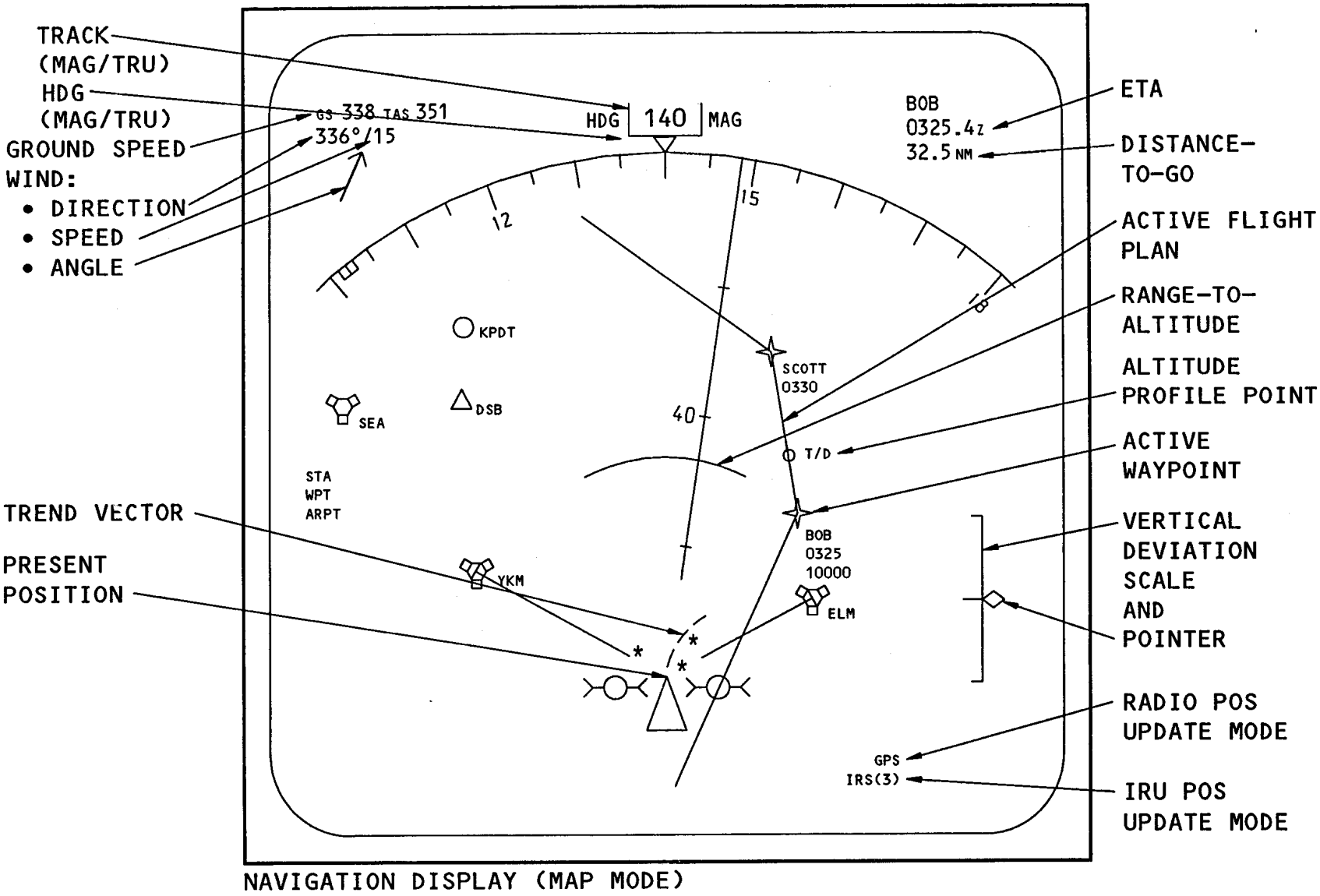
Trend Vector

The trend vector helps the pilot intercept a course/path and shows the degree of airplane turn. The trend vector shows the airplane's directional trend based on position, ground speed and cross track acceleration. The trend vector segmented line(s) shows the airplane's position in 30, 60 and 90 seconds. The map range determines how many trend vector segments show.

Map Data-Selections

Map data selector switches on the EFIS control panel add or remove data from the map display. The EFIS control panel has these selections:

- STA displays navaids.
- WPT displays waypoints and ground reference points.
- ARPT displays airports.
- DATA displays flight waypoint data.
- POS displays position check data.



NAVIGATION DISPLAY (MAP MODE)

Figure 35 NAVIGATION DISPLAY DATA

CDU MENU PAGE

General

This page provides MENU selection of the systems that use the CDU.

Page Access

The MENU page shows at CDU power-up or by pushing the MENU button.

MENU Page

The function of the page is discussed by the operation of each line:

- (1L through 6L) The appropriate system prompt is shown when the system is operational. If a system is not operational, the prompt is not shown. Select the prompt to show the system's initial page.

  When a system desires to use the CDU for communications, an EICAS message is shown. The MENU button should then be pushed to show the MENU page. When the MENU page shows, <ACT> shows beside the system that is currently using the CDU, and <REQ> shows beside the system that desires communication with the CDU.

The MENU page shows <SEL> next to <FMC at line 1L. To view one of the FMC preflight pages push line select key 1L.

- (1R) If the EFIS CP fails, SELECT> shows. Push the key and the ALT EFIS CP page shows.
- (2R) If the EFIS CP fails, SELECT> shows. Push the key and the ALT EICAS CP page shows.

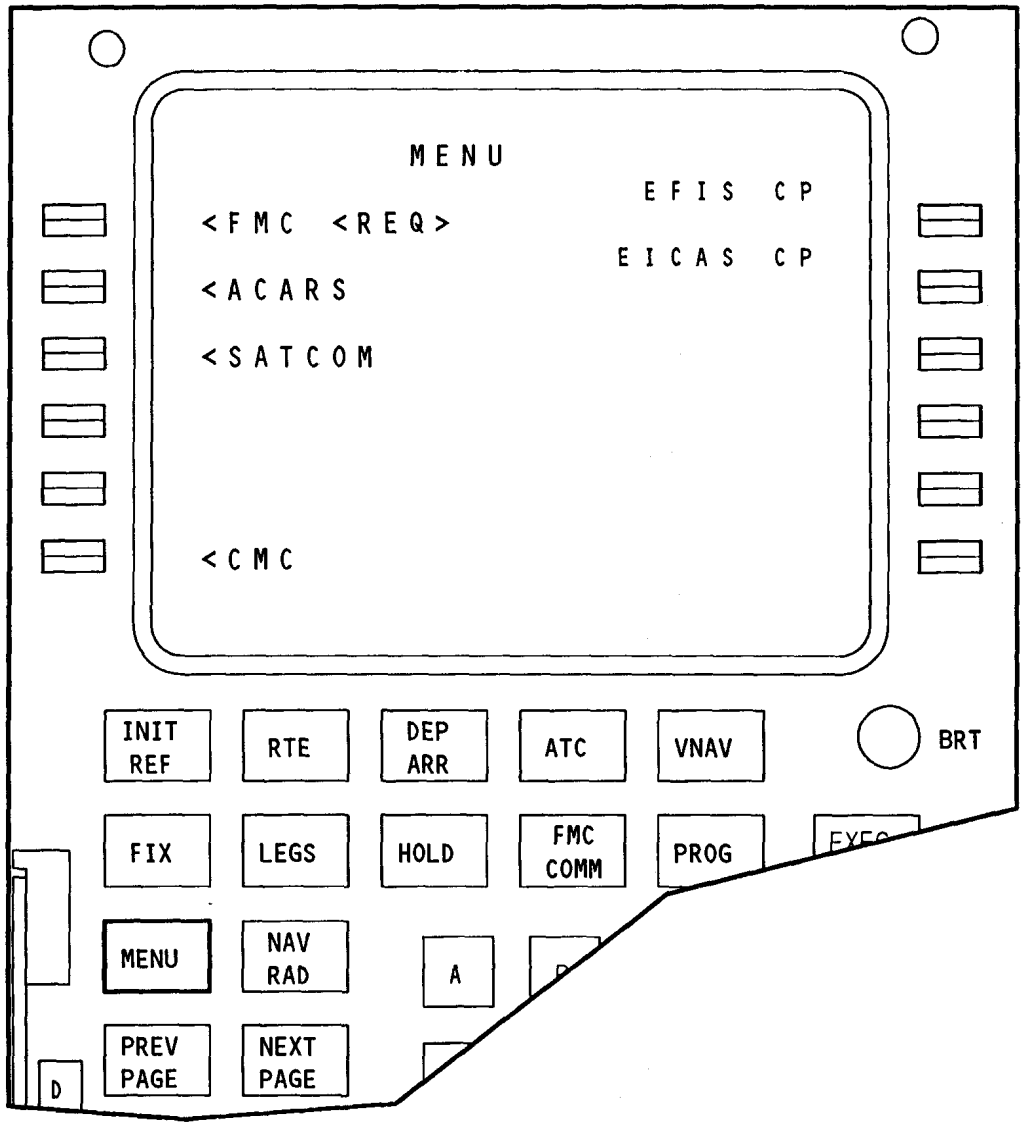


Figure 36 CDU MENU PAGE

IDENTIFICATION PAGE

General

The identification (IDENT) page allows review of the FMC data base and program configuration.

Page Access

Push these line select keys to gain access to the IDENT page:

- 1L on the MENU page
- 1L on the INIT/REF INDEX page (IDENT)

IDENT Page

The function of this page is discussed by the operation of each line:

- (1L) MODEL NUMBER is the airplane model as read from the airframe/engine program pins. If the program pins do not match the stored performance data base, the line is blank.
- (2L) NAV DATA line shows the data base identifier. If the data base did not load (receive) correctly, this line is blank.
- (4L) OPERATIONAL PROGRAM NUMBER line shows the operational program and performance data base part number. The last powered FMC locks on this page if this is different than the other FMC.
- (5L) DRAG/FUEL FLOW FACTOR line shows the fuel mileage factor assigned to drag and fuel flow, shown as a percentage. New values may not be entered on this page. However, new values may be entered by maintenance personnel on a maintenance page.
- (6L) this key selects the INDEX page.
- (1R) ENGINE IDENTIFICATION line shows the engine identification number as read from the airframe/engine program pins. If the program pins do not match the stored performance data base line is blank.
- (2R and 3R) NDB EFFECTIVITY shows the active and inactive data bases in the FMC. These two lines show the dates through which they can be used. The lines can be interchanged (by the line select keys). When this is done, the data base shown in line 2L is the active data base. Selection can only be done on the ground.
- (4R) SPARE ENG line shows in the header line and ACTIVE shows in the data line if the FMC is advised of a spare engine carry by the Air Data Computer (ADC).
- (5R) CO DATA line shows the airline policy file identifier in large font.
- (6R) POS INIT line shows the next page that needs data input for preflight completion.

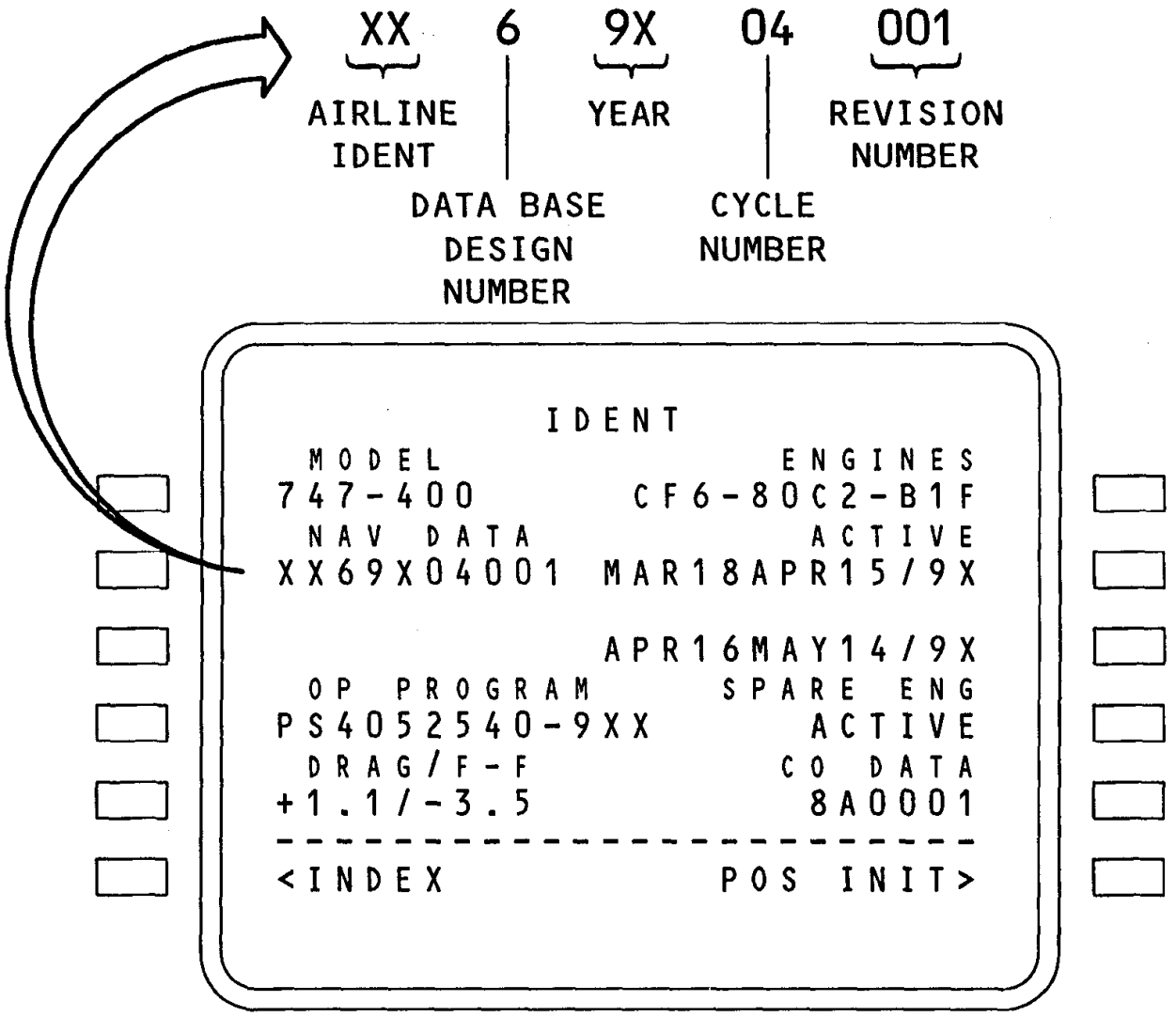


Figure 37 IDENTIFICATION PAGE

INITIALIZATION/REFERENCE INDEX PAGE

General

The initialization/reference (INIT/REF) index page provides access to the pages of data required for initialization of the FMC and IRS.

Page Access

Push the INDEX (6L) line select key on any INIT/REF page to get the INIT/REF index page.

INIT/REF INDEX Page

The function of this page is discussed by the operation of each line.

- (1L) IDENT: this key allows access to the identification page.
- (2L) POS: this key allows access to the position initialization page.
- (3L) PERF: this key allows access to the performance initialization page.
- (4L) THRUST LIM: this key allows access to the thrust limit page.
- (5L) TAKEOFF: this key allows access to the takeoff reference page.
- (6L) APPROACH: this key allows access to the approach reference page.
- (1R) NAV DATA: this key allows access to the navigation data page.
- (6R) MAINT: this key allows access to ground maintenance pages; crossload, perf factors, IRS monitor, and BITE report. This prompt is shown only on the ground.

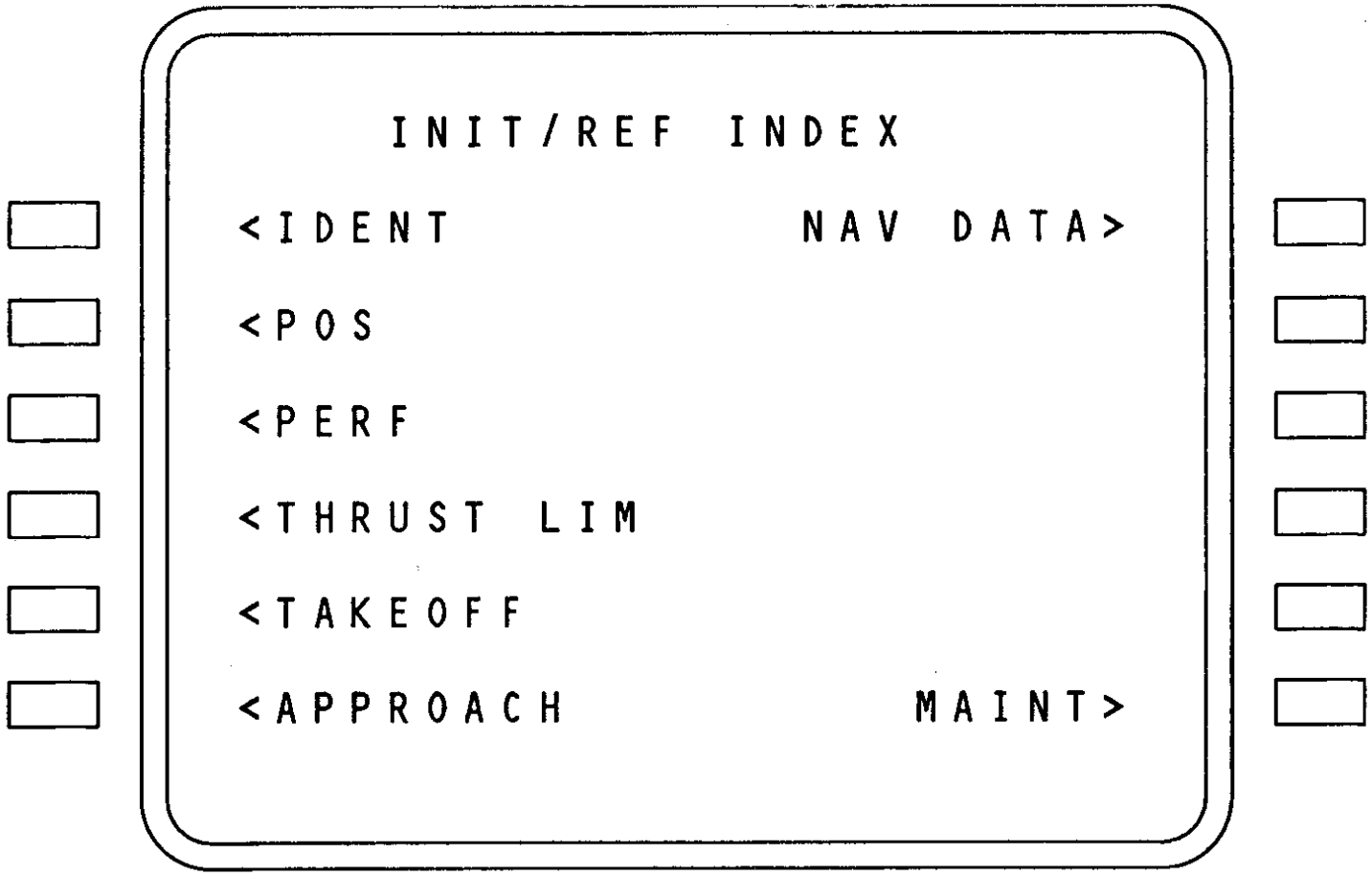


Figure 38 INITIALIZATION/REFERENCE INDEX PAGE

POS INT & POS REF PAGES

General

The position initialization (POS INIT) page provides position initialization data to the inertial reference system (IRS) for alignment.

The position reference (POS REF) pages show the current position and groundspeed as computed by the FMCS, GPS, NAV radios, and IRS. The page also shows navigation position update mode and required navigation performance (RNP), actual navigation performance (ANP), and provides the ability to inhibit the GPS or purge the radio update to the FMC position.

Page Access

To access the POS INIT page:

- Use line select key 2L (POS) on the INIT REF INDEX page.
- Use line select key 6R (POS INIT) on the IDENT page.
- Select the INIT REF mode key when on the ground and any IRS is in the align mode.
- Use line select key 6R (POS INIT) on the TAKEOFF REF page when the IRS has not been initialized.

Access to the position reference pages is by the NEXT PAGE mode key when the POS INIT page shows on the CDU.

POS INIT Page

The function of this page is discussed by the operation of each line.

- (2L) REF AIRPORT: valid entries to this line are airport identifiers stored in the NAV data base. Stored LAT/LON for the reference airport position shows on line 2R when this function is used.
- (3L) GATE: valid entries to this line are gate identifiers stored in the NAV data base for the reference airport. Stored LAT/LON for the gate position shows on line 3R when this functions is used.

POS INIT Page

- (4L) UTC (GPS or MAN): GPS time shows on this line if GPS time is valid from the left GPSSU. If the left GPSSU is not valid, time from the right GPSSU shows. If GPS time is not valid, time from the captain's clock (MAN) shows. If time from the captain's clock is not valid, time from the first officer's clock shows.
- (5L) SET IRS HDG: this line shows dashes only when an IRS is in the attitude mode. Valid entries are three digit headings. When an entry is made, the heading goes to the IRS in the attitude mode. The line shows dashes again four seconds after an input is made.
- (6L) INDEX: this key selects the INIT REF INDEX page.
- (1R) LAST POS: this line shows the FMC computed airplane position at all times. Information on this line is retained at power down.
- (2R) REF AIRPORT LAT/LON: selection of this line is allowed when a valid reference airport entry is made on line 2L.
- (3R) GATE LAT/LON: selection of this line is allowed when a valid reference gate entry is made on line 3L.
- (4R) GPS POS: this line shows the left GPSSU position if the horizontal integrity limit is less than or equal to .5 nm. If the left GPSSU exceeds this limit data from the right GPSSU shows. The line is blank if neither GPSSU is valid or both exceed the limit.
- (5R) SET IRS POS: this line shows box prompts when any IRS is in the align mode and the airplane is on the ground. Valid entries to this line are the LAT/LON from various sources on the POS INIT page or keyboard entry. Entered LAT/LON shows until the IRS enters the NAV mode, upon which this data field blanks.
- (6R) ROUTE: this line selects the MOD ROUTE, ACT ROUTE, OR ROUTE 1 page.

POS REF Page 2

- (1L) FMC POS (GPS L, GPS R, LOC GPS L, LOC GPS R, LOC DD, LOC VD, LOC, or RADIO): this line shows the current FMC computed airplane position and the update mode.
- (2L) IRS (3, L, C, or R): this line shows the IRS position currently used by the FMCs and the IRS update mode.
- (3L) RNP/ACTUAL: this line shows the required navigation performance followed by the actual navigation performance. Manual entries of RNP are allowed on this line. Manual entries show in large font. Default values of RNP are based on stored values determined by flight phase. Actual navigation performance values show which are based on the position update mode.
- (5L) PURGE: selection of this line results in the dynamic display of the IRS position (2L) in line 1L, and the corresponding accuracy in line 3L. CONFIRM then shows on line 5L. Selection of CONFIRM causes the FMC position to revert to the IRS position.Leaving this page with CONFIRM showing causes the purge function to dis-arm.
- (6L) INDEX: this line selects the INIT REF INDEX page.
- (1R and 2R) GS: this line shows the ground speeds for the positions on lines 1L and 2L.
- (3R) NAV STA: this line shows the identifiers for the navigation stations currently being used for radio update. The header of this line shows the current radio update mode.
- (5R) GPS NAV: selection of this line inhibits the use of GPS data for position updating, and causes ENABLE to show. Selection of ENABLE enables GPS updating to resume.
- (6R) BRG/DIST: selection of this line causes the positions on line 2L, and lines 1L through 5L on the position reference page 3, to show in bearing distance format relative to the FMC position. This line then changes to LAT/LON. Selection of LAT/LON returns the displays to latitude/longitude format.

POS REF page 3

- (1L through 5L): these lines show the positions for the specified systems. These positions may be selected to the scratch pad.
- (6L): this line selects the INIT REF INDEX page.
- (1R through 5R): these lines show the ground speeds for the specified systems.
- (6R) BRG/DIST: selection of this line causes the positions on lines
- 1L through 5L and line 2L on POS REF page 2, to show in bearing distance format relative to the FMC position.

This line then changes to LAT/LON. Selection of LAT/LON returns the displays to latitude/longitude format.

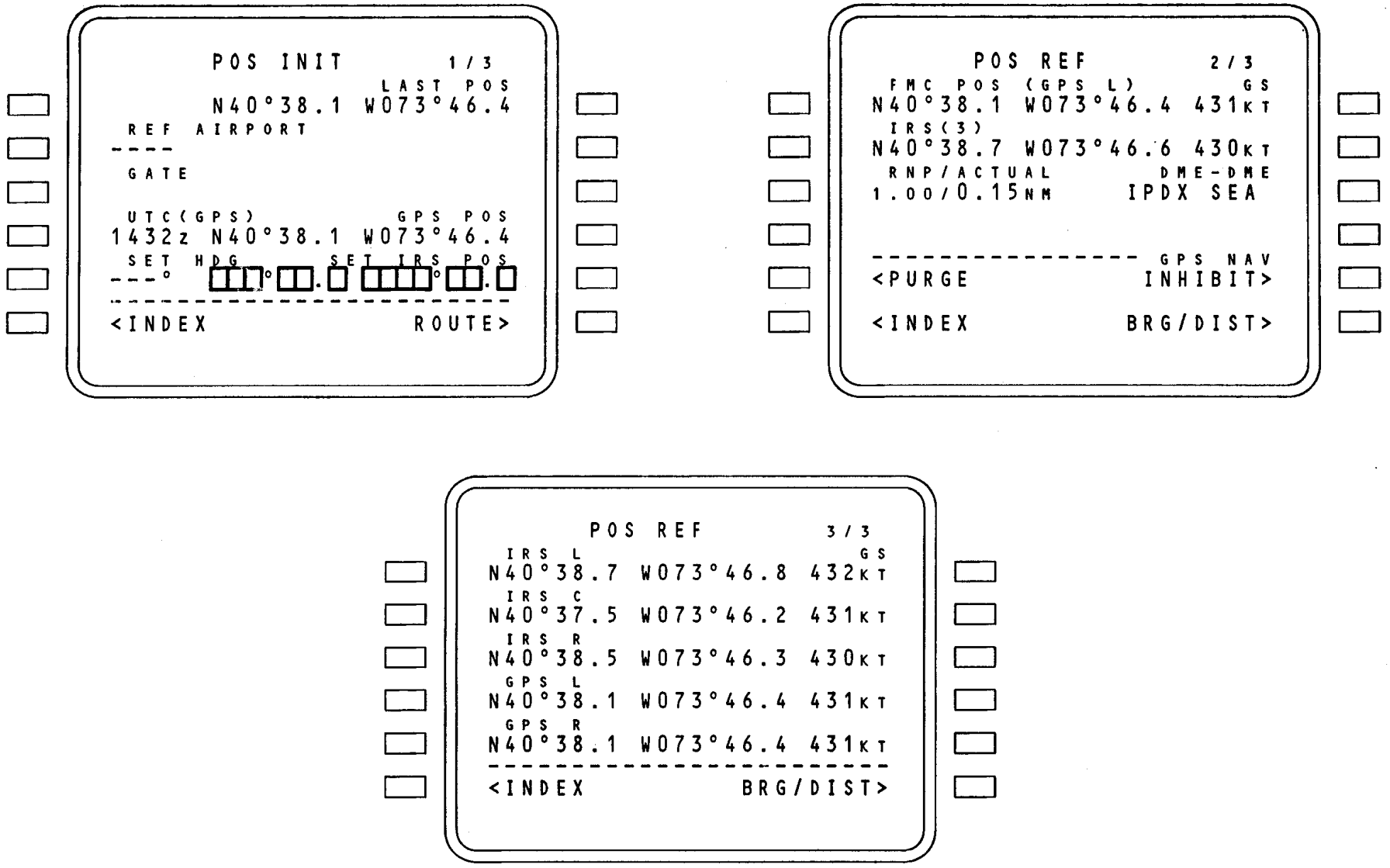


Figure 39 POS INI & POS REF PAGES

ROUTE PAGES

General

The route (RTE) pages let the flight crew enter up to two routes into the FMCs. The route page also lets the flight crew make a request for or report a flight plan via the airline operational communications data link.

Page Access

To access the route page:

- Select the RTE mode key.
- Line select ROUTE from the POS INIT, POS REF, TAKEOFF REF, or FMC COMM pages.
- Line select RTE 1 from the RTE 2 page.
- Line select RTE from the DEP/APR pages.

RTE Page 1

The function of this page is discussed by the operation of each line:

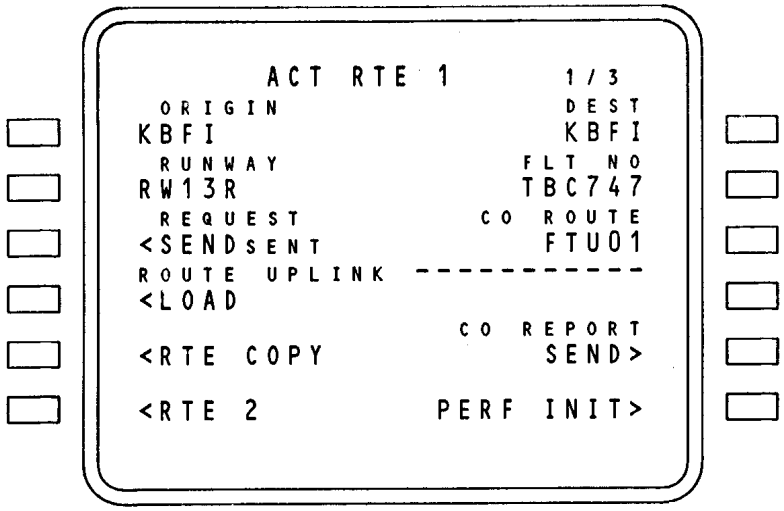
- (1L) ORIGIN: this line initially shows box prompts. Valid entries are airport identifiers in the NAV data base. A change of the origin airport to the same or other airport will clear the route if one is entered. When the airplane is in the air, the origin airport can not be changed.
- (2L) RUNWAY: valid entries to this line are runways for the origin airport.
- (3L) ROUTE REQUEST: push this line select key to initiate a route request. SENDING shows until network acknowledgement is received. After acknowledgment is received, SENT shows in small font next to SEND. If the data link status is no comm, voice or fail, the data field title line shows DATA LINK and the data field shows NO COMM, VOICE, or FAIL.
- (4L) ROUTE UPLINK LOAD: this data field shows when a flight plan uplink is received. Selection of LOAD will cause the uplinked flight plan to be loaded into the displayed route (RTE 1 or RTE 2).
- (5L) RTE COPY: selection of this line select key will cause the active route to be copied to the inactive route. Any flight plan in the inactive route will be replaced by this action. COMPLETE shows when this function is finished.
- (6L) RTE 2: this line selects the ROUTE 2 page. When an active route is modified, ERASE shows to allow the modification to be cancelled.
- (1R) DEST: initially this line shows box prompts. Valid entries to this line are airports in the NAV data base.
- (2R) FLT NO.: the flight number may be entered into this data field. This flight number will show on the progress page and the ATC STATUS/LOGON page and also will be output to other systems.
- (3R) CO ROUTE: entries to this line may be company route identifiers in the NAV data base. Entry results in the route being loaded into the
- route page. Any previously entered flight plan will be cleared through this action. If the company route is not in the NAV data base, entry is allowed, and will be included in the route request when sent.
- (4R) ROUTE UPLINK PURGE: this line shows when an inactive route uplink is received. Select PURGE to clear the data from the FMCs.
- (5R) COMPANY REPORT: selection of this line initiates a flight plan downlink report. Initially this line shows SEND. SENDING shows until network acknowledgement is received. After acknowledgement is received, SENT shows in small font preceeding SEND. This line is blank if there is no active route.
- (6R) ACTIVATE: selection of this line will activate the route shown on the page. The EXEC key lights, and line 6L changes to ERASE upon selection. Push the EXEC key to make the route active or push ERASE to de-activate the route. After activation this line shows PERF INIT if the performance initialization is not complete. Select PERF INIT to show the performance initialization page. TAKEOFF shows on the ground when the performance initialization is complete. Select TAKEOFF to show the takeoff reference page. In the air this line shows OFFSET. Valid entries to this line are left or right lateral offsets of up to 99 nm. Entry of 0 or deleting the line cancels the offset. Push the EXEC key to execute this change to the flight plan.

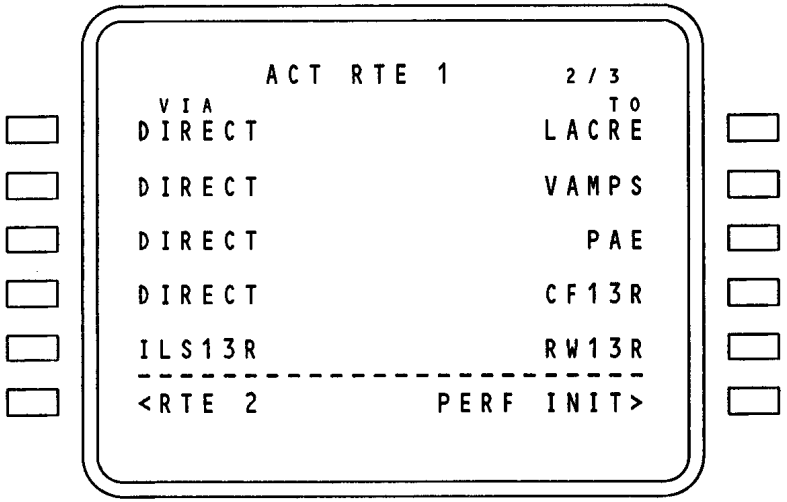
RTE Pages 2/XX

The following route pages show the waypoints of the flight plan. The flight crew can initiate a direct to or intercept function by changing the waypoint on the first line. This action will cause the EXEC key to light. Push the EXEC key to then make this change to the flight plan.

The format of the pages shows the waypoints on the right side of the page and the method of connecting the waypoints on the left. The VIA may show DIRECT, airways, or SIDS or STARS routing. Route discontinuities show as box prompts. Fill the box prompts with an entry to remove the discontinuity.

The 6L and 6R lines are the same as previously discussed.





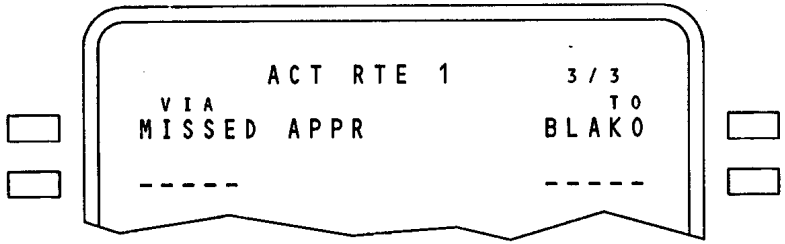


Figure 40 ROUTE PAGES

DEPARTURE/ARRIVAL INDEX

General

The departure/arrival (DEP/ARR) pages help to build a flight plan route. The pages give a menu of the departure and arrival procedures for the origin and destination airports. When a procedure is selected, it is put directly in the route.

Page Access

To access this page:

- Push INDEX line select from DEPARTURE or ARRIVAL page
- Push DEP/ARR mode key when no flight plan is active, or if an inactive RTE or LEGS page is presently shown

DEP/ARR Index

The function of this page is discussed by the operation of each line.

- (1L) < DEP: this key selects the departure page for the origin of RTE 1.
- (3L) < DEP: this key selects the departure page for the origin of RTE 2.
- (6L) DEP: this key selects the departure page for the airport identifier entered in the scratch pad.
- (1R) ARR >: this key selects the arrival page for the origin of RTE 1.
- (2R) ARR >: this key selects the arrival page for the destination of RTE 1.
- (3R) ARR: this key selects the arrival page for the origin of RTE 2.
- (4R) ARR: this key selects the arrival page for the destination of RTE 2.
- (6R) ARR: this key selects the arrival page for the airport identifier entered in the scratch pad.

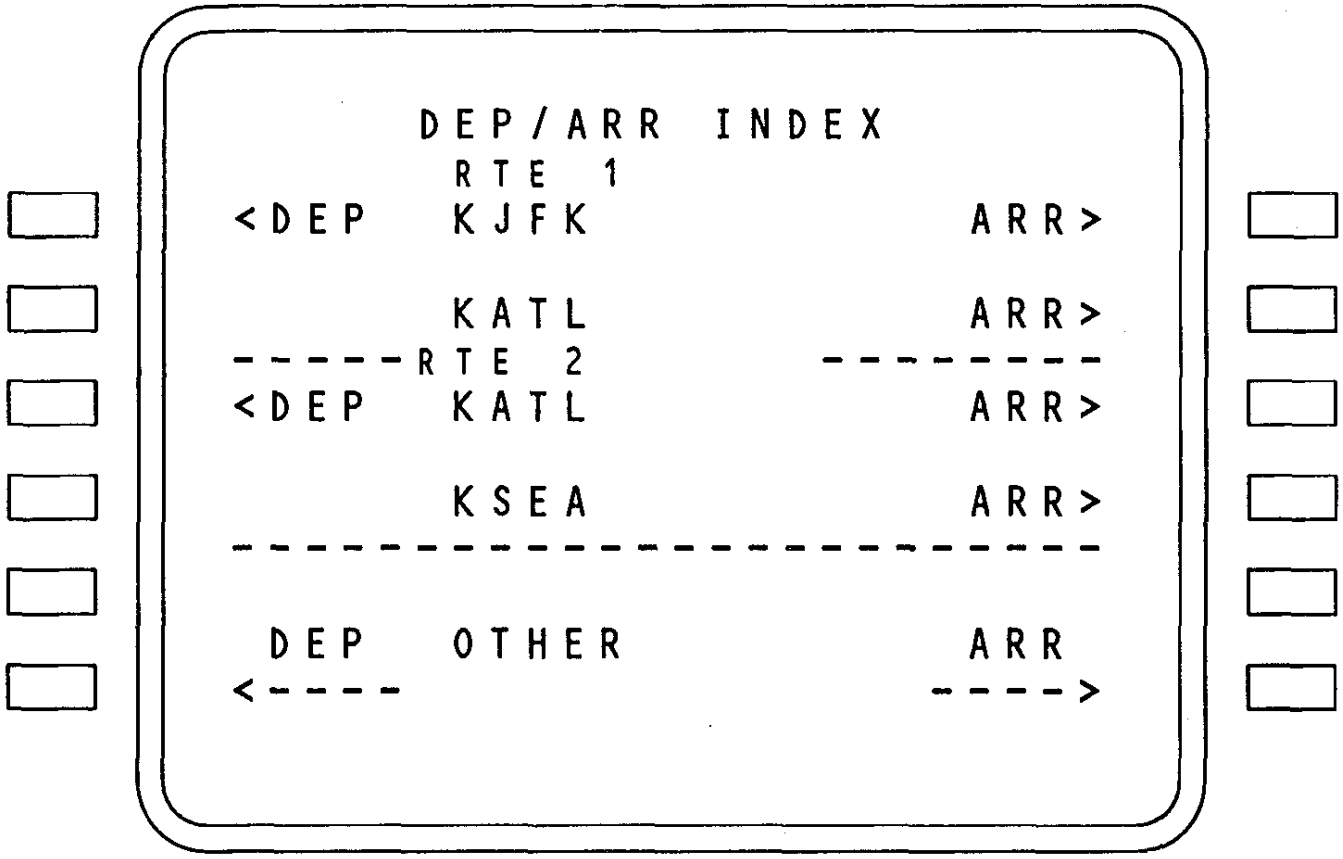


Figure 41 DEPARTURE/ARRIVAL INDEX

DEPARTURES PAGE AND ARRIVALS PAGE

General

These pages give departure procedures from the selected origin airport and arrival procedures to the selected destination airport.

Page Access

To access the DEPARTURE page, select the DEP/ARR mode key when the airplane is on the ground if there is an active route..

To access the ARRIVAL page, select the DEP/ARR mode key when there is an active route and the airplane is in the air. When the airplane is less than 400 nm from the departure airport, or less than halfway along the active route (whichever is least), arrival procedures for the departure airport show. otherwise, arrival procedures for the destination airport show on the display.

Departures Page

The function of the page is discussed by the operation of each line.

- (L through 5L) When the page is initially shows, standard instrument departures (SID) in the data base for the specified airport are shown. SEL or ACT labels show that a SID is already in the route. If a runway is selected, only the SIDs related to that runway are shown. Selection of a SID results in display of the departure page (that SID is shown on line 1L). SEL shows it is selected. A list of route transitions related to that SID are also shown (starts on line 2L). Selection of a transition results in display of the departure page with the transition shown on line 2L. SEL shows it is selected. The EXEC switch light comes on if it is not already on.
- (6L) INDEX: line selection of the INDEX prompt results in the display of the DEP/ARR INDEX page.
- ERASE: the ERASE prompt shows after selection has occurred and before the EXEC switch is pushed. Select the ERASE prompt to remove any selections made from this page since the last EXEC action.
- (1R through 5R) When this page initially shows, runways in the data base for the specific airport are shown. SEL or ACT labels show that there is a runway already in the route. If a SID is selected, only the runways related to that SID are shown.

Selection of a runway results in display of the departure page with that runway shown on line 1R. SEL shows it has been selected. All SIDS related to the selected runway are also shown. The EXEC switch light will-come on if it is not already on.

- (6R) ROUTE: select this key to show the RTE 1 or 2 page.

Arrivals Page

This page is nearly the same as the DEPARTURES page. The difference is that this page has arrivals to the destination airport and standard terminal arrival routes (STARs).

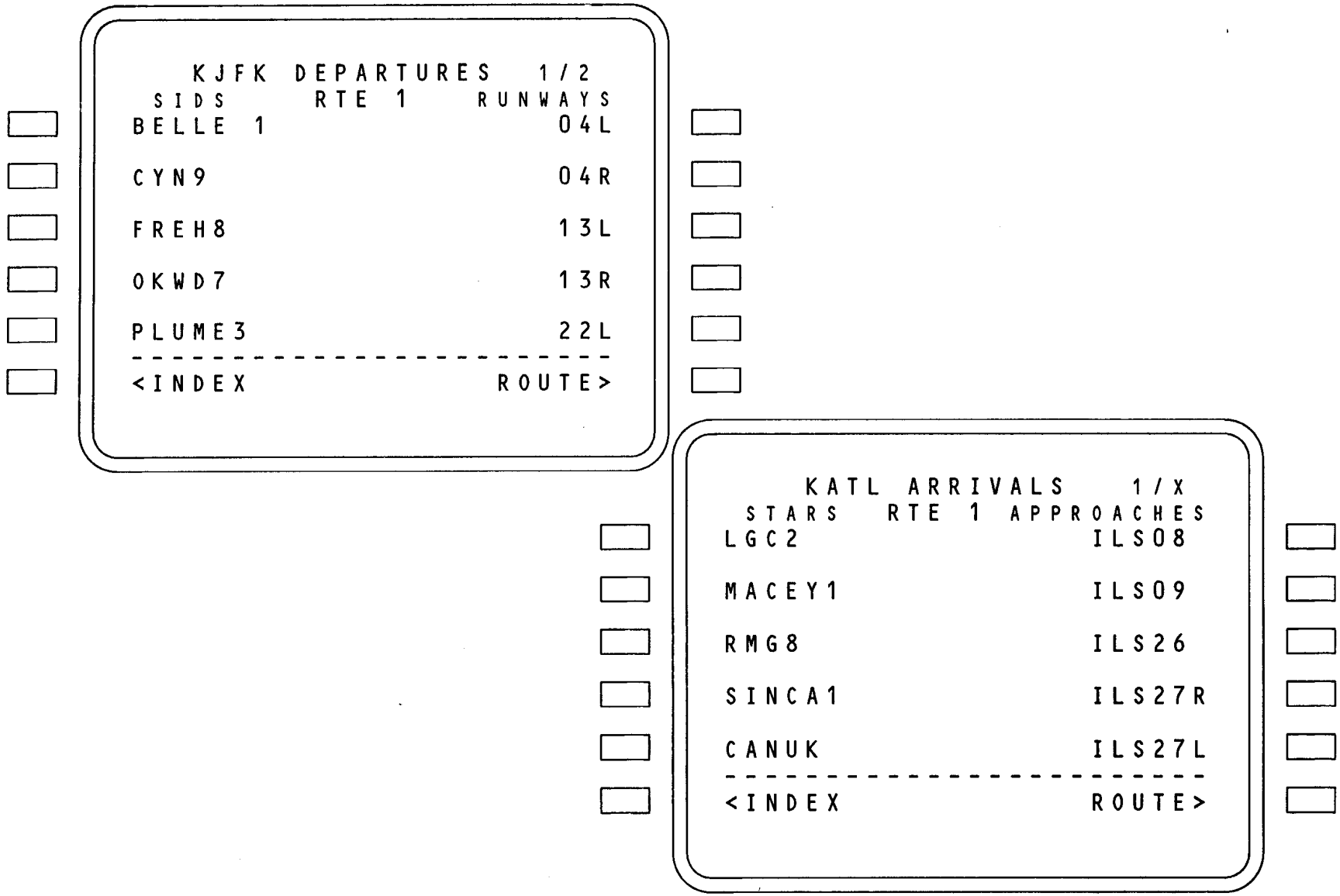


Figure 42 DEPARTURES PAGE AND ARRIVALS PAGE

PERFORMANCE INITIALIZATION PAGE

General

The performance initialization (PERF INIT) page is used for initialization of the FMC for performance (VNAV) calculations. It is part of the preflight sequence.

Page Access

To access the PERF INIT page:

- Push the INIT/REF mode key on the ground when the IRS position has been initialized
- Push the PERF INIT line select key from the ACT RTE or TAKEOFF REF pages
- Push the PERF line select key from the INDEX page

PERF INIT Page

The function of this page is discussed by the operation of each line.

- (1L) Gross weight (GR WT) entered on this line results in calculation and display of zero fuel weight on line 3L. This line goes blank when fuel weight is not valid.
- (2L) FUEL: this line normally shows the FMC calculated (CALC) fuel quantity. When the airplane is on the ground before engine start, the FMC calculated fuel quantity is set equal to the airplane fuel totalizer system value.

After engine start, the calculated fuel quantity comes from the totalizer value minus the integrated fuel flow. If at any time the fuel flow values become invalid for greater than 2 minutes, the calculated value will be invalid. The fuel totalizer system value is then used for FMC calculations and shows in line 2L as SENSED. Also, if there is a difference of more than 9000 pounds (4091 kilograms) between the calculated fuel quantity and the fuel totalizer system value, the value shown will be the SENSED fuel totalizer system value.

Entry results in the display of this value as a MANUAL value. The MANUAL entry is then updated by integrated fuel flow.

Box prompts show when fuel quantity is invalid prior to engine start at 2L. MANUAL shows at 2L when a scratch pad entry is completed.

manual entry of a fuel quantity value will have priority over the fuel totalizer system input until the flight is completed.

- (3L) ZERO FUEL WT: entry into this line results in the calculation and display of gross weight (line 1L).
- (4L) RESERVES: this line shows prompt boxes until a value is entered.
- (5L) COST INDEX: box prompts are shown on this line unless a company route is entered that has this cost index number, or a manual entry. This number may be changed.
- (6L) INDEX: this key selects the INIT/REF INDEX page.
- (1R) CRZ ALT: entry into this line is made from this page or from the climb or cruise pages. Change of altitude on this page is not allowed when the airplane is in the air.
- AR) CRZ CG: this line shows the default or pilot entered cruise CG value. The default value comes from the performance data base, and shows in small font. Manual entries show in large font.
- (5R) STEP SIZE: this line shows the climb altitude increment that is used for the optimum step profile. Entries are from 1000 feet to 9000 feet. The default value is ICAO.
- (6R) THRUST LIM: selection shows the thrust limit page.

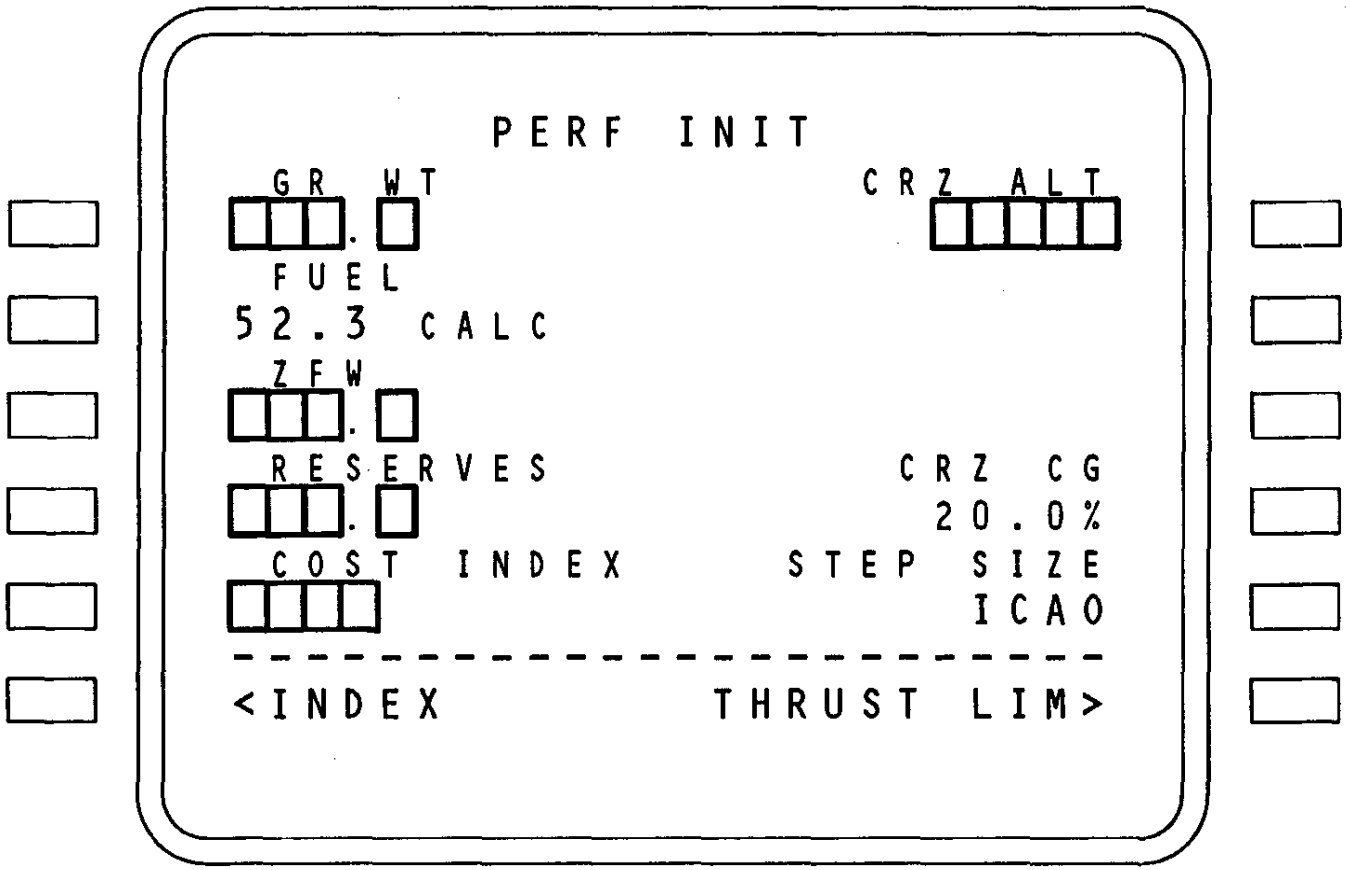


Figure 43 PERFORMANCE INITIALIZATION PAGE

FMCS - THRUST LIMIT PAGES

General

The thrust limit (THRUST LIM) page allows selection of thrust limit modes. It also has the capability to derate the engines for reduced thrust.

Page Access

When the airplane is on the ground or has a TO thrust limit mode selected, this page can be selected from INIT/REF INDEX, PERF INIT, TAKEOFF REF or APPROACH REF pages.

THRUST LIM Page (GROUND or TAKEOFF Mode)

The function of this page is discussed by the operation of each line:

- <SEL> shows for the present thrust limit mode (also shown on EICAS).
- <ARM> shows for the appropriate climb thrust limit mode when a takeoff thrust limit is selected (<SEL>).
- (1L and 1C) SEL and OAT shows outside air temperature in OC from the ADC. Line IL shows the entered assumed temperature for thrust derate. Temperature entry is in degrees centigrade or degrees Fahrenheit (if followed by an F).
- (2L through 5L) TO, TO 1, and TO 2 shows selected (<SEL>) status of the takeoff (TO) or derated takeoff (TO 1 or TO 2) thrust limit modes. These may be selected when on the ground. TO mode is automatically selected on the ground.
- The fixed percentage TO 1 and TO 2 derates may be changed from 0-30%. To do this go to the PERF FACTORS page, arm it and enter the values on line 3L.
- (6L) INDEX selects the INIT/REF INDEX page.
- (1R) THRUST MODE, EPR LIMIT shows the selected thrust limit calculated by the FMC thrust management function. Entry of a temperature in 1L that reduces the thrust limit causes a D to show in the header line and on the main EICAS display.
- (2R through 4R) CLB, CLB 1 and CLB 2 shows arm (<ARM>) status of the climb or derated climb thrust limit when a takeoff mode is selected (<SEL>). The armed climb mode becomes selected <SEL> at the thrust reduction altitude. (The thrust reduction altitude is displayed on the TAKEOFF REF page). If the airplane is above 400 feet AGL, push the thrust button on the MCP to change the armed <ARM> CLB mode to selected <SEL>.
- (6R) TAKEOFF selects the TAKEOFF REF page.

THRUST LIM Page (Airborne)

Most line select keys for this page are the same as the ground or takeoff mode THRUST LIM page except:

- (2L) GA selects the go-around thrust limit mode. The go-around thrust limit mode is automatically selected during approach.
- (3L) CON selects the maximum continuous thrust limit for the thrust limit mode.
- (4L) CRZ selects cruise (CRZ) as the thrust limit mode. If it shows on the PERF FACTORS page, CRZ is automatically selected after FMC mode transition at top of climb (T/C) if VNAV is engaged.
- (6R) APPROACH selects the APPROACH REF page.

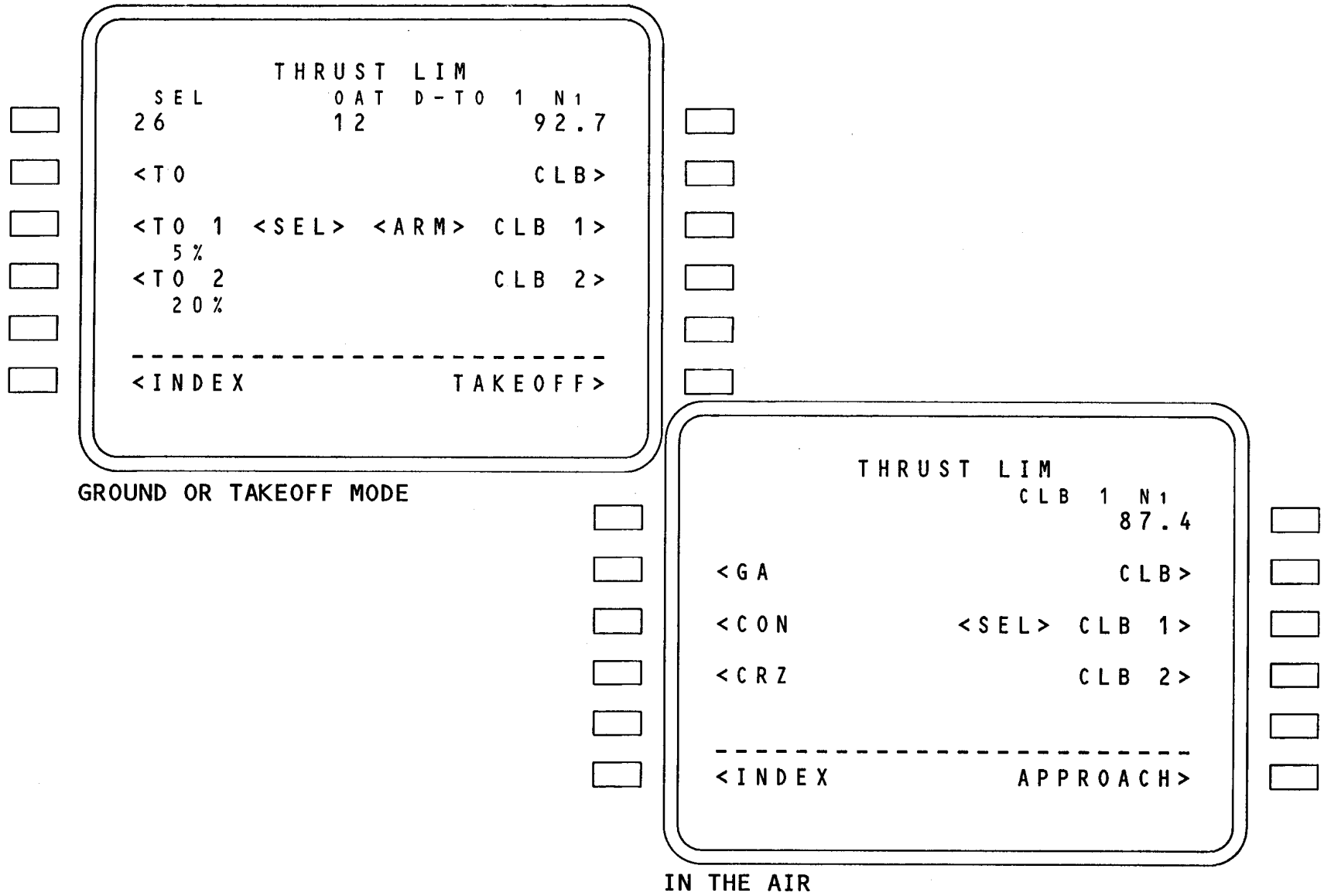


Figure 44 THRUST LIMIT PAGES

TAKEOFF REFERENCE PAGES

General

Entry or validation of takeoff speeds (V1, Vr, V2) center of gravity (CG) and takeoff flaps is done on the TAKEOFF REF page. The takeoff speeds are calculated by the FMC for nominal conditions (no wind, zero slope and dry runway). The calculated values are validated by selection of the key next to the value or they are changed by entry of other values. The validated or manually entered speeds are sent to the PFD for display on the speed tape.

The center of gravity (CG) and gross weight are used to calculate a stabilizer position that is sent to the modular avionics warning electronic assembly (MAWEA) for the green band check.

The ACCEL HT is the height where acceleration begins for flap retraction for all engine or engine out operations.

-The completion status of the preflight sequence shows at the bottom of the page. If the preflight sequence is not

complete, a line shows PRE-FLT. Prompts below this line show the CDU page where preflight data is not complete. The order of the prompts are:

- POS INIT > shows until a valid IRS position is entered.
- ROUTE > shows until a route is activated.
- PERF INIT > shows until gross weight or zero fuel weight, reserves, cost index and cruise altitude are entered.

Page Access

Access to the takeoff reference page is by TAKEOFF line selection from:

- INDEX page
- PERF INIT page
- RTE page
- THRUST LIM page

TAKEOFF REF Page

The function of this page is discussed by the operation of each line:

- (1L) FLAP/ACCEL HT shows the takeoff flap setting and when acceleration begins for flap retraction. Display initially shows prompt boxes for flap setting and a small font default height value. Valid entry or selection shows in large font. Valid flap entries are flaps 10 or 20. Height is entered as hight above airport elevation, and valid entries are 400 to 9999.
- (2L) E/O ACCEL HT shows the height where acceleration begins for flap retraction for engine out operation. Display initially shows the small front value. Entry shows in large font. Valid entries are 400 to 9999. Deletion puts the default height in small font.
- (3L) THR REDUCTION shows the altitude (AGL) or flap position when the thrust limit automatically change from takeoff limit to the selected climb limit. A default value initially shows in small font.

Entries have priority over the default value in large font. Deletion of the entered value changes the display to the default value. Entries can be 400 to 9999. The only allowable flap setting is 5 degrees. Entry of 5 in line 3L results in the display of FLAPS 5.

CLB shows to the right of FLAPS 5 in the diagram. This shows the climb thrust limit mode is armed to engage at the thrust reduction altitude or flap position. This armed climb mode is selected from the thrust limit page and can be CLB, CLB 1 or CLB 2.

- (6L) INDEX selects the INIT/REF INDEX page
- (1R through 3R) (V1, VR, V2 show FMC computed values of (V1, VR and V2 in small font when valid gross weight (large font), runway identifier, flap input 1L (Takeoff Ref page) and a thrust limit show in 1R of the Thrust Limit page. Line selection of a valid pilot entry into any of these fields (1R through 3R) or selecting 1R through 3R when the scratch pad is empty causes the speed in large font without a caret.
- (4R) TRIM CG shows with dashes when no data is entered. Valid entries are whole numbers of CG shown as a percentage of mean aerodynamic cord (MAC). The range of entry is 0 to 40. The FMC also computes the stabilizer position (TRIM). If the calculated TRIM is in the stab trim green band range in the performance data base, TRIM shows in small font. Otherwise, the TRIM field is blank. Also, this display goes blank after takeoff.

- (5R) POS SHIFT shows the runway and pilot entered distance of the takeoff brake release point from the runway threshold. Entry of the runway shift value is made in hundreds of feet. The FMC calculates the LAT and LON of the brake release point with the entered value. This position is used to update the FMC position of the airplane when the goaround switch is pushed to start the takeoff mode.
- (6R) THRUST LIM shows when the pre-flight sequence is completed. When pushed, this selects the THRUST LIM page. The header line to this field shows PRE-FLT until all of the pre-flight ranges are complete and then shows dashes. The data line shows prompts to go to the first page. The first page then requires data entry to complete the pre-flight sequence. All data fields are held when the airplane is in the air and are removed at flight completion or by a long-term power interrupt.

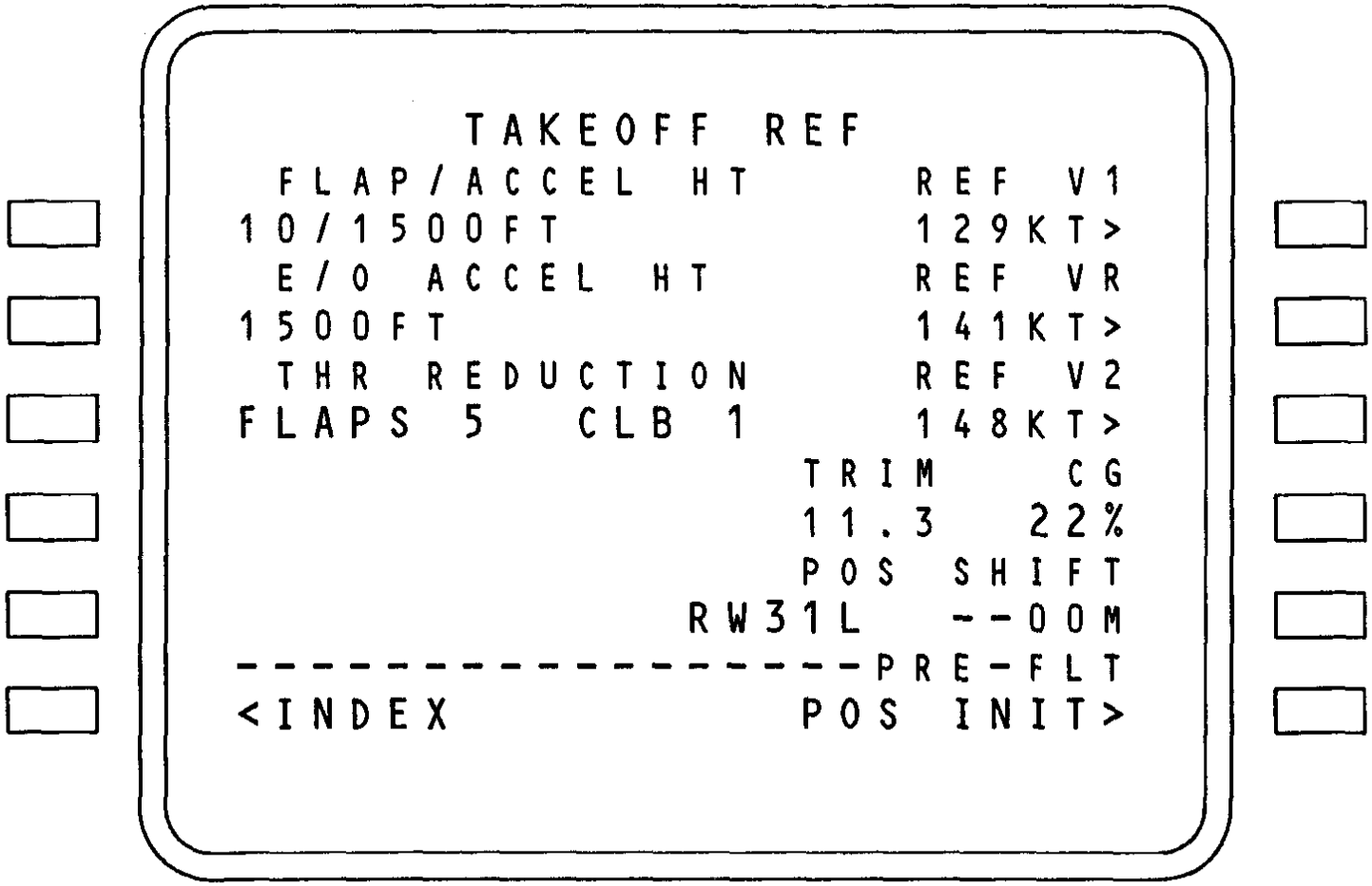


Figure 45 TAKEOFF REFERENCE PAGES

APPROACH REFERENCE PAGE

General

The approach reference (APPROACH REF) page shows reference data for the approach.

Page Access

For access to the page, push the APPROACH prompt from the INDEX page or push the INIT/REF mode key (on the CDU) when a climb mode is not active.

APPROACH REF Page

The function of the page is discussed by the operation of each line.

- (1L) GROSS WT: this line shows the calculated gross weight. If calculated gross weight is not valid, box prompts are shown.
- (4L) RUNWAY LENGTH: this line shows the runway length in feet and meters for the origin airport up to 400 nm along the route, or before the halfway point to the destination, whichever is less. It shows the runway for the destination after more than 400 nm or beyond the halfway point, whichever is less.
- (6L) INDEX: this key selects the INIT/REF INDEX page.
- (1R through 3R) VREF: these lines show the calculated VREF up to three flap settings. These displays are blank unless a valid gross weight is in 1L. The line select in either field when the scratch pad is empty is used to select the flap setting/speed to the scratch pad for entry into 4R.
- (4R) FLAP/SPEED: this field initially shows dashes until data is entered. A speed or flap setting/speed is entered to show which speed is to be used for landing. The speed is also shown on the PFD speed tape.

When data is removed from this field, data will also be removed from the speed tape and the field will again show dashes.

- (6R) THRUST LIM: this key selects the THRUST LIM page.

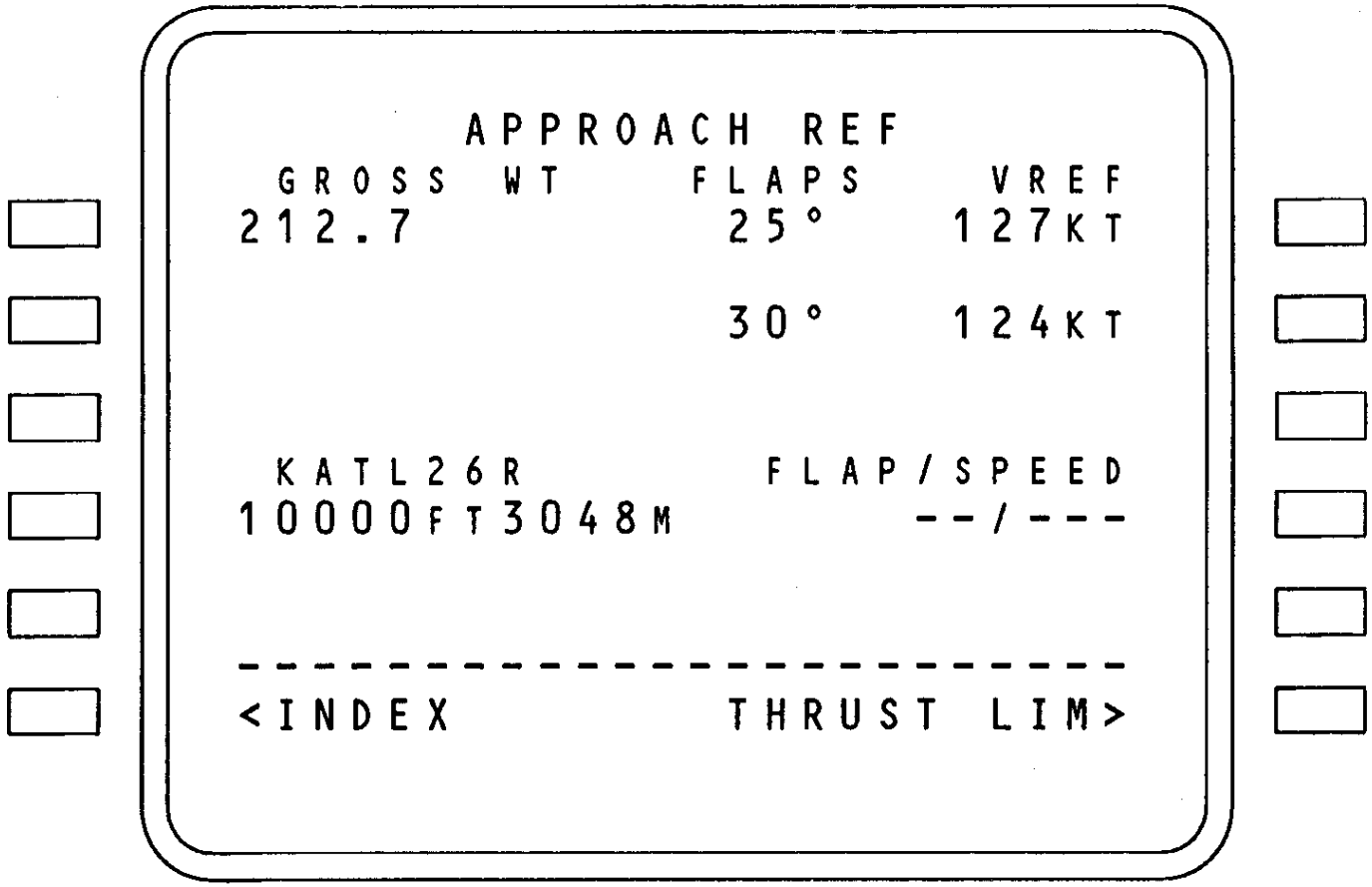


Figure 46 APPROACH REFERENCE PAGE

REFERENCE NAVIGATION DATA PAGE

General

This page shows additional data about a selected waypoint, navaid, airport, runway or route that resides in the navigation data base. This page can also inhibit the use of specific navaids for position updating and inhibit VOR/DME position updating.

Page Access

To access the page, push the REF NAV DATA line select key from the INIT/ REF INDEX page.

REF NAV Data Page

The function of this page is discussed by the operation of each line.

- (1L) IDENT: shows dashes initially. Enter a valid waypoint, navaid, airport, or destination runway to show the related information. If the entry is not valid, the message NOT IN DATA BASE shows in the scratch pad. Push the clear key or leave and return to the page to clear the scratch pad message.
- (2L) Latitude: this line shows the latitude of a navaid, waypoint, airport, or runway in line 1L.
- (3L) MAG VAR or LENGTH: if the identifier in 1L is a navaid, this line shows the magnetic variation of the navaid. If the identifier in 1L is a runway, this line shows the runway length. For other entries in 1L, this line and the header line is blank.
- (4L/4R) NAVAID INHIBIT: shows dash prompts initially. An entry of a navaid on this line inhibits its use for navigation position updating. Entry of two VORs, VOR/DMEs, VORTACs, or DMEs is possible with these keys. Entry/delete to a line that shows a navaid removes the inhibit of the navaid. Long term power interrupt or flight completion clears all entries. A navaid entry at 4L/4R is not inhibited from manual, route or procedure tune capability.
- (5L/5R) VOR ONLY INHIBIT: shows dashes initially. An entry of a navaid on this line inhibits its use for navigation position updating. Entry of up to two VORs is possible using these keys. Entry or a delete to a line that shows a navaid removes the inhibit of the navaid. A long term power interrupt or flight completion clears all entries. A navaid entry at 5L/5R is not inhibited from manual, route or procedure tune capability.
- (6L) INDEX: push to return to the INIT/REF index.
- (1R) FREQUENCY: if the identifier in line 1L is a navaid this field shows the navaid's frequency. Otherwise this field is blank.
- (2R) LONGITUDE: this line shows the longitude of the navaid, waypoint, airport, or runway threshold in 1L.
- OR) ELEVATION: shows elevation of the navaid, airport, or runway threshold in line 1L. For waypoints entries in 1L this field is blank.
- (6R) VOR/DME NAV: when the inhibit prompt shows, selection of this key inhibits VOR/DME radio position update and changes the prompt to ENABLE. When the ENABLE prompt shows, ALL shows in 5L and 5R in small font. Entries in this line overwrites the present navaid identifier shown in 5L or 5R. Selection of this key when ENABLE shows, enables VOR/DME update, returns the prompt to INHIBIT and returns 5L and 5R to dash prompts. Status is kept through flight completion and power interrupts.

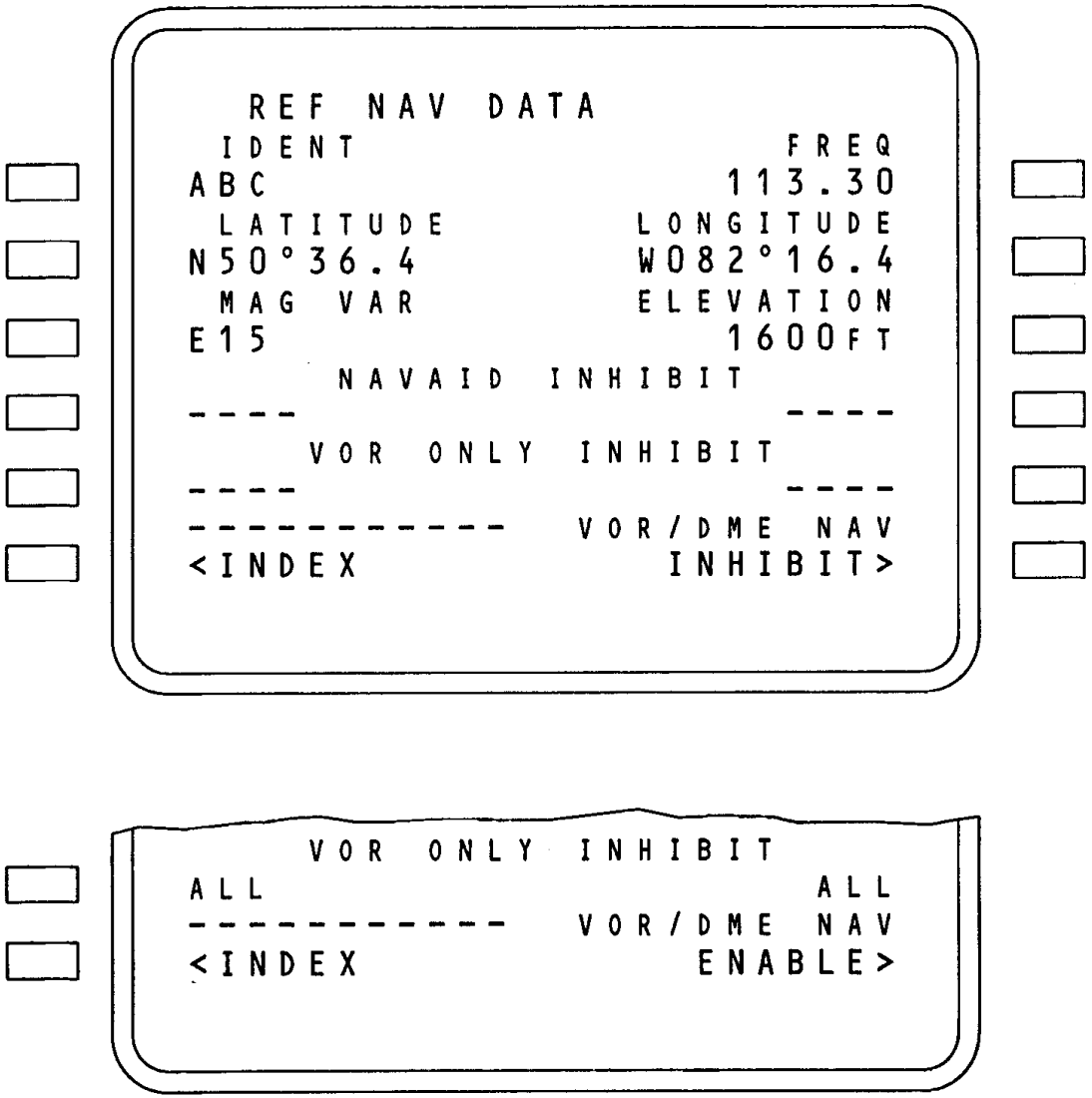


Figure 47 REFERENCE NAVIGATION DATA PAGE

MAINTENANCE PAGES

General

The maintenance pages show maintenance related data that is accessible on the ground through the INIT/REF INDEX page. Selection of the MAINT> prompt causes the MAINTENANCE INDEX page to show. The maintenance pages are:

- Navigation data (NAV DATA) crossload page
- Performance (PERF) factors page
- Inertial reference system (IRS) monitor page
- BITE download

NAV Data Crossload Page

This page is used to transfer the navigation data base of one FMC to the other to save time. This occurs in the normal 28 day update. This page shows automatically at power-up if the FMCs detects a difference in the navigation data bases.

Performance Factors

The performance factors page shows performance data that the maintenance crew can modify due to engineering requirements. The FMC uses this data in its performance calculations. The flight crew can modify some of these parameters on the TAKEOFF REFERENCE page. At the end of the flight the flight crew entries go away and the values found on this page show.

IRS Monitor Page

This page shows an estimate of position error rate for each IRU at the end of each flight. The maintenance crew uses this data to help determine the serviceability of the IRUs.

BITE

This selection allows the maintenance crew to transfer FMC internal BITE data to the airborne data loader.

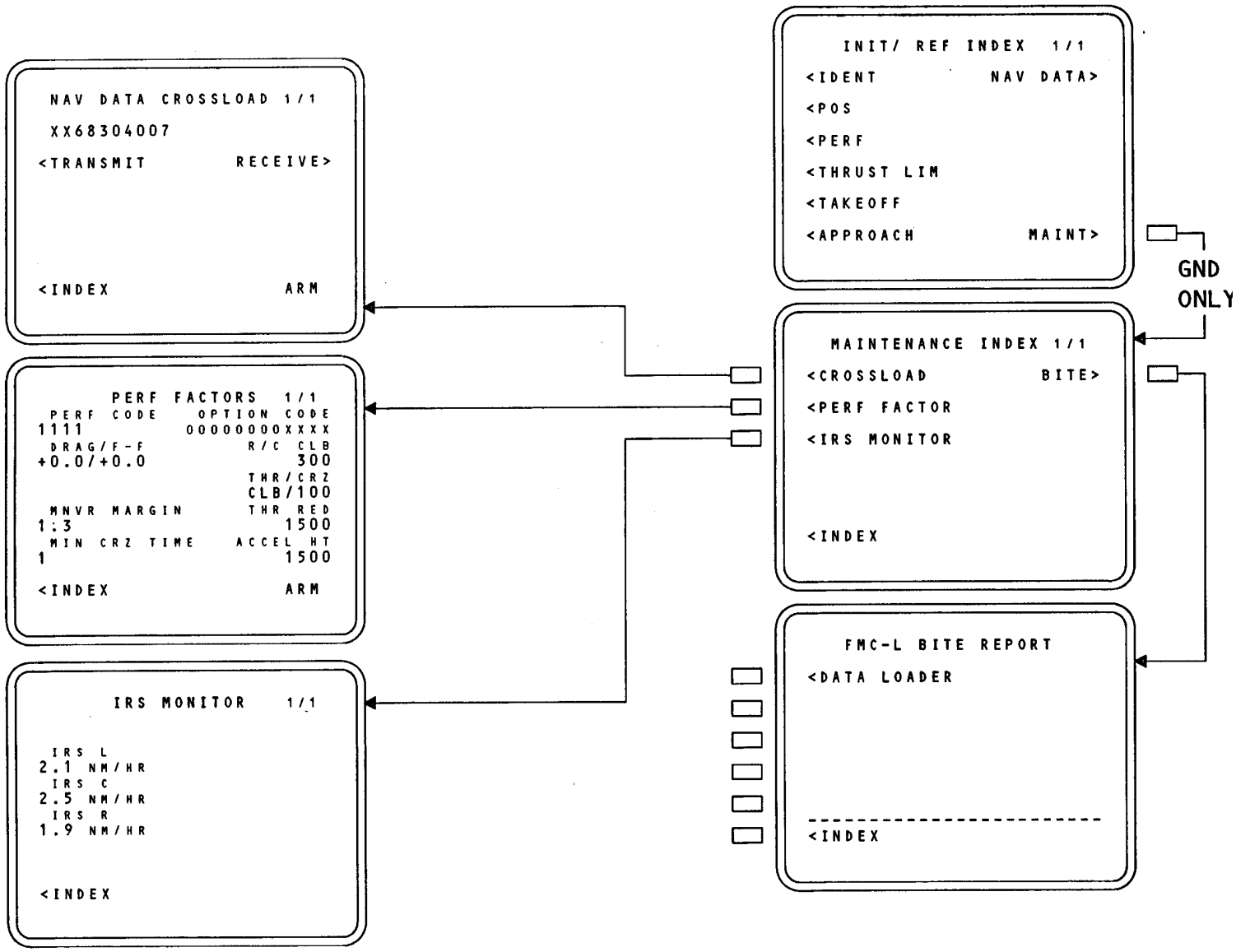


Figure 48 MAINTENANCE PAGES

CLIMB PAGES

General

The VNAV mode key on the CDU is used to select climb, cruise and descent performance modes. When the VNAV key is pushed in flight, the page shown is the active performance mode (CLB, CRZ or DES). On the ground, the page shown is the CLB page. To access the other pages, the climb, cruise and descent pages are numbered 1/3, 2/3, and 3/3.

Three CLB performance modes are available:

- Economy (ECON)
- Selected Speed (SEL SPD)
- Engine Out (ENG OUT)

CLE segments may be determined for altitudes only or to show constraints at the waypoints of the flight plan.

The default climb has two segments, 250 knot climb to 10,000 feet followed by an economy climb from 10,000 feet to cruise altitude. However, the speed transition altitude and limit speed values change automatically, this occurs when a departure airport is entered that has a stored speed transition altitude that is different

than the normal default values. The limit speed value is a minimum speed that uses gross weight.

Page Access

Access the climb page by selection of the VNAV mode key (on the CDU) when CLB is the active performance mode.

Economy Climb Page

The function of this page is discussed by the operation of each line.

- (1L) CRZ ALT: a cruise altitude entry on the PERF INIT page shows on this page. This altitude may be changed.
- (2L) ECON SPD or SEL SPD: entry of a speed or mach value results in a change to selected speed (SEL SPD) .
- (3L) SPD TRANS: this line shows the speed transition altitude stored in the navigation data base for the origin airport. This value can not be modified.
- (4L) SPD RESTR: this line allows entry of a speed restriction to an altitude less than the cruise altitude. When the SPD RESTR segment is passed, it is replaced by dashes.
- (5L) ECON: this line shows when SEL SPD is on 2L. Selection of this line changes speed in 2L to ECON speed.
- (6L) ERASE: this line shows when a vertical or lateral flight plan modification is pending. When this line is selected, all modifications that are pending are erased.
- (1R) AT XXXXX: (XXXXX is next constrained waypoint) This line shows speed and altitude constraints, if there-are any. They can be removed, but they can not be modified.
- (2R) ERROR: this line shows a calculated error at the waypoint in 1R. If the error is predicted to be less than 200 feet low or if the distance error is predicted to be less than 1 nm long, or if no climb waypoint constraints are there, this line is blank. LO resolution is 10 feet. LONG resolution is 1 nm.
- (3R) TRANS ALT: at FMC power-up, this value defaults to 18,000 feet. The value may be changed.
- (4R) MAX ANGLE: this line shows calculated flaps up max angle climb speed for the present conditions.
- (5R) ENG OUT: this key selection changes the page display to the ENG OUT mode.
- (6R) CLB DIR: this line shows when there is an altitude constraint in the climb part of flight. When selected, all altitude constraints are removed between the current altitude and the MCP altitude.

All other climb pages show data that is nearly the same but the data is changed for the type of CLB mode.

Selected Speed Climb Page

This page shows when a climb speed (see line 2L above) is selected.

Engine Out Climb Page

This page shows when an engine-out climb (see line SR above) is selected.

Engine Out Selected Speed Climb Page E/O 240KT CLB Page

This page shows when an engine-out climb speed is selected.

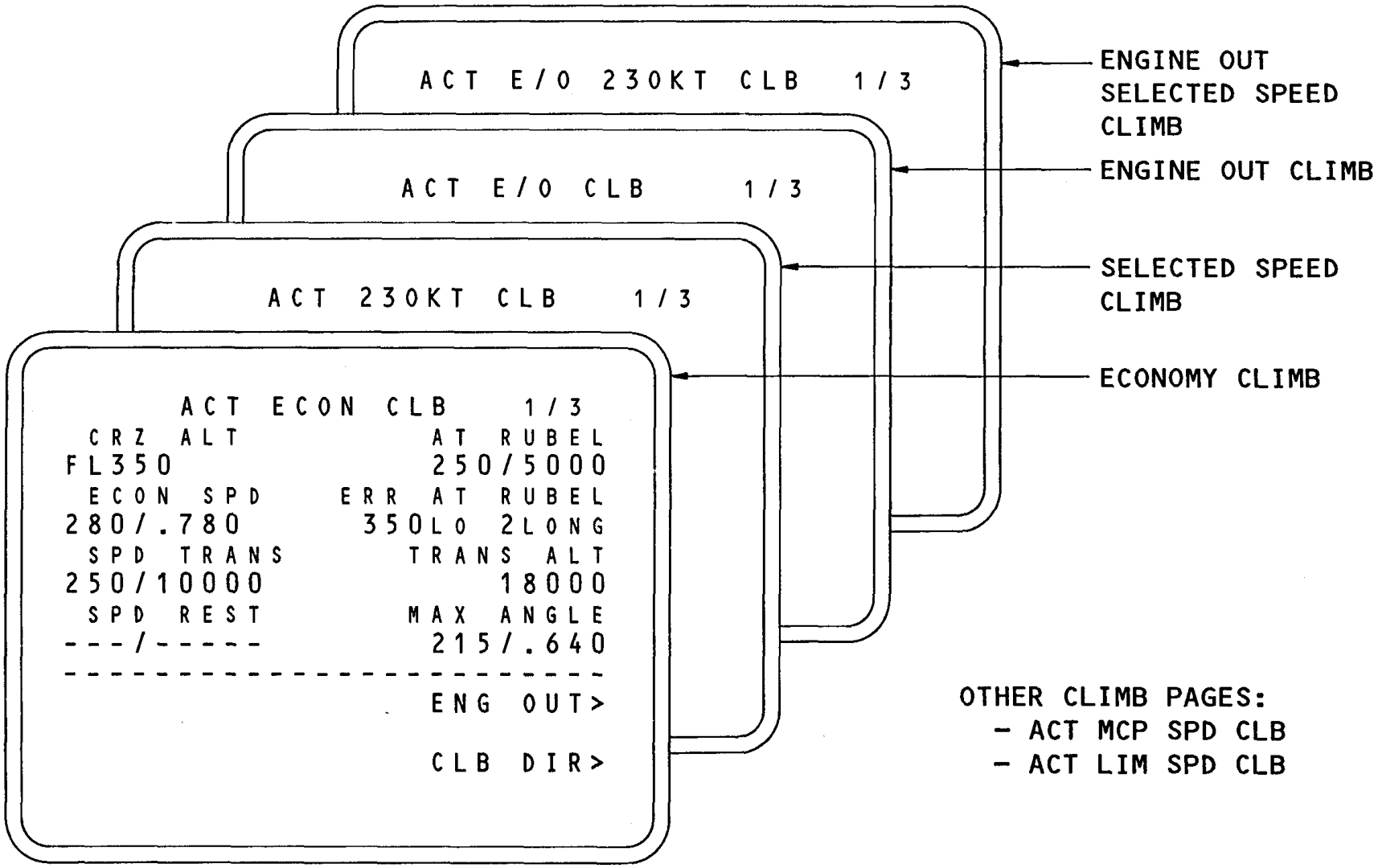


Figure 49 CLIMB PAGES

CRUISE PAGES

General

Use the VNAV mode key to select cruise (CRZ) performance modes. Seven cruise modes are available:

- Economy (ECON)
- Selected speed (SEL SPD)
- Long range cruise (LRC)
- Engine out (E/O)
- Cruise climb (CRZ CLB) and
- Cruise descent (CRZ DES)
- Required time of arrival (RTA)

Economy cruise is the normal cruise mode. Push the VNAV mode key to show the active cruise page when the cruise mode is active.

The cruise page allows evaluation of trip-fuel burn and time-to-destination for the cruise phase with step climbs or with no step climbs. It also allows change of the cruise altitude or cruise mode when the airplane is in VNAV cruise.

Page Access

Access to the CRZ page is by:

- Selection of VNAV mode key when the CRZ mode is active
- Automatic access if the CLB page is shown and a change is made from CLB to CRZ (and ECON was the active CLB mode)
- Selection of NEXT PAGE from the CLB page
- Selection of PREV PAGE from the DES page

Page Title

The page title line shows the present active cruise mode. If mode control panel (MCP) speed intervention is selected, the page title changes to ACT MCP SPD CRZ. When guidance controls to a limit speed, the page title changes to ACT LIM SPD CRZ.

Economy Cruise Page

The function of this page is discussed by the operation of each line.

- (1L) CRZ ALT: this line shows the VNAV CRZ ALT (cruise altitude) target. This value may be changed two ways. A new altitude may be entered in the scratch pad and transferred to line 1L. Also, the altitude in the MCP altitude display is placed in line 1L when the MCP altitude knob is pushed. When the CRZ ALT target is changed, the page title changes to CRZ CLB or CRZ DES.
- (2L) ECON SPD, SEL SPD or LRC SPD: this line shows the speed target for the cruise phase of flight. SEL SPD may be changed by line selection from the scratch pad.
- OL) EPR: this line shows the target EPR when on an active cruise, cruise climb or cruise descent page. When in active CRZ, the value is the EPR required to maintain the target airspeed at the cruise altitude.
- (4L) STEP SIZE: this line shows the entered step size used for step point predictions and step climb predictions.
- (6L) RTA PROGRESS: provides access to the RTA PROGRESS page 3/3. ERASE shows when a vertical or lateral flight plan modification is pending. When this is selected, requested modifications are erased.
- (1R) STEP TO: display is an altitude which is different than the CRZ ALT (1L) by a multiple of the step size in 4L or a pilot entered altitude.

NOTE: THIS IS SHOWN IF THE TOP OF DESCENT (T/D) IS NOT LESS THAN 200 NM. ALSO THIS GOES BLANK WHEN TO T/D SHOWS IN LINE 2R.

- (2R) AT: this line shows when a STEP TO altitude is in line 1R. It shows the ETA/distance to the next optimum step climb point. After the step climb AT point is passed, and the airplane does not climb to the STEP TO altitude, 2R shows NOW. NONE shows if no step is requested.
- AVAIL AT: this is the first point after the planned step AT point where a step can be made. That is, if the planned step point occurs before the airplane can climb, because of thrust or buffet limits, the AVAIL AT time and distance shows.
- TO T/D: this shows calculated ETA and distance to go to top of descent (T/D) when within 200 nm.
- (3R) DEST FUEL/ETA: this line shows the predicted fuel and estimated time-ofarrival at destination.
- OPT: optimum altitude is shown for this line.
- (4R) MAX: Present maximum altitude is shown on this line.

Economy Cruise Page (cont)

- (5R) ENG OUT: selection of this line changes page display to engine out LRC CRZ, engine out LRC CRZ DES, engine out LRC CRZ CLB or engine out LRC D/D (drift down).
- (6R) LRC: this selection changes speed in 2L to computed LRC speed.

Selected Speed Cruise Page

This is the page shown when an FMC cruise speed other than ECON cruise speed is selected.

Economy Cruise Climb Page

This is the page shown when the FMC cruise altitude is changed to be higher. That is, the pilot changes line 1L on the ECON CRZ page.

Economy Cruise Descent Page

This page is nearly the same as ECON CRZ CLB but the FMC cruise altitude is changed to be lower.

Long Range Cruise Page

This page shows the data related to the long-range cruise mode. This page is shown when the LRC line select key is pushed. (see 6R above).

Engine Out Cruise Page

This page provides for FMC control of the airplane in an engine-out situation.

Engine Out Selected Speed Cruise Page

This page is the same as E/O CRZ with a new speed selected.

Engine Out Long Range Cruise Page

This page is the same as E/O CRZ with the long-range cruise mode selected.

Required Time of Arrival Cruise Page

This page is the same as the ECON CRZ page with the required time of arrival function active. RTA speed may be changed on this page.

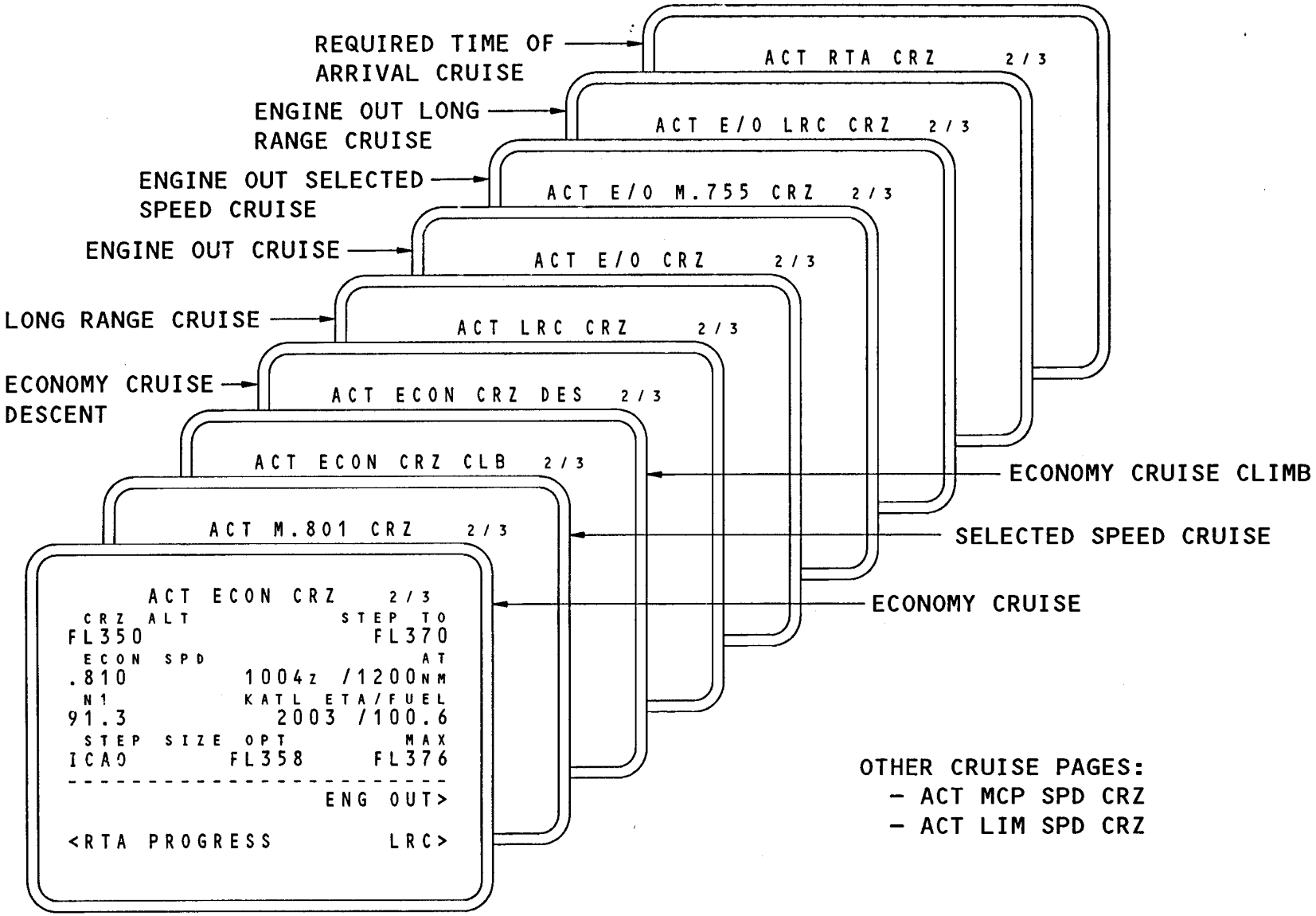


Figure 50 CRUISE PAGES

DESCENT PAGES

General

Use the VNAV mode key to select descent performance modes. Two modes are available: economy (ECON DES) and selected speed (SEL SPD DES). These descent modes can be part of a preplanned route or can be selected.

A difference between the descent modes and the climb modes is that all descents are waypoint constrained descents. They have a calculated descent path that is used as a geographically fixed reference path (3D path) for descent guidance.

If no descent mode is selected the default descent mode has a two segment descent. The FMC subtracts 10 knots from the transition speed for display and guidance. Therefore, the two-segment descent is: ECON to 10,000 feet followed by a 240 knot selected speed descent to the end of descent (E/D) altitude.

Page Access

Access to the descent page is by:

- Selection of the VNAV mode key when ECON is the descent mode
- Selection of the PREV PAGE from the CLB page or NEXT PAGE from the CRZ page when ECON is the DES mode
- Automatic access if the CRZ page shows and a change is made from CRZ to DES (and ECON was the active CRZ mode).

Page Title

The page title line shows the present or active descent mode. If MCP speed intervention is selected, the page title line changes to ACT MCP SPD DES. When guidance is controlled to a limit speed (such as flap placard), the page title changes to ACT LIM SPD DES. When at the E/D altitude, the page title changes to ACT END OF DES.

ECON DES Page

The function of this page is discussed by the operation of each line.

- (1L) E/D AT: this line shows the lowest altitude constraint at a waypoint. If there is no constraint, the page is blank with DES as title.
- (2L) ECON SPD (SEL SPD): in ECON mode, command speed is a computed value. Entry of a speed or mach results in a mode change to SEL SPD DES at the entered value.
- (3L) SPD TRANS: this line shows the speed transition altitude in the navigation data base for the destination airport less 10 knots to make sure the airplane does not go faster than speed limit. If there is a change to the SPD TRANS segment, the field goes blank and the constraint speed moves to line 2L.
- (4L) SPD RESTR: this line allows entry of a speed restriction at an altitude higher than E/D altitude (CAS only). If there is a change this segment, the data is replaced by dash prompts and the constraint speed moves to line 2L.
- (5L) ECON: this line shows only when the selected speed mode is inline 2L. Selection changes display in 2L to ECON.
- (6L) ERASE: this line shows only when a vertical or lateral flight plan modification might occur. if this is selected, all modifications about to occur are erased.
- OFFPATH DES: this line shows when the necessary data has been entered to allow VNAV flight (gross weight cost index and cruise altitude have been entered). With an active flight plan, OFFPATH DES is shown only when ERASE is not shown. Selection shows the OFFPATH DES page.
- (1R) AT: when a speed/altitude constraint has been entered on a LEGS page, the first related waypoint is shown in this field.
- (5R) FORECAST: this line shows the descent forecasts page.
- (6R) DES DIR: this line is shown when descent is active and there is an altitude constraint between present altitude and the E/D. Line selection causes all constraints to be removed between present altitude and MCP altitude. If the MCP altitude is lower than the E/D altitude, the E/D altitude is not changed.
- DES NOW: this is shown on the descent page when it is not active. The DES NOW function causes the system to provide guidance at a 1,250 feet per minute descent rate to the intersection of the vertical profile.

ECON DES Page (cont)

Other descent pages show data nearly the same but the data is changed for the type of DES mode.

Selected Speed Descent Page

This page is shown when a selected speed descent is selected (See line 2L above).

OFFPATH DES Page

This page allows data to be shown that is related to a normal descent or a speed brake descent to a defined point.

DESCENT FORECASTS Page

This page allows the operator to enter forecast values of some specified parameters to more accurately define the computed descent profile. Data includes wind speed and direction, and altitude when thermal anti-ice starts.

End of Descent

This page provides a means to change the end of descent. Page access is:

- Push the V-NAV mode key when at the end of descent altitude
- Push PREV PAGE (from the CLB page) or NEXT PAGE (from the CRZ page) when at the end of descent altitude.

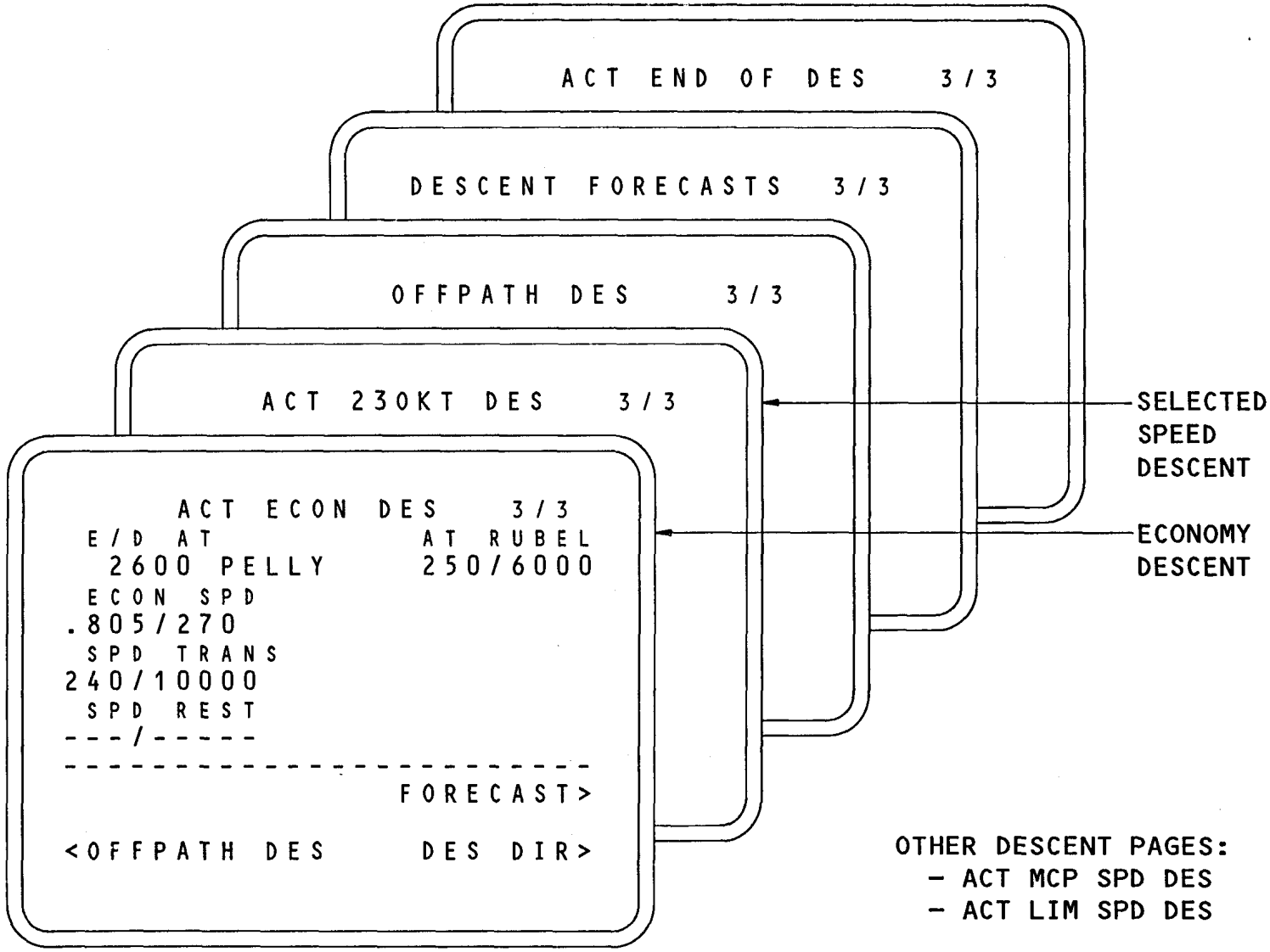


Figure 51 ECON DES Page

DESCENT FORECAST PAGE

General

The descent forecast page allows entry of wind and other data. This allows the FMCS performance function to better define the descent profile.

This page also allows the flight crew to make a downlink request for descent forecast data. When the data is received the flight crew can load the data using this page.

Page Access

To access the descent forecast page:

- Select FORECAST on the DESCENT page.
- Select FORECAST on the FMC COMM page 1/2.

Operation

The operation of this page is discussed by the function of each line:

- (1L) TRANS LVL: This line normally shows the default value (FL180) of transition altitude. This display may be overwritten, or change automatically when there is a stored value for the entered destination airport or arrival procedure.
- (2L - 5L) ALT: These data fields allow entry of altitudes where wind direction and speed are known. When an entry is made, dashes appear on the right side of the line to enter the actual wind direction and speed. Deleting a line causes both the altitude and the entered wind data to blank.
- (6L) REQUEST SEND: This line is blank if the airplane is active in the descent or approach modes. Select this prompt to initiate a downlink request for descent forecast data.

When a descent forecast uplink is received this line shows FORECAST UPLINK LOAD. Select LOAD to enter the data into the FMC.

The data link status also shows on this line. SENDING shows after selection of SEND prior to network acknowledgement. When network acknowledgement is received, SENT shows in small font next to SEND. If network acknowledgement is not received, SEND shows again by itself. Data link status of NO COMM, VOICE, FAIL or READY can also show.

- (1R) TAI/ON ALT: This line normally shows dashes. This line allows entry of the altitude where thermal anti-ice is expected to be activated. The line may be deleted, which returns the display to dashes.
- (2R - 5R) WIND DIR/SPD: These data fields are normally blank. Dashes show when an altitude is entered on the left side of the page. These data fields allow entry of wind direction and speed for the altitude entered on the left side of the page. Deleting this line causes only the wind entry to clear and the line returns to dashes.
- (6R) DES: Select this prompt to show the descent page.

FORECAST UPLINK PURGE shows when a descent forecast uplink is received. Select this prompt to clear the uplinked data. After selection the line changes back to DES.

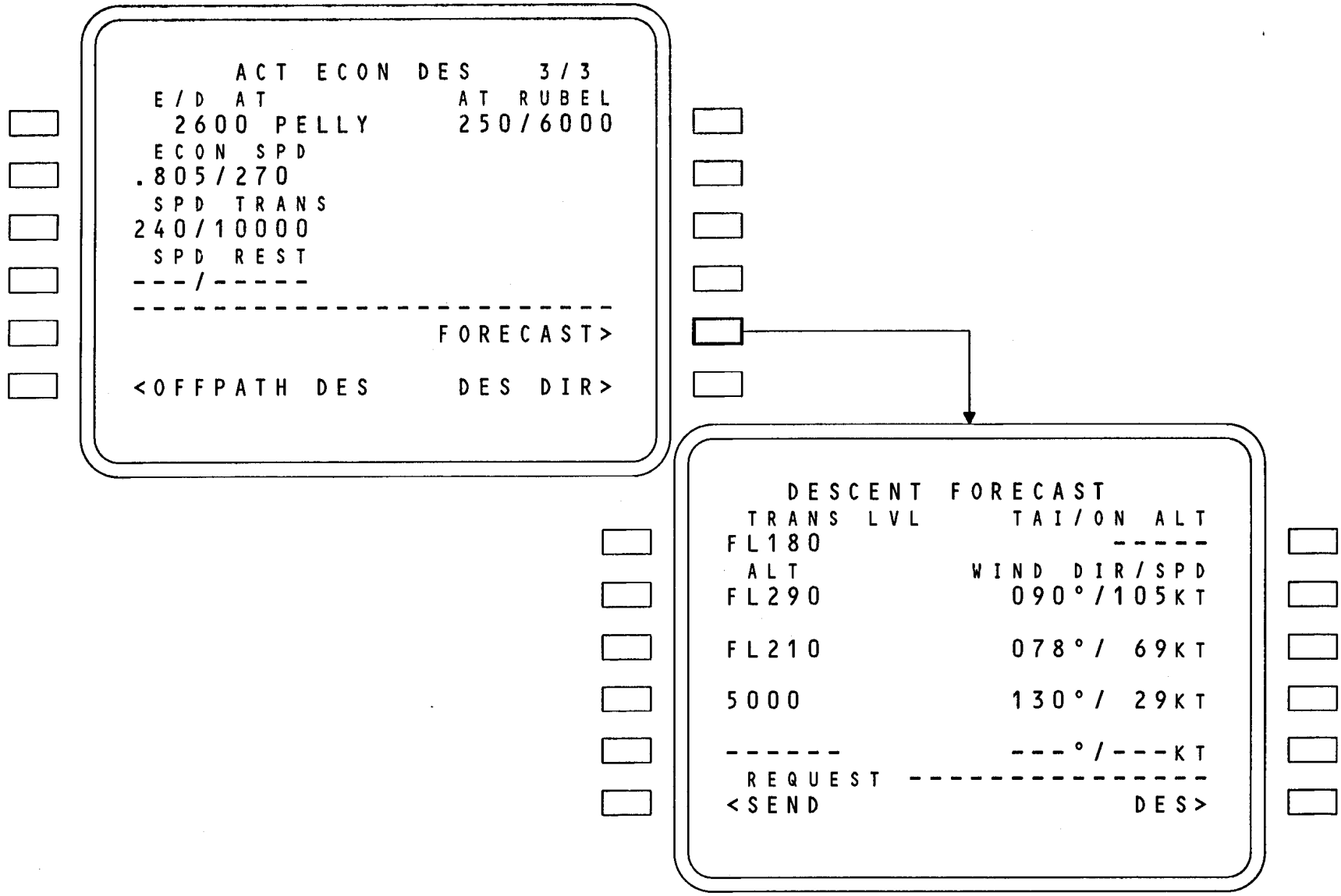


Figure 52 DESCENT FORECAST PAGE

PROGRESS PAGES 1/3 AND 2/3

General

The PROGRESS pages show data about the progress of the flight. The pages show present dynamic flight data.

Page Access

Push the PROG mode select key to access the PROGRESS page.

PROGRESS Page 1

The function of the page is discussed by the operation of each line. The company flight number from the RTE page I shows in the title block on this page.

- (1L) LAST/ALT/ATA/FUEL: this line shows waypoint identification altitude, actual time of arrival (ATA) and fuel remaining at the last waypoint that was passed.
- (2L) TO/DTG/ETA: this line shows the next active waypoint identification, distance to go (DTG), estimated time of arrival (ETA) and fuel remaining.
- (3L) NEXT: same as 2L but for the next waypoint.
- (4L) DEST: data (DTG, ETA and fuel remaining) about the destination shows in this line. An alternate destination may be entered to replace the destination waypoint.
- DIR TO ALTERNATE: this shows when an alternate waypoint has been entered which is not in the active flight plan.
- EN ROUTE WPT: this shows when an alternate waypoint is entered which is in the active flight plan. If both CDUs leave this page, this deletes the alternate destination waypoint.
- (5L) LRC SPD, ECON SPD, SEL SPD: this line shows when the data in 5L agrees with the appropriate performance mode. LIM SPD: this shows when the airplane performance is limited. MCP SPD: this shows when speed intervention is active.
- E/O SPD: this shows when the engine out minimum drag speed mode is active.
- (6L) POS REPORT: this line provides access to the position report page.
- (5R) TO: this line shows ETA and distance-to-go to for:
- TOP of climb (T/C) when CLB mode is active.
- STEP CLIMB when in CRZ mode.
- Top of descent (T/D) when in CRZ mode and within 200 nm.
- End of descent (E/D) when in DES mode.
- LEVEL AT when in the drift down (D/D) mode.
- (6R) POS REF: this line provides access to the position reference page 2/3.

PROGRESS Page 2

- (1L) WIND: this line shows wind data. The wind bearing data is the direction the wind is from in degrees true north.
- (2L) XTK ERROR: this line shows present cross track error.
- (3L) TAS: this line shows the present true airspeed.
- (3C and 4L through 4R) FUEL USED: the total fuel used on line 3C and fuel used on each engine shows on lines 4L through 4R. If the fuel flow is invalid for more than 2 minutes after engine start, or is invalid while on the ground, the displays blank.

FUEL USED values stay through flight completion and are removed at engine start or a long term power down.

- (5L): this line is blank unless there is a 9,000 pound difference between the fuel totalizer and the calculated fuel value. The data fields show when a difference occurs for greater than five (5) minutes.

Select this prompt to use the fuel totalizer value and inhibit the calculation of fuel used. Line 6R (CALCULATED fuel) blanks if 5L is selected.

- (6L and 6R) TOTALIZER/CALCULATED: the fuel totalizer system value shows in 6L. The CALCULATED value in 6R is set equal to the TOTALIZER value before engine start. The FMC normally uses the calculated value for its performance calculations.

If the fuel flow data is invalid for more than 2 minutes after engine start, the CALCULATED fuel quantity in 6R blanks the same as the FUEL USED display. The FMC uses the TOTALIZER value for its performance calculations.

- (2R) VTK ERROR: this line shows the present vertical track error for a path descent.
- (3R) SAT: this line shows the present static air temperature.
- (SR): this is the same as 5L but causes the system to use the calculated fuel and inhibits the totalizer input.

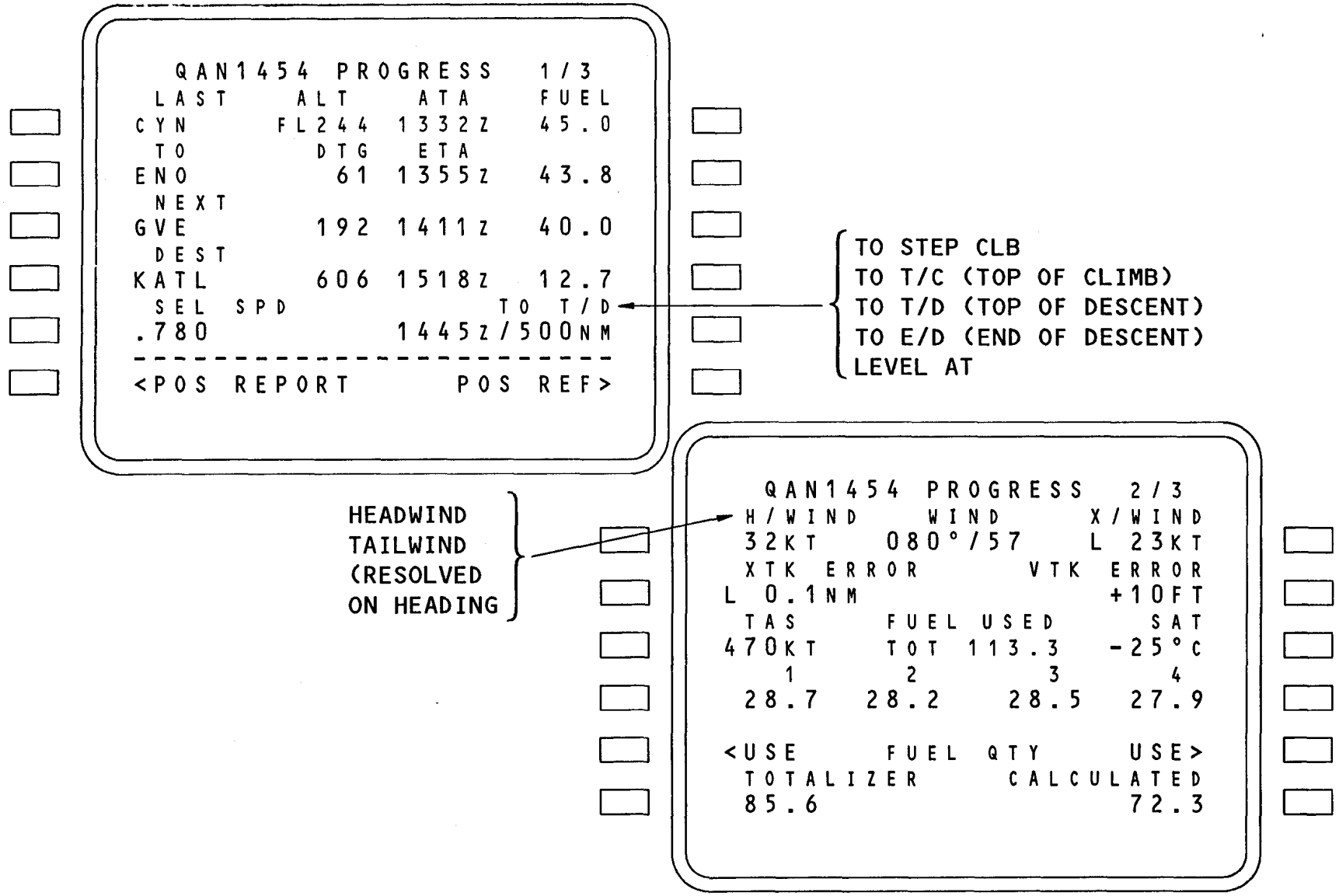


Figure 53 PROGRESS PAGES 1/3 AND 2/3

RTA PROGRESS PAGE

General

The required time of arrival (RTA) function is initialized and activated from the RTA PROGRESS PAGE 3/3. This function also may be cancelled from this page. The flight crew can specify a maximum speed limit for the RTA cruise speed adjustment. This page also provides a display of the FMC predicted altitude and ETA at the RTA fix. The RTA function can only be made active in the air and is only for the cruise phase of flight.

Page Access

To access the RTA PROGRESS page 3/3:

- Push the next page key from the PROGRESS page 2/3, or twice from the PROGRESS page 1/3.
- Select RTA PROGRESS on the CRUISE page 2/3.

Operation

The function of this page is discussed by the operation of each line.

- (1L) FIX: this line shows the current RTA fix. This line initially shows box prompts. The display blanks if an engine out condition is detected or when on the ground. Valid entries are identifiers from the modifed, pending active or active route. An entry into this line causes box prompts to show in line 1R (RTA). This line may be deleted, which causes box prompts to show again. Deleting this line while this function is active causes the EXEC key to light and line 6L shows ERASE. Select the EXEC key to terminate the RTA function.
- (2L) RTA SPEED: this line shows the current (or top of climb) RTA speed. The display format shows MACH unless the current altitude is below the transition altitude. If the airplane is below the transition altitude, computed airspeed (CAS) shows. When VNAV is active in descent mode this line is blank.
- (5L) MAX SPEED: This line shows the current selectable maximum limit for the RTA adjusted cruise speed. The default display is .880M, and shows in small font. Valid manual entries are MACH values from .100 to 990. This limit governs the RTA speed only when it is less than the current maximum speed limit and more than the FMC hold speed.
- (6L) ERASE: The ERASE prompt shows when a modification is pending. Select this line to cancel all pending modifications.
- (1R) RTA: This line shows the current required time of arrival. This line is normally blank, and changes to box prompts when an RTA fix is entered into line 1L. Valid entries to this line are clock times from 0000.0 to 2359.9. Entries may be suffixed by ”A” for at/after, or ”B” for at/before. An entry to this data field causes the EXEC key to come on and line 6L shows ERASE. Push the EXEC key to activate the RTA function. This line may be deleted, which terminates the RTA function.
- (2R) ALT/ETA: This line shows the current predicted altitude and ETA at the fix that shows in line 1L. This line is blank until an entry is made into line 1L.
- (6R) PRIOR RTA: The PRIOR RTA prompt shows only when the RTA function is not active, but an RTA fix and time were previously entered and activated, and the RTA fix is still present in the route. Select this prompt to show the previously entered fix and time. The EXEC key light comes on, and line 6L shows ERASE. Push the EXEC key to activate the RTA function with the prior RTA.

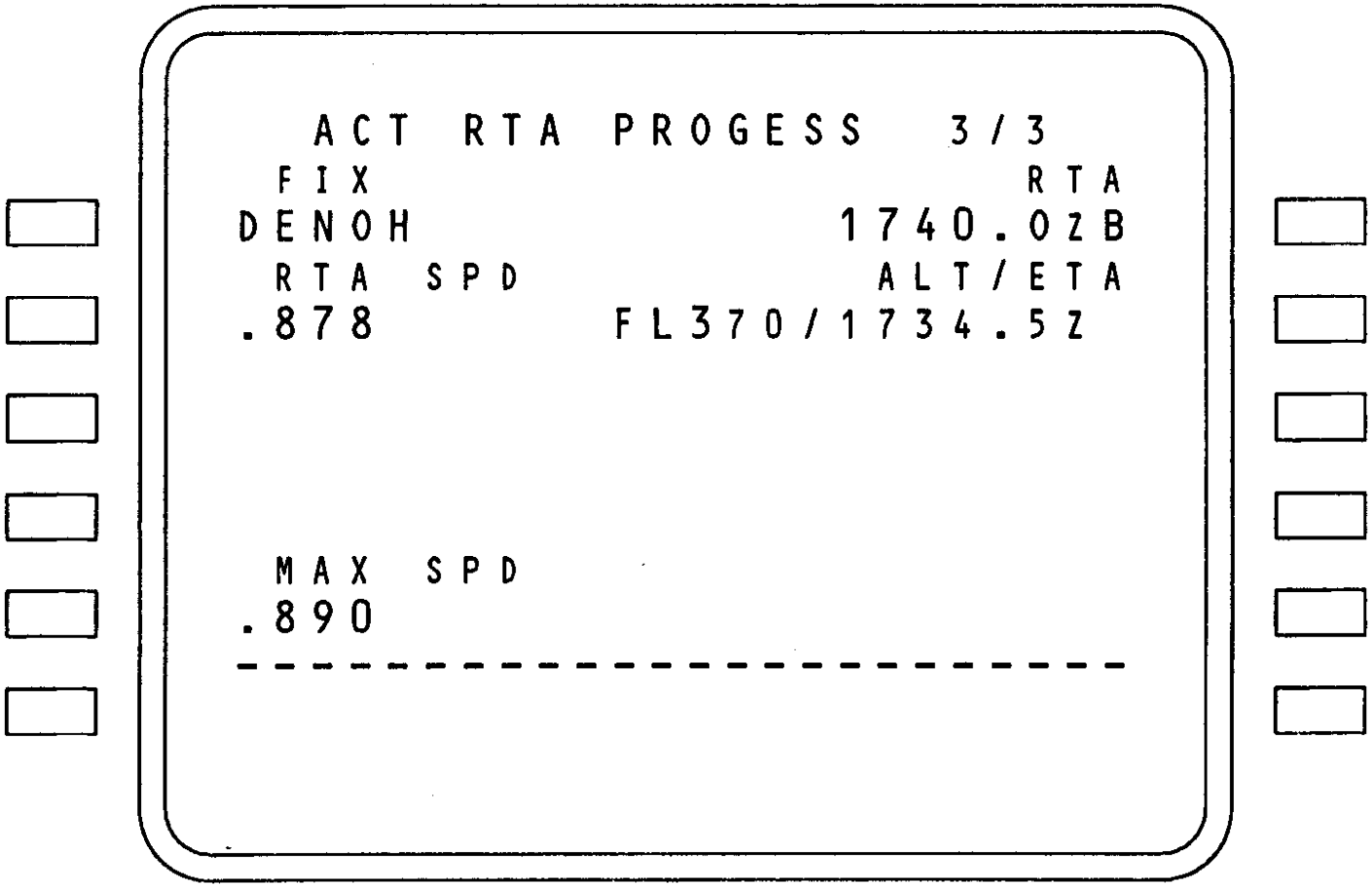


Figure 54 RTA PROGRESS PAGE

HOLD PAGES

General

The HOLD AT page allows selection of the present airplane position or any other waypoint for the holding pattern. The HOLD also page allows for selection of details of the holding pattern.

Page Access

To access the HOLD AT page push the HOLD mode select key when there is no other holding pattern, or select NEXT HOLD on the ACT RTE 1 HOLD page.

The HOLD page is shown automatically when a valid holding fix has been entered in the HOLD AT RTE LEGS page. Or push the HOLD mode key after a holding fix has been entered in the route.

HOLD AT Page

The function of this page is discussed by the operation of each line.

- (1L/R through 5L/R) this is the same as the lines on the RTE LEGS page.
- (6L) HOLD AT: any valid waypoint (1L through 5L) can be transferred to line 6L. A HOLD AT leg is then made after that waypoint. The display then goes to the MOD RTE HOLD page.
- (6R) PPOS: this key selection makes a holding pattern with the fix at the present position at the time EXEC is pushed.

HOLD Page

- (1L) FIX: this line shows the holding fix position.
- (2L) QUAD/RADIAL: this line allows entry of a specific holding quadrant and radial, if desired.
- (3L) INBD CRS/DIR: this line shows inbound course and turn direction for a holding pattern. Default is right (R) turn pattern, but the turn direction may be changed when L is entered.
- (4L) LEG TIME: the leg time may be changed. The default values are 1.5 minutes above 14,000 feet, or 1.0 minute at or below 14,000 feet.
- (5L) LEG DIST: this field will normally show dashes unless a keyboard entry is made. If a LEG DIST entry is made, the LEG TIME field shows dashes.
- (6L) NEXT HOLD: this key selection makes prompts for a new holding fix.
- ERASE: this is shown only on the MOD HOLD Page. If this is selected, modifications about to occur are deleted.
- (1R) SPD/TGT ALT: the speed/altitude shown will be the same as that shown on the RTE LEGS page for the HOLD AT leg. This changes to the best speed for the target altitude.
- (2R) FIX ETA: this line shows the next time the fix will be passed.
- OR) EFC TIME: this line shows a keyboard entry of the time at which further clearance will occur.
- (4R) HOLD AVAIL: this line shows the holding time available before exit is required to be at the destination with required reserves.
- (5R) BEST SPEED: this line shows the best holding speed for the present altitude.
- (6R) EXIT HOLD: this key selection replaces EXIT HOLD with EXIT ARMED and turns on the EXEC light. Push EXEC to activate flight back to the FIX and continue the flight on the active route. EXIT HOLD shows when a HOLD is active.

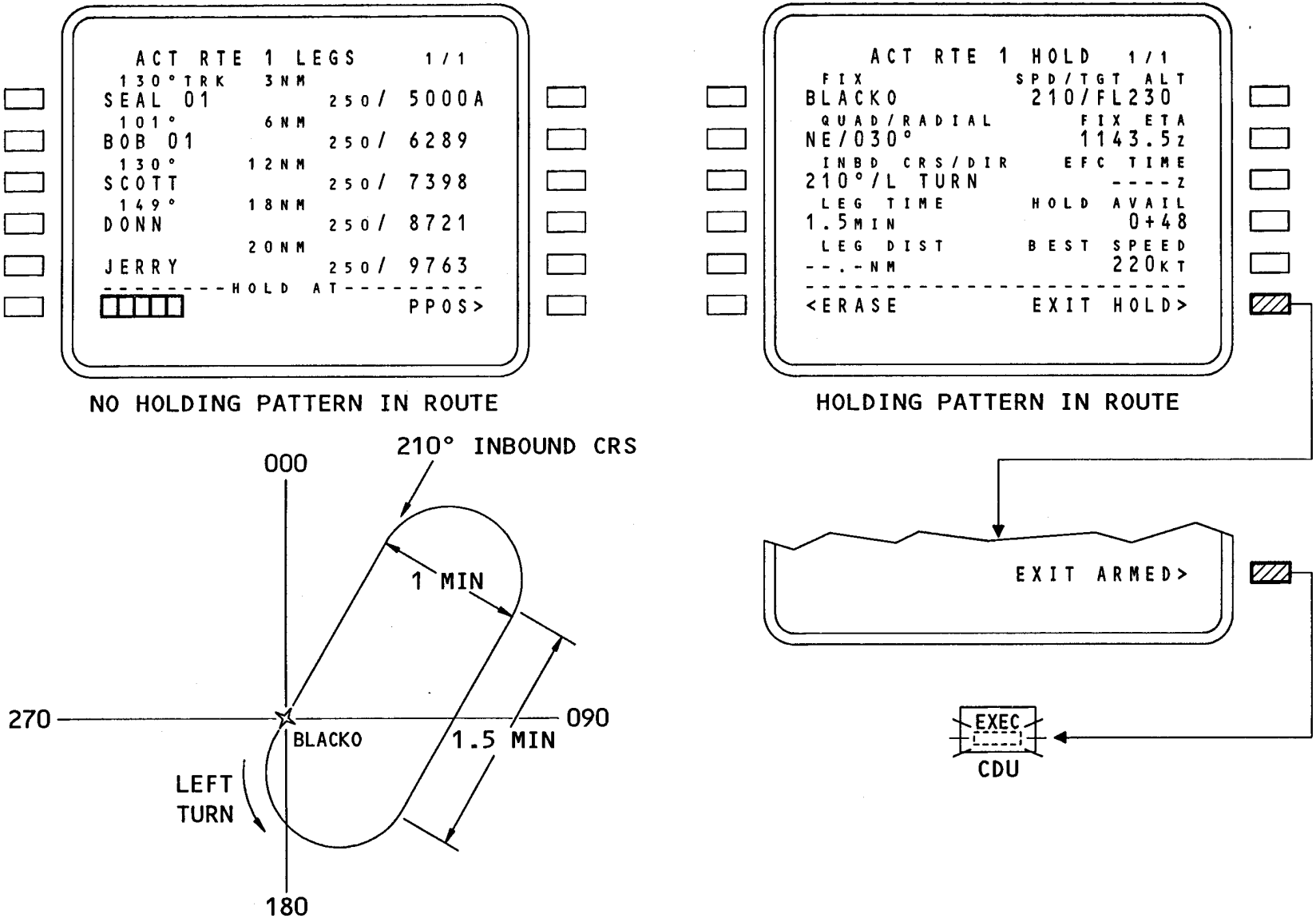


Figure 55 HOLD PAGES

ROUTE LEGS, ROUTE DATA AND WIND PAGES

General

The route legs (RTE LEGS) page allows details of each leg of the route to be entered and shown. The route data (RTE DATA) page provides a display of more leg data and an access to the waypoint wind page. The WINDS page allows for the entry and display of forecast winds and temperatures at specified altitudes for waypoints in the active route.

Page Access

Access to the LEGS page is by:

- LEGS mode key selection
- RTE 1 LEGS line selection on RTE 2 LEGS page
- Legs line selection on RTE 1 data page.
- Automatic access from WINDS or RTE DATA pages on flight completion.
- Automatic access when alternate route is activated on offside CDU.

Access to the RTE DATA page is by selection of RTE DATA from RTE LEGS page or waypoint WINDS page.

Access to the WINDS page is by selection of the prompt from the RTE DATA page.

RTE LEGS Page

The function of this page is discussed by the operation of each line.

Leg directions: these lines show the calculated course or heading to a waypoint. It also shows specified procedural instructions from the data base such as:

- HOLD AT
- PROCTURN

NOTE: FOR HEADING OR TRACK LEGS, HDG OR TRK FOLLOWS THE DISPLAYED VALUE. COURSES AND HEADINGS ARE RELATIVE TO MAGNETIC NORTH BETWEEN 73'N AND 60'S LATITUDE, OTHERWISE TRUE NORTH. THE VALUE IS ALSO RELATIVE TO TRUE NORTH WHEN THE HDG REF SWITCH IS SET TO TRUE. ONLY VALUES RELATIVE TO TRUE NORTH ARE FOLLOWED BY THE LETTER T (FOR EXAMPLE, 222'T OR 137'TTRK).

- (1L through 5L) Waypoint identifier; valid entries are: waypoints, airports, navaids, runways for destination airport, waypoints selected on the ARRIVAL page, or latitude/longitude.

If a destination runway is entered before the last waypoint of the flight plan, all waypoints after the runway are removed.

- (6L) RTE 2 LEGS: this line shows on all pages but MOD pages. Select to show RTE 2 LEGS page.
- ERASE: this shows only on MOD pages. Select to remove all LEGS modifications.
- (1R through 5R) Speeds/Altitudes: speeds and altitudes may be entered on these lines.
- (6R) RTE DATA: this line shows only on active or modified RTE LEGS pages and when not in PLN mode (on EFIS control panel). Line select to show the RTE DATA page.
- MAP CTR STEP: this shows only if in the PLN mode (on EFIS control panel). The LEGS page shows a MAP CTR STEP prompt. It replaces the RTE DATA prompt and a CTR symbol shows next to one of the waypoints. This waypoint is the same waypoint that is centered on the navigation display (ND)
  The CTR symbol moves to the next waypoint by line select of the MAP CTR STEP prompt. Continue to select the MAP CTR STEP key to move down the page through the entire route.
- ACTIVATE: this shows only on non-active RTE LEGS pages when not in PLN mode.

RTE DATA Page

- (1L through 5L) ETA WPT FUEL: this line shows the estimated time of arrival and estimated fuel at the specified waypoint. ETA and estimated fuel calculations are for a direct flight across route discontinuities.
- (6L) LEGS: select to show the RTE LEGS page. ERASE shows on all MOD pages. Select to remove all route or wind modifications.
- (1R through 5R) WIND: selection will show the waypoint WINDS page for that waypoint. The W> prompt shows that future winds have been entered at that waypoint.
- (6R) REQUEST SEND: select this key to initiate a downlink request for wind data. After selection, SEND is replaced by SENDING: When a wind data uplink is received, the line changes to WIND DATA LOAD. Selection of LOAD, enters the uplinked wind data into the active route in a MOD state. The flight crew can then review the data, and then execute or erase the change.

WINDS Page

- (1L through 4L) ALT OAT: these lines show waypoint wind altitudes and temperatures. Dashes show if less than 4 altitudes have been entered.
- (1R through 4R) DIR/SPD: these lines show the wind speed and direction.
- (5R) ALT/OAT: dash prompts show unless the offside CDU has ALT/OAT entries and also shows the WINDS page. Entry of an OAT at an altitude shows in 5R and results in a change of the OATs in lines 1L through 4L. OAT entries are in degrees centigrade.
- (6R) RTE DATA: select this key to show the RTE DATA page.

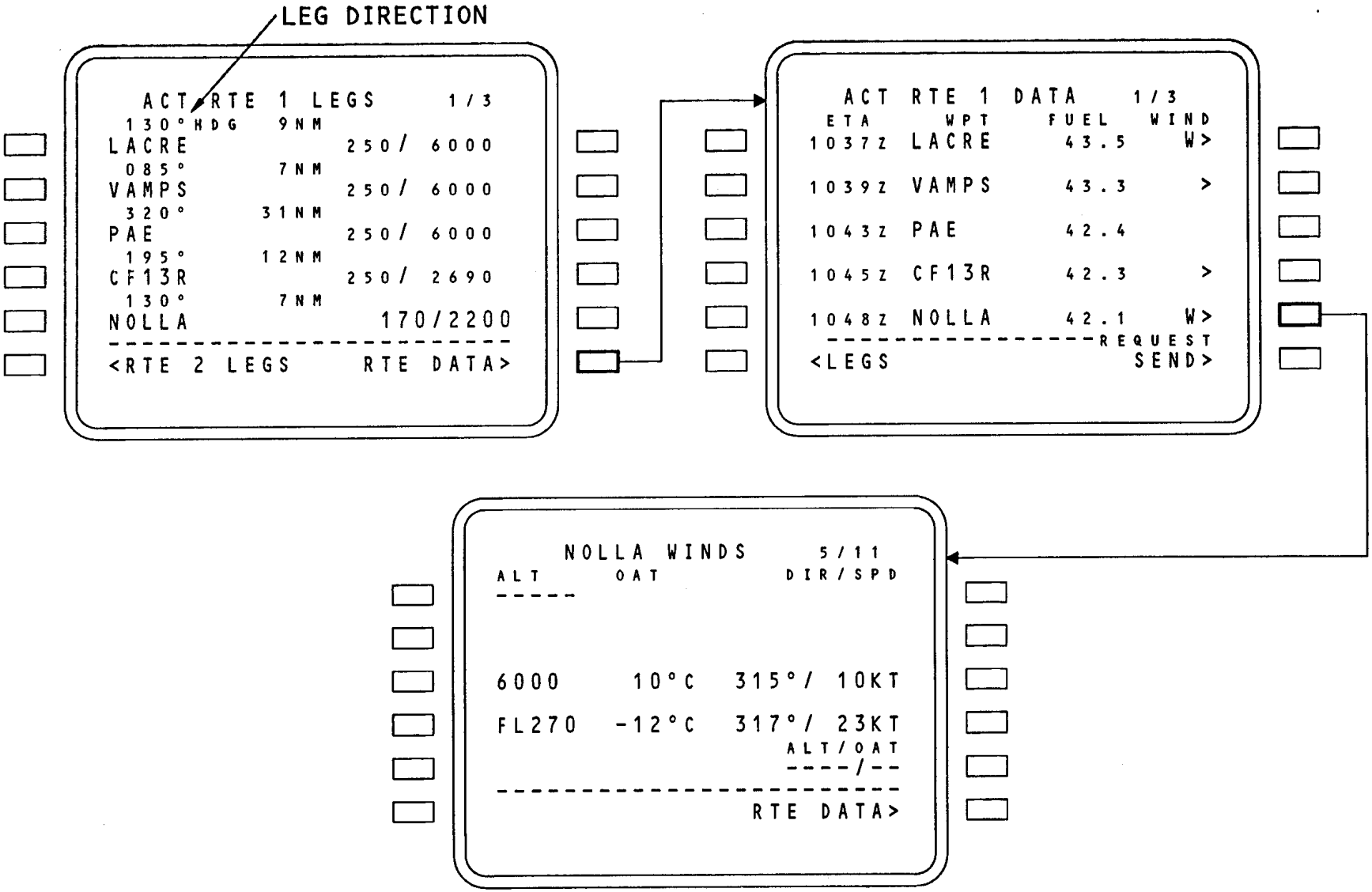


Figure 56 ROUTE LEGS, ROUTE DATA AND WIND PAGES

FIX PAGE

General

The fix page allows the waypoints to be made from the intersection of the present flight plan and selected radials and distances from known waypoints. These fixes are shown on the navigation display (ND).

Page Access

Push the Fix mode key to access this page.

FIX Page

The function of this page is discussed by the operation of each line.

- Azimuth data: azimuth data is related to magnetic north when the airplane is between 73'N and 60'S latitude. otherwise, it is relative to true north. The data is also related to true north when the HDG REF switch is set to TRUE.
- (1L) FIX/SELECTED REFERENCE POINT or waypoint identifiers in the data base may be entered on this line:
- Airport
- Navigation Aid
- Waypoint
- Radial and distance from a point
- Latitude/longitude

These entries may be made through the keyboard or with line selection from another page. Entry of a fix shows on the ND with a green circle around the appropriate symbol. The bearing and distance from that fix also shows.

- (2L through 4L) BRG/DIS: valid entries are bearing or distance from the FIX. If an intersection of the radial line or distance circle with the active flight plan is there, the ETA and estimated altitude at the intersection shows.

Entry of a bearing causes the ND to show the selected radial(s) as dashed (--) green lines, that extend for 700 nm from the selected reference point (fix). Along each radial, the radial angle for magnetic north shows with the letter R before it.

Entry of a distance causes the ND to show the selected distance as a dashed green circle around the selected reference point (fix). The radius of the circle is equal to the selected distance. Along the circle, when in view, the distance value shows in green numbers. A distance is valid, and shows, if it crosses the flight plan.

- (5L) ABEAM (nearest point abeam): selection results in the display of the bearing and distance from the FIX to the nearest intersection on the flight plan path, also shown is the distance along the flight plan to the nearest abeam point plus the ETA and altitude at that point.
- (6L) ERASE FIX: this selection causes all FIX data for that page to be removed from the CDU display.

NOTE: NEXT PAGE ALLOWS SELECTION OF THREE RADIALS AND/OR DISTANCES AND A POINT ABEAM FROM A SECOND FIX POINT AND A SECOND ETA-AL T ENTRY.

- (6R) ETA/ALT: valid entries are altitude, flight level or time. Time entry must be followed by a Z to show the difference between altitude, flight level and time.

Entry of an altitude/flight level or time results in the display of the airplane's future positions along the active route at that altitude or time on the ND.

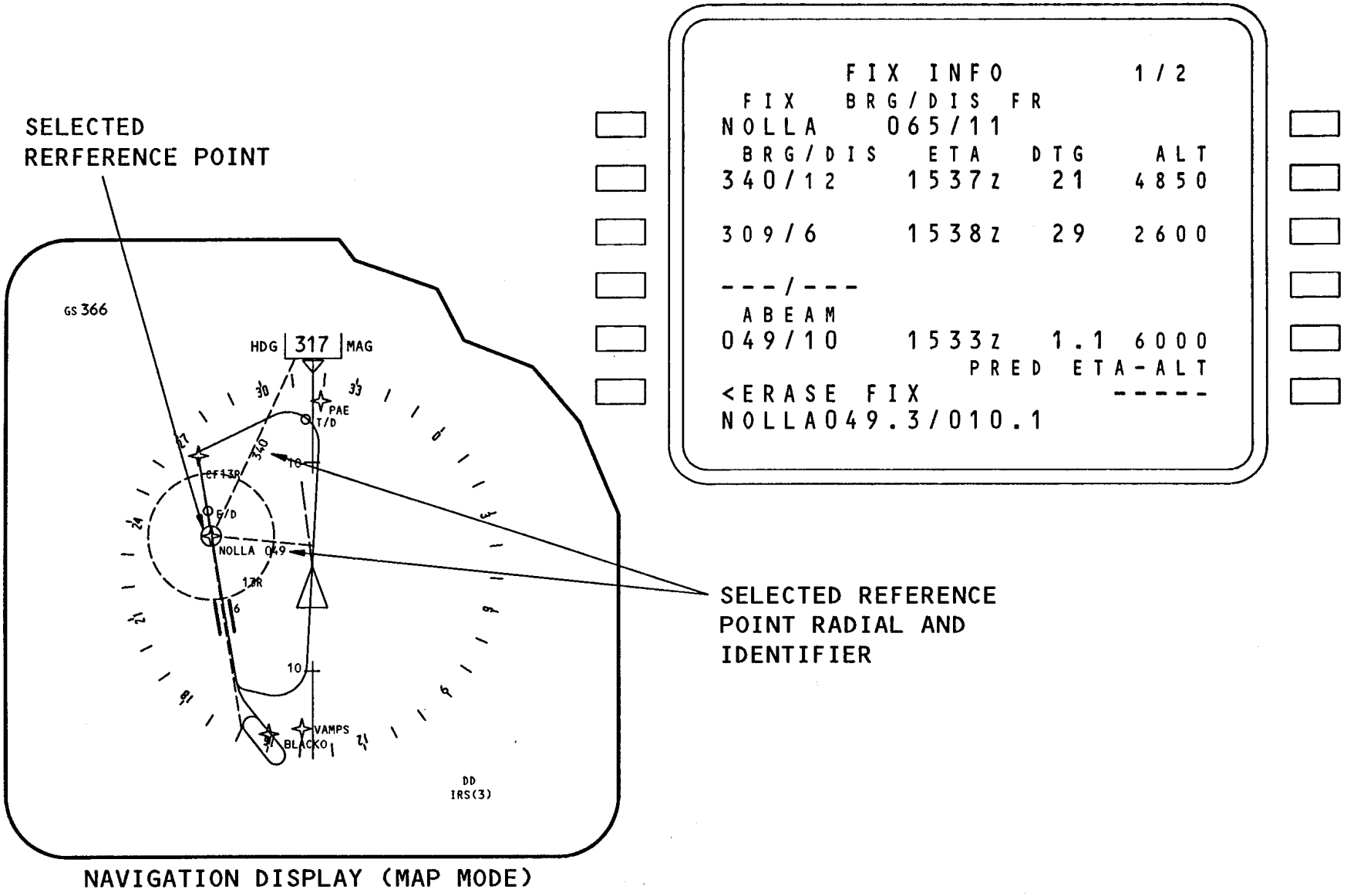


Figure 57 FIX PAGE

ATC INDEX PAGE

General

The ATC INDEX page provides access to the different air traffic control data link functions. The operation of the ATC mode key on the CDU also shows on the graphic.

Page Access

To access the ATC INDEX page:

- Select the ATC mode key on the CDU when logon to an ATC center has been successfully completed and no pending ATC COMM uplinks exist.
- Select the INDEX prompt on the EMERGENCY REPORT page.
- Select the INDEX prompt on the ATC REQUEST page.
- Select the INDEX prompt on the ATC REPORT page 1 or 2.
- Select the INDEX prompt on the ATC LOG page.
- Select the INDEX prompt on the ATC LOGON/STATUS page.
- Select the INDEX prompt on the WHEN CAN WE EXPECT page.
- Select the INDEX prompt on the VERIFY REQUEST page.

Operation

The function of this page is discussed by the operation of each line.

- (1L) EMERGENCY: This prompt selects the EMERGENCY REPORT page.
- (2L) REQUEST: This prompt selects the ATC REQUEST page.
- (3L) REPORT: This prompt selects the ATC REPORT page 1/X, where X is 1 or 2 depending on the number of reports awaiting transmission.
- (4L) LOG: This prompt selects the ATC LOG page 1/X, where X is the number of ATC LOG pages.
- (5L) LOGON/STATUS: this prompt selects the ATC LOGON/STATUS page.
- (6L) PRINT LOG: this prompt causes the contents of the ATC LOG to be sent to the printer for a hard copy report. The current status of the printer, such as BUSY, PRINTING, FAIL or ERROR may also show.
- (1R) POS REPORT: this prompt selects the POS REPORT page.
- (2R) WHEN CAN WE: this prompt selects the WHEN CAN WE EXPECT page.
- (4R) CLEARANCE: this prompt selects the VERIFY REQUEST page 1/X for the clearance request.
- (5R) VOICE: this prompt selects the VERIFY REQUEST page 1/X for the voice contact request.

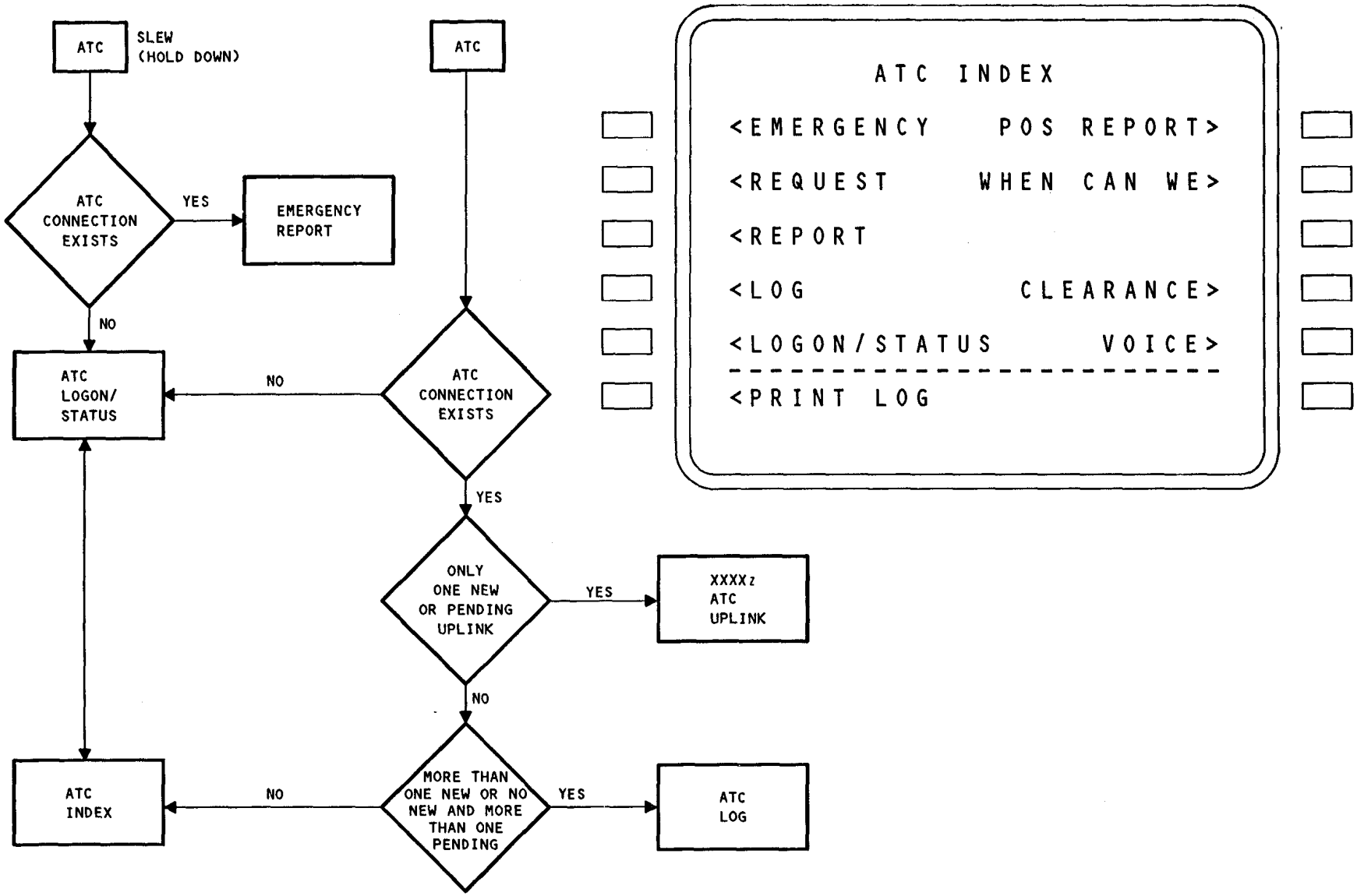


Figure 58 ATC INDEX PAGE

ATC LOGON/STATUS PAGE

General

The ATC LOGON/STATUS page provides the capability to initiate an air traffic services facilities notification (AFN) downlink to a specified ATC center. This page also provides the status display and control of automatic dependant surveillance (ADS), air traffic control data link (ATC COMM), and the data link status.

Page Access

To access the ATC LOGON/STATUS PAGE:

- Push the ATC mode key on the CDU when logon to an ATC center has not been successfully completed.
- Hold down (SLEW) the ATC mode key when no ATC data link connection exists.
- Select LOGON/STATUS on the ATC index page.

Operation

The function of this page is discussed by the operation of each line:

- (1L) LOGON TO: this line initially shows box prompts. Valid entries are four letter ATC center codes. Entry of valid four letter codes along with a flight number in line 2L, causes the prompt LOGON SEND to show on line 1R.
- (2L) FLT NO: this line shows the flight number that was entered on the RTE page. If no flight number was entered on the route page, box prompts show to allow entry here. Entry on this page will propagate to the route and progress pages. Entry of a flight number over an existing flight number causes LOGON SEND to show on 1R, terminates any ATC COMM connections which exist, and aborts any AFN process in progress at the time of entry.
- (3L) ATC COMM SELECT OFF: this line is blank, until receipt of a positive response to an AFN logon request, or after all ATC COMM connections have been terminated. Selection causes a termination of any active ATC data link connection, and blanks lines 3L, 3R, and 4R.
- (5L) ADS SELECT OFF/ADS SELECT ARM: selection of this line when SELECT OFF shows terminates all ADS connections and ADS reporting. Selection of this line when ADS ARM shows arms ADS reporting. The data field title line shows the ADS status of ARM, ACT, or OFF.
- (6L) INDEX: this prompt selects the ATC INDEX page.
- (1R) LOGON SEND: this line is blank until an ATC center and flight number are entered, upon which SEND shows. Select SEND to logon to the ATC center. SENDING shows until network acknowledgement is received. If acknowledgement is not received, or the AFN timer expires, RESEND shows. After network
- acknowledgement is received, SENT shows. After a positive acknowledgement is received from the ATC center, ACCEPTED shows. If a negative acknowledgement is received from the ATC center, REJECTED shows.
- (3R) ACT CTR: this line is blank, until the first ATC data link message is received and the ATC data link is available. The data field blanks again when the ATC data link function is turned off (5L), or both ATC COMM connections have been terminated.
- (4R) NEXT CTR: this line is blank until a logon to an ATC center is done, the data link status is ready, and the next ATC center is known.
- (5R) ADS EMERG SELECT ON: select this prompt to put ADS into the emergency mode. The line then changes to ADS EMERGENCY SELECT OFF. Select this prompt to turn off the ADS emergency mode.
- (6R) DATA LINK: this line shows the data link status. READY, NO COMM, VOICE, and FAIL are possible annunciations.

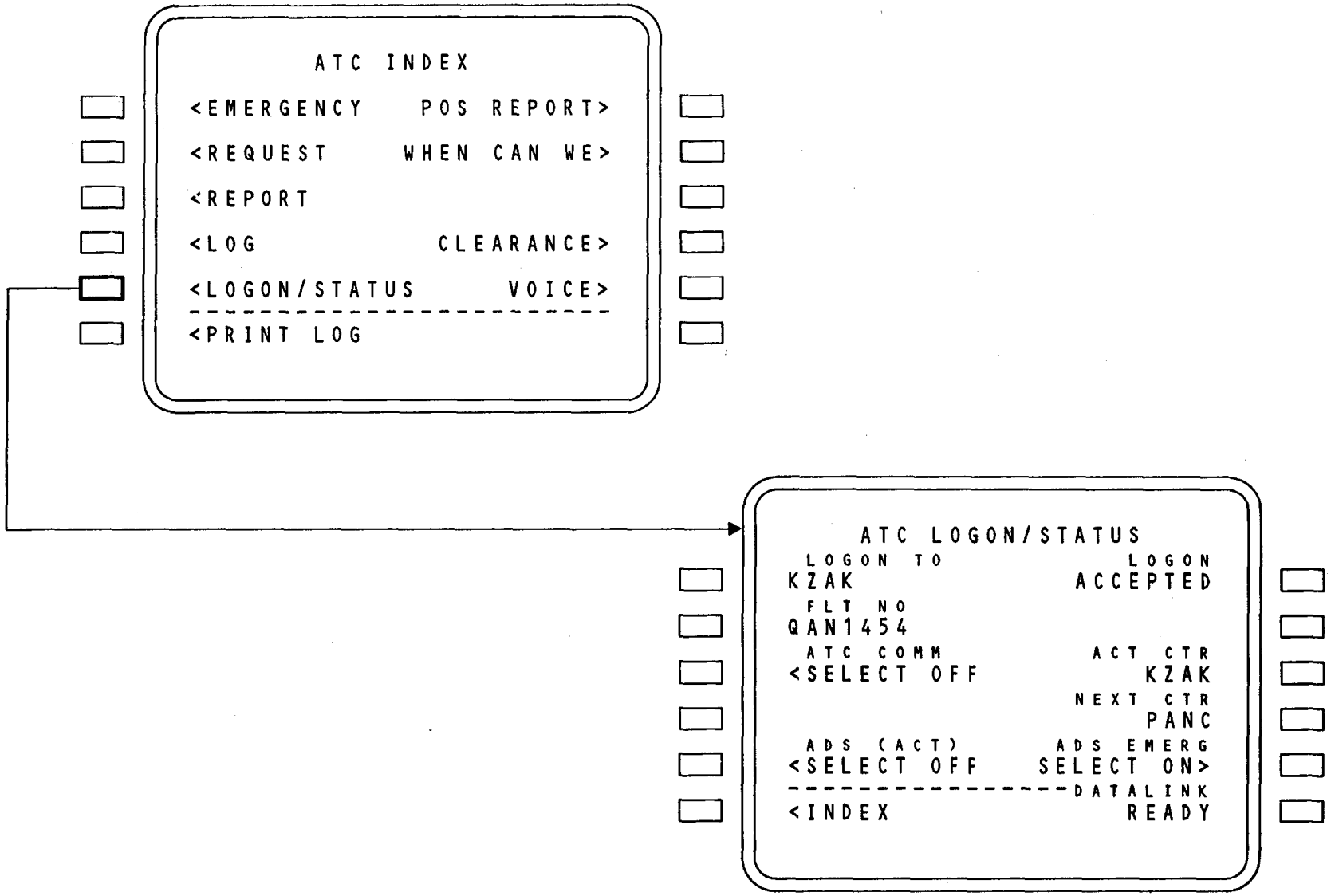


Figure 59 ATC LOGON/STATUS PAGE

DATA LINK INDICATIONS

General

Uplink messages can come from air traffic control and airline operations. The flight crew are alerted to these uplinked messages by indications in the flight deck. The flight crew can view the uplinked message from ATC by selecting the ATC mode key on the CDU. Airline operations messages contain data for loading into the FMC. The data must be loaded before it can be reviewed. The flight crew can access the proper page for loading the data by selecting the FMC COMM mode key on the CDU. EICAS messages are also shown for data link status.

All data link functions are done by the master FMC.

ATC Uplink Messaae Indications

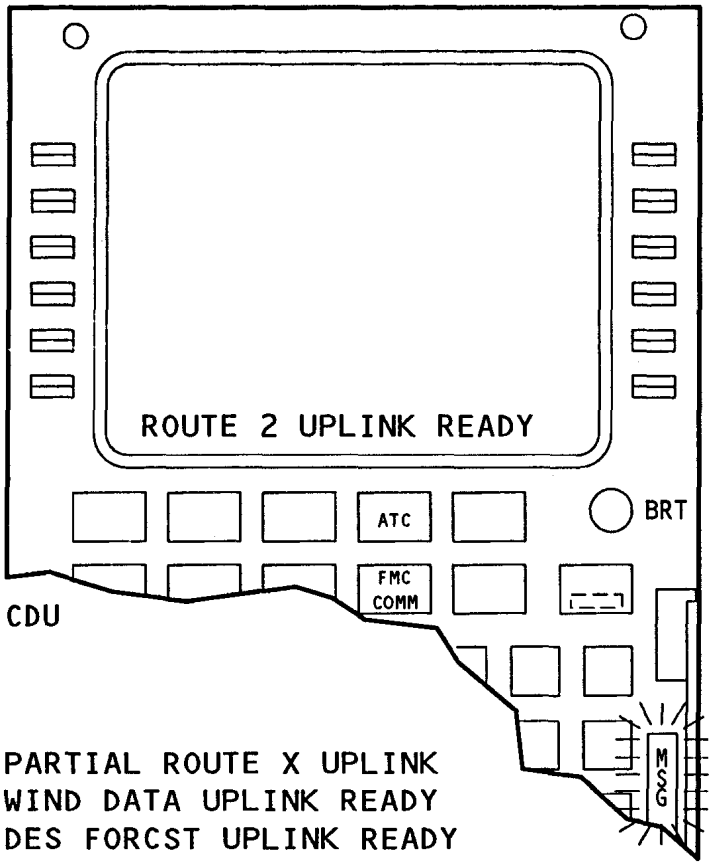
When an ATC uplink message is received by ACARS and is passed on to the FMC, the FMC sends an output to the MAWEA to sound a chime. The FMC also sends an output to EICAS to show the memo message ATC MESSAGE. This EICAS message clears when the flight crew view the message. If there is more than one new message, all new messages must be viewed from the ATC LOG before the EICAS message clears.

Airline Operations Message Indications

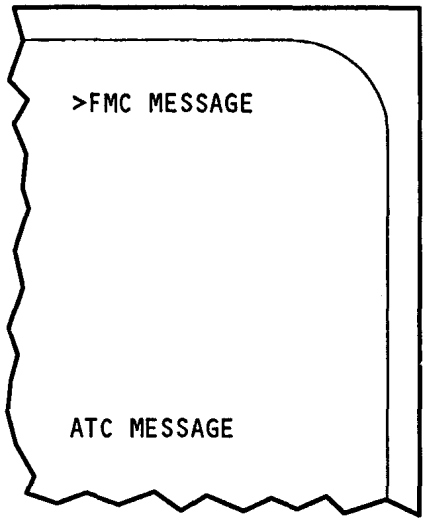
When an airline operations uplink message is received by ACARS and is passed on to the FMC, the FMC sends an output to EICAS to show the message FMC MESSAGE. The CDU message light turns on, and a CDU scratchpad message will indicate the type of uplink message received. Scratchpad messages can also show for messages that were received that contain errors.

System Status Messages

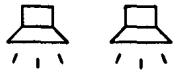
The SATCOM data unit sets messages that indicate loss of voice or data capability or total failure of the system. The active ACARS management unit can also set messages to indicate a message has been received or the unit has failed. The FMC sets a message when a data link has been lost, or regained after loss.



PARTIAL ROUTE X UPLINK
WIND DATA UPLINK READY
DES FORCST UPLINK READY
FLT NUMBER UPLINK
INVALID ROUTE UPLINK
INVALID FLT NO UPLINK
INVALID WIND DATA UPLINK
INVALID FORECAST UPLINK
INVALID ATC UPLINK



MAIN EICAS DISPLAY



CHIME

AURAL WARNING SPEAKERS

>DATALINK LOST (C)
>DATALINK AVAIL (C)
>DATALINK SYS (C)
>SATCOM (C)
>SATCOM DATA (C)
>SATCOM VOICE (C)
>SATVOICE LOST (C)
>SATVOICE AVAIL (C)
ACARS MESSAGE (D)

OTHER POSSIBLE EICAS MESSAGES

Figure 60 DATA LINK INDICATIONS

ATC UPLINK MESSAGE

General

When an ATC message is received, the flight crew views that message by pushing the ATC mode key on the CDU. Most lateral clearances can be loaded directly using the message page. The flight crew can also respond back to ATC using the ATC UPLINK page. After the flight crew accepts or rejects the message, the response and time shows at the bottom of the ATC UPLINK page. This graphic shows a typical ATC uplink message and possible responses to that message.

XXXXz ATC UPLINK Page Operation (first page)

The function of this page is discussed by the operation of each line:

- (IL) REQUEST: select this prompt to show the XXXXz ATC REQUEST page which corresponds to the displayed uplink message.
- (2L - 5L) MESSAGE TEXT: these lines display the message received from ATC.
- (1R) STATUS: this line shows the message status. Annunciations are as described in the ATC LOG page.
- (6R) LOG: select this prompt to show the ATC LOG page.

There may be additional pages of message text.

XXXXz ATC UPLINK Page Operation (last page)

The operation is the same as the first page with these exceptions:

- (4L) STANDBY: select this prompt to show the VERIFY RESPONSE page for the STANDBY response.
- (5L) REJECT: select this prompt to show the REJECT DUE TO page.
- (6L) PRINT: select this prompt to make a hard copy printout of the displayed message. Printer status also shows on this line.
- (4R) LOAD: this line will normally be blank. LOAD shows when the uplinked message contains loadable data. Select this prompt to load the clearance into the FMC.
- (5R) ACCEPT: select this prompt to show the VERIFY RESPONSE for the WILCO, ROGER, or AFFIRM response as appropriate for the uplinked message.

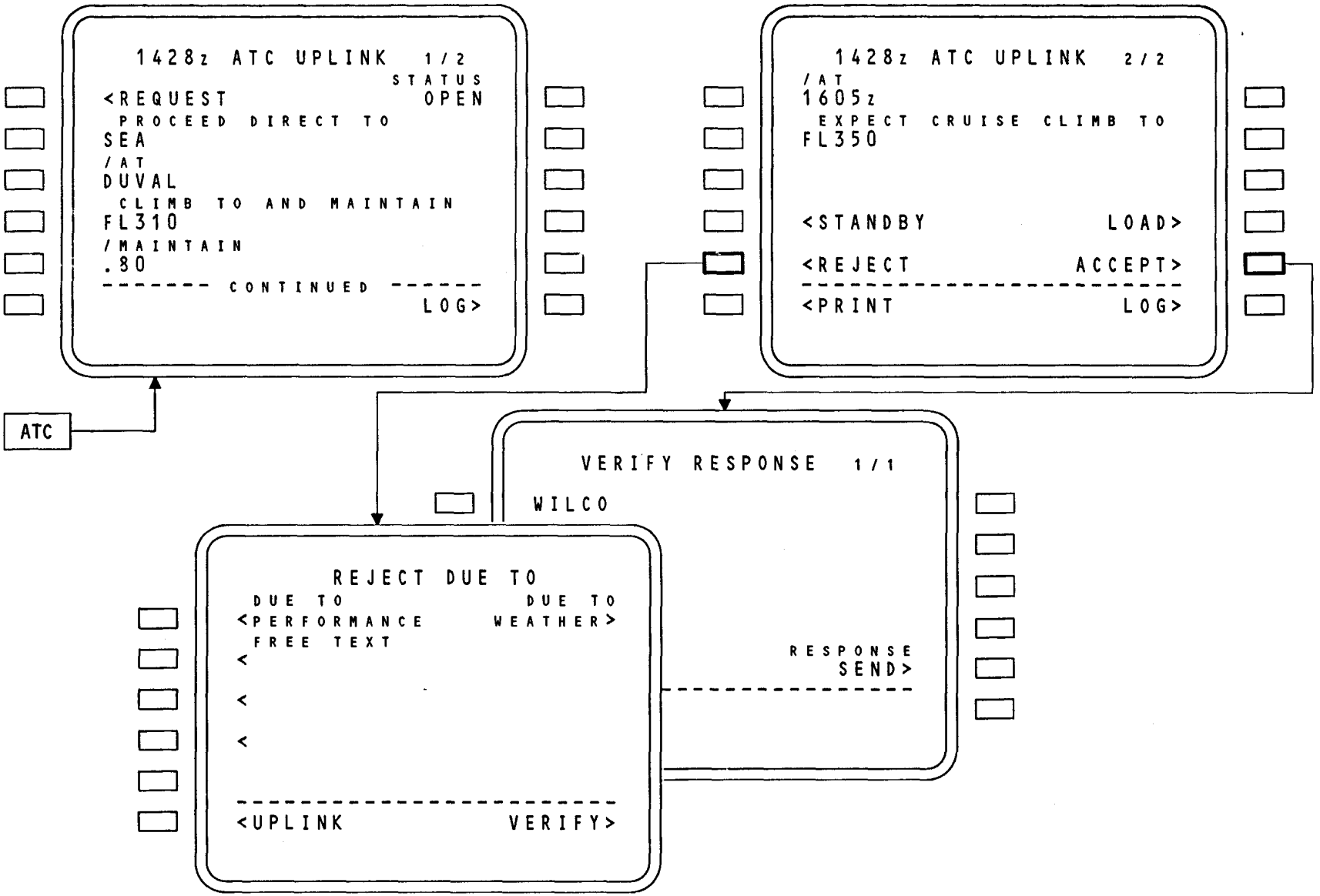


Figure 61 ATC UPLINK MESSAGE

ATC REPORT

General

ATC uplink messages can request that the flight crew report information back to ATC. The FMC automatically generates an appropriate message and stores it for the flight crew, so that they can easily respond. The ATC REPORT page provides access to these VERIFY REPORT pages. The VERIFY REPORT page lets the flight crew view the response. The VERIFY REPORT page is also used to arm or initiate the downlink of the message. Arming a report lets the FMC send the message when the specified condition occurs.

Page Access

To access to the ATC REPORT page:

- Select the REPORT prompt on the ATC INDEX page.
- Select the REPORT prompt on an XXXXz ATC UPLINK page which contains an ATC request for information.
- Select the REPORT prompt on any of the VERIFY REPORT pages.

ATC REPORT Page Operation

The number of pages of ATC reports, depends on how many reports the FMC has generated in response to ATC requests. The function of this page is discussed by the operation of each line.

- (1L) ATC RTE REPORT: select this prompt to show the VERIFY REPORT page for the ATC ROUTE REPORT. The route report is for the active route. This line will be blank if there is no active route.
- (1L, except first page - 5L) VERIFY REPORT: select a prompt to show the VERIFY REPORT page corresponding to the item as shown. Items can be deleted on this page. Once the report has been transmitted and network acknowledgement has been received, the item blanks.
- (6L) INDEX: select this prompt to show the ATC INDEX page.
- (1R first page only) FREE TEXT: select this prompt to show the VERIFY REPORT page. The page shows with only fields for free text entry.

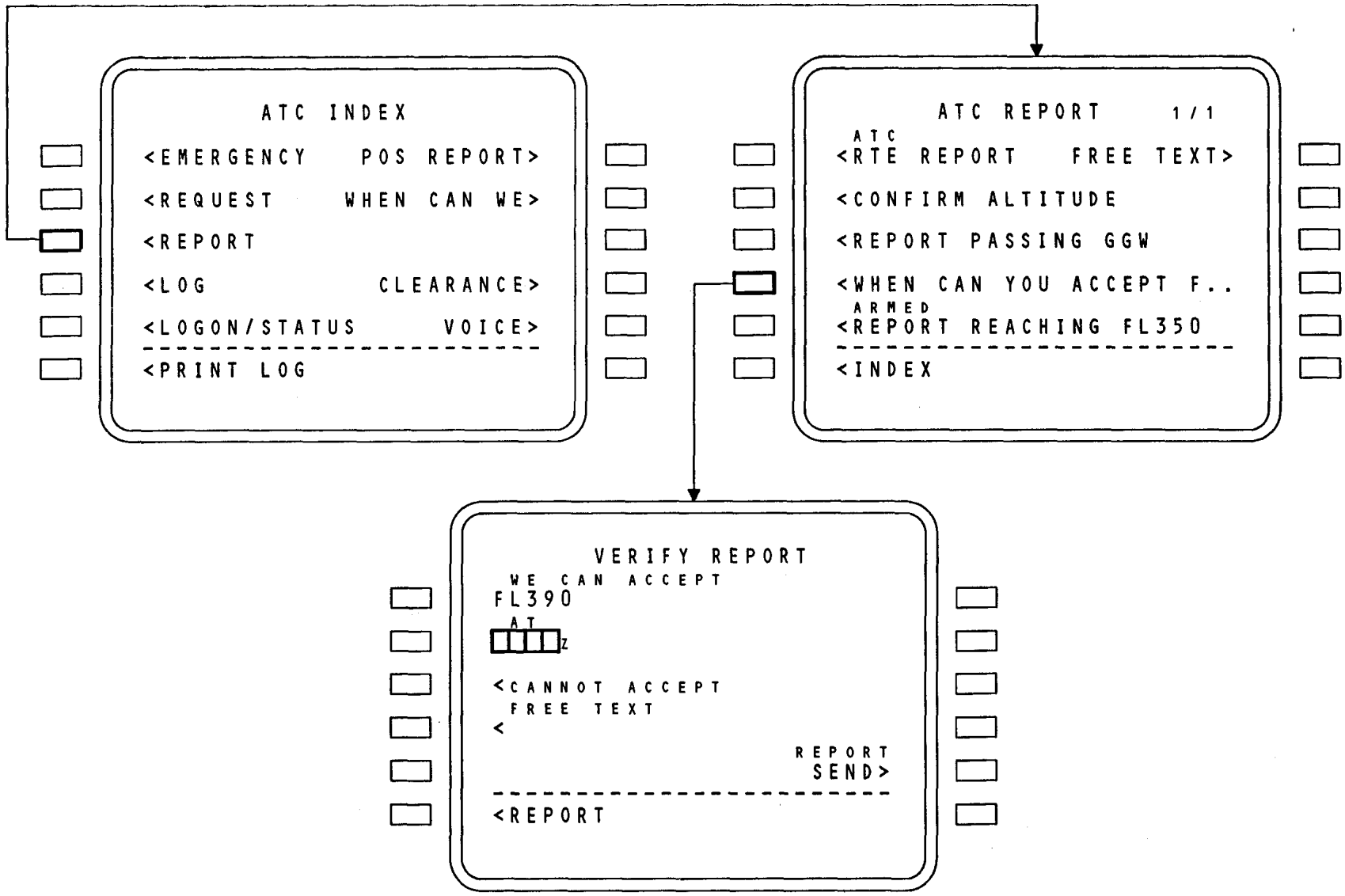


Figure 62 ATC REPORT

ATC REQUEST PAGES

General

The ATC REQUEST page allows the flight crew to enter an altitude request, a speed request, or an offset request. This page also provides access to the ATC ALT REQUEST, ATC SPEED REQUEST, ATC OFFSET REQUEST, ATC ROUTE REQUEST, ATC INDEX and VERIFY REQUEST pages.

The ATC ALT REQUEST, ATC SPEED REQUEST, ATC OFFSET REQUEST, and ATC ROUTE REQUEST pages allow additional information to be added about the specific request. The VERIFY REQUEST page allows the flight crew to verify the message they intend to send, and provides the selection to initiate the downlink.

Page Access

To access the ATC request page:

- Select the REQUEST prompt on the ATC INDEX page.
- Select the REQUEST prompt on the ATC ALT REQUEST page.
- Select the REQUEST prompt on the ATC SPEED REQUEST page.
- Select the REQUEST prompt on the ATC OFFSET REQUEST page.
- Select the REQUEST prompt on the ATC ROUTE REQUEST page.
- Select the REQUEST prompt on the VERIFY REQUEST page.

ATC REQUEST Page Operation

The operation of this page is discussed by the operation of each line.

- (1L) ATC ALT REQUEST: this line initially shows dashes. Selection of the prompt causes the ATC ALT REQUEST page to show. Entry of an altitude into the data field causes the ATC ALT REQUEST page to show with the entered altitude on that page. Altitude entries may be in feet, flight level, or in meters if the entry is suffixed with an M. After entry of a valid altitude, the data field shows in large font.
- (2L) ATC SPEED REQUEST: this line initially shows dashes. Selection of the prompt causes the ATC SPEED REQUEST page to show. Entry of a speed or MACH causes the ATC SPEED REQUEST page to show with the entered speed on that page.
- (3L) ATC OFFSET REQUEST: this line initially showes dashes. Selection of this prompt causes the ATC OFFSET REQUEST page to show. Entry of an offset direction and distance causes the ATC OFFSET REQUEST page to show with the entered distance and direction on that page.
- (4L) ROUTE REQUEST: select this prompt to show the ATC ROUTE REQUEST page.
- (5L) ERASE REQUEST: -this line is initially blank, until a selection or entry is made on this page Select this prompt to remove all entries or selections that were made to any of the five request pages.
- (6L) INDEX: this prompt selects the ATC INDEX page.
- (6R) VERIFY: select this prompt to show the VERIFY REQUEST page.

ATC ALTITUDE REQUEST PAGE Operation

The function of the ATC ALTITUDE REQUEST page is discussed by the operation of each line. The operation of the ATC SPEED REQUEST and ATC OFFSET request pages are similar, and are tied together with NEXT PAGE and PREV PAGE Keys.

- (1L) ALTITUDE: this line shows dashes if the prompt ALTITUDE was selected on the ATC REQUEST page. If an altitude was entered on the ATC REQUEST page, it will show here. Altitude entries on this page are propagated back to the ATC REQUEST page. Altitude entries may be in feet, flight level, or in meters if the entry is suffixed with an M.
- (2L) STEP AT: this line is initially blank, until an entry is shown in line 1L. After an entry to line 1L, the data field shows dashes. Valid entries are a position identifier or a time.
- (4L) AT PILOTS DISCRETION: select this prompt to include this message element in the downlink message.
- (6L) REQUEST: select this prompt to show the ATC REQUEST page.
- (1R - 4R) These prompts may be selected to include the message element in the downlink message.
- (6R) VERIFY: select this prompt to show the VERIFY REQUEST page.

VERIFY REQUEST Page Operation

The VERIFY REQUEST page shows the text of the message which will be downlinked to ATC for a WHEN CAN WE EXPECT query, CLEARANCE request, VOICE CONTACT request, or an ALTITUDE, SPEED, OFFSET, or ROUTE CLEARANCE request. This page also allows free text messages to be included in the downlink.

- (1L - 5L or 4L on last page) Message Text: the message elements selected on the associated pages show, followed by entry fields for free text entries.
- (6L) REQUEST, INDEX, or WHEN CAN WE: select this prompt to show the ATC REQUEST, ATC INDEX, or WHEN CAN WE EXPECT page respectively. The page depends on which page the VERIFY REQUEST page was selected from.
- (5R) REQUEST SEND: this prompt shows on the last VERIFY REQUEST page. Selection of this prompt causes the displayed message to be sent to the active ATC center.

The data link status also shows on this line. SENDING shows after selection of SEND or RESEND prior to network acknowledgement. If network acknowledgement is not received, RESEND shows. Data link status of NO COMM, VOICE, or FAIL can also show. NO ATC COMM shows if no ATC connection exists.

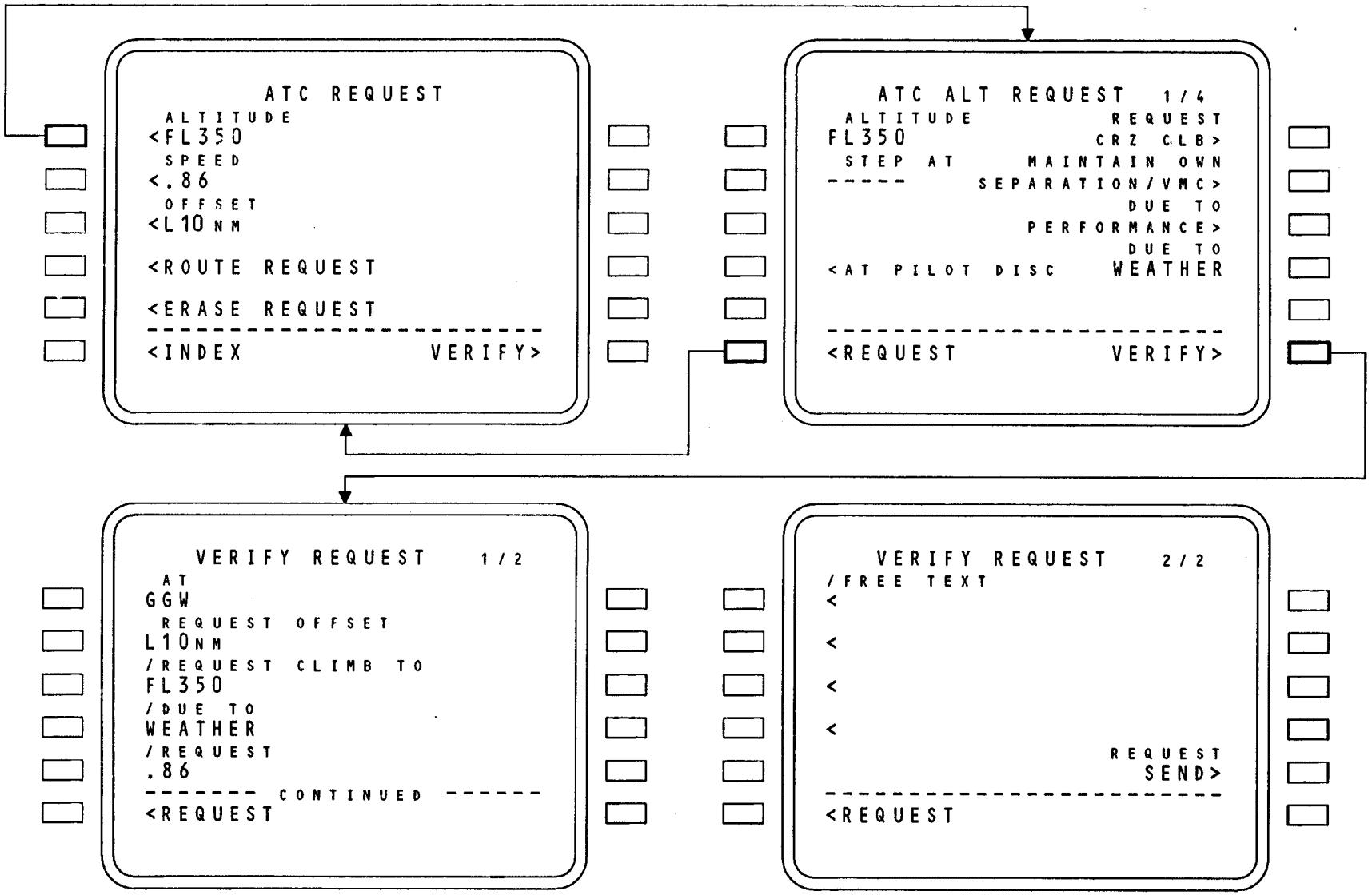


Figure 63 ATC REQUEST PAGES

FMCS - WHEN CAN WE EXPECT PAGE

General

The WHEN CAN WE EXPECT page is used by the flight crew to query ATC as to when they can expect to receive certain clearances. After entries are made, the VERIFY REQUEST page is selected to confirm and send the message to ATC.

Page Access

To access the WHEN CAN WE EXPECT page:

- Select the WHEN CAN WE prompt on the ATC INDEX page.
- Select the WHEN CAN WE prompt on the VERIFY REQUEST page.

Operation

Data field selections and entries are done on this page which select message elements to be included in the downlink message.

The function of this page is discussed by the operation of each line:

(1L) CRZ CLIMB TO: this data field initially shows dashes. Valid entries are altitude in feet, flight level or in meters. Metric altitude entries are suffixed with an M. This line may be deleted after an entry is made. Entry to this line blanks lines 2L, 2R, 3L, and 3R.

(2L) CLIMB TO: this data field initially shows dashes. Valid entries are altitude in feet, flight level or in meters. Metric altitude entries are suffixed with an M. This line may be deleted after an entry is made. Entry to this line blanks lines 1L, 2R, 3L, and 3R.

(3L) DESCENT TO: this data field initially shows dashes. Valid entries are altitude in feet, flight level or in meters. metric altitude entries are suffixed with an M. This line may be deleted after an entry is made. Entry to this line blanks lines 1L, 2L, 2R, and 3R.

(4L) SPEED: this line initially shows dashes. Valid entries are three digit airspeed or MACH values. This line may be deleted after an entry is made.

- (5L) ERASE WHEN CAN WE: this line initially is blank. After an entry or selection is made on this page, the prompt shows. Select this prompt to return all entered and selected items to their default state.
- (6L) INDEX: select this prompt to show the ATC INDEX page.
- (2R - 4R) MESSAGE ELEMENTS: select these message elements for inclusion in the when can we expect downlink message. The items initially show in small font. Selection causes the item to show in large font. Large font items may be deleted. Items and selections on lines 1L, 2L, 3L, 2R, and 3R, are mutually exclusive. Only one of these may be selected. When one is-selected, the other data fields blank. Delete the entry/selection to show the other data fields again.
- (6R) VERIFY: select this prompt to show the VERIFY REQUEST page for the WHEN CAN WE EXPECT downlink message. The VERIFY REQUEST page is used to confirm the message that the flight crew intend to send, and to initiate the downlink.

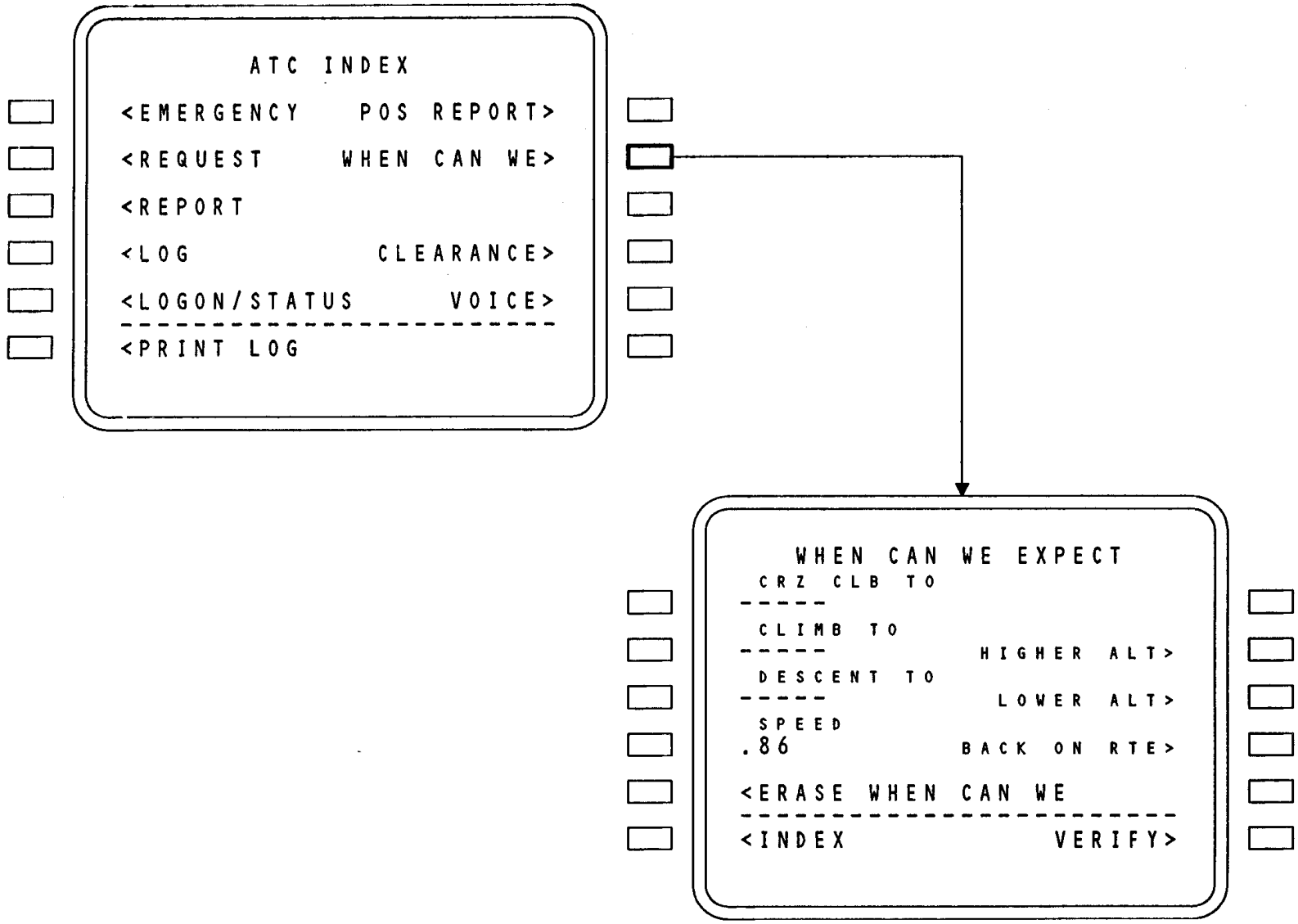


Figure 64 WHEN CAN WE EXPECT PAGE

POSITION REPORT PAGE

General

The POSITION REPORT page shows reporting parameters for both the AOC and ATC data link functions. This page also is used to initiate the position report downlink.

Page Access

To access the POSITION REPORT page:

- Select the POS REPORT prompt on the ATC INDEX page.
- Select REQUEST POSITION REPORT on the ATC REPORT page.
- Select POS REPORT on the PROGRESS page 1/3.
- Select POS REPORT on the FMC COMM page.

Operation

The function of this page is discussed by the operation of each line:

- (1L) LAST: This line shows the last sequenced flight plan waypoint. The data line is blank if there is no active route.
- (2L) ALT: This line shows the current altitude.
- (3L) TO: This line shows the active flight plan waypoint. The line is blank if an active waypoint does not exist. valid entries to this line are waypoints from the active route.
- (4L) NEXT: This line shows the next waypoint in the flight plan after the active waypoint. The line is blank if a next waypoint does not exist. Valid entries to this line are flight plan waypoints from the active route.
- (5L) TEMP: This line shows the current static air temperature in degrees celsius.
- (6L) COMPANY SEND: select this prompt to initiate the AOC data link position report. The data link status also shows on this line. SENDING shows after selection of SEND prior to network acknowledgement. When network acknowledgement is received, SENT shows in small font next to SEND. If network acknowledgement is not received, SEND shows again by itself. Data link status of NO COMM, VOICE, or FAIL, can also show.
- (1R) ATA: this line shows the time at which the waypoint on line 1L was sequenced.
- (2R) SPD: this line shows the current target MACH number. Valid entries to this line are up to three digit MACH number values.' Deleting this line after an entry returns the display to the default value.
- (3R) ETA: this line shows the estimated time of arrival at the waypoint on line 3L. Valid entries to this line are four digit times in an HHMM format. Deleting this line after an entry returns the display to the default value.
- 4R) DEST ETA: this line shows the estimated time of arrival at the destination airport. Valid entries to this line are four digit times in an HHMM format. Deleting this line after an entry returns the display to the default value.
- (5C) WIND: this line shows the current wind as computed by the FMC.
- (5R) FUEL: this line shows the fuel available at the time the waypoint-shown on line 1L was sequenced. The display shows the lessor of the-totalizer or FMC calculated fuel.
- (6R) ATC SEND: select this prompt to initiate the position report downlink to the active ATC center. The data link status also shows on this line. SENDING shows after selection of SEND or RESEND prior to network acknowledgement. If network acknowledgement is not received, RESEND shows., Data link status of NO COMM, VOICE, or FAIL can also show.

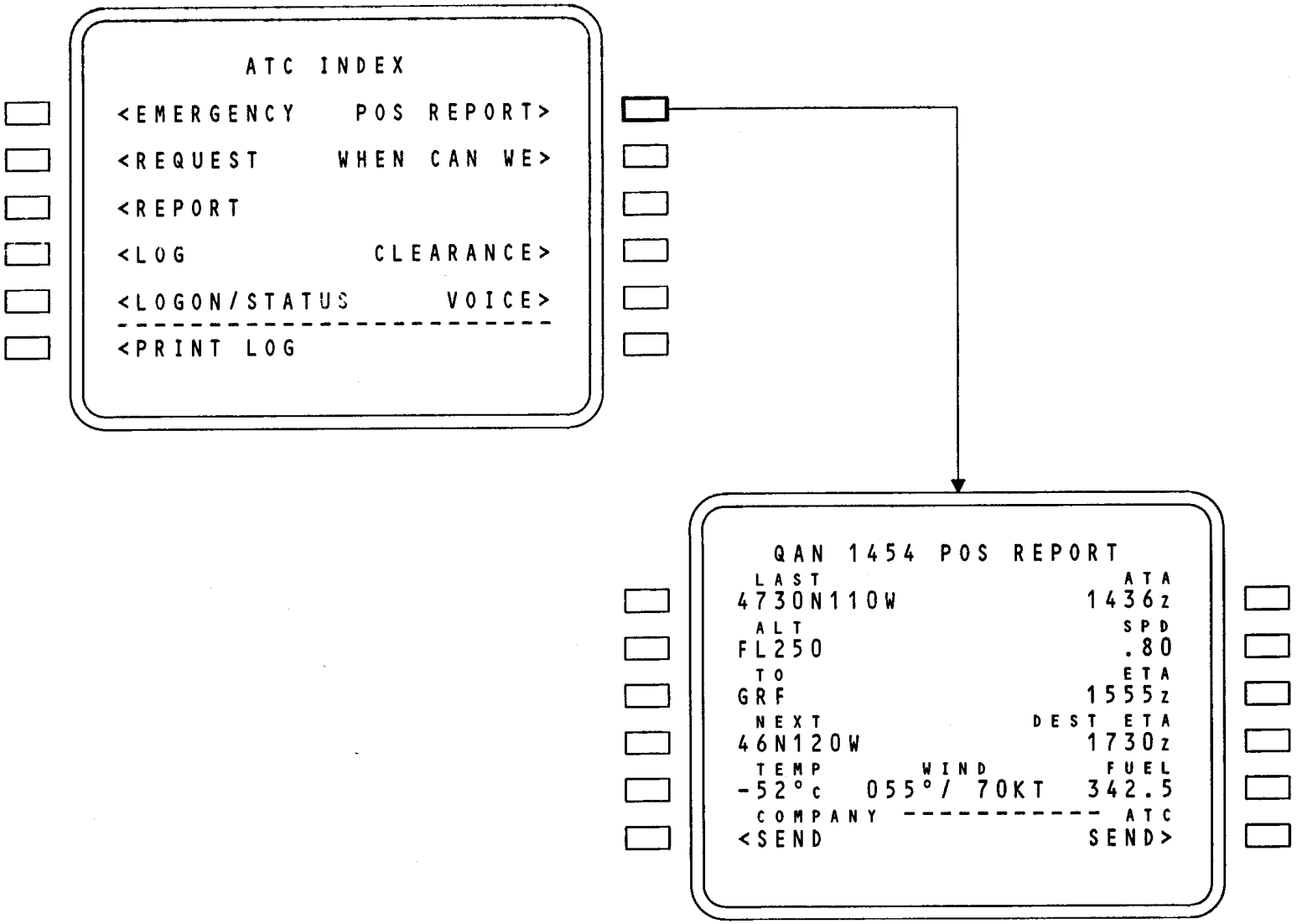


Figure 65 POSITION REPORT PAGE

EMERGENCY REPORT PAGES

General

The EMERGENCY REPORT page is used to create messages to alert ATC of an airplane emergency. These messages can contain airplane information and lateral and/or vertical maneuvers that the crew intend to execute. Data field entries and selections result in message elements for the emergency report downlink message.

The VERIFY EMERGENCY page lets the flight crew view the downlink message before it is sent, add free text, and initiate the downlink.

Page Access

To access the EMERGENCY REPORT page:

- Select EMERGENCY on the ATC INDEX page.
- Hold down (slew) the ATC mode key on the CDU when an ATC data link connection exists.
- Select the EMERGENCY prompt on the VERIFY EMERGENCY page.

Emergency Report Page Operation

The function of this page is discussed by the operation of each line.

- (1L) MAYDAY: select this prompt to show the VERIFY EMERGENCY page for the emergency report downlink message. MAYDAY initially shows in small font. After selection, MAYDAY shows in large font to indicate inclusion in the downlink report.
- (2L) DIVERT TO: this line shows the destination airport in small font if one is included in the active route. If no destination airport exists for the active route, the line shows dashes. Entries to the data field are the same as waypoint entries to the route page. After selection or entry to this data field, the format changes to large font.
- (3L) OFFSET: this line initially shows dashes. Entries are direction of offset and offset distance.
- (4L) DESCEND TO: this line shows the autopilot mode control panel (MCP) altitude in small font if the data is valid from the MCP. The flight crew can enter altitude in feet, flight level, or meters. A meters entry must be followed by an M. Selection or entry causes this data field to show in large font.
- (5L) ERASE (or CANCEL) EMERGENCY: this line is blank until an entry is made into one of the data fields on this page. After an entry is made into this page, select ERASE EMERGENCY to return the page to its default state, and deselect any selected message elements. After a successful transmission of an emergency downlink, and before selection or entry into a data field on this page the line shows CANCEL EMERGENCY in small font. Select the prompt to change the format to large font and cancel the ADS emergency MODE when the message is sent.
- (6L) INDEX: this prompt selects the ATC INDEX page.
- (1R) PAN: this **line initially shows** PAN in small font. Selection of this prompt causes the display of the VERIFY EMERGENCY page for the emergency report downlink message. After selection PAN shows in large font.
- (2R) SOB: this line initially shows dashes. Valid entries of souls on board are one to three digits. An entry into this data field results in the display of fuel quantity remaining on line 3R.
- (3R) FUEL REMAINING: this line is normally blank until an entry is made on line 2R (SOB). When the entry is made to 2R, the lesser of the totalizer or FMC calculated fuel shows along with the calculated value of fuel in terms of time. Valid entries are up to two digits (hours of fuel remaining) followed by a plus (+) sign, followed by up to two digits (minutes).
- (6R) VERIFY: select this prompt to show the VERIFY EMERGENCY page.

Verify Emergency Page Operation

The operation of this page is discussed by the operation of each line:

- (1L - 5L or 4L on last page) Message Text: the message elements selected on the EMERGENCY REPORT page show, followed by fields for free text entries.
- (6L) EMERGENCY: select this prompt to show the EMERGENCY REPORT page.
- (5R) REPORT SEND: this prompt shows on the last VERIFY EMERGENCY page. Selection of this prompt causes the displayed message to be sent to the active ATC center. If MAYDAY is selected as part of the message, a position report is included in the downlink. This selection will also put the ADS function into the emergency mode.

The data link status also shows on this line. SENDING shows after selection of SEND or RESEND prior to network acknowledgement. If network acknowledgement is not received, RESEND shows. Data link status of NO COMM, VOICE, or FAIL can also show. NO ATC comm shows if no ATC data link connection exists

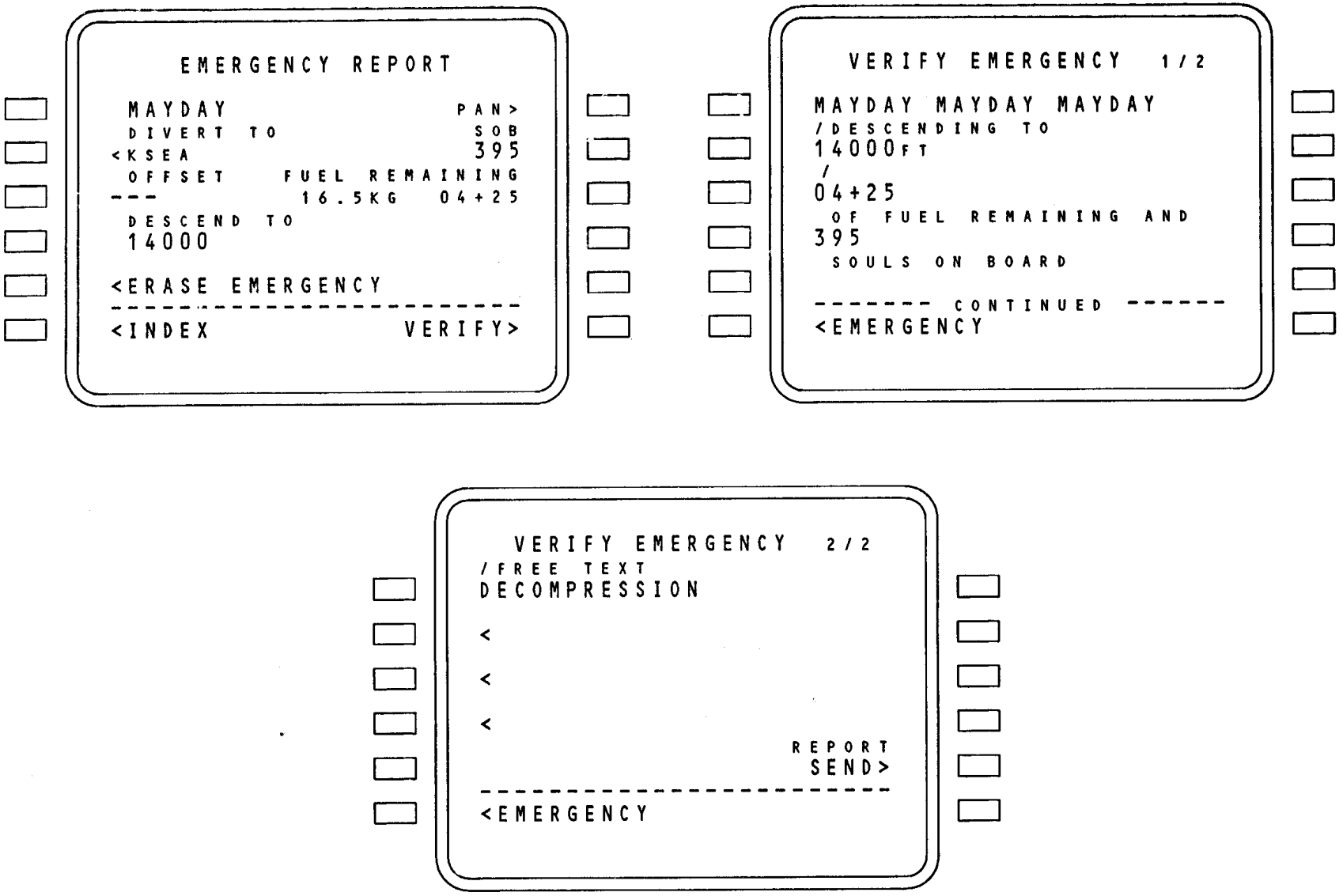


Figure 66 EMERGENCY REPORT PAGES

ATC LOG

General

The ATC LOG provides a listing of all stored uplinks and downlinks. The page provides access to the XXXXz ATC REPORT, XXXXz ATC UPLINK, XXXXz ATC REQUEST, and XXXXz EMERGENCY pages corresponding to each logged uplink or downlink.

Page Access

To access the ATC LOG page:

- Select the LOG prompt on the ATC INDEX page.
- Select the LOG prompt on the XXXXz ATC UPLINK page.
- Select the LOG prompt on the XXXXz ATC REQUEST page.
- Select the LOG prompt on the XXXXz ATC REPORT page.
- Select the LOG prompt on the XXXXz EMERGENCY page.
- Select the ATC mode key on the CDU when one or more new or pending messages exist.

Operation

The operation of this page is discussed by the operation of each line:

- (1L - 5L) ATC LOG ENTRIES: log entries show in the order that they were received or sent, with the most recent at the top of the page. An arrow indicates that the message is an uplink or downlink. Select the prompt next to a message to show the message page. The message status shows above the message.

The seven possible uplink status messages are:

- NEW - The message has not been reviewed; the message is pending.
- OLD - The message was reviewed and the message does not require a response; the message is not pending.
- OPEN - The message was reviewed, the message requires a response, the flight crew has not sent a closure response or has sent a STANDBY response, or the response was sent and network acknowledgement has not been received; the message is pending.
- ACCEPTED - The message was reviewed, the message requires a response, a positive closure response was sent, and network acknowledgement was received; the message is not pending.
- REJECTED - The message was reviewed, the message requires a response, a negative closure response was sent, and network acknowledgement was received; the message is not pending.,
- ERROR - The message received contains errors; the message is not pending. This status message will not show on the page.
- ABORTED - The message was pending when both the connections were terminated.

The seven possible downlink status messages are:

- SENDING - The SEND or RESEND prompt was selected and network acknowledgement has not been received; the message is pending.
- NO ACK - The SEND or RESEND prompt was selected and network acknowledgement was not received within the time-out period; the message is pending.
- SENT - The SEND or RESEND prompt was selected, network acknowledgement was received, message does not require a response; the message is not pending.
- OPEN - The SEND or RESEND prompt was selected, network acknowledgement was received, the message requires a response, the response was not received or STANDBY response received; the message is pending.
- DEFERRED - The SEND or RESEND prompt was selected, network acknowledgement was received, message requires a response, REQUEST DEFERRED response was received; the message is pending.

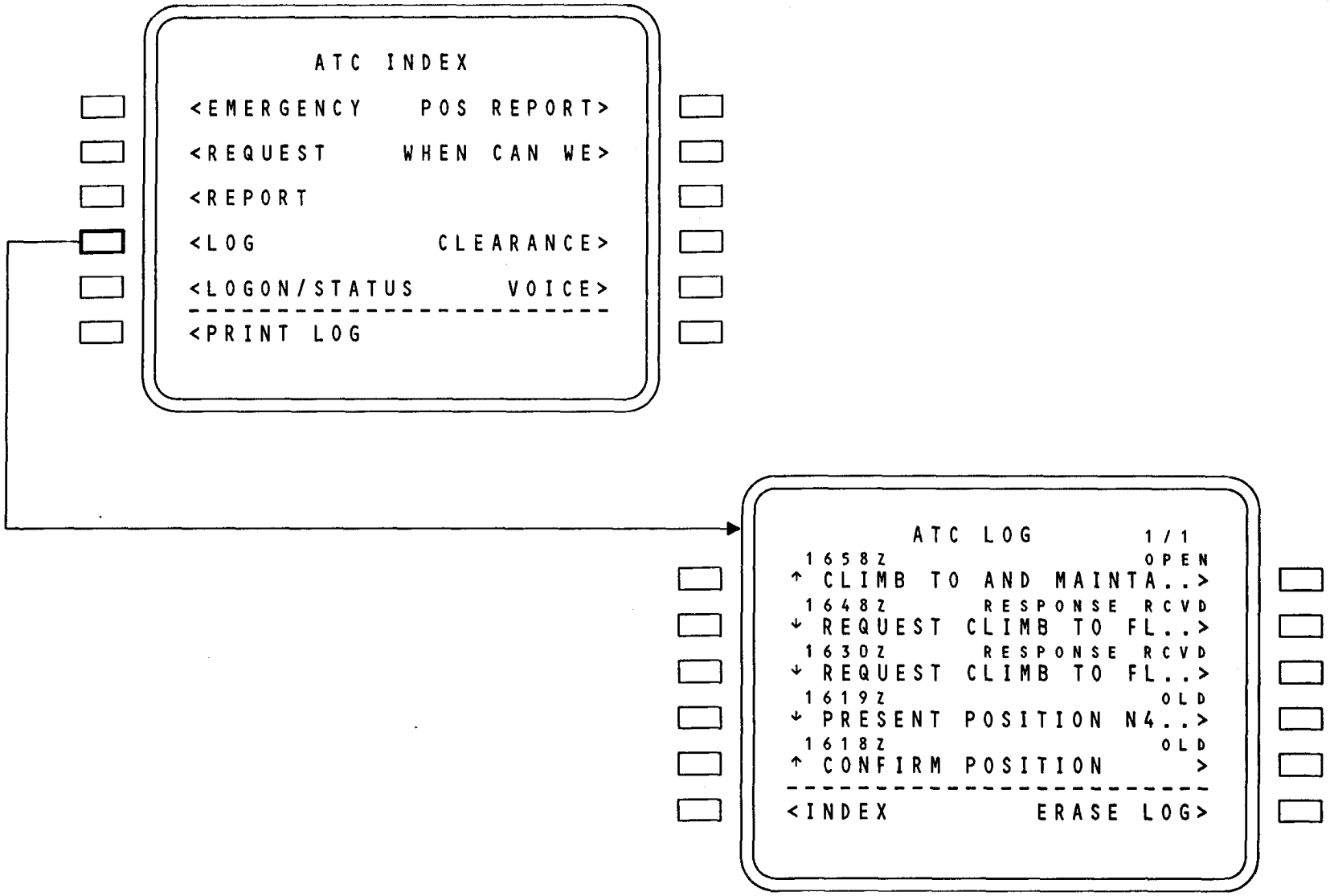


Figure 67 ATC LOG

FMC COMM PAGES

General

The FMC COMM page 1/2 provides a centralized access to the CDU pages that contain airline operational communications (AOC) data link functions.

The FMC COMM page 2/2 provides a centralized method of initiating downlink requests via the AOC data link.

Page Access

To access the FMC COMM pages, push the FMC COMM mode key on the CDU. The FMC COMM page 2/2 is selected using the NEXT PAGE key.

FMC COMM Page 1/2 Operation

The function of this page is discussed by the operation of each line:

- (1L) RTE X: If no route uplink is ready to be loaded, X is the number of the active route. If a flight plan uplink is received, X is the number corresponding to the uplinked route. Selection of the prompt causes the associated route page to show. The data field title line is normally blank. UPLINK shows when a flight plan uplink is ready to be loaded, or a flight number uplink is received and neither route page has been accessed.
- (2L) DES FORECAST: Select this prompt to show the DESCENT FORECAST page. The data field title line is normally blank. UPLINK shows when a descent forecast data uplink is ready to be loaded.
- (3L) RTE DATA: This line is blank if no active route exists. when an active route does exist, select this prompt to show the RTE X DATA page, where X is the number of the active route. The data field title line is normally blank. UPLINK shows when an enroute wind data uplink is pending.
- (1R) POS REPORT: Select this prompt to show the position report page.

FMC COMM Page 1/2 Operation (Cont)

- (6R) DATA LINK: The data link status shows on this line. Possible annunciations are READY, NO COMM, VOICE, or FAIL.

FMC COMM Page 2/2 Operation

The function of this page is discussed by the operation of each line:

- (1L) RTE REQUEST: select this prompt to initiate a downlink request for the company route shown on line 1R. The data link status also shows on this line. SENDING shows after selection of SEND prior to network acknowledgement. If network acknowledgement is not received, SEND shows again.
- (2L) WIND REQUEST: select this prompt to initiate a wind data request downlink. The data link status also shows on this line. SENDING shows after selection of SEND prior to network acknowledgement. If network acknowledgement is not received, SEND shows again.
- (6R) DATA LINK: the data link status shows on this line. Possible annunciations are READY, NO COMM, VOICE, or FAIL.

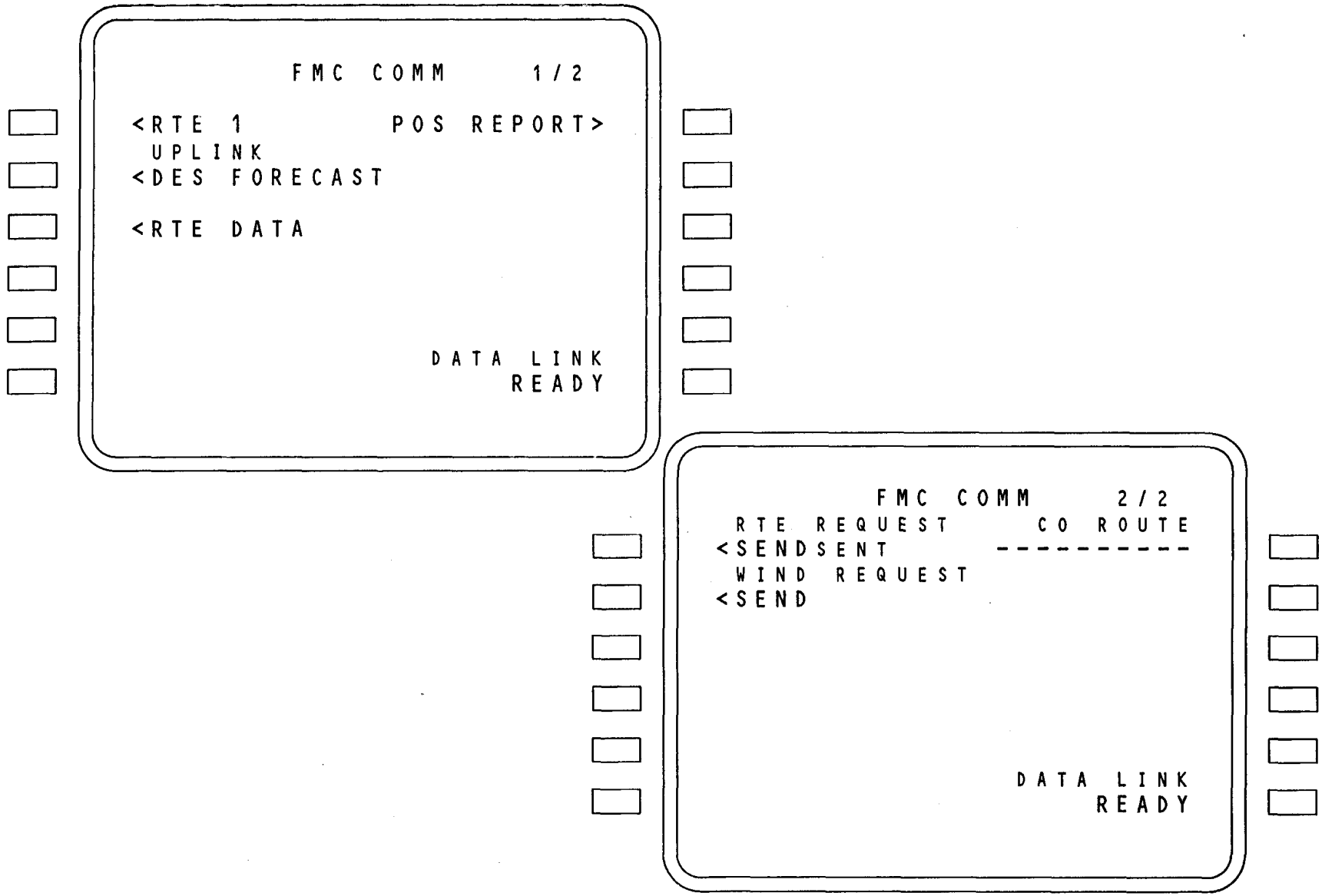


Figure 68 FMC COMM PAGES

NAVIGATION RADIO PAGE

General

The NAV RADIO page is used to manually tune the radios, delete entries and to preselect data for future use.

Page Access

To show the NAV RADIO page, select the NAV RAD mode key when one or more FMCs are operable.

NAV RADIO Page

The functions of this page is discussed by the operation of each line key.

- (1L) VOR L: data on this line is frequency, tune mode identifier and VOR identification. The tune modes are manual (M), procedure (P), route (R) and autotune (A). -When the FMC tunes a DME with no colocated VOR station, the DME identifier shows in the data field at line 1L.

  Mode entry: enter a frequency or identifier in the scratchpad then select the L and/or R VOR fields to enter the manual tune mode. The autotune mode shows when there is no M, R or P tune mode(s) present.

- (2L) CRS/RADIAL: the airplane's radial shows on line 2L. If the VOR on line 1L is manual course may be entered on line 2L. If this is done when the map mode shows on the navigation display (ND) the FMC sends coordinates of the selected course as a great circle radial line to the ND.

  The ND then shows the selected VOR course as green lines on the map. The selected course and radials extend in both directions for 700 nm from the not autotuned navaid. The selected course and reciprocal course show along the course radial in green numbers.

- (3L) ADF L: data on this line is ADF station frequency and tune mode. Station frequency is manual entry only. There are three modes: ADF, BFO and ANT. The default mode is ADF. To change a mode enter the first letter of the mode in the scratch pad and select the ADF line. To cancel a mode select the DEL key in the scratch pad and enter this on the ADF line. The ADF mode does not show, in this case.

- (4L) ILS: data on this line is ILS frequency/course and/or PARK or frequency/course (A) auto or (M) manual annunciations.

The frequency and course show as small numbers followed by PARK when the airplane is less than 200 miles from topof-descent, or past the active route halfway point.

This occurs when the runway is ILS equipped and in autotune. Before this PARK shows only. PARK is removed and the frequency and course (A) display are in large letters when 50 nm from top of descent or within 150 nm direct distance to the runway threshold or when active in descent.

To enter ILS data manually, enter the ILS frequency/course in the scratch pad and select the ILS line key. Manual entry of a course is not allowed when autotune is active.

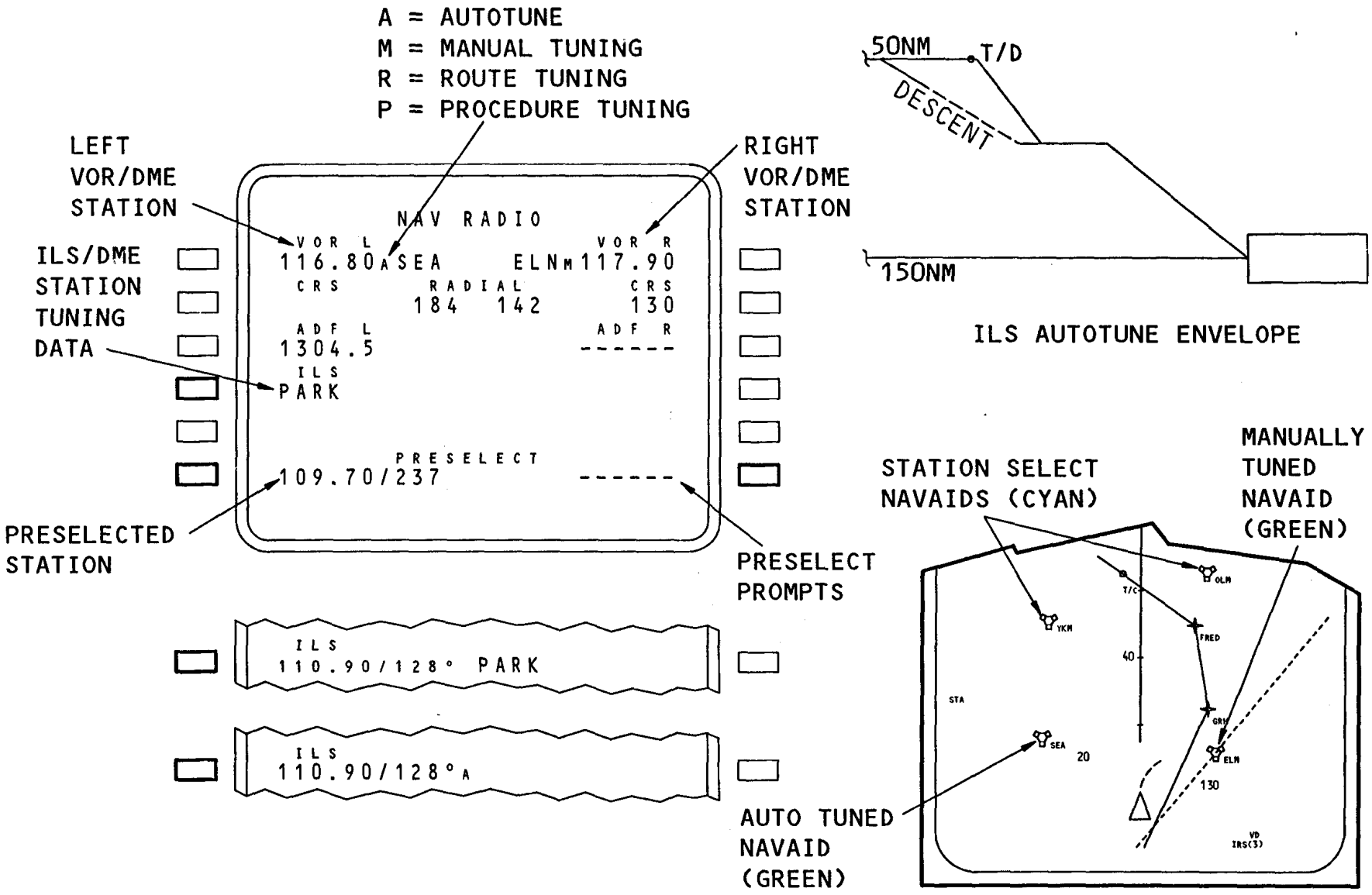


Figure 69 NAVIGATION RADIO PAGE

IRS LEGS AND IRS PROGRESS PAGES

General

Airplane navigation is usually done by the FMCs. If the FMCs fail, the CDUs provide some navigation capability. During normal operations, FMC route data is sent to and stored in the CDUs. If the FMC fails, the CDU uses IRS data to update the FMC route data.

When the selected FMC input to the CDU has failed and the LEGS or PROGRESS mode key is pushed, the IRS LEGS or IRS PROGRESS page is shown.

The IRS LEGS page allows details of each leg of the route to be entered and shown.

The IRS PROGRESS page shows data about the progress of the flight.

Page Access

To show the IRS LEGS page or IRS PROGRESS page, push the LEGS or PROG mode key when the FMC selected by the CDU is failed.

IRS LEGS Page

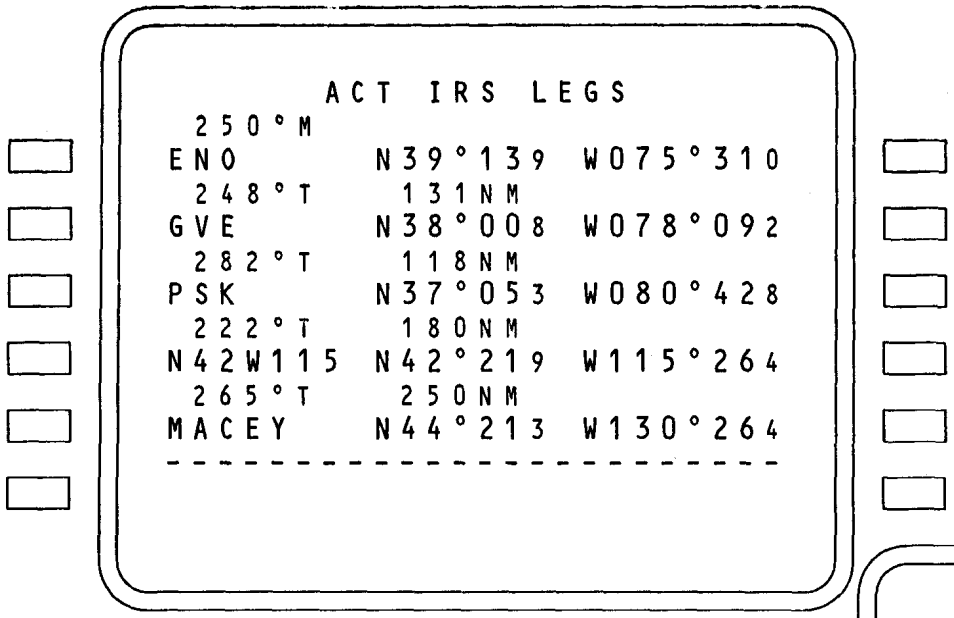
The function of the page is discussed by the operation of each line.

- Leg Directions: this shows the computed course to waypoint. For the first waypoint, the course is related to the present selected reference, magnetic north or true north. For the other waypoints, the course is referenced to true north. Values relative to true north are followed by the letter T. Values relative to magnetic north are followed by the letter M.
- (1L through 5L) Waypoint Identifier: valid entries on these lines are waypoint identifiers. The latitude/longitude of these waypoints shows to the nearest 0.1 minute.
- (6L) ERASE: this line shows only on MOD pages. Its selection removes all MOD data.
- (1R through 5R) Latitude/longitude: the CDU shows latitude/longitude for each waypoint on these lines.

IRS PROGRESS Page

The IRS progress page shows present dynamic flight data. Usually, no entries or selections are possible, but on line 4L they are possible.

- (1L) LAST: this line shows the waypoint identifier and altitude of the last waypoint passed.
- (2L and 2R) TO DTG and TTG: this line shows distance-to-go and time-to-go to the next waypoint.
- (3L and 3R) NEXT: these lines show waypoint identification, distance-to-go (DTG) and time-to-go (TTG) from the present position along the route.
- (4L and 4R) DESTINATION: usually, this line shows DTG and TTG for the destination. However, a different latitude/longitude or other flight plan waypoints may be entered. If this is done, data is shown for the airplane to go to that waypoint. The header shows DIR TO ALTERNATE if the waypoint entry is not in the active flight plan. The header shows EN-ROUTE WPT if the waypoint entry is part of the active flight plan. The DELETE function is used to remove the waypoint entry.
- (5L) IRS: this line shows the present position based on the IRS with a specific source (L, C or R).
- (6L) XTK ERROR: this line shows the present crosstrack error.
- (6C) DTK: this line shows the desired track angle related to the magnetic or true reference, and it is followed by an M or T.
- (5R) GS: this line shows present ground speed.
- (6R) TK: this line shows the present track angle related to the magnetic or true reference and is followed by an M or T.



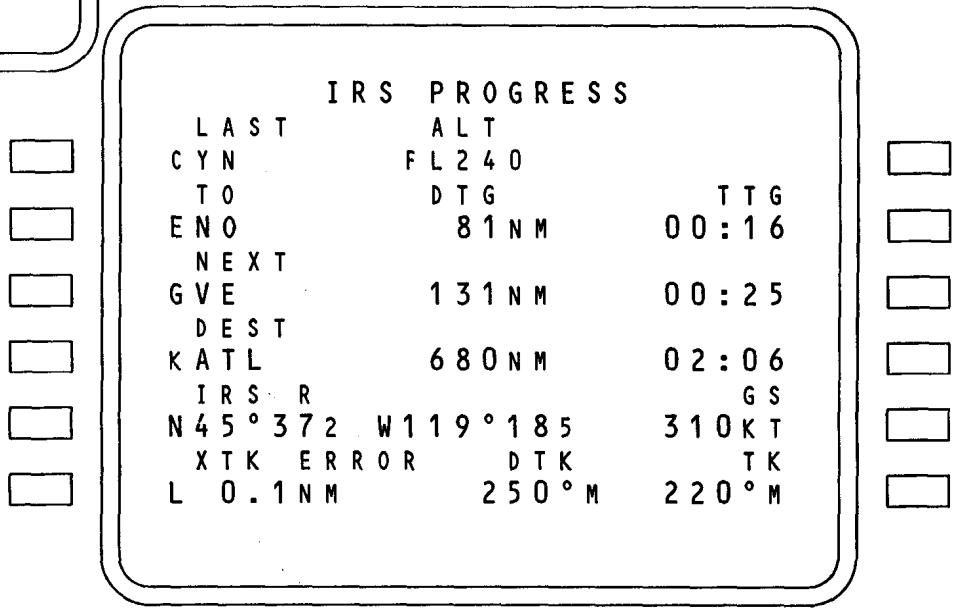


Figure 70 IRS LEGS AND IRS PROGRESS PAGES

ALTERNATE NAVIGATION RADIO PAGE

General

The ALTN NAV RADIO page provides an alternate way to tune the navigation radios.

Page Access

To show the ALTN NAV RADIO page, push the NAV RAD mode key when both FMCs have failed and airplane on ground or when airborne and the master FMC is failed.

ALTN NAV RADIO Page

The function of the page is discussed by the operation of each line.

- (1L) VOR: this line contains the manually entered VOR frequency. The letter M follows the frequency; this shows the frequency is manually tuned. However, this function is blank on the center CDU.
- (2L) CRS: this line shows the manually entered course for the VOR in line 1L. Dashes are shown if no course has been entered, or if it has been manually deleted. This function is blank on the center CDU.
- (3L) ADF: this line shows the manually entered ADF frequency. BFO or ANT follows the frequency if the ADF is in one of those modes. If the ADF is in the ADF mode, no letters follow the frequency. This function is blank on the center CDU.
- (4L) ILS: this line shows the manually entered ILS frequency and the course, with a / in between. If no frequency has been entered, PARK is shown.
- (6L and 6R) PRESELECT: this line is an easy-access storage for data to be entered later in lines 1L through 4L.

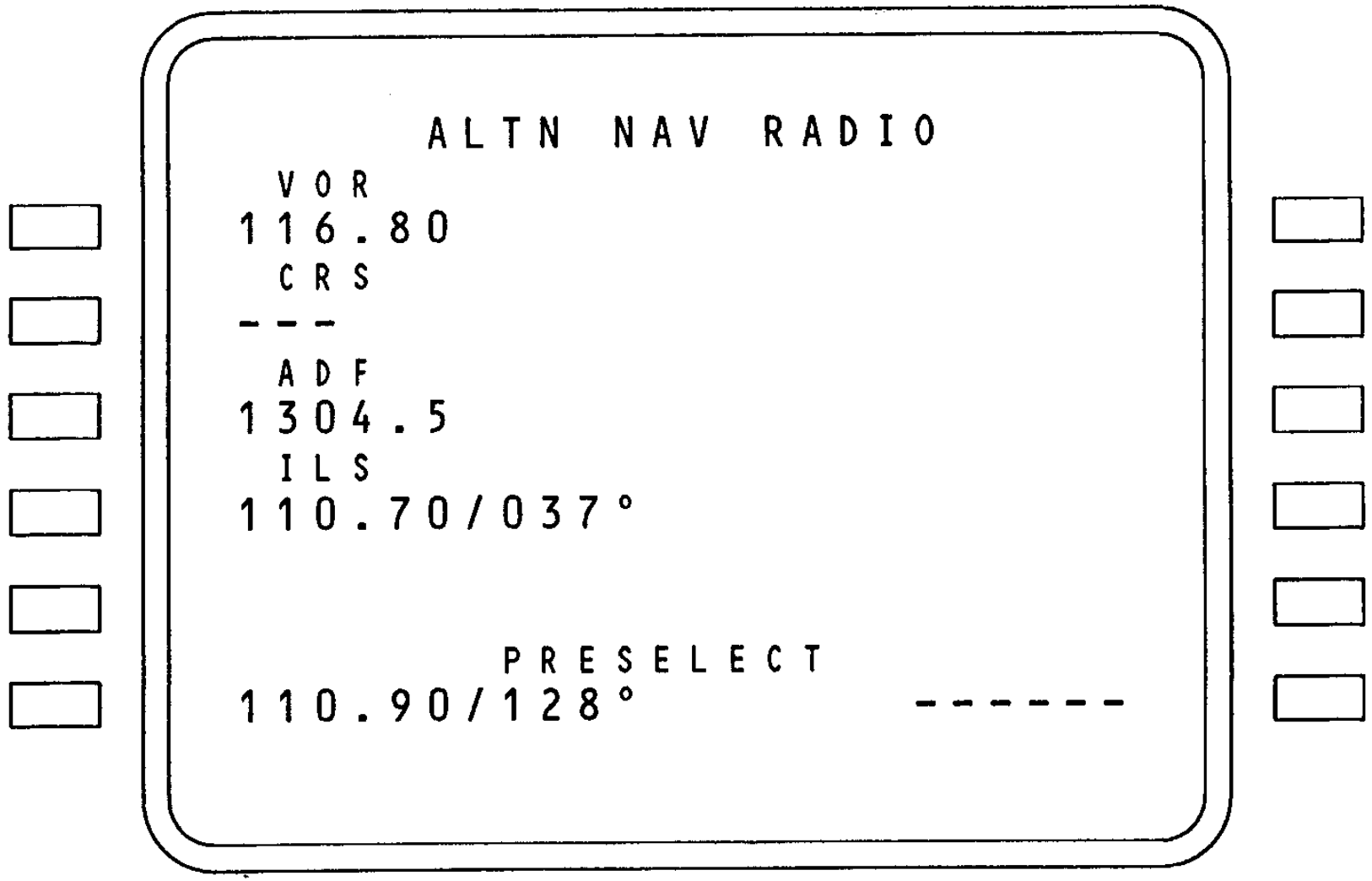


Figure 71 ALTERNATE NAVIGATION RADIO PAGE

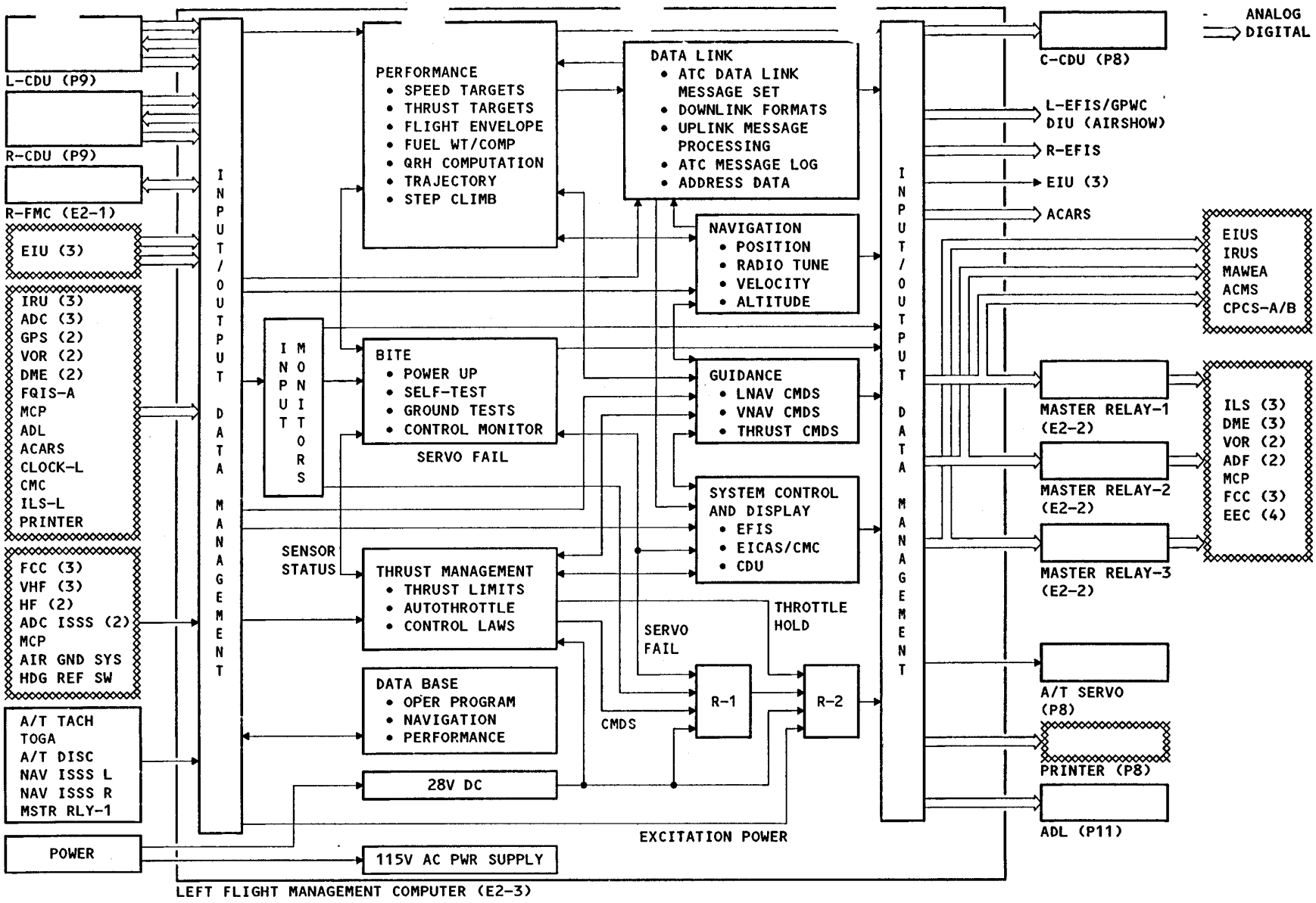


Figure 72 FMCS - SCHEMATIC DIAGRAM

FUNCTIONAL BLOCK DIAGRAM

General

The FMCS performs many functions to reduce crew workload and improve airplane economy. The FMCS does this by processing information received through the airplane and flight crew interfaces. The processing done by the FMC is divided into the following nine functional blocks:

- Input/output
- Navigation and radio tune
- Performance
- Guidance
- Thrust management
- EFIS map display
- Data link
- Data base storage
- BITE

The processing done by the CDU is divided into these four functional blocks:

- EFIS map display
- Alternate navigation
- Alternate radio tune
- ARINC 739 interface

Input/Output Function

The FMCS gets flight crew information from the CDU and airplane information from discrete and ARINC digital interfaces. The information is first checked for presence and validity and then stored for use by the other functional blocks of the FMC. The input/output function also sends data to other systems. ARINC digital and discrete interfaces allow the FMC to present information to the flight crew and to control other airplane systems.

Navigation/Radio Tune Function

Airplane position and velocity data are determined by the navigation function. Position and velocity data comes from the inertial reference system. Radio position data comes from the GPS, ILS, VOR, and DME. The navigation function also computes other parameters required for lateral guidance using NAV data base and sensor data.

Navigation radios are normally autotuned by the master FMC. Manual tuning is done through the CDU NAV radio page.

Performance Function

The vertical profile of the airplane's flight is computed by the performance function. Using initialization and sensor data and information stored in the performance data base, predictions of airplane performance are done. The vertical profile is computed to produce the optimum trajectory for economical operation, but can be changed through flight crew inputs.

Guidance Function

The outputs required to control the airplane along the lateral and vertical paths computed by the navigation and performance functions are computed by the guidance function. The lateral flight plan consists of a string of waypoints from origin to destination airport. The vertical profile is defined by a string of performance legs which contain the control parameter of either path or speed. Each performance leg also defines a means of control of either path or speed on elevator. Speed commands go to the thrust management function when the path on elevator function is active.

Thrust Management Function

The thrust management function performs these three functions:

- Autothrottle
- Thrust limit
- Engine trim

The autothrottle drives the thrust levers with the autothrottle servomotor generator in response to commands from the guidance function. The autothrottle also has dedicated modes which are selected on the AFCS MCP. The thrust limit function computes maximum thrust and thrust limit mode for display and control. The engine trim function equalizes thrust of all engines to eliminate throttle stagger.

EFIS Function

The navigation display map modes are used to monitor aircraft progress along the flight plan. Vertical profile points along the route are also displayed. Map data selector switches on the EFIS control panel add or remove information from the display.

Data Link

The FMC can transmit and receive messages using the interface with ACARS. Two way communication can be done with both ATC and airline operations. The FMC uses a standard set of messages when communicating with ATC. Free text messages can also be included. Airline operational communications includes flight plan, wind, and descent forecast data. Position reports and request for flight plan or route data can be done. Automatic Dependant Surveilance lets airline operations or ATC query the FMC for flight information. The FMC responds without the need for flight crew action.

Data Base Storage

Data bases are stored in the FMC to supply information to the various functional blocks. There are three types of stored data:

- NAV data base
- Performance data base
- Operation program
- Airline Policy File

The Navigation data base contains:

- Navaid data
- Waypoints and ground reference points
- Airways
- Airports/runways/gates
- Procedures (SIDS, STARS and approaches)
- Company routes

The performance data base contains:

- Engine model data
- Aerodynamic model data
- Aircraft characteristics
- Speed/altitude data

The operational program defines the order of operations and calculations to run in the various functional blocks.

The airline policy file selects customer options. Other files are used to enable or disable and set values for certain FANS 1 functions.

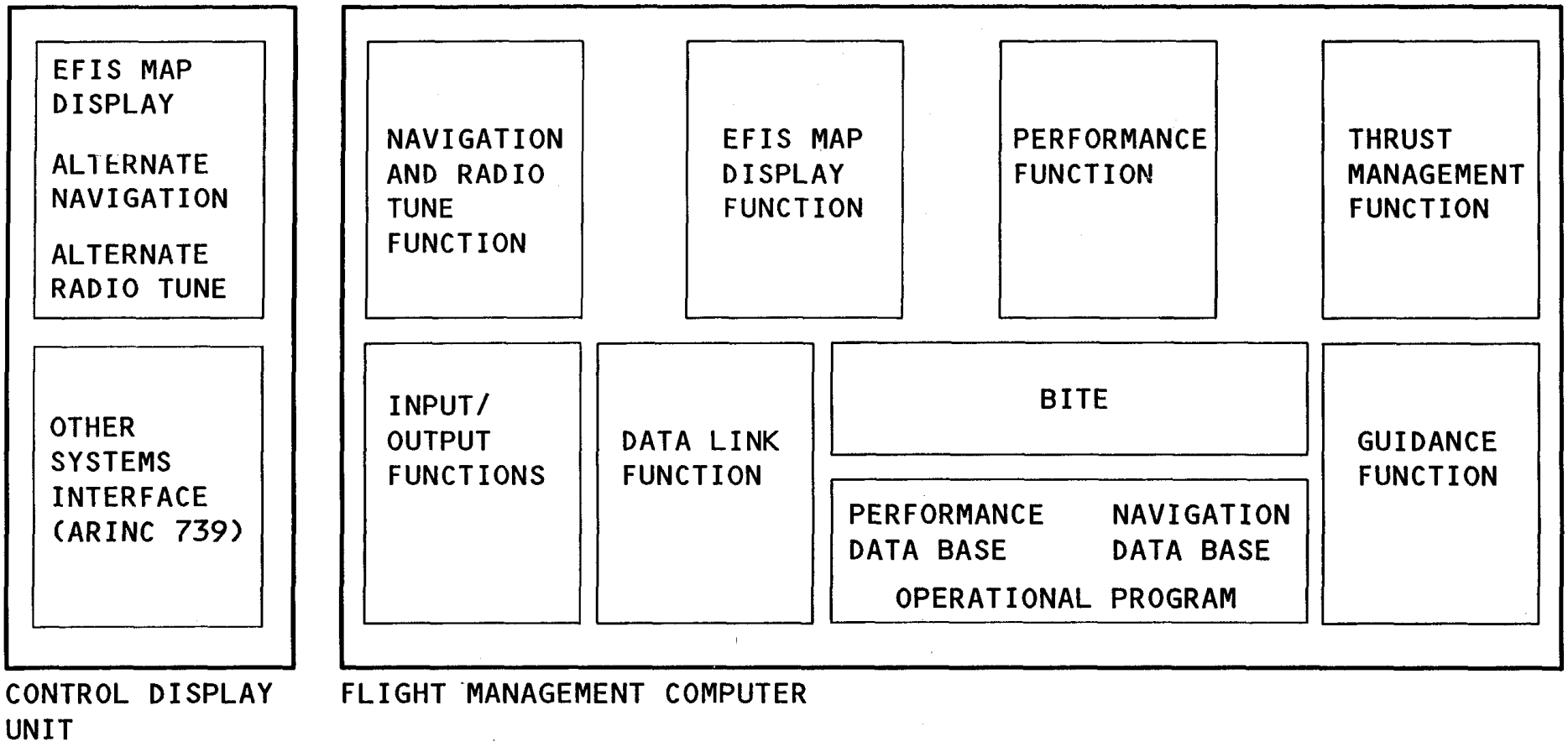


Figure 73 FUNCTIONAL BLOCK DIAGRAM

NAVIGATION FUNCTION

General

The navigation function of the FMC calculates airplane position, velocity data and navigation data for the guidance and performance functions and for display.

Position Calculation

The FMCs use the different calculations of position in this priority:

- LOC/GPS
- LOC/DME/DME
- LOC/VOR/DME
- LOC
- GPS
- DME/DME/IRS
- VOR/DME/IRS
- IRS only

Localizer Position Update

If valid localizer data is available, the FMCs uses localizer beam deviation to correct airplane position normal to the approach path. Distance data from either GPS, DME/DME, or VOR/DME

corrects airplane position along the approach path.

DME/DME Position Calculation

Slant range is changed to ground range and the intersections of the resulting range rings gives two possible locations for airplane position. The FMC decides which location to use by IRS position data. The result is DME/DME latitude and longitude.

VOR/DME Position Calculation

Airplane position is calculated from the bearing and range provided by the VOR and DME data.

IRU Position Average and Rejection

If all three IRU inputs are valid, the FMC computes IRU position as the weighted average of all three inputs. If a single IRU position is different from the average position by more than 30 nm for over five seconds, the data from that IRU is not used for the rest of the flight.

If only two IRUs are available, each FMC uses data from one IRU. FMC-L uses the left or center IRU and the FMC-R uses the center or right IRU.

If only one IRU is available for navigation, both FMCs use its data for position and velocity.

IRU Velocity Average and Rejection

Average of the three north and east velocity components from the IRUs is used to compute the FMC north and east velocity for the FMC velocity vector. If three IRUs are available for velocity data, an individual IRU's north and east velocity components are looked at in addition to the average velocity components. If the sum of the differences between an individual IRU's velocity components and the average velocity components is more than 30 knots for more than five seconds, that IRU is not used for the rest of the flight.

Polar Navigation

Polar navigation begins when the FMCs position reaches a latitude greater than 84 degrees. At this point the FMCs use only onside IRU for position update. If there is a difference between FMC position and single IRU position at the beginning of polar navigation, the FMC slowly washes out the error.

Altitude

The altitude calculation is a combination of inertial data and ADC.

Active Route Data

The active route is received from the CDU and stored in the FMCs. The FMCs monitor progress along the route and sequences the waypoints.

GPS Position

GPS Position is used from the onside GPSSU. The offside GPSSU can be used if the onside is not valid. GPS position is based on satellite measurements. The GPSSU calculated figure of merit or integrity limit is used for the ANP.

Navigation Performance

A value of actual navigation performance (ANP) is calculated based on the sensors being used for position updating. Each method of position update has a different potential error or uncertainty term. Required navigation performance (RNP) is based on regulatory requirements. The RNP changes based on the flight phase, and is stored in memory. An alert is output when the ANP exceeds the RNP.

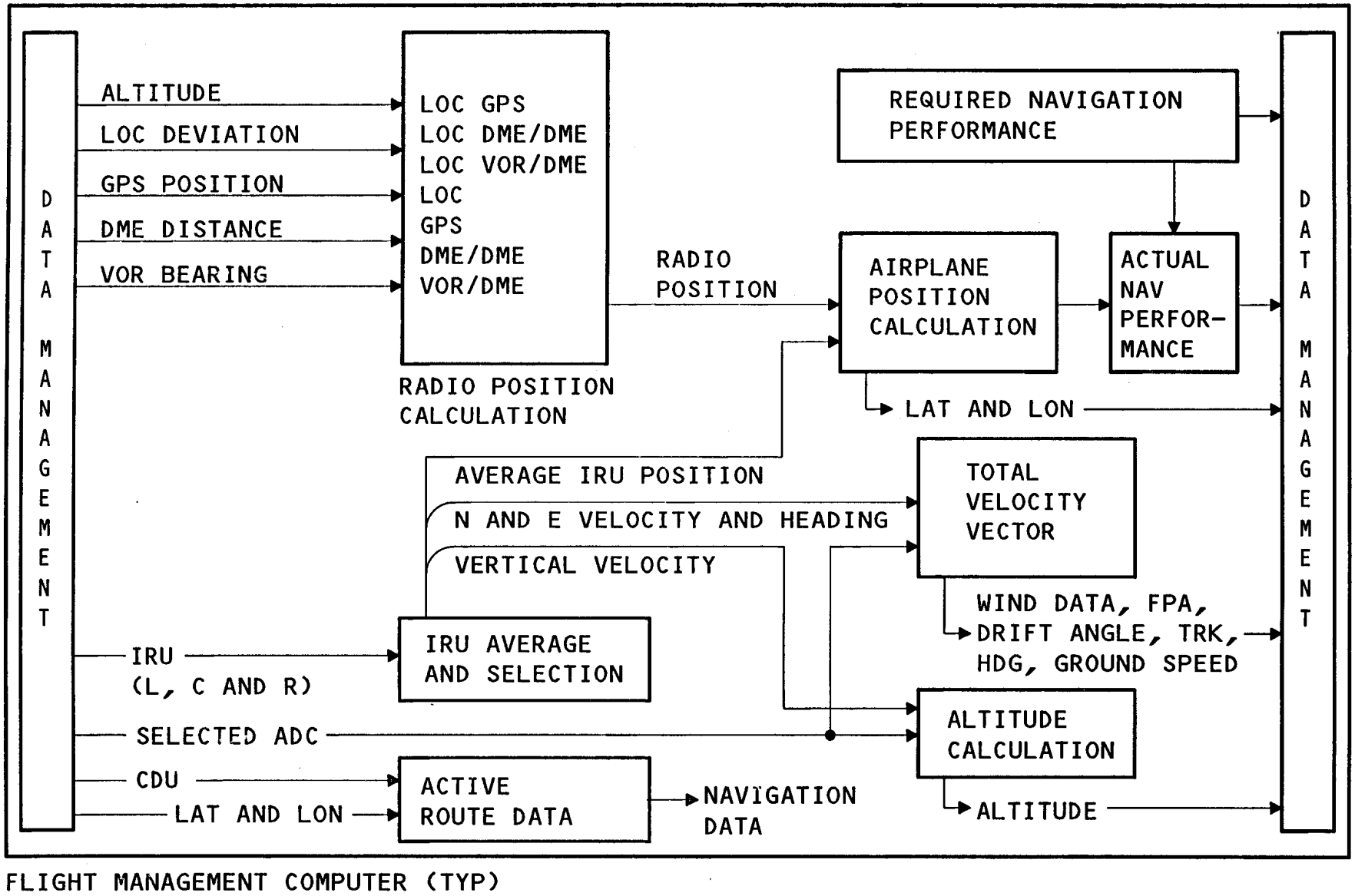


Figure 74 NAVIGATION FUNKTION

NAVIGATION RADIO TUNING

General

The master FMC sends tuning frequencies to the navigation radios. The frequencies are determined automatically by the FMC or manually through the CDU entries on the nav radio page. The navigation radios send bearing and distance data back to the FMC. The GPSSU sends position data to the FMC. The FMC computes airplane position using radio and inertial data.

Tuning Methods

The following are the four ways the VOR and DME are tuned by the FMCS listed in the order of priority:

- Manual tuning occurs when an entry is made on the CDU.
- Procedure tuning occurs when a navaid is specified in the active departure or arrival procedure.
- Route tuning occurs when a VOR station is the next or last waypoint of the active route.
- Autotuning occurs when none of the above modes is active.

DME Tuning

The DME sends slant range distances to the FMC. The FMC corrects the slant range using airplane altitude. The DME is a scanning type which can provide distance to multiple stations. The FMC controls the DME's foreground list of five channels. Channels one and two are always in an autoselection mode of the pair of navaids selected by the FMC calculations of best geometry. Channels three and four are directed to the next best pair or a procedure, manual, or route tuned station. Channel five contains the ILS DME station.

Navaids are first selected using the nav data base. The data base is searched to find the navaids within the maximum EFIS map display range. This list of navaids is then sorted for navaids which meet certain criteria and geometry. This candidates list then has navaids selected from it which are validated by the background scan of fifteen stations done by the DME.

VOR Tuning

When any tuning method other than autotune is active, the VOR receivers are tuned to the indicated station. When autotune is active, the VOR receivers are tuned to the stations determined to be the best pair.

ILS Tuning

The ILS receivers are normally tuned automatically by the master FMC. This is done during the approach when certain criteria are met. The ILS receivers can also be tuned through inputs on the CDU. When no manual or automatic selection is made, the FMC parks the ILS receivers.

ADF Tuning

The ADF receivers are manually tuned through inputs on the CDU.

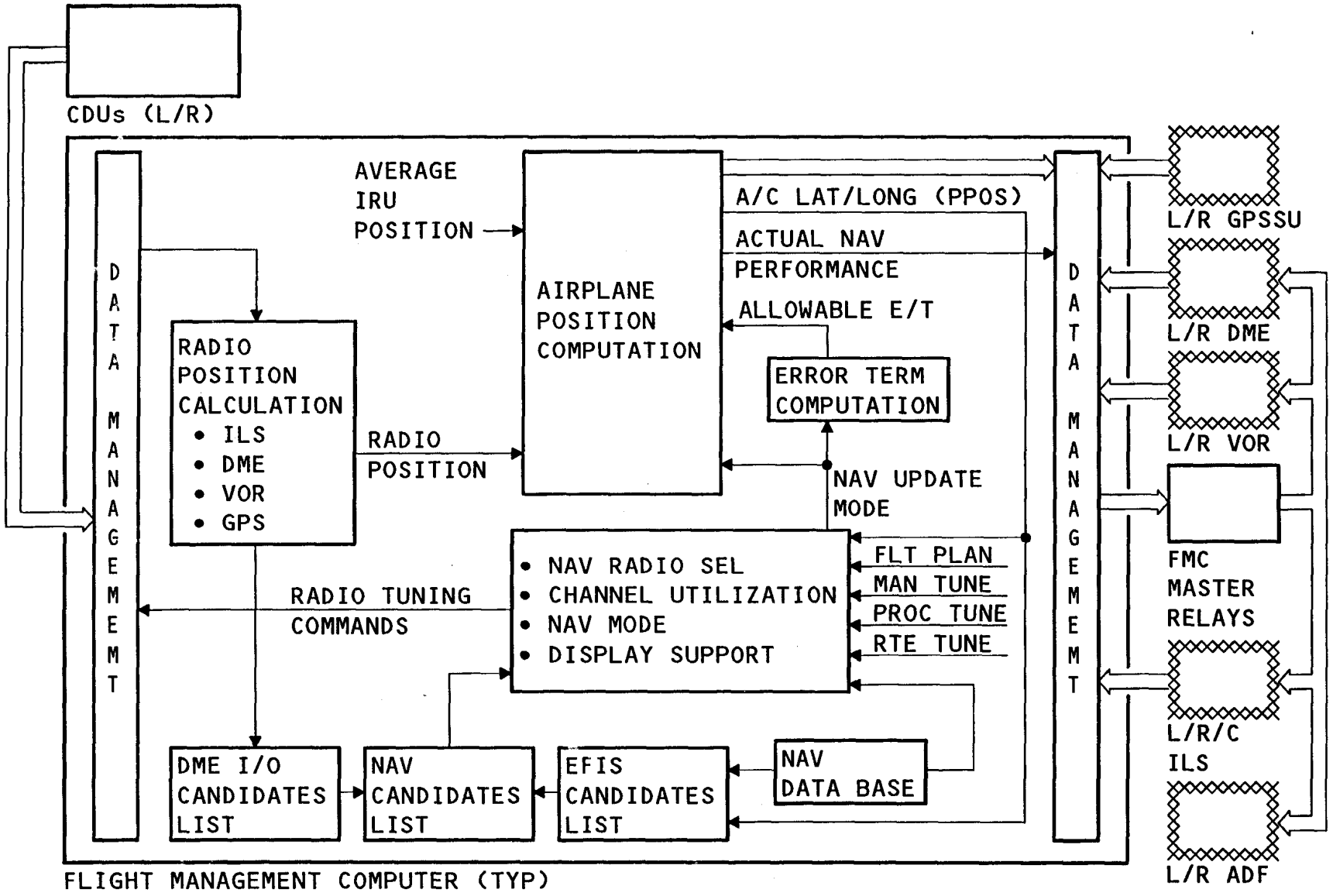


Figure 75 NAVIGATION RADIO TUNING

PERFORMANCE FUNCTION

General

Performance management is the FMCS function that optimizes the airplane's vertical profile. The FMC's performance function provides optimal values for speed and thrust. It also provides the most economical flight path profile. These values are calculated with:

- Fuel/weight
- Speed envelope and optimum speed
- Flight plan trajectory
- Maximum altitude and optimum altitude
- Thrust target
- Takeoff speeds and stab trim
- Approach reference speeds lookup tables
- Required Time of Arrival (RTA)

Fuel/Weight Calculation

This function calculates airplane gross weight, fuel burnoff and fuel remaining. It also sends a fuel quantity alert. This alert is a CDU and EICAS message: FUEL QTY ERROR-PROG PG 2 (CDU) and FMC message (MAIN EICAS).

It shows when the calculated fuel remaining is different from the fuel quantity system (FQS) by 9,000 pounds for five minutes. A valid calculation of gross weight is required for all other performance calculations.

During preflight, either zero fuel weight (ZFW) or gross weight should be entered on the PERF INIT page (or the weight and balance computer gross weight should be validated on the PERF INIT page). ZFW and gross weight can be entered or updated in flight. All performance calculations will be inhibited until this entry is made.

Speed Envelope and Optimum Speed Calculations

The speed envelope function calculates the minimum and maximum operating speeds for any altitude, weight and configuration inputs (such as flap position, maneuver load factor, gear position).

The FMC calculates optimum VNAV speed targets. The calculation mixes altitude, pressure, cost index, gross weight, wind and temperature to minimize airplane operating cost. The optimum VNAV speed targets are:

- minimum transition climb
- Economy climb
- Economy cruise
- Economy descent
- Maximum angle climb
- Long range cruise
- Engine out long range cruise
- Engine out minimum drag
- Best hold

The FMC invalidates all speed targets and removes calculated speeds from all CDU pages when any of the performance targets become invalid during flight.

Flight Plan Trajectory Calculation

The trajectory prediction function uses equations of motion, along with models of the airplane and engine characteristics, to simulate the flight of the airplane over the planned trajectory. This trajectory optimizes the time the airplane is in an idle engine configuration. It still must observe altitude and speed restrictions.

The simulation provides data about the predicted path of the airplane to the guidance function, CDU display and EFIS display. It also provides data for scheduling the cabin pressure control system (CPCS). The flight path prediction function uses:

- Gross weight
- Cost index
- Cruise altitude
- Destination airport
- At least one waypoint
- Latitude and longitude
- Active lateral and vertical guidance
- Altitude
- Fuel quantity
- Lateral path with two or more waypoints
- End of descent (E/D) point

In addition to these, there are several optional inputs which increase the accuracy of the flight path prediction. They are:

- Wind at altitude at each waypoint and temperature forecasts
- Icing conditions forecast for the descent
- Fuel flow factor
- Climb thrust derate
- Drag factor

When all of the above are present, the flight path prediction function calculates the flight trajectory from takeoff to landing.

If descent path data is not there, the predicted flight trajectory will not

include a descent path for guidance, or a valid top of descent (T/D) for display on the ND. Also, waypoint predictions to the end of the flight plan will not show a descent. In fact, all waypoints past the top of climb (T/C) show a continuation of the cruise.

If full trajectory data is not there, the prediction capability is reduced to those items on the CDU PROG page (but not descent data).

Maximum and Optimum Altitude Calculation

Maximum altitude is the altitude the airplane can climb so the planned climb speed and the selected cruise speed are in the speed envelope. This shows on the CRZ page. If the entered cruise altitude is equal to or more than the maximum altitude, the fuel predictions do not show. This is done to prevent bad predictions.

optimum cruise altitude is calculated for the selected cruise mode and the flight plan distance.

Takeoff Speeds and Stab Trim Calculation

This function calculates advisory takeoff speeds (V1 VR and V2) and takeoff stabilizer position equal to those found in a quick reference handbook (QRH). The data for this function is in the performance data base.

The advisory stabilizer position is calculated with the entered gross weight and center of gravity in addition to thrust rating.

Thrust Target Calculation

This function calculates two thrust targets:

- A cruise target thrust. This value is a reference value to set an approximate thrust value when the airplane is at the planned cruise altitude with the autothrottle disengaged.
- A target for the thrust management function to set the throttles when the speed in level flight mode is reached.

Approach Reference Speeds Calculation

This function takes the approach speeds (Vref) from the performance data base (PDB) for gross weight and flap positions. It also provides these values to the CDU for display on the INIT/REF APPROACH page.

Required Time of Arrival (RTA)

The RTA function, when enabled, changes the cruise speed to reach a specified fix at a specified time. This function is only available during the cruise phase of flight. An alert is output when the RTA cannot be acheived.

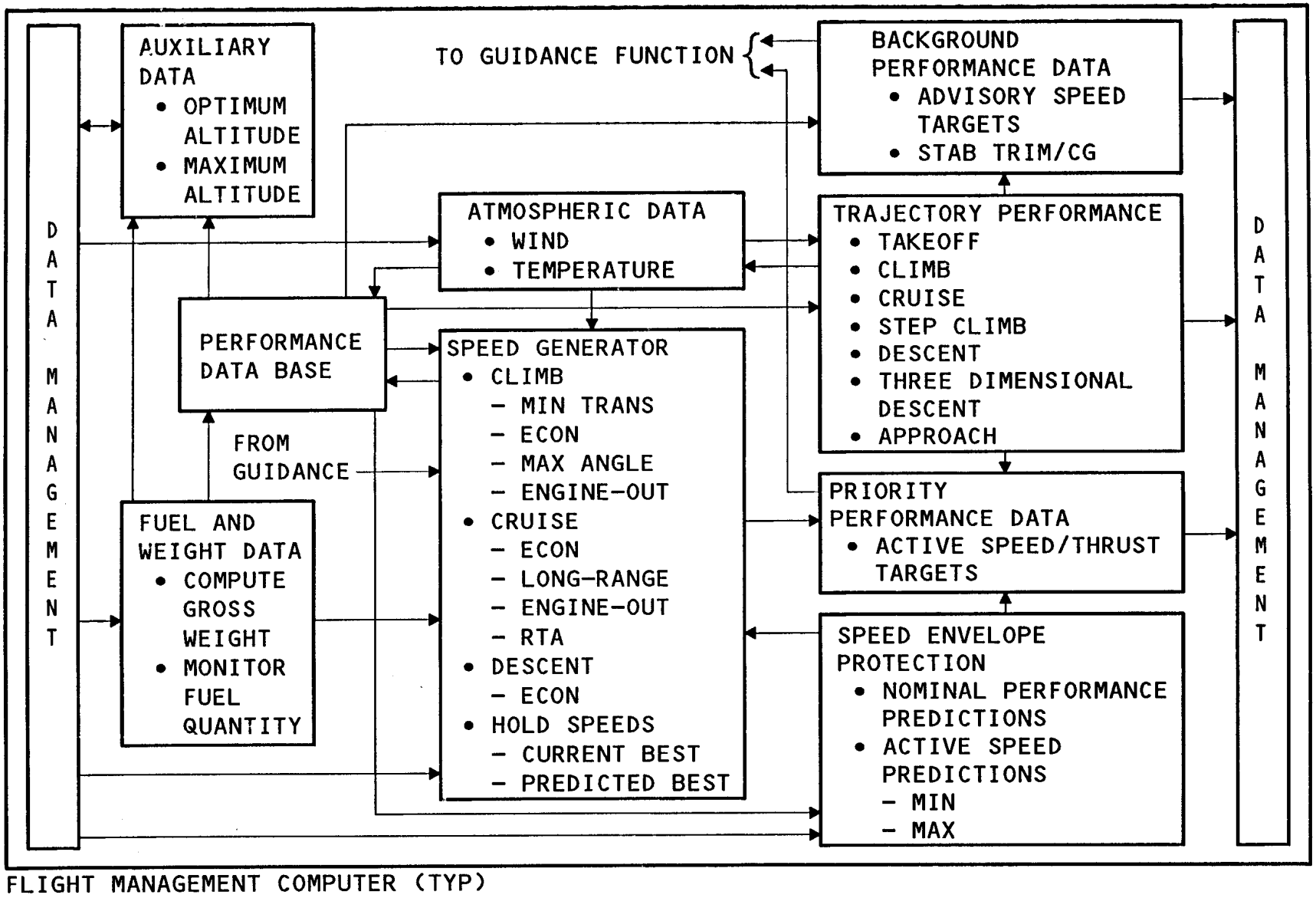


Figure 76 PERFORMANCE FUNCTION

GUIDANCE FUNCTION

General

The guidance function receives inputs from the CDU, performance and navigation functions and MCP. The guidance function processes these inputs and sends commands to the:

- Autopilot flight director system (AFDS) for lateral and vertical flight control
- Thrust management block for autothrottle servo control

Guidance Position

With data from the navigation and performance blocks and inputs from the CDU and MCP, the FMC calculates lateral and vertical guidance of the airplane.

Lateral Navigation

The FMC calculates lateral guidance for the paths between waypoint and curved transitions between each path segment. The guidance function looks at the route, desired and airplane position to

calculate lateral guidance (LNAV) commands. These go to the AFDS.

Vertical Navigation

The FMC calculates vertical guidance with initial inputs as the vertical flight plan and compares that to the present vertical position. The guidance function sends vertical steering (VNAV) commands to the AFDS and thrust and speed commands to the autothrottle function for vertical control of the airplane. The FMC calculates four basic VNAV modes:

- The VNAV Speed/Thrust causes the autopilot elevators to control to the FMC speed and the throttles to control to a thrust value. This occurs in climb, to initiate an early descent or during an engine out driftdown.
- The VNAV Path/Speed mode commands vertical path (altitude) on elevators and airspeed on throttles. This mode is used during cruise and shallow path descents.
- The VNAV Path/Idle commands a descent path on elevators and throttles to the idle position. This is the basic descent mode.
- The VNAV Speed/HOLD mode commands airspeed on elevators and the throttles to hold (this removes servo power from the servomotor). This allows manual throttle control. This mode is used in step descents.

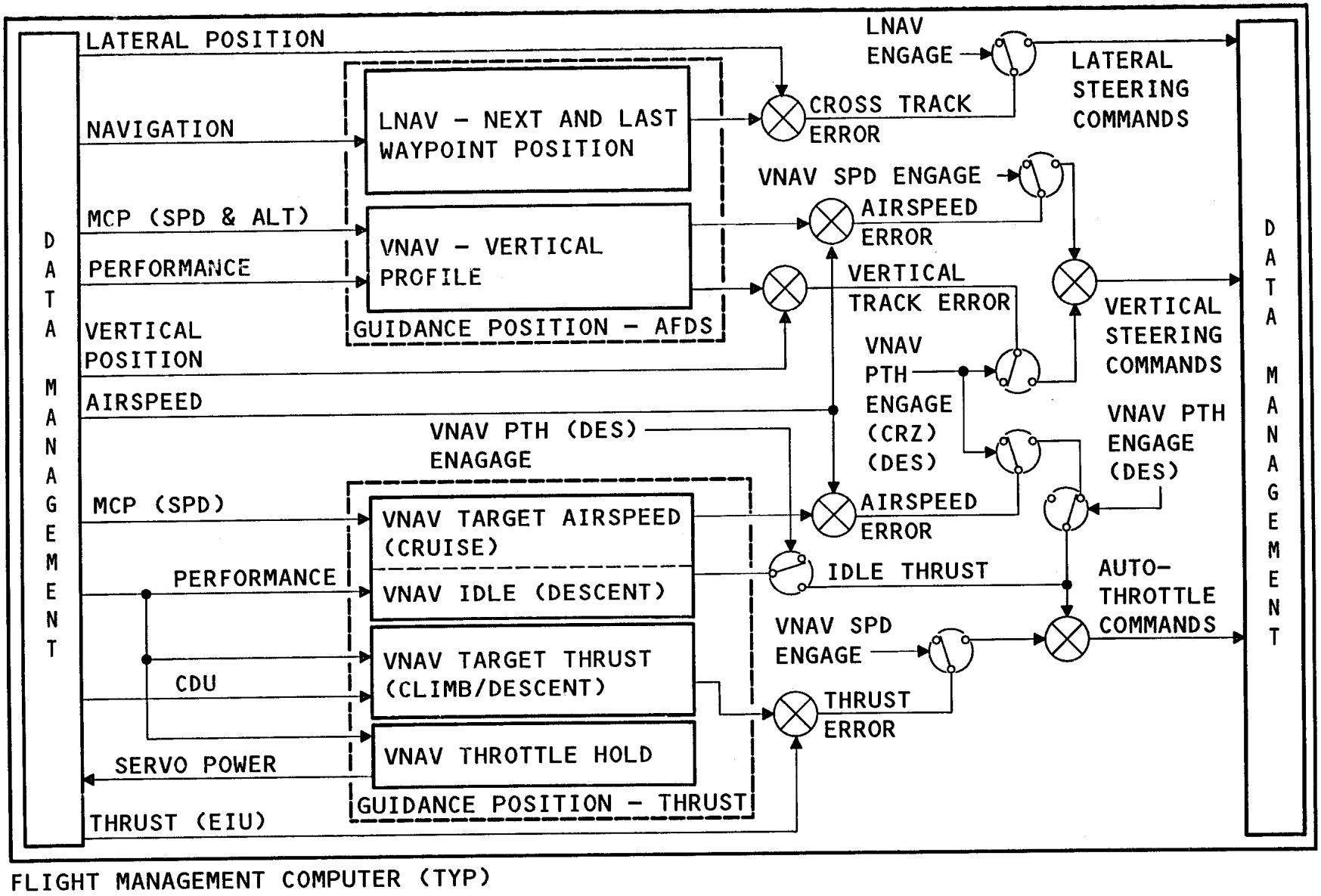


Figure 77 GUIDANCE FUNKTION

LNAV ENGAGE REQUIREMENTS

Engage Initiation

LNAV starts by a push of the LNAV button on the AFCS mode control panel (MCP). The MCP sends the LNAV request to the flight control computer (FCC).

FCC/MCP Response

When the FCC gets the LNAV request, the FCC determines if the transition to LNAV operations is allowed. If LNAV is possible, the LNAV arm signal goes to the MCP and to the PFD. Indication of LNAV arm is the primary flight display (PFD) flight mode annunciator (FMA) shows LNAV in white, the LNAV light on the MCP comes on and a signal called LNAV ARM goes to the FMC.

LNAV Engage Criteria

If the airplane is within 2.5 NM of the desired active flight plan leg when LNAV is requested, the FMC captures LNAV. If the airplane is more than 2.5 NM from the active leg when LNAV is requested, the FMC captures when:

- The airplane track will intercept the active leg and,
- The airplane will make a smooth change to the active leg with a maximum bank angle of 25 degrees

FMC Response

When the FMC gets the LNAV ARM signal from the AFCS MCP, and the requirements shown on the graphic are met, the sign status matrix (SSM) of the lateral commands from the FMC change from NCD to valid.

FCC Action

The FMC lateral commands go to the FCC. When the FCC detects that the SSM has changed to valid, LNAV changes from armed to engaged. The FCC uses the commands to produce the roll commands for flight director display and/or for control of the lateral control servos. Indication of LNAV engaged is the FMA shows LNAV in green. A signal called LNAV OPERATE goes to the MCP to keep the mode engaged.

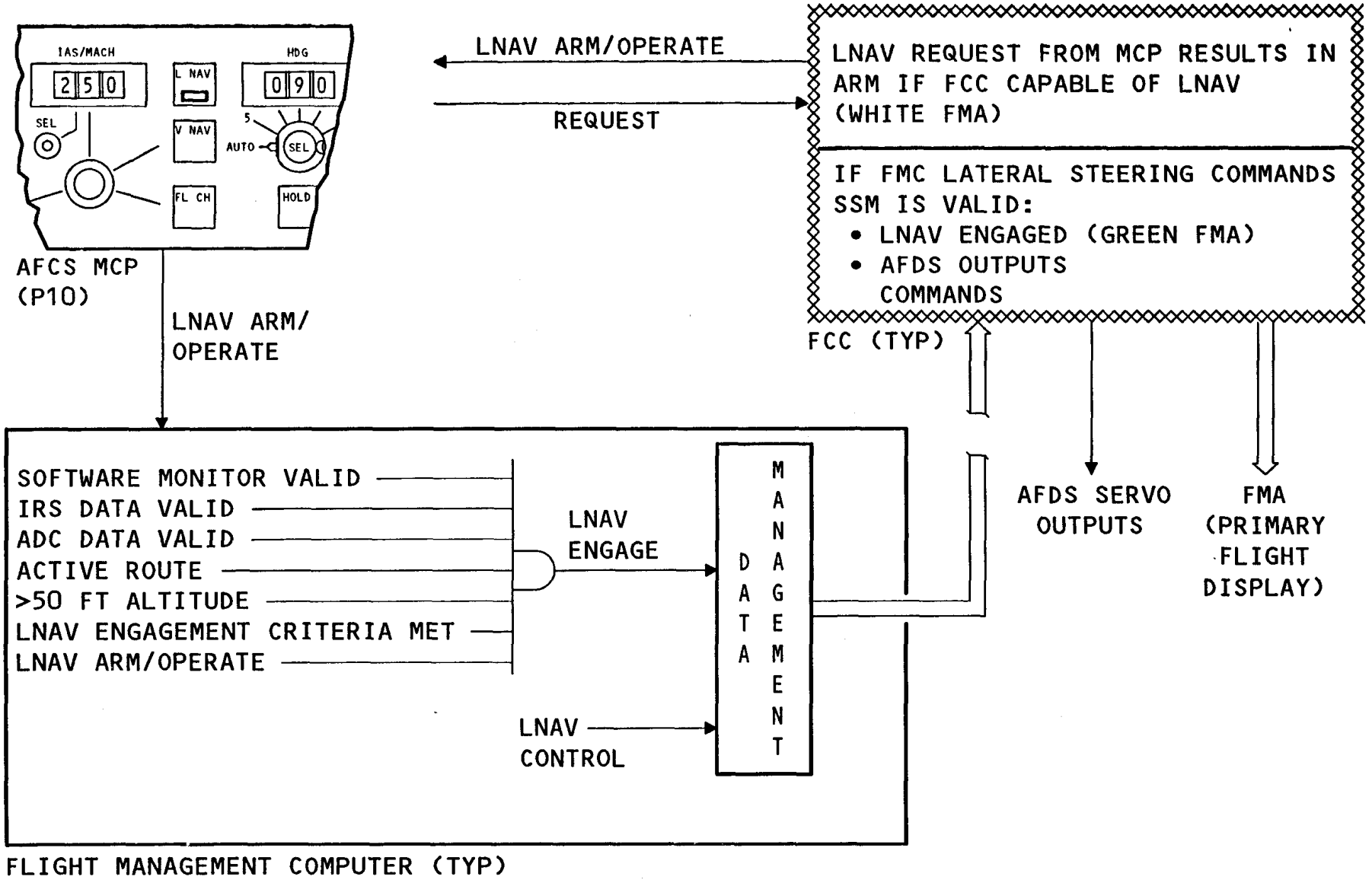


Figure 78 LNAV ENGAGE REQUIREMENTS

VNAV ENGAGE REQUIREMENTS

The engage requirements for VNAV are nearly the same as those of LNAV but for those shown.

It should be noted that the FMC requirements are different and that the FMC has another output to the autothrottle servo.

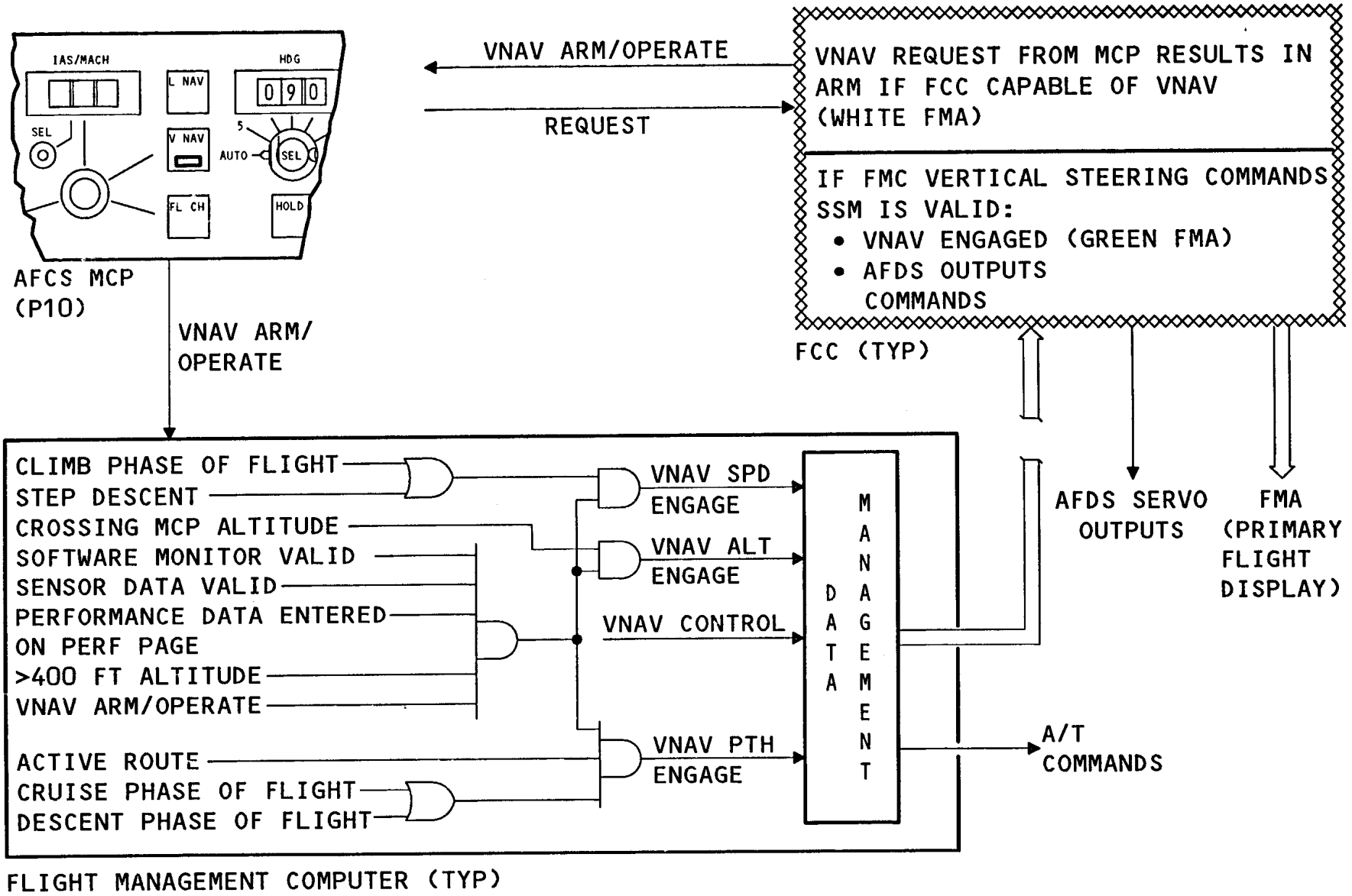


Figure 79 VNAV ENGAGE REQUIREMENTS

SPEED AND ALTITUDE INTERVENTION

Speed Intervention

when in VNAV operation, the FMC calculates the target airspeed for display on the PFD speed tape and for VNAV commands. For this reason, the speed display on the AFCS MCP is normally blank in VNAV. An easy way to manually change the target airspeed is to use the speed intervention function. Push the speed select knob on the MCP. A switch behind the knob sends a discrete to the FMC. The speed display unblanks and shows the present FMC target speed. This value may now be changed. The FMC uses the speed selected on the MCP display as the target instead of its calculated value. Push the speed select knob again to return the FMC to normal operation.

Altitude Intervention

The AFCS MCP is also used for altitude intervention. The FMC uses the altitude display and switch behind the altitude select knob to:

- Delete altitude constraints
- Change FMC cruise altitude
- Capture the MCP altitude

Altitude Constraint Deletion

In VNAV climb (or descent) and with the MCP altitude set above (below) a constraint altitude, the constraint is deleted when the altitude select knob is pushed. If there are multiple constraints, they are deleted one at a time with each push of the knob.

In VNAV altitude hold at a constraint altitude and with the MCP altitude set in the direction of the cruise altitude (in climb) or descent altitude (in descent), the constraint is deleted when the altitude select knob is pushed. In addition, this deletes any constraints below the airplane (in climb) or above the airplane (in descent).

Cruise Altitude Change

In VNAV climb if the MCP altitude is set above the active cruise altitude, a push of the altitude select knob causes the cruise altitude to change to the MCP altitude.

In VNAV cruise if the MCP altitude is set above or below the present altitude, a push of the altitude select knob causes the cruise altitude to change to the MCP altitude. This also causes the FMC to change to VNAV climb or VNAV descent to go to that altitude. If the MCP altitude is below the present altitude and the airplane is within 50 NM of top of descent, the FMC changes to DES NOW.

MCP Altitude Capture

If the VNAV profile tries to fly the airplane through or away from the MCP altitude, the FMC captures and holds the MCP altitude. This mode is VNAV ALT.

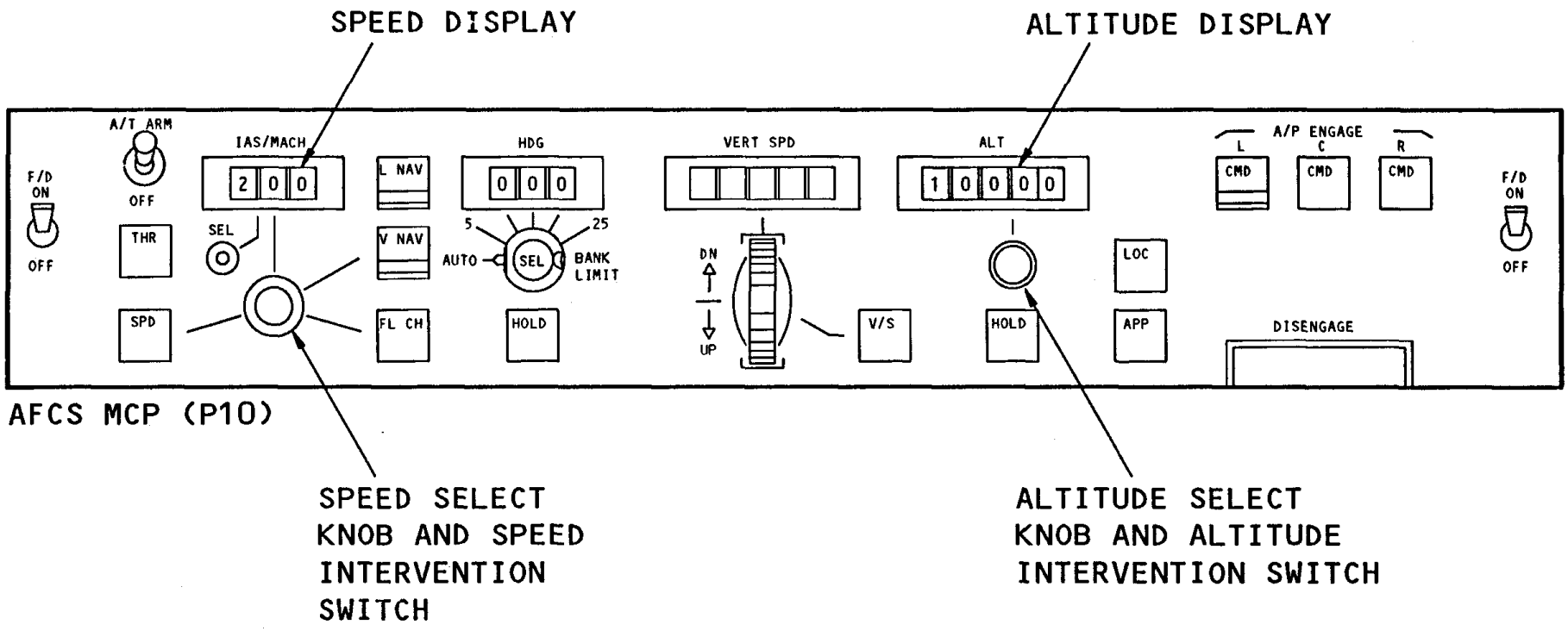


Figure 80 SPEED AND ALTITUDE INTERVENTION

EFIS FUNCTION

General

The FMC can produce two independent maps for display on the captain's and first officer's ND. The FMC shows map data in either the MAP or PLAN modes. Mode control is from the EFIS control panel. The EFIS control panel also has selections for map range and map data selector switches. The CDU can be used to make route modifications, select reference points and step through the plan display.

EFIS Map Processing

The EFIS function gets the lateral flight plan from the guidance function. There are three types of flight plans that can show:

- Active
- Modified
- Inactive

Computations are done to smoothly connect all waypoints of the route. The EFIS function also searches the navigation data base for all navaids that exist in the display area. This information is used in the navigation

radio tuning function as well as in the formatting of the map display.

The navigation data base also contains the locations of waypoints and ground reference points, and airports which are considered background data. This data is not required to be updated as fast as dynamic data. Dynamic data are parameters and symbology that moves relative to the map display and must be updated at a fast rate. The guidance function provides information for the rotation and translation of the dynamic data.

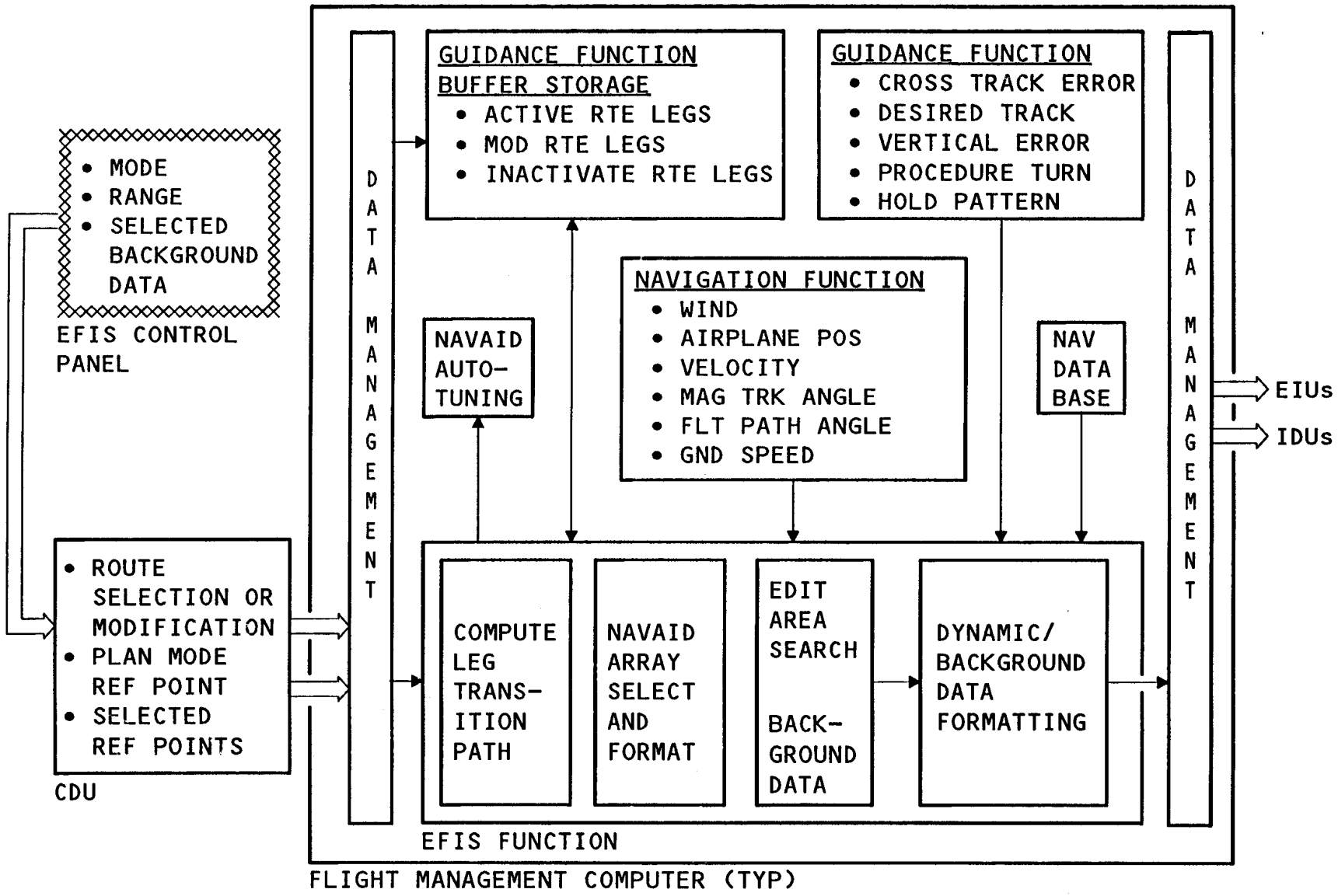


Figure 81 EFIS FUNCTION

DATA LINK FUNCTION

General

The data link function supports airline operational communications (AOC), automatic dependant surveillance (ADS), and ATC data link communications. The flight crew use the air traffic services facilities notification function (AFN) to logon to an ATC center. The ARINC communications addressing and reporting system (ACARS) is used by the FMC to send and receive messages. The AOC and ATC data link functions are controlled by the flight crew using the CDU. The automatic dependant surveillance function is enabled by the flight crew, but is controlled by uplinked ADS contracts.

Operation

The ACARS master FMC does all of the data link functions. The ACARS master FMC is the left FMC unless it fails, and then the right FMC becomes ACARS master. The flight crew are alerted of an ATC uplink message by an EICAS message and an aural chime. The flight crew then press the ATC mode key on the CDU to view the uplink message. An AOC uplink message causes the EICAS message

”FMC MESSAGE” and a CDU scratchpad message. There is no indication to the crew of ADS activity.

The ATC data link function contains message element tables which the flight crew use to assemble downlink messages. ATC uplinks also use a standard message element table. Free text can be included with most messages. After verification the flight crew initiate the downlink. The data link function contains the different message formats and communicates with ACARS using the appropriate protocol. The data link function also supplies address data to ACARS for the proper routing of the message through the network. ACARS can use either VHF or satellite communications networks. ATC messages are stored in a log. The flight crew can view the different messages that were received as well as messages that they sent to ATC.

AOC uplink messages can contain flight or route data. The information is passed from the data link function to the navigation or performance function as appropriate. The flight crew can load the information or purge that data from the buffer. The flight crew can also downlink requests for route and flight data.

Automatic dependant surveillance lets a ground station (ATC or AOC) make requests for flight or route data from the FMC. These uplinked contracts can specify the reporting period; which can be one time, periodic, or upon reaching a certain condition. The contract can also specify the type of information being requested. ADS also has a selectable emergency mode which causes a message to be sent repeatedly.

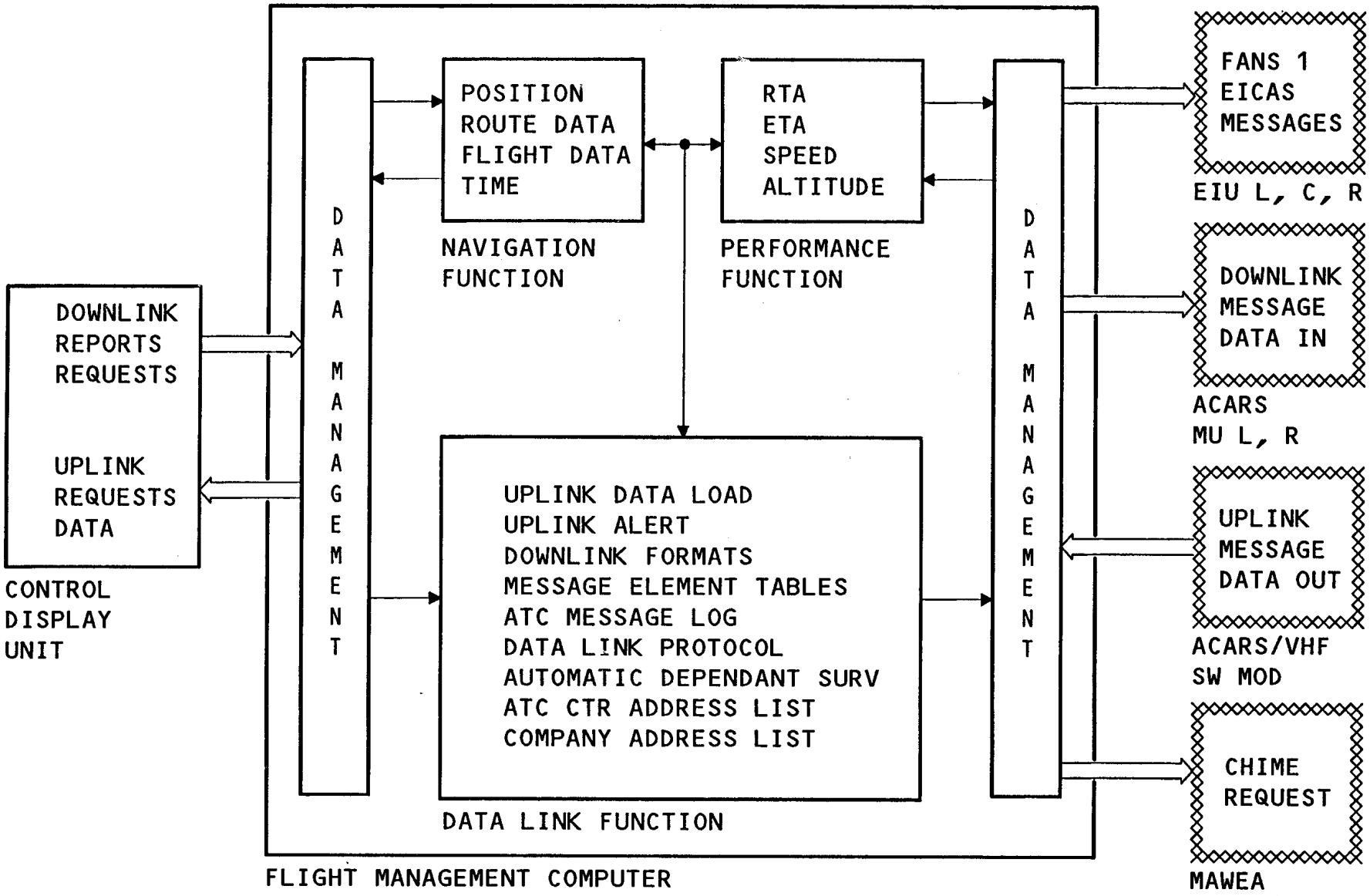


Figure 82 DATA LINK FUNCTION

CONTINUOUS FAULT MONITOR

General

The FMCs are self monitoring with BITE (built in test equipment- hardware and software monitors). The continuous fault monitor monitors the health of the FMC at power up and during operation.

Operation

The continuous monitor performs these activities during operation:

- Power up BITE tests
- All input sensors SSM
- All ARINC receivers
- All ARINC transmitters
- Internal processor tests

Test Results

The results of the continuous monitor tests are sent to the test failure response logic. When certain failures occur a rerun of power up BITE is requested. If the power up test passes, this may lead to a request to

resynchronize from the other FMC. The FMC that is resynchronized shuts down its output bus during this time.

When test results cause the FMC to fail, the CDU shows the MENU page and the select caret and FMC (<FMC) is removed. The CDU's FAIL annunciator lights and the scratchpad message TIMEOUT - RESELECT shows. The continuous fault monitor sends test results to the display block which reports this to the CMC, EICAS and stores it in memory. The last ten flight faults are shop accessible. BITE data may also be sent to the airborne data loader.

EICAS shows these possible messages

.when the continuous fault monitor circuit detects a fault:

- >AUTOPILOT (CAUTION) master caution lights and aural if the AFDS mode is LNAV and/or VNAV.
- >AUTOTHROT DISC (CAUTION) master caution lights and aural if the autothrottle was engaged.
- >FMC LEFT or >FMC RIGHT (ADVISORY)
- >FMC MESSAGE (ADVISORY, this indicates that an alert message is in the CDU scratchpad)

The PFD and ND show these displays:

- PFD shows a blank A/T FMA
- PFD shows LNAV and/or VNAV mode failures if either were the AFDS operate mode.
- ND shows the MAP and VTK flags

The VTK flag shows right away, and the MAP flag shows after 30 seconds.

The fail light on the front panel of the FMC comes on when the FMC has shut down due to a detected failure.

Cycle power to the FMC to run the power up BITE. If the fault was caused by a software error, the FMC may resume operation.

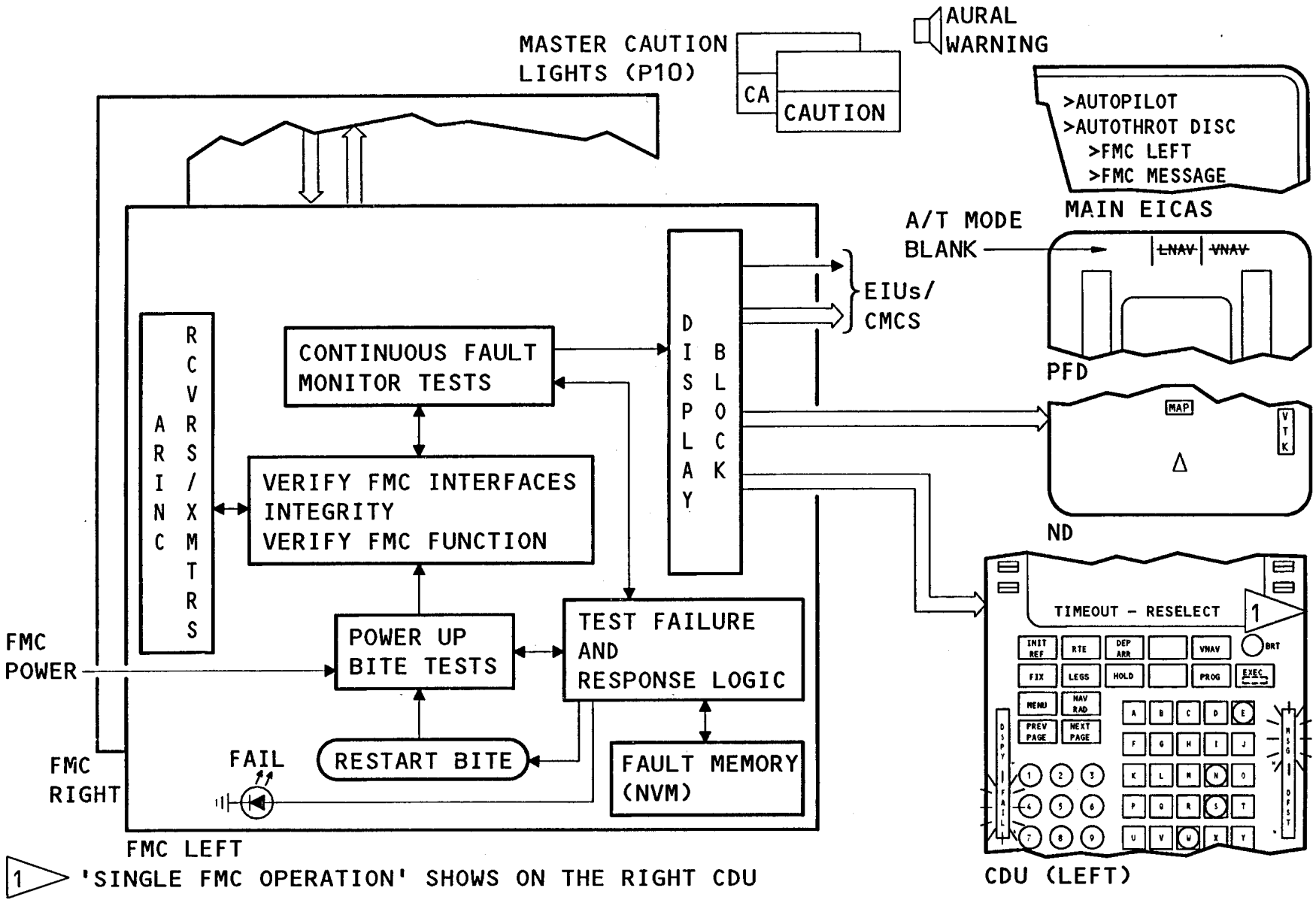


Figure 83 CONTINUOUS FAULT MONITOR

RESYNCHRONIZATION

General

An FMC will resynchronize (resync) the other FMC if one of these two conditions ocurrs:

- If the calculated data from the two FMCs does not match properly
- If one FMC fails an internal test and can not operate unless it goes through a restart, after which a resync is necessary

Data Comparison Failure

Some data calculated by each FMC is transmitted on the intersystem bus to the other FMC. Each FMC compares the other FMC's data with its own data. If there is a difference between the data of the two FMCs, the master FMC starts a resync of the other FMC. The process takes about 15 seconds.

During a resync, flight plan and performance data goes to the other FMC. During a resync, the master FMC can perform all functions normally.

FMC Internal Test Failure

If either FMC fails an internal test, its output buses are shut-down. The test failure response logic will cause a restart of the FMC. After the restart, the FMC needs to be resync. The slave can resync the master for this type of failure.

Resync Indications

If the FMC that needs a resync is the master FMC, and if VNAV, LNAV and autothrottle are engaged, then the indications occur as shown on the chart. The main EICAS, PFD and ND will all show a loss of the master FMC.

If the FMC that needs a resync is not the master FMC, the indications are:

- On side CDU frozen on current display page.
- Offside CDU shows the scratch pad message "RESYNCHING OTHER FMC".

If a resync is successful, normal operation will resume. If resync attempts are not successful, the FMC will latch fail.

SITUATION: THE LEFT FMC IS MASTER AND HAS FAILED AN INTERNAL TEST. IT NEEDS RESYNC BY THE RIGHT FMC. CAPT'S ISSS IS ON L-FMC, F/O'S ISSS IS ON R-FMC. AIRCRAFT IS IN LNAV, VNAV WITH AUTOTHROTTLE AND FLIGHT DIRECTORS ON.
INITIAL INDICATIONS:

L-CDU	R-CDU	MAIN EICAS	BOTH PFDS	CAPT'S ND	OTHER
DISPLAY FROZEN	SCRATCH PAD MSG: -SINGLE FMC OPERATION, THEN -RESYNCING OTHER FMC 1	->AUTOPILOT ->AUTOTHROT DISC ->FMC MESSAGE	-ROLL & PITCH FMA SHOW MODE FAIL -A/T FMA BLANK	-VTK FLAG ETA AND DTG FOR ACTIVE WAYPOINT DISAPPEAR	-F/D BARS BIASED OUT OF VIEW
INDICATIONS IF RESYNC FAILED (AFTER 35 SEC):					
MENU PAGE, FAIL ANNUNCIATOR LIGHTED	FAIL ANNUNCIATOR LIGHTED	SAME AS ABOVE PLUS >FMC-L	SAME AS ABOVE	SAME AS ABOVE PLUS -MAP FLAG	SAME AS ABOVE
INDICATIONS IF CAPT'S NAV ISSS SHIFTED TO R-FMC, AND R-FMC SELECTED AS MASTER:					
DISPLAY DATA IS FROM RIGHT FMC. NORMAL OPERATION	NORMAL MESSAGES	ALL MSGS CLEAR EXCEPT >AUTOTHROT DISC (A/T SWITCH OFF THEN ON TO REENGAGE) AND >FMC-L	NORMAL VNAV & LNAV	NORMAL DISPLAY	F/D BARS RESTORED WHEN FMC MASTER CHANGED

1 DO NOT MAKE PB REQUESTS DURING RESYNCS

Figure 84 RESYNCHRONIZATION

CDU MESSAGES

General

The FMCs can show an alert for conditions that reduce its functions. There are two types of messages. They are alert and advisory messages. The alert and advisory messages turn on the message (MSG) annunciator light on the CDU.

Only the alert messages set the CDU MESSAGE output discrete to show FMC MESSAGE (level C) on the main EICAS.

Uncleared messages (not removed) and uncleared alphanumeric data are stored in a message stack. As alert messages occur, they are shown in the scratch pad of each CDU. As uncleared alert messages are replaced by other alert messages, they are added to the top of the stack.

As the CLR key is pushed, in steps, the stack is shown and messages and data are cleared in sequence from the top to the botton When the CLR key is held, it does not cause all messages to be cleared continuously.

A CDU message will clear if the logic that caused the message is reset or if the CLR key on the CDU is pushed.

Alert Messages

Alert messages have a higher priority than advisory messages and therefore, show before or replace advisory messages. Alert messages have priority over any other message in the scratch pad. If an alert message is already in the scratch pad when another alert message is received, the new alert message is shown. The previous message is stored in a stack type configuration.

Display of all alert messages is inhibited below 500 feet altitude above ground level (AGL) during approach when a runway is in the active route. If there are more alert messages during this time, they will be shown at flight completion or after the airplane climbs through 1000 feet AGL.

Alert messages only set the CDU message output discrete to show FMC MESSAGE (level C) on the main EICAS.

Advisory Messages

There are two types of advisory messages. They are data entry error advisory messages and basic advisory messages. Data entry error advisory messages have priority over the advisory messages. The advisory messages are shown only on the CDU where the condition occurred.

All advisory and alert messages cause the CDU MSG lite to come on.

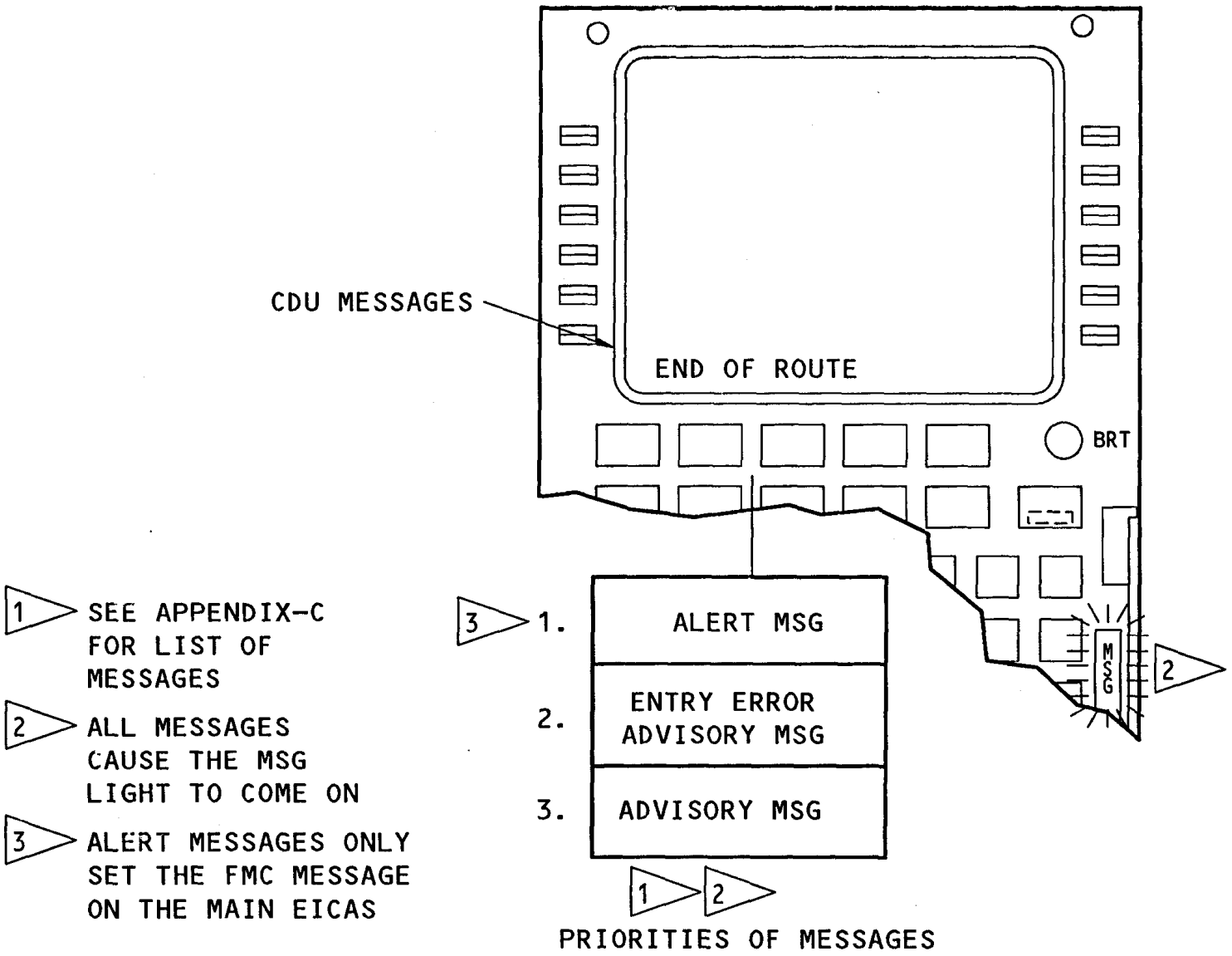


Figure 85 CDU MESSAGES

THRUST MANAGEMENT - INTRODUCTION

Autothrottle

The autothrottle (A/T) is armed by a switch on the MCP and TO/GA switches. The autothrottle mode is determined by mode selection on the MCP. The FMC sends a command to the A/T servo to move the throttle levers. The A/T servo moves the throttle levers and provides a rate feedback to the FMC.

As the throttle levers move either by A/T or manual (pilot) input, the throttle resolver angle (TRA) transducers send throttle position data to the electronic engine controls (EECs). The EECs send data to the fuel control units to do a coarse adjustment of the engines. The engines provide thrust feedback to the FMC through the EIUs.

Engine Trim

Engine trim equalization occurs during both manual and autothrottle operation. In this process, the FMC uptrims the trailing engines to match the highest engine thrust until it reaches the trim authority limit. If equalization is

not achieved, downtrim then occurs for the leading engine. To do this, the FMC receives actual engine thrust from the EIUs and then calculates the trim commands. These commands are sent through the FMC master relay No. 2 to the EECs.

Thrust Limit

The thrust limit calculation is done by the FMC with the mode of operation and other factors such as temperature, ambient pressure and barometric altitude which affect the thrust limit. The FMC also calculates a maximum limit which is sent to the EIUs and the EECs.

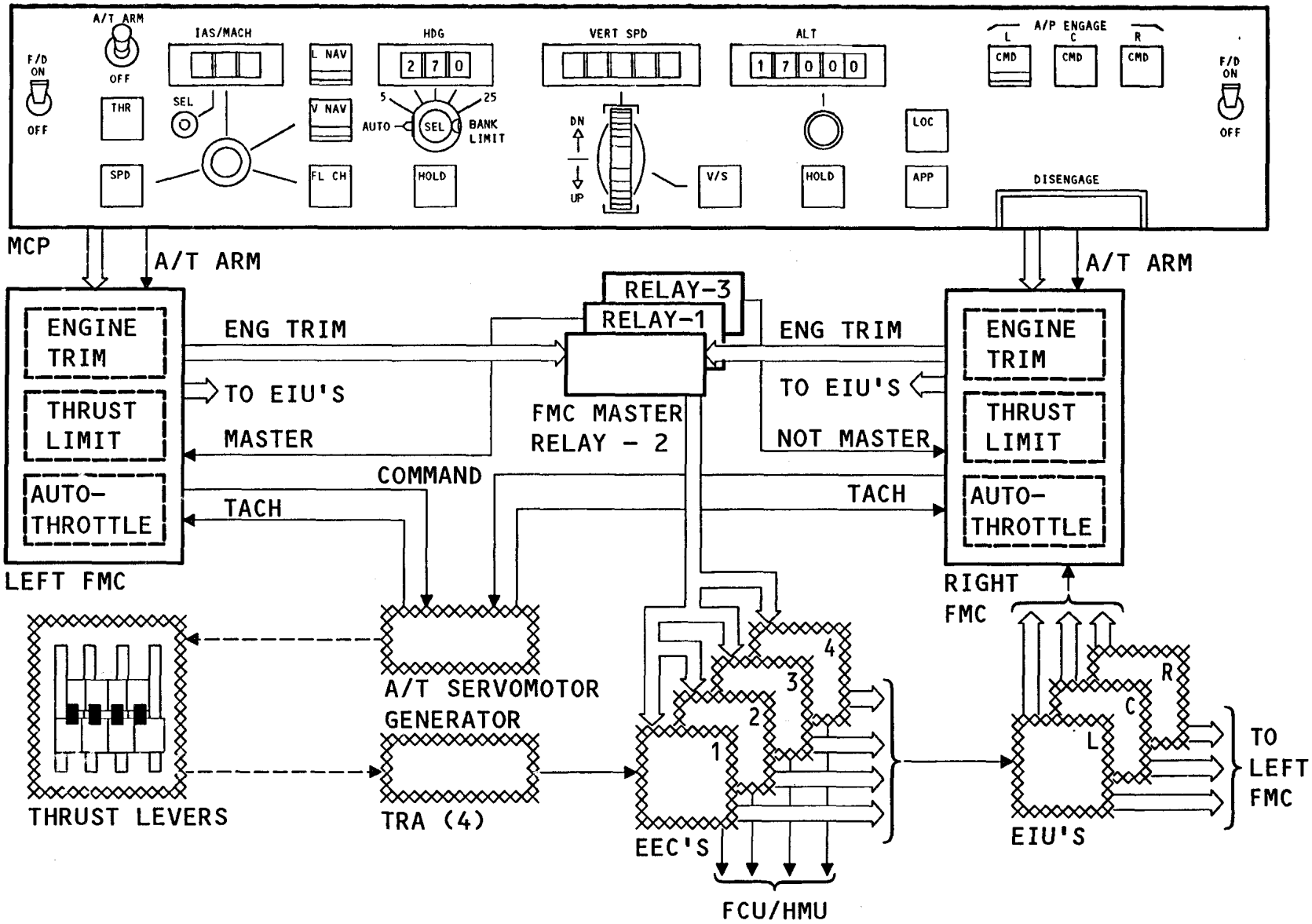


Figure 86 THRUST MANAGEMENT - INTRODUCTION

THRUST MANAGEMENT FUNCTION

General

The thrust management function of the FMC has two functions. These are autothrottle and thrust limit.

The thrust management function requires sensor inputs from ADCs, IRSs, EIUs, flight deck analog signals, MCP and the offside FMC. The received data is used to control the throttles for the airplane's flight path operations and for thrust limit calculation.

Autothrottle

The autothrottle processor produces servo control commands, thrust equalization outputs to the EECs and data for EICAS, CDU and PFD display. There are four activities done in the autothrottle control processor:

- Engage logic
- Control Laws
- Mode logic
- Engine trim

The engage logic function determines the validity of the control law data and enables the software control laws.

This function enables the servo motor excitation voltage.

The control laws function calculates the autothrottle command with the mode of operation.

The mode logic in the processor allows for manual or automatic selection of available throttle modes.

The engine trim function calculates thrust equalization commands for the leading and trailing engines with a maximum trim authority of five percent below 20,000 feet and ten percent above 20,000 feet.

Thrust Limit Calculation

The thrust limit calculation supplies the autothrottle control function with the maximum and reference thrust limits. These thrust limits show on the CDU and main EICAS.

The processor receives mode requests from the CDU and MCP and data from external sensors and analog switches. Calculations include fixed derates and assumed temperature derates.

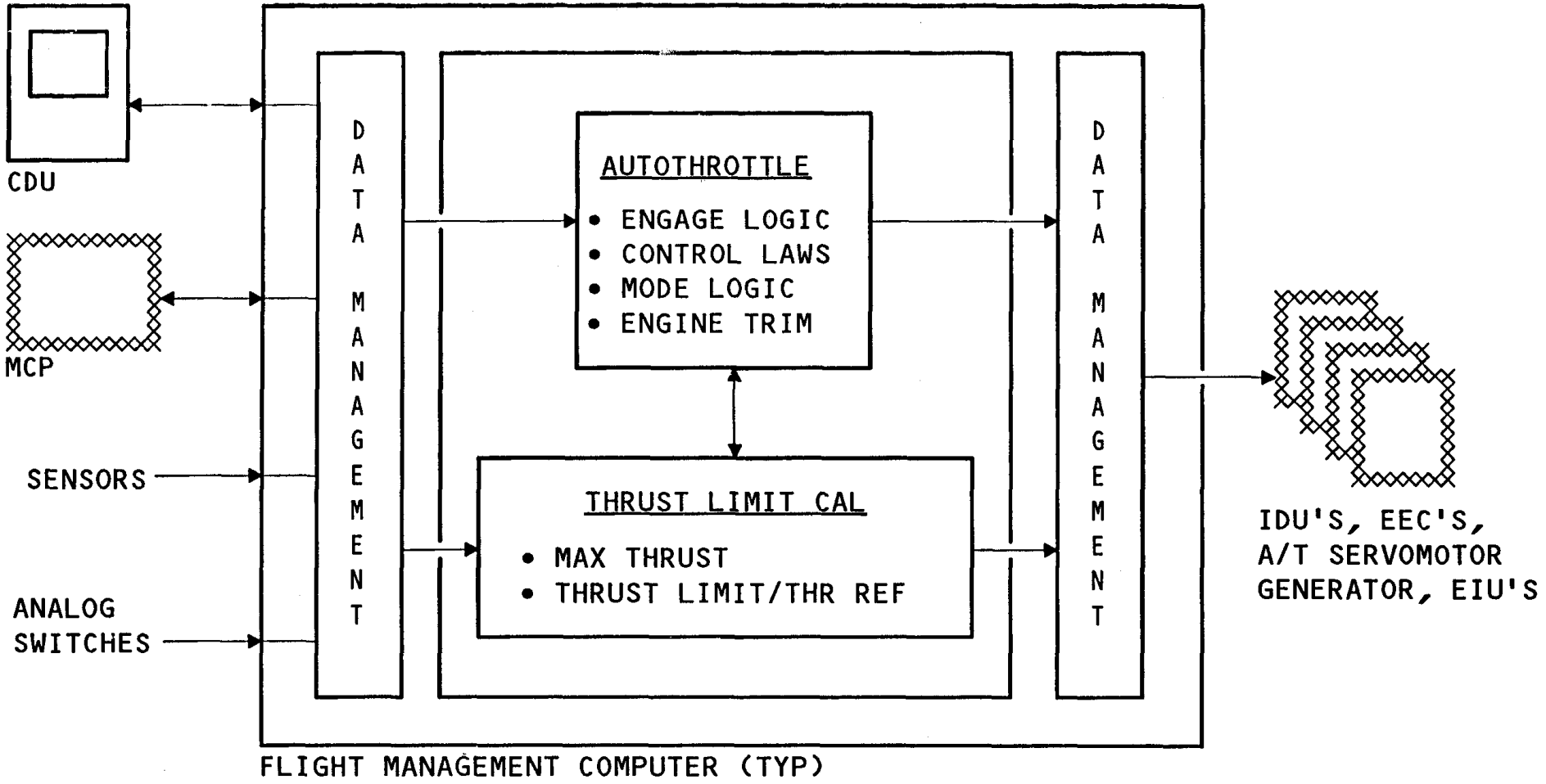


Figure 87 THRUST MANAGEMENT FUNCTION

THRUST LIMIT CALCULATION

General

The thrust limit calculation produces two limits. These are:

- Maximum thrust
- Thrust limits/THR REF

Maximum Thrust

The maximum thrust is calculated for display on EICAS. The maximum thrust is not reduced by any mode or derate selection.

Thrust Limits and THR REF

The thrust limit is calculated for display on the CDU and main EICAS and for the autothrottle to use as a limit value. This limit is calculated for the mode selected.

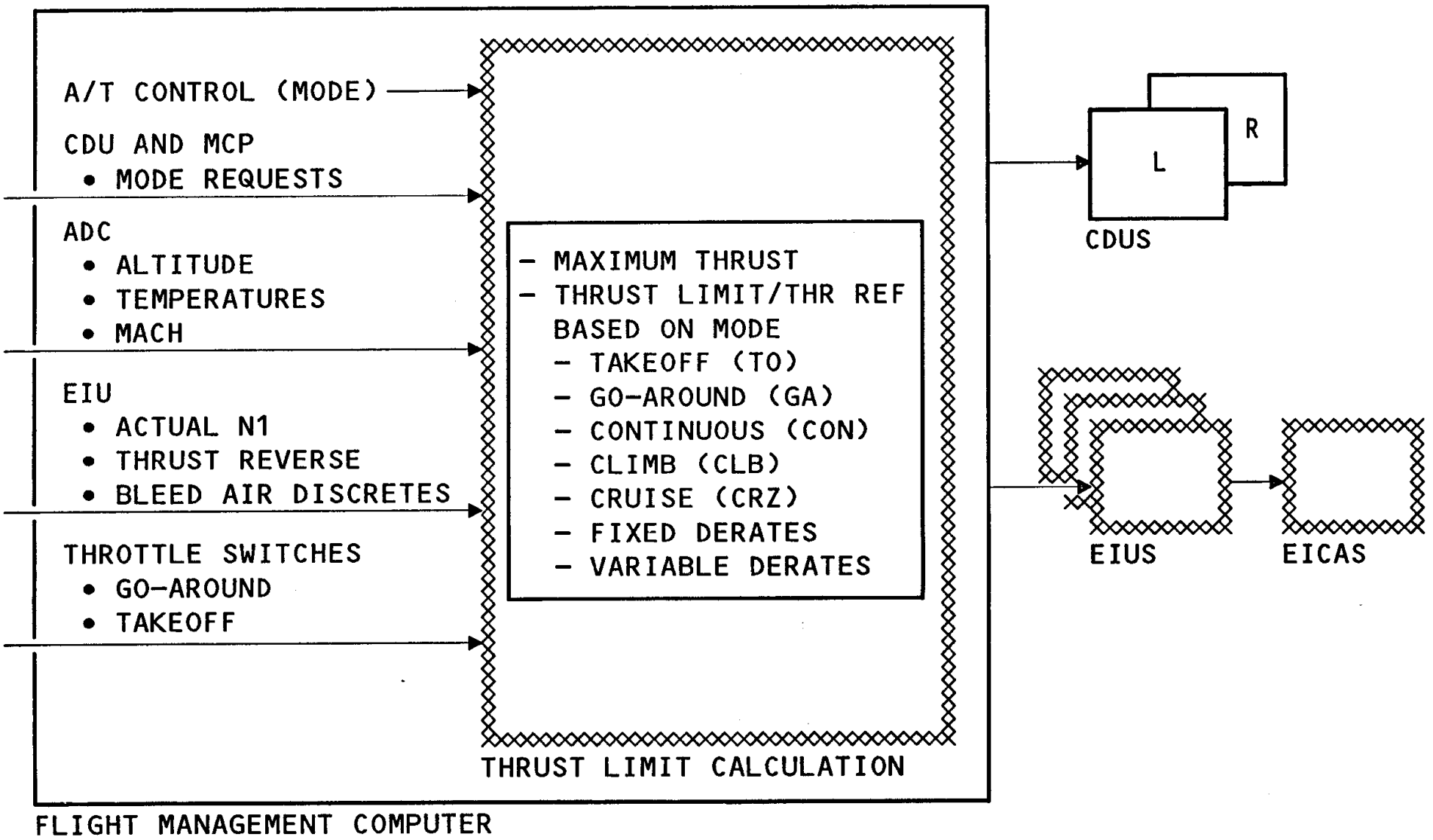


Figure 88 THRUST LIMIT CALCULATION

AUTOTHROTTLE ENGAGE LOGIC

General

The autothrottle engage function monitors airplane and FMC parameters for autothrottle engagement. if conditions allow autothrottle engagement, excitation power is sent to the servomotor. The throttle hold mode removes excitation from the servomotor but does not disconnect the autothrottle.

Servo Loop Monitor

When engaged, the autothrottle sends a command to the servomotor which sends throttle rate data (tachometer) back to the FMC.

The autothrottle compares these two signals and disconnects excitation to the servomotor if the signals do not generally agree. This is called the servo loop monitor and is used to detect failures in the autothrottle system.

Autothrottle Disconnect

The A/T DISCONNECT message shows on EICAS when the autothrottle goes from an engage status to off. This occurs for any condition (manual or automatic) but not for disengage on the ground with thrust reverser application.

In this situation, the A/T DISCONNECT message will not occur. The A/T DISCONNECT is a level B message which also causes a master CAUTION annunciation.

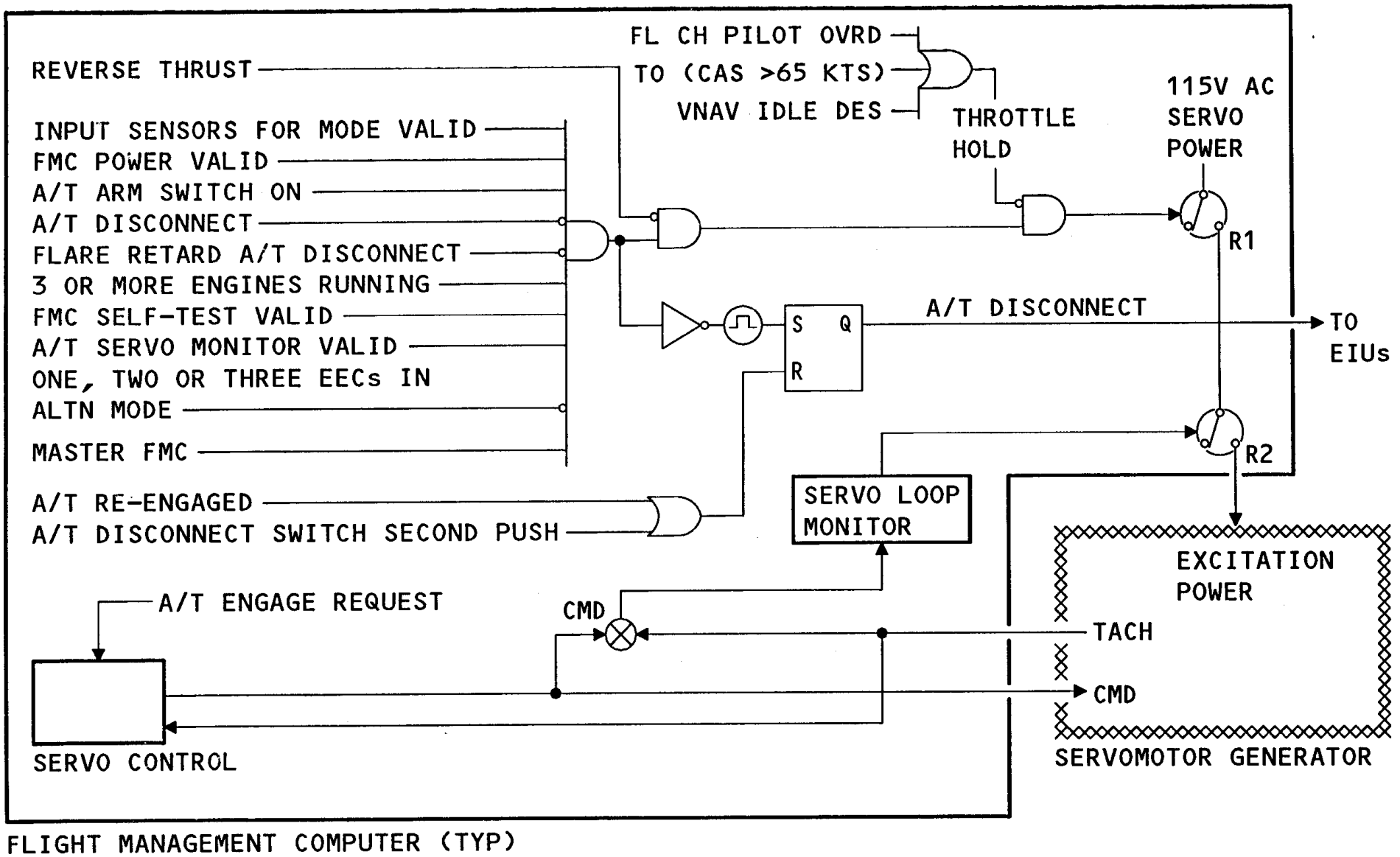


Figure 89 AUTOTHROTTLE ENGAGE LOGIC

AUTOTHROTTLE CONTROL LAWS & MODE LOGIC

General

There are three processes for autothrottle control. These are:

- Speed
- Vertical speed
- Thrust

The mode logic determines the selection of these processes.

Speed

Two modes are in the speed control process. These are VNAV speed mode and MCP speed mode. The VNAV speed mode uses a true airspeed (TAS) supplied by the FMC performance function. This speed is compared with the air data computer (ADC) airspeed and an airspeed error is generated.

The control law calculates a throttle command with this error. Thrust limit protection is maintained to make sure engines do not overboost.

The MCP speed mode uses the MCP airspeed, changes it to TAS and operates in the same way as the VNAV speed mode discussed above. Also, both of these modes can operate to hold mach in addition to airspeed.

Vertical Speed

The vertical speed process calculates a vertical speed for the flight level change (FLCH) mode and provides a set vertical speed (2000 FPM) for the go around (GA) mode. The control law calculates a thrust setting. If the vertical speed reduces below that needed, the control law applies more thrust. However, if the vertical speed is above that needed, the control law does not reduce thrust.

Thrust

The thrust process operates to maintain the engines at takeoff (TO), full go around (GA) or VNAV climb/descent thrust limit modes. The control law does not**,** however, allow the engines to go over the Vmo/Mmo limit.

Mode Logic

The autothrottle modes when engaged shows on the primary flight display (PFD) in the A/T sector. These are the selectable A/T modes from the mode control panel (MCP):

- THR (thrust) when selected causes the control section to control to the full thrust limit of the active thrust limit mode shown on the EICAS display
- SPD (speed) when selected causes the SPD control section to control to use the MCP speed as a target
- FLCH (flight level change) causes the vertical speed control section to control to a vertical speed that captures the MCP altitude in 125 seconds
- VNAV when selected causes the speed control section to control to an FMC calculated speed and the thrust control section to control to an FMC reference thrust

The autothrottle arm switch and a flight director (F/D) or an autopilot

(A/P) engaged are necessary to engage an autothrottle VNAV or FLCH mode from the MCP. The A/T arm switch must be on to select the SPD or THR mode from the MCP.

These are the selectable modes from the throttle control stand (TO/GA switches):

- Takeoff (TO) selection causes the thrust section to control to the TO thrust limit mode when selected on the ground. The thrust limit mode shows on the main EICAS.
- Go-Around (GA) selection causes the vertical speed (V/S) section to control to a V/S of 2,000 fpm. A second push causes the thrust control section to control to the full GA thrust limit mode that shows on the main EICAS display.

The A/T arm switch must be on to engage the TO or GA mode.

The flare retard mode, when engaged, causes the A/T servo to drive the throttles to the AFT mechanical stop at 5 degrees per second. The AFDS sends a flare retard request during a LAND3/LAND-2 condition. This occurs at <25 feet radio altitude.

Thrust Limit Protection

In the TO mode and other A/T modes, maximum speed and flap placard speed protection occurs at 400 feet above ground level (RADIO ALT). In the GA mode, maximum speed and flap placard speed protection occurs when full GA thrust is commanded.

Pilot Override Logic

The pilot override logic occurs when the throttles are moved to a position that differs from the servo command by 8 degrees in the FL-CH mode. This causes the A/T mode to change from THR to HOLD on the PFD. In this case excitation power is removed from the A/T servo. When other A/T modes are engaged and manual override occurs, the throttles return to the servo commanded position when no manual override input is present. In this case, there is no A/T mode change on the PFD.

Servo Control

Each control section, SPD, V/S and THR sends an error rate command for the appropriate mode engaged. The servo control section integrates this and sends a throttle position command to the servo. As the servo runs, the tachometer increases its output and eventually equals the throttle command. This results in a constant output from the servo control and the throttles move at a constant rate. Servo commands stop when the error rate goes to zero.

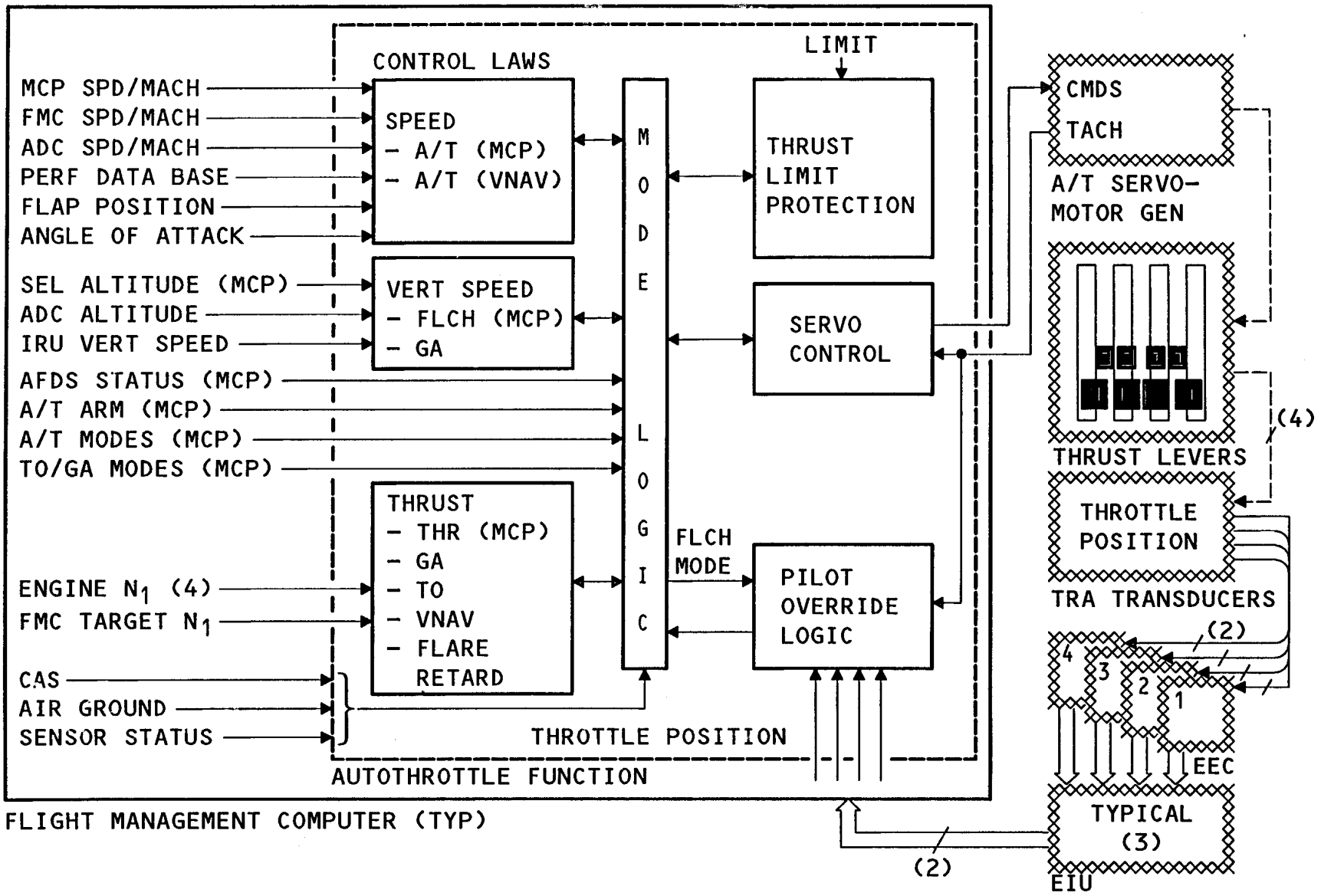


Figure 90 AUTOTHROTTLE CONTROL LAWS & MODE LOGIC

EICAS THRUST DISPLAY

General

The EICAS thrust display shows FMC data related to engine/thrust performance. This data is:

- Total air temperature
- Thrust limit mode
- Selected temperature
- Thrust limit
- Maximum thrust limit
- Target N1

Total Air Temperature

The primary source of total air temperature data is the master FMC. The EIUs select the data from the air data computers if the FMC data is invalid. Total air temperature is used to calculate thrust limits.

Selected Temperature

Selected temperature can be entered from the THRUST LIM page. Selected temperature is used for thrust limit calculations instead of the total air temperature if the selected temperature is higher.

Thrust Limit

The thrust limit is calculated by the FMC with the thrust limit mode selected. This selection can be manual or automatic. The thrust limit is shown as a digital value and as a green cursor.

Maximum Thrust Limit

The maximum thrust limit is calculated by the FMC. The thrust should always be less than this value. The EEC is secondary for maximum thrust limit display.

Target Thrust

The target thrust cursor is calculated by the FMC. The target cursor shows magenta in climb when VNAV is engaged. The target thrust cursor changes to green during other phases of flight when VNAV is engaged. It shows magenta in descent when VNAV idle thrust mode is active and anti-ice is on. The magenta thrust target also shows when the autothrottle arm switch is off for pilots, response in manual thrust applications.

Derates

There are two fixed derates and a selected temperature derate available. Derates are used if the airplane load and runway length do not require full takeoff or climb thrust. The fixed and temperature derates are selected from the THRUST LIM page.

If the selected temperature entered results in a reduction in the TO thrust limit, D is shown in front of the thrust limit mode annunciated on the EICAS.

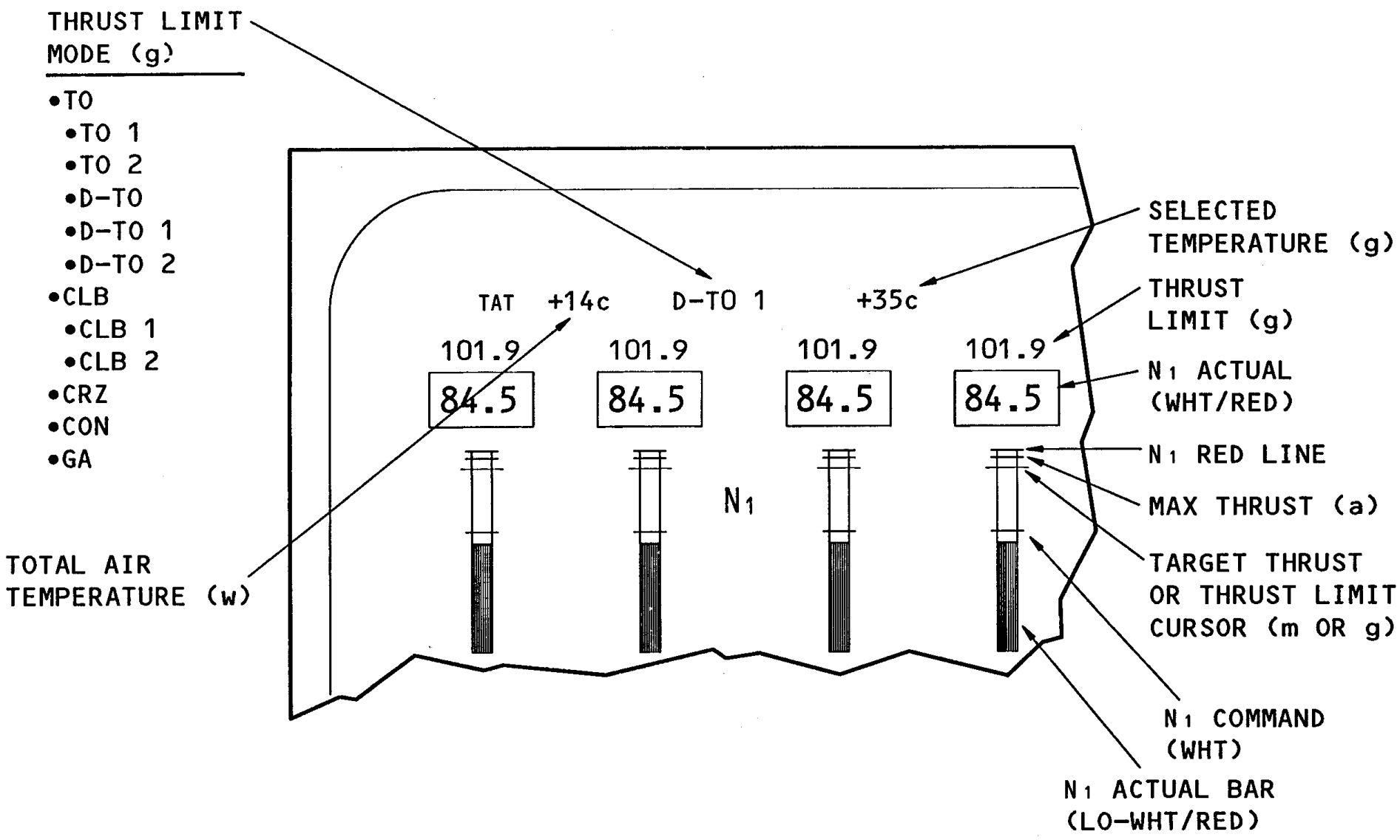


Figure 91 MAIN EICAS THRUST DISPLAY

PFD AUTOTHROTTLE MODE DISPLAY

General

The autothrottle (A/T) modes show on the PFD in green when an A/T mode engages. When no A/T mode is engaged (MCP switch off or with the A/T switch on but no A/T mode selected), this sector is blank.

A/T Modes

Speed (SPD) shows when A/T engage conditions are valid and vertical navigation (VNAV) commands the throttles to hold speed or the speed mode is selected from the MCP. This also occurs when VNAV or flight level change (FLCH) transitions to a pitch mode due to a glide slope, vertical speed or altitude hold capture.

Thrust (THR) shows when the FMC receives a request and enters VNAV descent, FLCH or a GA thrust mode.

Thrust reference (THR REF) shows when the FMC thrust function is in a takeoff (TO), VNAV, go-around (GA) or THR (MCP THR button) thrust mode.

Hold shows when the throttle hold mode is active:

- FLCH IDLE or pilot override.
- TAKEOFF when CAS > 65 kts.
- VNAV idle descent.

Idle shows when a VNAV idle, FLCH idle or flare retard idle command is present.

Test shows when one of the three FMC tests is active:

- FMC push button (FMC front panel)
- FMC ground test (CDU and CMC)
- FMC ground test, servo loop (CDU and CMC)

The A/T mode blanks when no mode is active or the A/T arm switch is off.

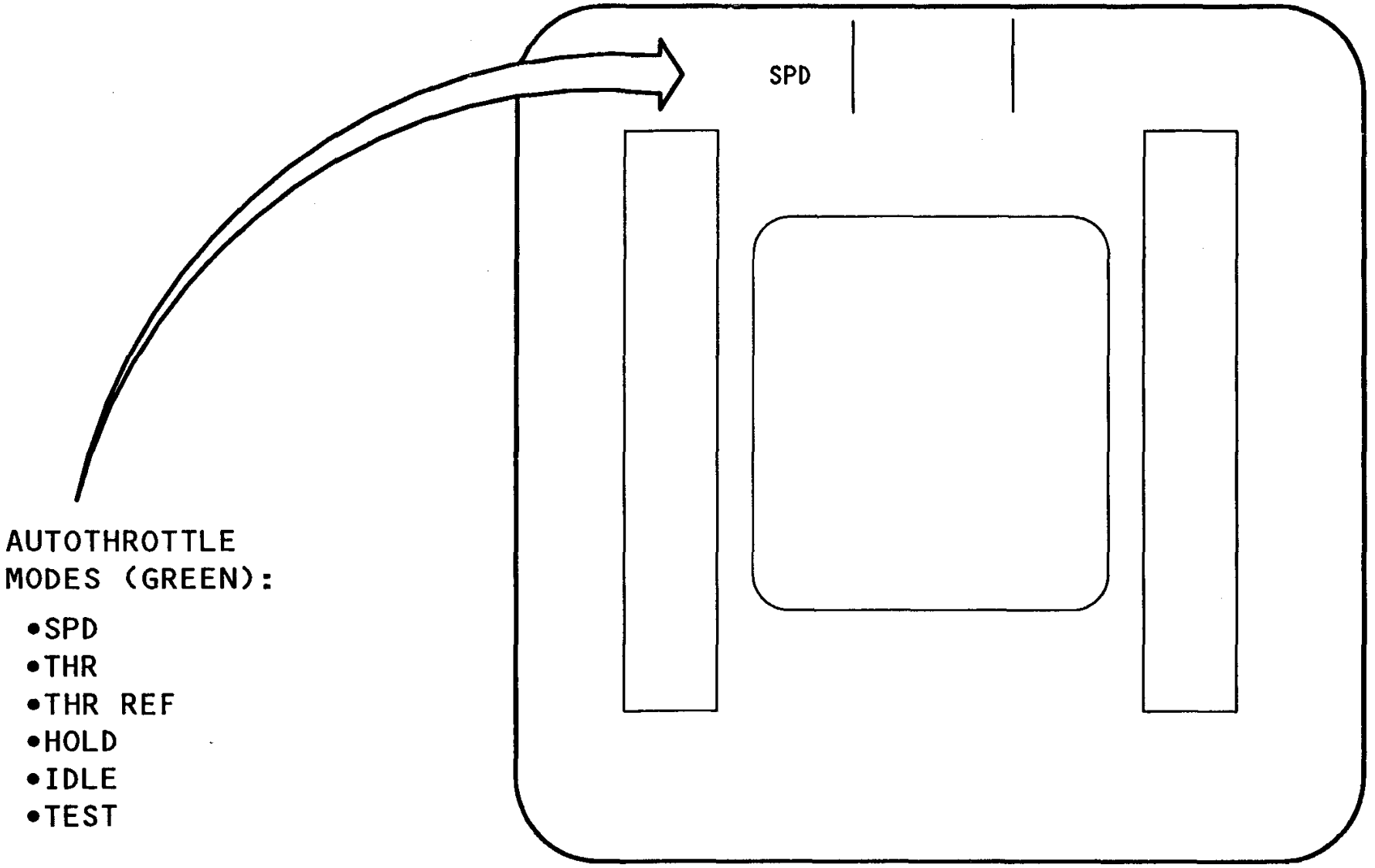


Figure 92 PFD AUTOTHROTTLE MODE DISPLAY

AUTOTHROTTLE FLIGHT PROFILE

General

The autothrottle function of the FMC may be used in all phases of the airplane's flight:

- Takeoff
- Climb
- Cruise
- Descent
- Approach
- Go-around
- Flare

Takeoff

In takeoff, the autothrottle controls the thrust to takeoff limit. The A/T mode is THR REF. At 65 knots, the A/T mode changes to HOLD.

Climb

Climb can be done with the autothrottle in four ways:

- VNAV
- Flight level change (FLCH)
- Speed
- Thrust reference

If VNAV is used for climb, the A/T mode is THR REF. If FLCH is used, the A/T mode is THR. If the AFDS is in vertical speed or if the autopilot and flight director are both off, speed or thrust reference may be selected as the A/T mode.

Cruise

Cruise can be done with the autothrottle in three ways:

- VNAV
- Speed
- Thrust reference

If VNAV is used in cruise, the A/T mode is SPD. If the AFDS is in any mode but VNAV, or if both the autopilot and flight director are off, speed or thrust reference may be selected as the A/T mode.

Descent

Descent can be done with the autothrottle in three ways:

- VNAV
- Flight level change (FLCH)
- Speed

In VNAV descent, the A/T mode is IDLE or it may be HOLD if the throttles reach the aft stops as a result of the idle mode or pilot override. If FLCH is used, the A/T mode is THR or it may be HOLD for the same reason as for VNAV. If the AFDS is in vertical speed or if the autopilot and flight director are off, speed may be selected as the A/T mode for descent. Thrust reference is a possible mode for descent, but it would not be a normal situation.

Approach

In approach with glide slope active or in a manual approach, the normal mode is speed.

Go-Around

A go-around mode request with autopilot or flight director on, the A/T mode is THR. If the autopilot and flight director are off, the A/T mode is THR REF.

Flare Retard

Flare retard occurs on approach with a command from the AFDS. The A/T mode annunciation is IDLE on the PFD.

A/T Disconnect

The autothrottle disconnects with thrust reverser application or at the selection of the pilot.

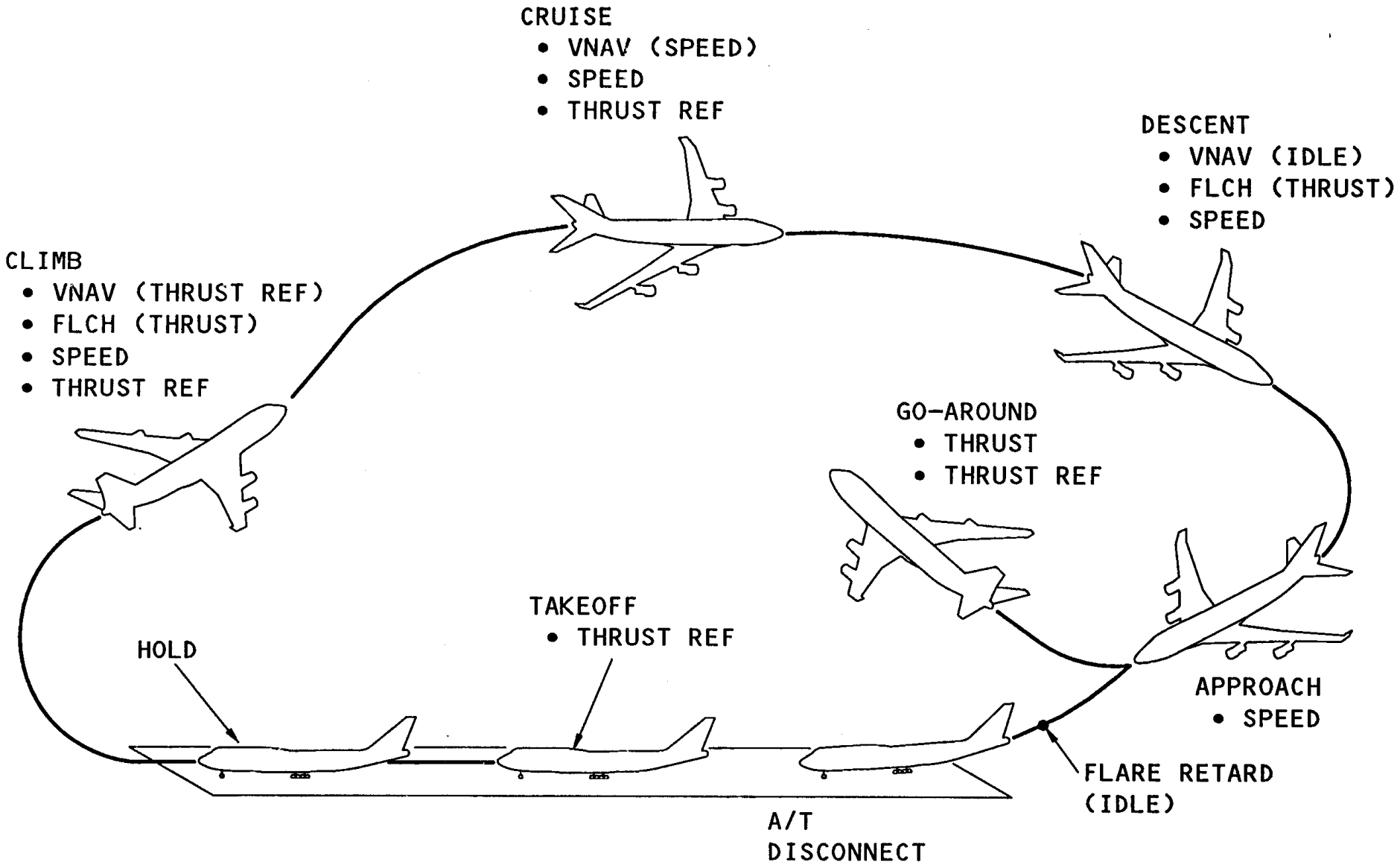


Figure 93 AUTOTHROTTLE FLIGHT PROFILE

ATHR OPERATION TAKEOFF

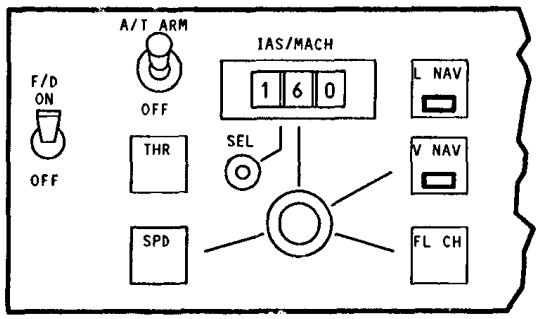
Mode Selection

The takeoff mode is engaged with these conditions:

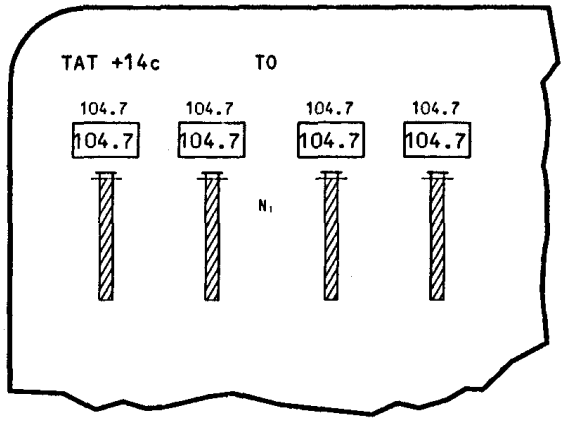
- Autothrottle armed
- Airplane on the ground
- Flap position not zero
- Thrust limit mode is TO (default on ground)
- Push go-around switch
- < 50KTS CAS

Takeoff Mode Operation

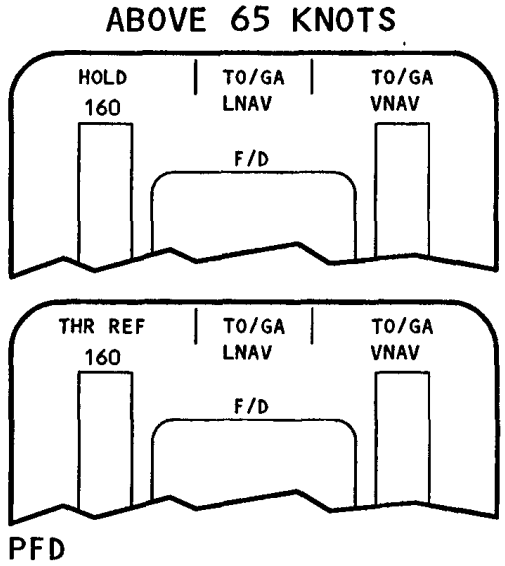
After a test is done to make sure the servo excitation can be removed, the throttles will move to achieve the TO thrust limit.



MCP



MAIN EICAS



PFD

SITUATION: ON THE GROUND, A/T ARMED, VNAV ARMED (NOT ENGAGED), THE GA LEVER HAS BEEN PUSHED ONCE WITH A CAS < 50 KTS AND THROTTLES HAVE MOVED FORWARD TO THRUST LIMIT.

MCP:

- VNAV BUTTON LIGHTED

MAIN EICAS:

- TO (TAKEOFF) THRUST LIMIT MODE SHOWS
- ENGINES ADVANCE TO THE THRUST LIMIT CURSOR (GREEN)

PFD:

- THE A/T MODE IS THRUST REFERENCE
- WHEN THE AIRPLANE REACHES 65 KTS, THE MODE CHANGES TO HOLD
- WHEN THE GA LEVER IS PUSHED A SECOND TIME, IN THE AIR ALL THRUST DERATES ARE REMOVED, A/T MODE CHANGES TO THR REF, AND THROTTLES ADVANCE TO THE NEW LIMIT
- FLAP SPEED PROTECTION ABOVE 400 FEET

Figure 94 ATHR OPERATION - TAKEOFF

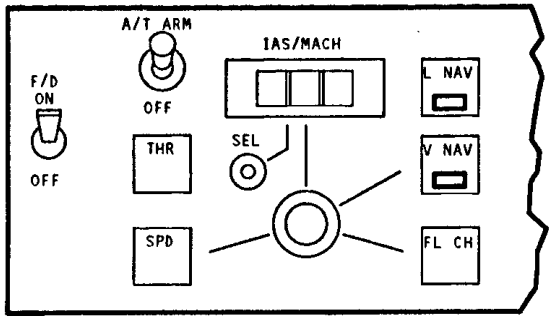
ATHR OPERATION - VNAV CLIMB

General

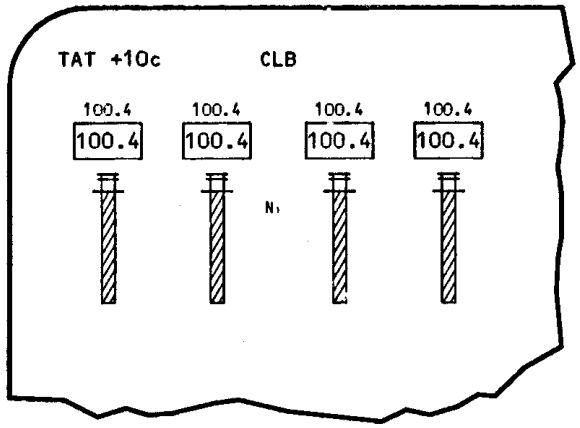
The VNAV mode may be selected above 400 feet altitude. If selected before this altitude, VNAV is armed and will be engaged when the altitude is reached.

Operation

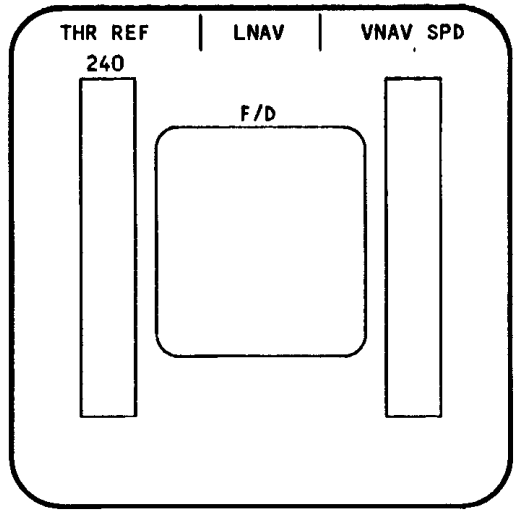
During climb, the thrust limit mode changes from TO to CLB at the thrust reduction altitude or flaps 5. The thrust reduction altitude is the altitude when the flaps reduce to five degrees or a crew selected altitude. The altitude is selected on the TAKEOFF REFERENCE page.



MCP



MAIN EICAS



PFD

SITUATION: IN A CLIMB, ABOVE 400 FT, VNAV ENGAGED.

MCP:

- AS THE AIRPLANE PASSED 400 FT, VNAV ENGAGED

MAIN EICAS:

- WHEN THE AIRPLANE PASSES THE THRUST REDUCTION ALTITUDE, THE THRUST LIMIT MODE CHANGES TO CLB (CLIMB), THE ENGINES REDUCE POWER TO THE CLIMB THRUST LIMIT AND THE CURSOR CHANGES TO MAGENTA

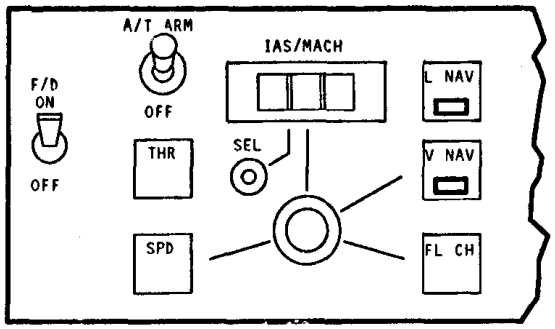
PFD:

- THE A/T MODE CHANGES TO THR REF

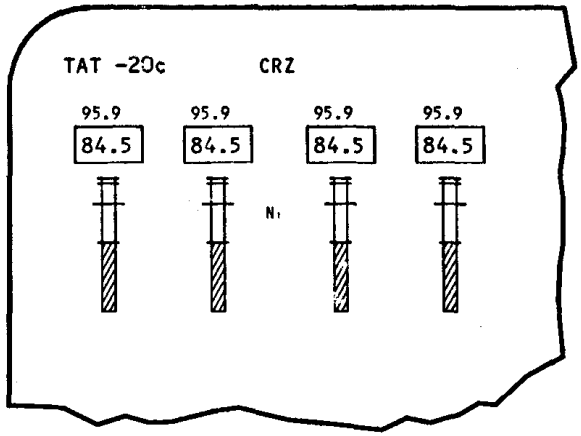
Figure 95 ATHR OPERATION - VNAV CLIMB

ATHR OPERATION - VNAV CRUISE

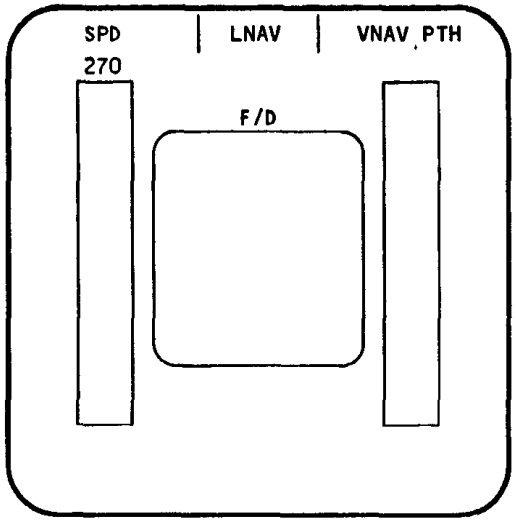
When the airplane reaches the FMC flight level altitude or the MCP altitude, the thrust limit mode changes to CRZ and the autothrottle mode changes to SPD.



MCP



MAIN EICAS



PFD

SITUATION: AIRPLANE REACHES CRUISE ALTITUDE, WITH VNAV ENGAGED, AIRPLANE CAPTURES SELECTED ALTITUDE

MCP:

NO CHANGES

MAIN EICAS:

- THRUST LIMIT MODE CHANGES TO CRZ
- CURSOR CHANGES TO GREEN AND INDICATES THE CRUISE THRUST LIMIT

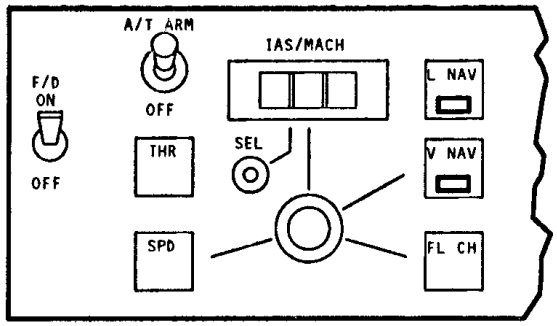
PFD:

- A/T MODE CHANGES TO SPD
- THE A/T CONTROLS THE AIRPLANE TO FMC SPEED

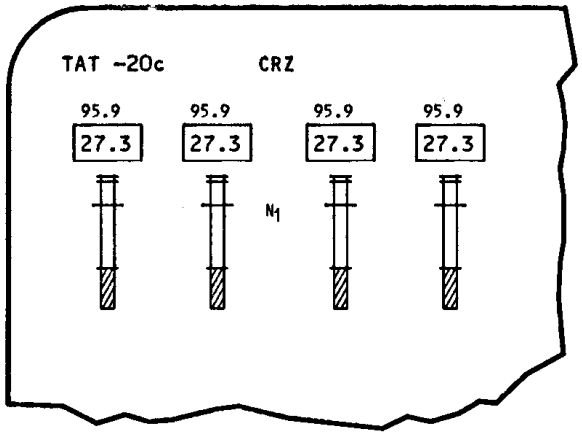
Figure 96 ATHR OPERATION - VNAV CRUISE

ATHR OPERATION - VNAV DESCENT

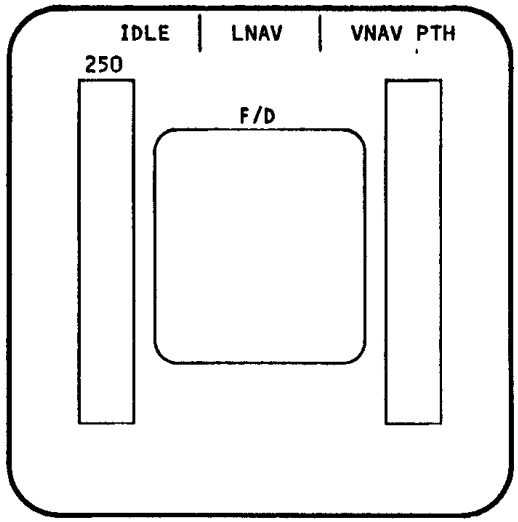
In VNAV DESCENT, the autothrottle mode is IDLE. If the flight crew moves the throttle manually or if the mechanical stop is reached, the mode changes to HOLD.



MCP



MAIN EICAS



PFD

SITUATION: AIRPLANE IS DESCENDING FROM CRUISE ALTITUDE TOWARD DESTINATION AIRPORT, VNAV IS ENGAGED.

MCP:

NO CHANGE

MAIN EICAS:

- CURSOR SHOWS CRZ THRUST LIMIT

PFD:

- WHEN DESCENT STARTS, A/T MODE CHANGES TO IDLE AND THROTTLES MOVE AFT
- IF THEY REACH THE MECHANICAL STOP, MODE CHANGES TO HOLD

Figure 97 ATHR OPERATION - VNAV DESCENT

ATHR OPERATION - SPEED

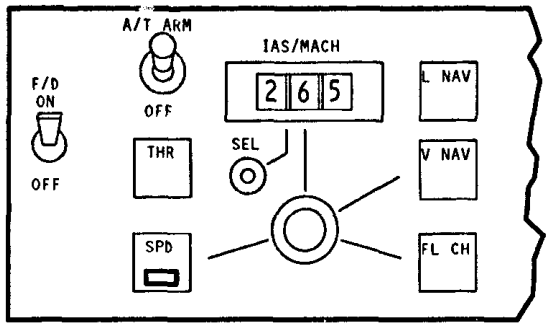
Mode Selection

The speed is engaged when there are these conditions:

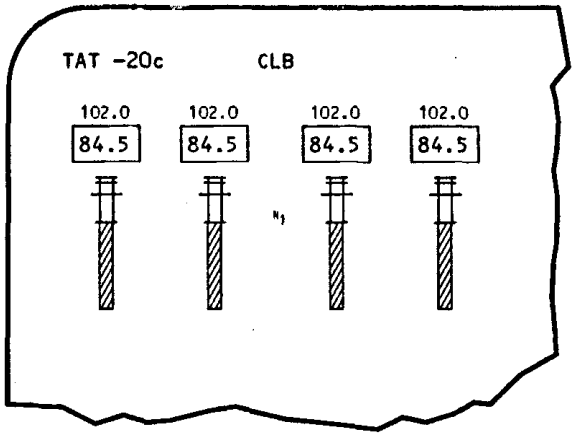
- Autothrottle armed
- Airplane in the air >400 feet
- Thrust limit mode not takeoff
- Go-around mode not active
- FLCH mode not active
- VNAV mode not active
- Select speed mode on MCP or
- Default SPD selection, for example, exit of FLCH or VNAV

Operation

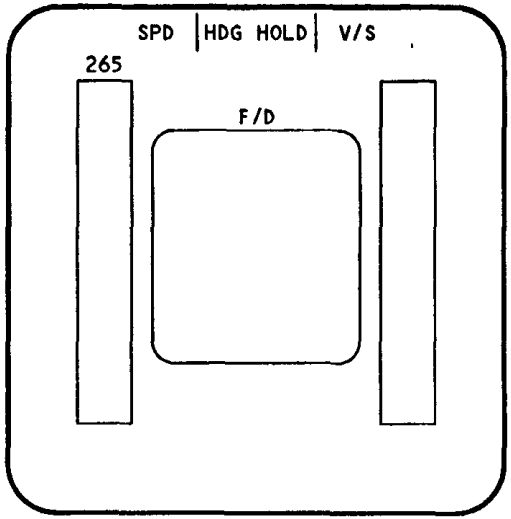
In the SPD mode, the autothrottle moves the throttles to control the airplane speed to the MCP selected speed. Thrust limit, speed limit and flap speed limit protection is provided.



MCP



MAIN EICAS



PFD

SITUATION: THE MCP SPD BUTTON HAS BEEN PUSHED.

MCP:

- THE SPD BUTTON LIGHTS
- THE DESIRED AIRPLANE SPEED IS SET IN THE MCP IAS/MACH DISPLAY

MAIN EICAS:

- THE THRUST LIMIT MODE DOES NOT CHANGE
- THE CURSOR (GREEN) INDICATES THE THRUST LIMIT

PFD:

- THE A/T MODE CHANGES TO SPD
- THE A/T CONTROLS THE AIRPLANE TO THE MCP SPEED

Figure 98 ATHR OPERATION - SPEED

ATHR OPERATION - FLIGHT LEVEL CHANGE

Mode Selection

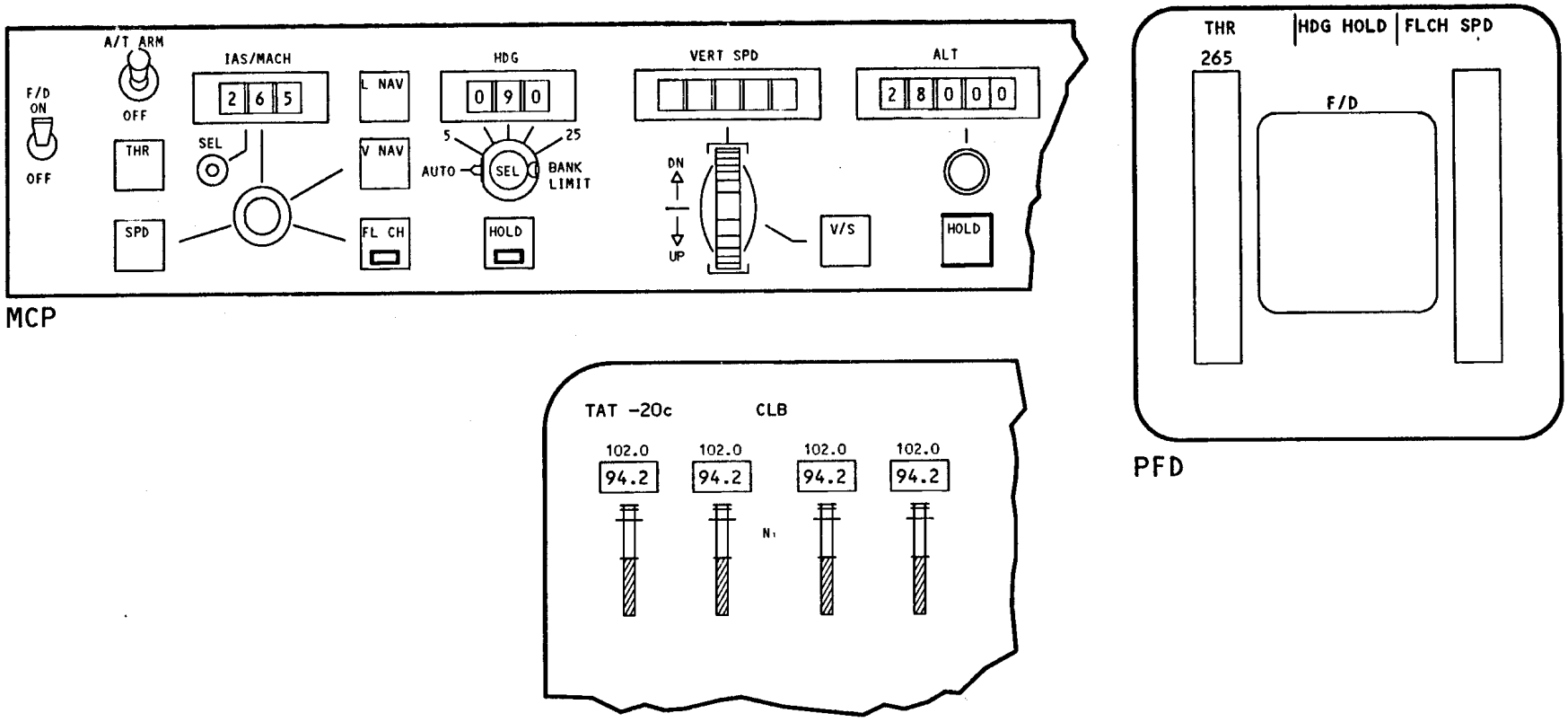
The FMCS operates in the FLCH mode when:

- The autothrottle is armed
- The AFDS engages FLCH

Operation

The FMC uses the difference between present altitude and the MCP altitude to calculate a vertical speed to capture the MCP altitude. The MCP synchronizes to the current airspeed when the FLCH mode is requested. The autothrottle control laws command a thrust which produces a vertical speed to complete the altitude change in 125 seconds. The thrust is limited to the thrust limit mode.

During the FLCH mode, if an override occurs, the autothrottle mode changes to throttle hold. HOLD shows as the mode on the PFD. This results from an eight degree difference between the throttle position and the commanded position. This difference can be caused by a pilot override or it occurs when the throttles reach the aft mechanical stops during a FLCH descent with a large altitude change.



SITUATION: AN ALTITUDE OTHER THAN CURRENT AIRPLANE ALTITUDE IS ENTERED ON THE MCP, THE FLCH BUTTON ON THE MCP IS PUSHED.

MCP:

- FLCH BUTTON LIGHTS

MAIN EICAS:

- THRUST LIMIT MODE IS CLB

PFD:

- THE A/T MODE CHANGES TO THR
- THE A/T CONTROLS VERTICAL SPEED

Figure 99 ATHR OPERATION - FLIGHT LEVEL CHANGE

AUTOTHROTTLE OPERATION THRUST

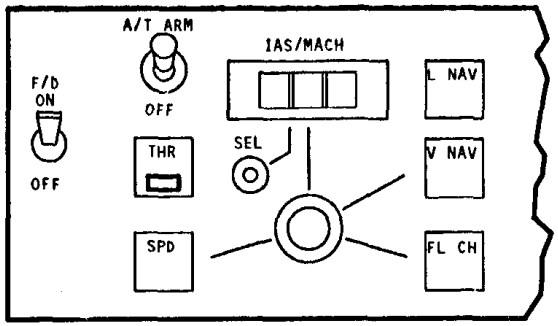
Mode Selection

The thrust reference (THR REF) mode is engaged when these conditions are in effect:

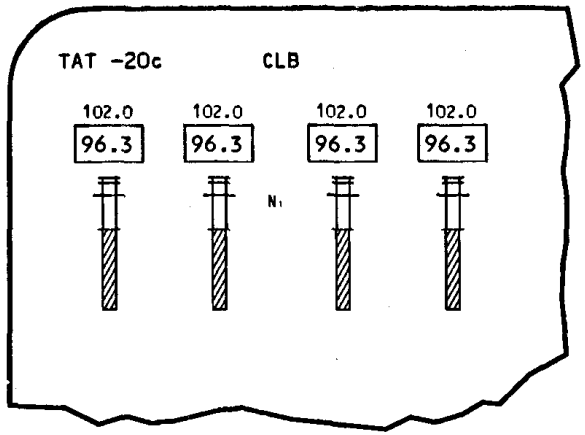
- Autothrottle armed
- Airplane above 400 feet AGL
- Not TO THR LIM
- FLCH mode not active
- VNAV mode not active
- Not GA THR LIM
- Select THR mode on MCP

Operation

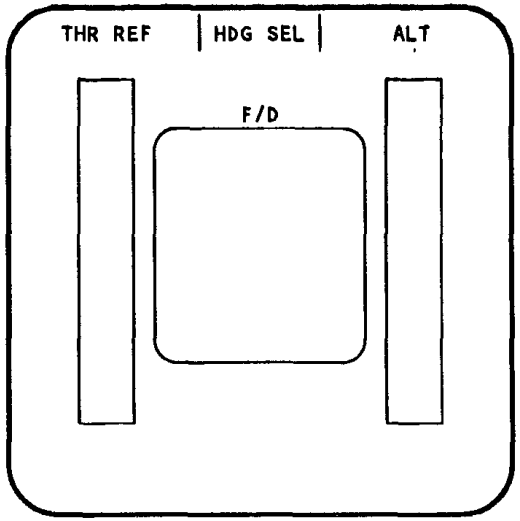
In the THR REF autothrottle mode, the throttles move to control the limit speed (either Vmo/Mmo or flap). Thrust limit protection is provided. It may seem that this statement is not correct and that the throttles should control to the thrust limit, with limit speed protection. If this were the situation and the limit speed were close to present speed, the airplane could go over the limit speed before the thrust were reduced. At the least, this situation would cause large throttle changes.



MCP



MAIN EICAS



PFD

SITUATION: THE MCP THR BUTTON HAS BEEN PUSHED.

MCP:

- WHEN THE THR BUTTON IS PUSHED, IT LIGHTS

MAIN EICAS:

- THE THRUST LIMIT MODE CHANGES TO CLB

PFD:

- THE A/T MODE CHANGES TO THR REF
- THE A/T CONTROLS THE AIRPLANE TO LIMIT SPEED

Figure 100 AUTOTHROTTLE OPERATION - THRUST

AUTOTHROTTLE OPERATION GO-AROUND

Mode Selection

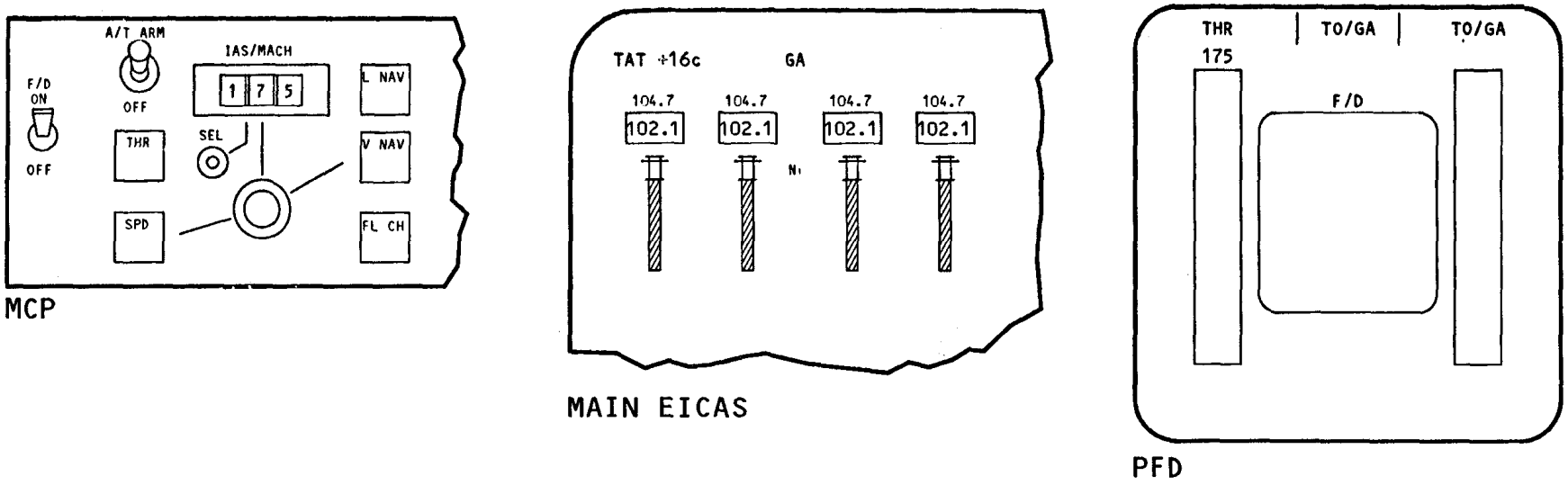
The go-aground mode is engaged when there are these conditions:

- Autothrottle armed
- Airplane in the air
- AFDS glideslope engaged or flaps not zero
- Thrust limit mode not TO

Operation

When the go-around (GA) lever on thrust lever 2 or 3 is pushed, the auto-throttle mode changes to THR. For this mode the autothrottle controls to 2000 FPM vertical speed.

A second push of the GA lever cause the autothrottle mode to change to THR REF. In this mode autothrottle controls to the full GA thrust limit.



SITUATION: DURING APPROACH, THE GA LEVER ON THROTTLE LEVER 2 OR 3 WAS PUSHED.

MCP:

- NO BUTTONS ARE ON

MAIN EICAS:

- DURING THE APPROACH, WHEN THE FLAPS WERE EXTENDED OR THE GLIDE SLOPE CAPTURED, THE THRUST LIMIT MODE CHANGED TO GA. THE CURSOR (GREEN) SHOWS THE LIMIT

PFD:

- IF THE A/P OR F/D WAS ON AT THE FIRST PUSH, THE A/T MODE CHANGES TO THR AND THE A/T CONTROLS TO 2000 FT/MIN V/S
- AT THE SECOND PUSH, THE MODE CHANGES TO THR REF AND THE THROTTLES GO FORWARD TO THE THRUST LIMIT (GA)

Figure 101 AUTOTHROTTLE OPERATION - GO-AROUND

NAV DATA CROSSLOAD PAGE

General

The maintenance pages show maintenance related data that is accessible on the ground. Selection of the MAINT> line select key on the INIT/REF INDEX page causes the MAINTENANCE INDEX page to show. The maintenance pages are:

- Navigation data (NAV DATA) crossload page
- Performance (PERF) factors page
- Inertial reference system (IRS) monitor page
- BITE report

NAV Data Crossload Page

This page is used to transfer the navigation data base of one FMC to the other to save time. This page shows automatically at power-up if the FMCs detect a navigation data base difference.

The function of this page is discussed by the operation of each line.

- (2L) Navigation data base identifier: this line is the same as the identifier shown on the IDENT page.
- (3L) TRANSMIT/RECEIVE: crossload is by selection of key 3L on one CDU followed by 3R on the other CDU, if ARM has been entered on line 6R.
- (4L and 4R): before transfer starts, this line is blank. During transfer, TRANSFER IN PROGRESS shows, and TRANSFER COMPLETE shows at the end of the data cycle. If the cycle is incomplete TRANSFER ABORTED shows.
- (6L) INDEX: this key selects the MAINT INDEX page.
- (6R): type ARM into the scratch pad and push this key. This arms the crossload function. To cancel the arm status go to another CDU page.

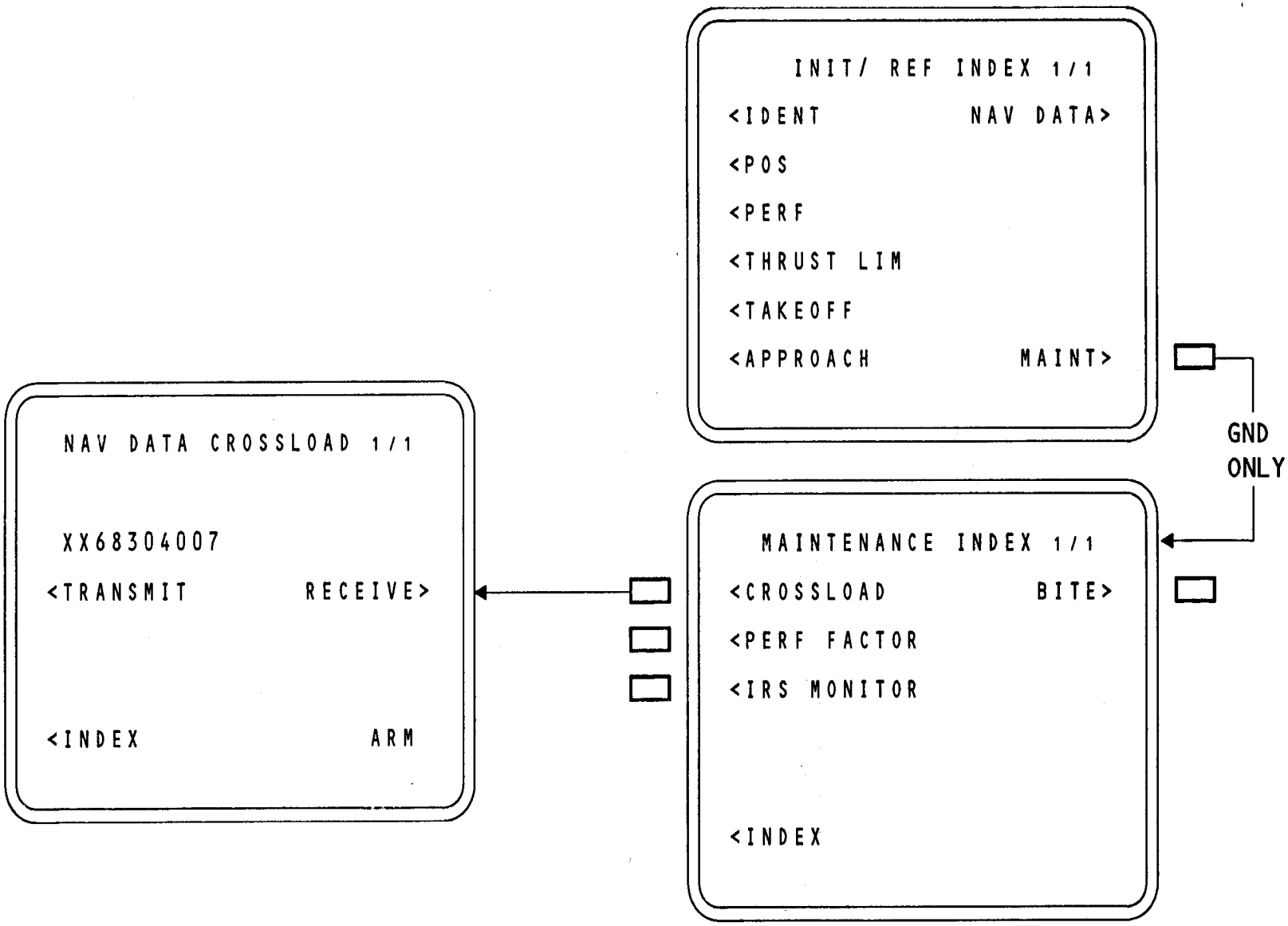


Figure 102 NAV DATA CROSSLOAD PAGE

PERF FACTORS PAGE

Performance Factors Page

Entries on this page modify the performance factors and causes the related value to show on the TAKEOFF REFERENCE page. This occurs at the end of each flight or after a long term power interrupt.

- (1L) PERF CODE: this line shows the binary state of the PERF OPTION CODE hardware program pins which are not active on 747-400.
- (2L) DRAG/F-F (fuel flow): the FMCs use this in the performance calculations to improve the accuracy in its performance predictions. The allowable entry range is -/+ 9.9 Fuel flow requires a slash (/) for entry. The DRAG/F-F factors also show on the IDENT page.
- (3L) TO 1/TO 2: this field shows a manual entry for a fixed derate percentage from 0-30%. To 2 requires a slash (/) for entry. These values also show on the THRUST LIMIT page.
- (4L) MNVR MARGIN: the FMCs use this data for flight envelope and bank limit calculations. Entries range from 1.20 - 1.30.
- (5L) MIN CRZ TIME: the FMCs use the minimum cruise time (minutes) for optimum altitude calculations.
- (6L) INDEX: this key selects the MAINT INDEX.
- (1R) OPTION CODE: this line shows a hexadecimal number which represents the customer's options in software (S/W) Option code disagreement between the FMCs causes the last FMC that powers up (or the nonmaster in a simultaneous power up) to show and lock up on the PERF FACTORS page.
- (2R) R/C CLB: the minimum rate of climb (ft/min) for max altitude calculations at climb speed and maximum climb thrust. The entry range is from 0 - 500.
- (3R) THR/CRZ: this line shows the minimum rate of climb margin (ft/min) for maximum altitude calculations at cruise speed and maximum climb at cruise thrust. Entry ranges are CLB or CRZ / 0500. Default entry for thrust is the last entry or CLB if no previous entry. Default entry for rate of climb is 100 with no previous entry.
- (4R) THR RED: this line shows the altitude or flap setting when the thrust limit automatically changes from TO to the preselected CLB thrust limit mode.
- (5R) ACCEL HT: this line shows the flap retraction height when acceleration begins in V-NAV for flap retraction. The inner field shows engine out altitude. Entry range is from 400-9999.
- (6R) ARM: type ARM into the scratch pad and push this line select key. This arms the PERF FACTORS page to modify all values except the H/W and S/W option codes.

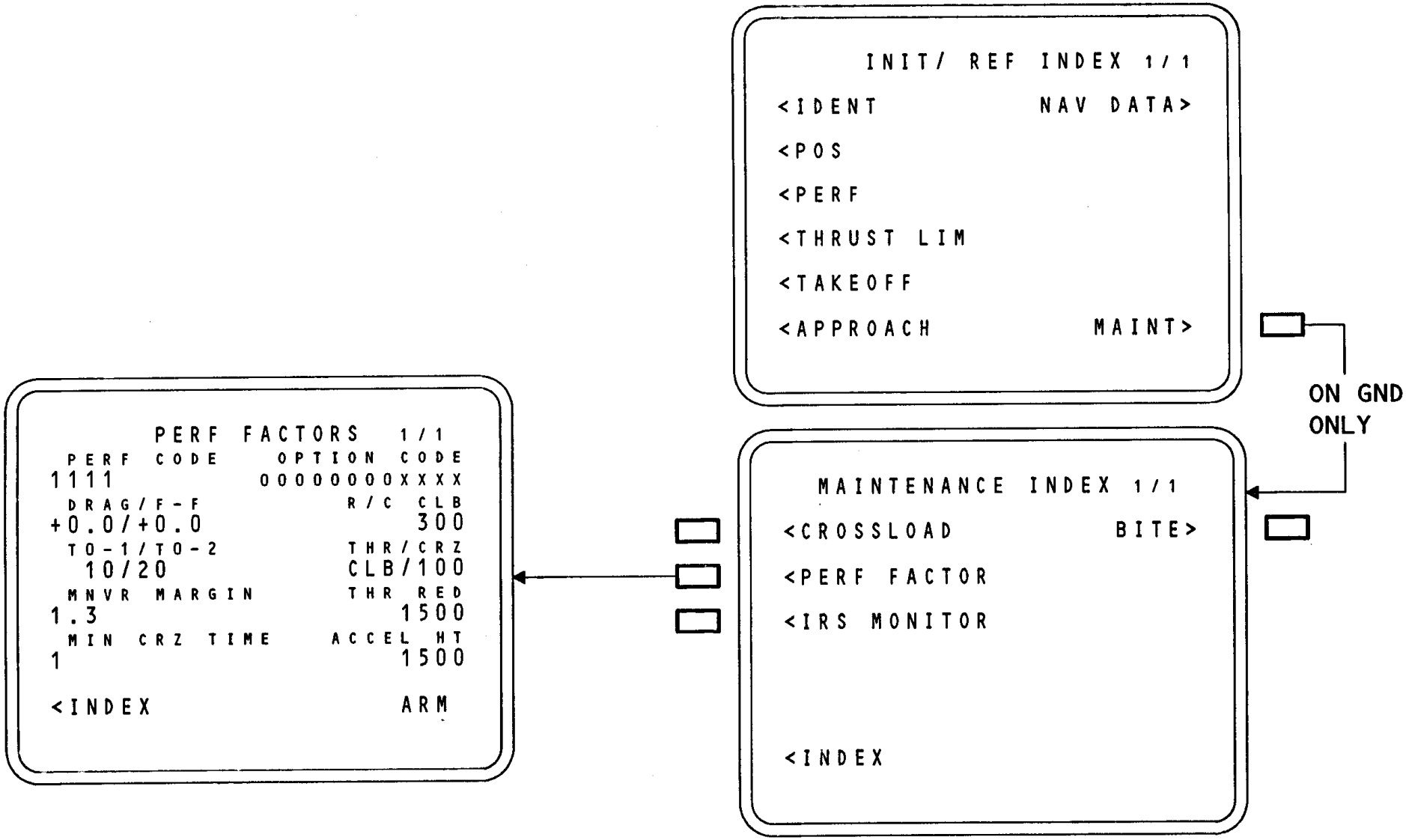


Figure 103 PERF FACTORS PAGE

IRS MONITOR PAGE

IRS Monitor Page

The IRS monitor page shows an estimate of position error rate for the IRUs at the end of each flight. The maintenance crews can use this data to help determine if an IRU has excessive position drift. Position error rate is calculated by dividing distance from the FMC position to the IRS position by the total flight time. This value is calculated at flight completion and is displayed approximately 45 seconds after all engines shut down. These values clear when in the air, or if power is cycled.

(6L): this line selects the MAINT INDEX page.

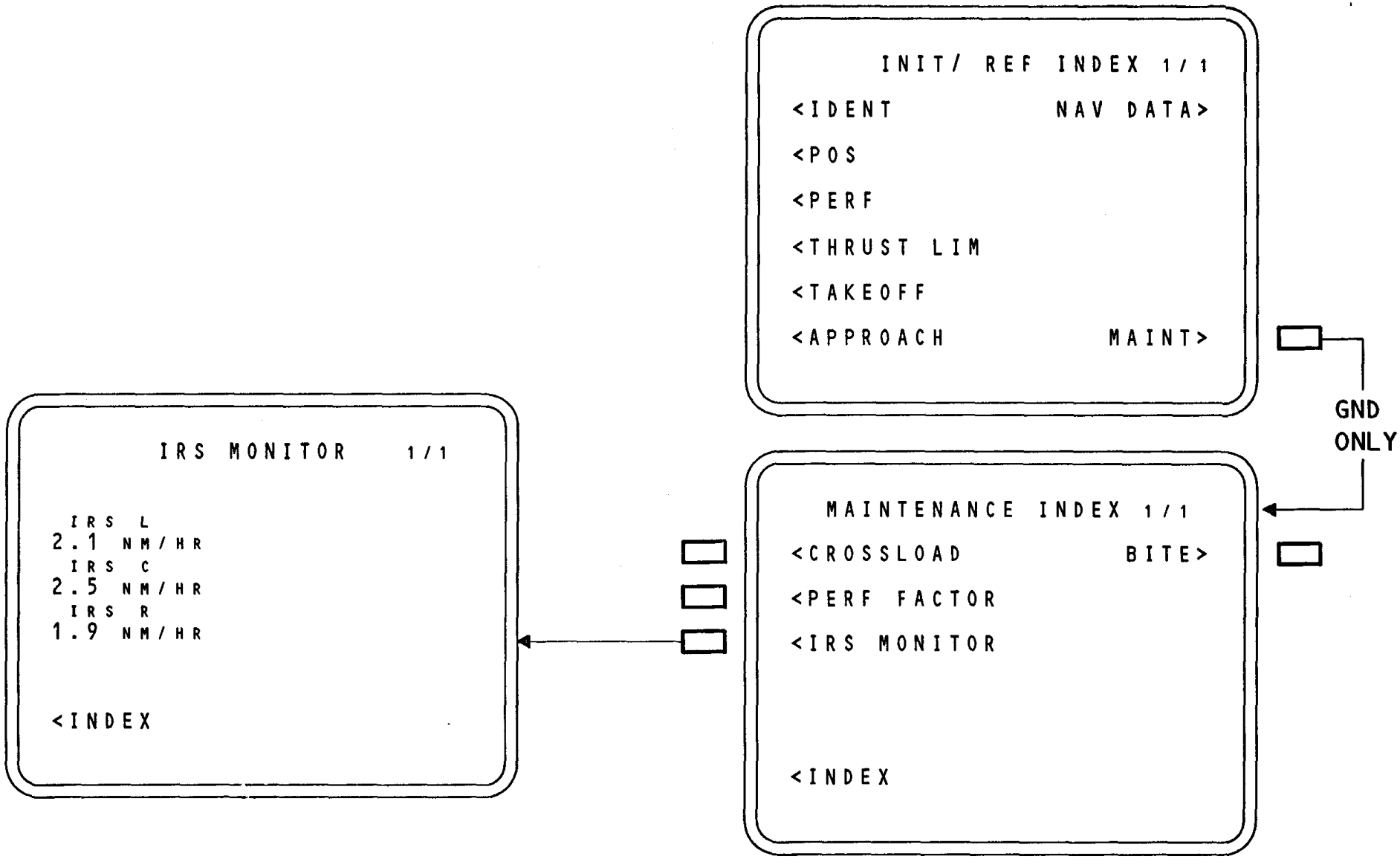


Figure 104 IRS MONITOR PAGE

BITE REPORT PAGE

Push the line select key next to BITE > on the MAINTENANCE INDEX to show the BITE REPORT page. The BITE REPORT page allows the FMC BITE history to be transferred to the data loader. This data may be used by the manufacturer to analyze faults in software and hardware. A pre-formatted disk with the proper file is required to perform this task.

The prompt DATA LOADER shows when the page is selected. The caret symbol shows only when these conditions are true:

- The airplane is on the ground.
- The data loader selector switch is set to the appropriate FMC.
- The data loader is powered (disk drive door opened) and the proper disk is inserted into the disk drive.

Push line select key 1L to start the download. During the transfer process, the CDU is locked on the BITE REPORT page. During the transfer, DOWNLOAD IN PROGRESS shows on the CDU. DOWNLOAD COMPLETE shows at the end of the transfer. DOWNLOAD ABORTED shows if the data loader does not respond within 30 seconds.

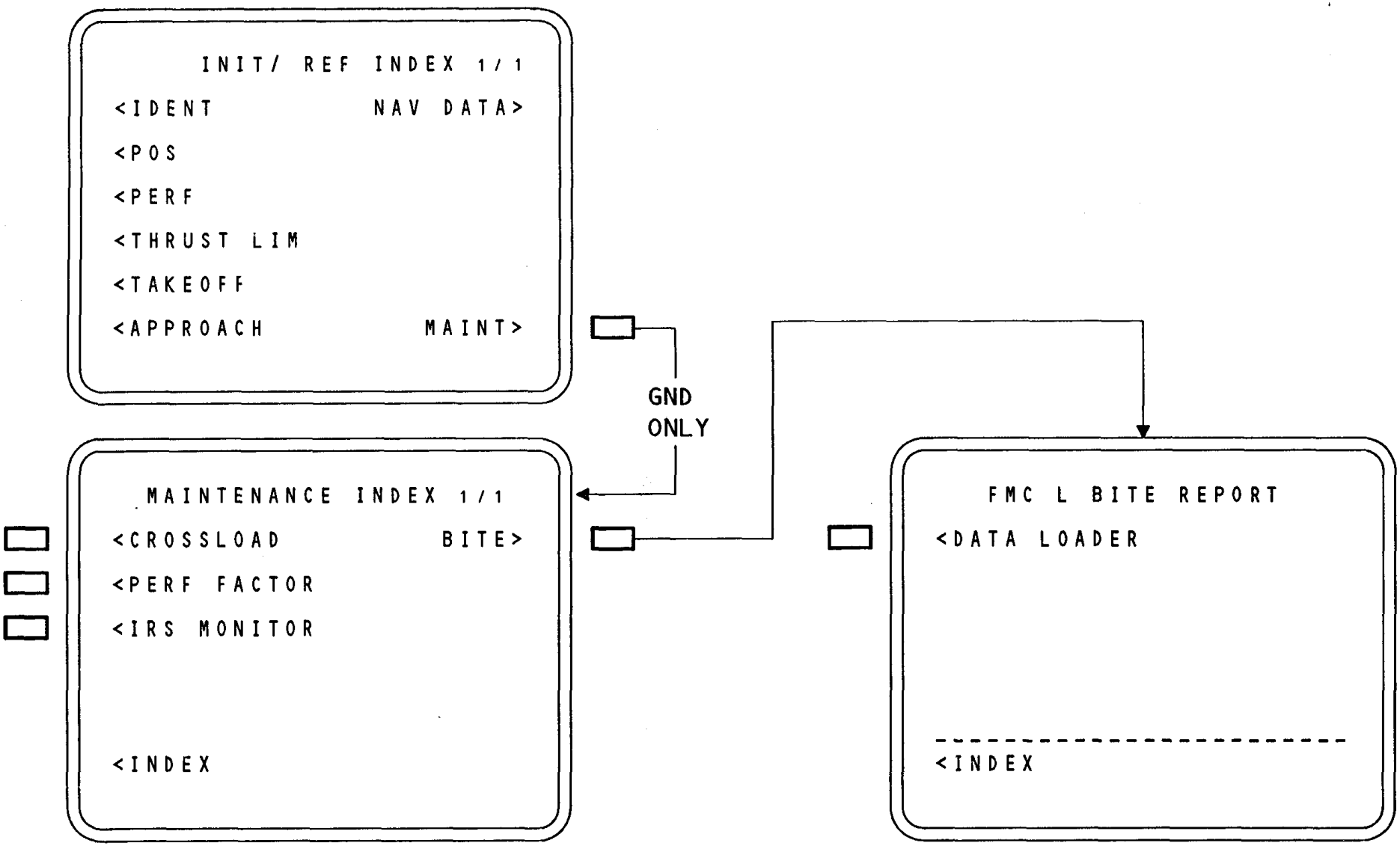


Figure 105 BITE REPORT PAGE

BITE AND FAILURE DISPLAYS

General

The FMCs are self monitoring with BITE (hardware and software monitors). The FMC front panel FAIL LED comes on when BIT'" detects a failure. Use the CMC to determine the cause of this failure. Perform the FMC front panel tests when equipment is changed or to verify component failures.

FMC Front Panel Test

The FMC INITIATE TEST/LAMP TEST switch on the front panel is a momentary push button switch and starts two tests when pushed:

- LAMP TEST: when pushed, both the FAIL (red) and IN PROCESS (yellow) LEDs come on. The FAIL LED stays on while the switch is held. When released, the FAIL light goes out and the IN PROCESS light remains on until test conclusion (15 seconds).
- SYSTEM TEST: a power-up BITE routine is started when the switch is pushed. The IN PROCESS LED stays on for the BITE duration of 15 seconds.The FAIL LED comes on at the end of the test when an internal or servo failure is detected.

  At test completion the FMC normal functions are restarted.

FMC Power-Up BITE

When power is first applied to the FMC, the FMC power-up BITE occurs. Power-up BITE can also occur for these other reasons:

- After an FMC system test
- After a long term power interrupt
- When BITE requests it
- FLT MGNT CMPTR CMC test

CMC Test

The CMC is used to test the FMC and autothrottle servo. In addition to the power-up BITE test, the CMC test allows the FMC to perform more thorough test routines. When a failure occurs the CDU shows FAIL>. Select the GND TEST MSG page(s) to determine if the failure is an FMC and/or an interface fault.

Bite Test Displays

The IDS shows test and failure indications on these displays:

- EICAS shows the AUTOTHROT DISC message for the duration of the test.
- EFIS shows normal PFD and ND data and test data when an FMC front panel test or CMC test is in progress. The PFD shows the word TEST, in green, in the autothrottle flight mode annunciator sector. The ND shows FMC 1/0 TEST OK in green above the FMC position during the test.
- The master warning lights come on and a siren aural warning sounds for a short time during the BITE test.

FMC Failure Displays

These are the displays in the flight deck that show FMC fault indications:

- EICAS shows status and advisory messages, FMC LEFT or FMC RIGHT.

EICAS shows an AUTOTHROTTLE DISC caution message (if A/T is engaged).

EFIS shows MAP AND VTK flags.

The offside CDU shows the message RESYNCHING, OTHER FMC or SINGLE FMC OPERATION in the scratchpad. The offside CDU MSG light comes on right away. The FAIL light comes on after 30 seconds during the test. The onside CDU FAIL light stays on when the test fails.

EFIS shows LNAV and VNAV mode failure displays (if LNAV and VNAV are operate modes).

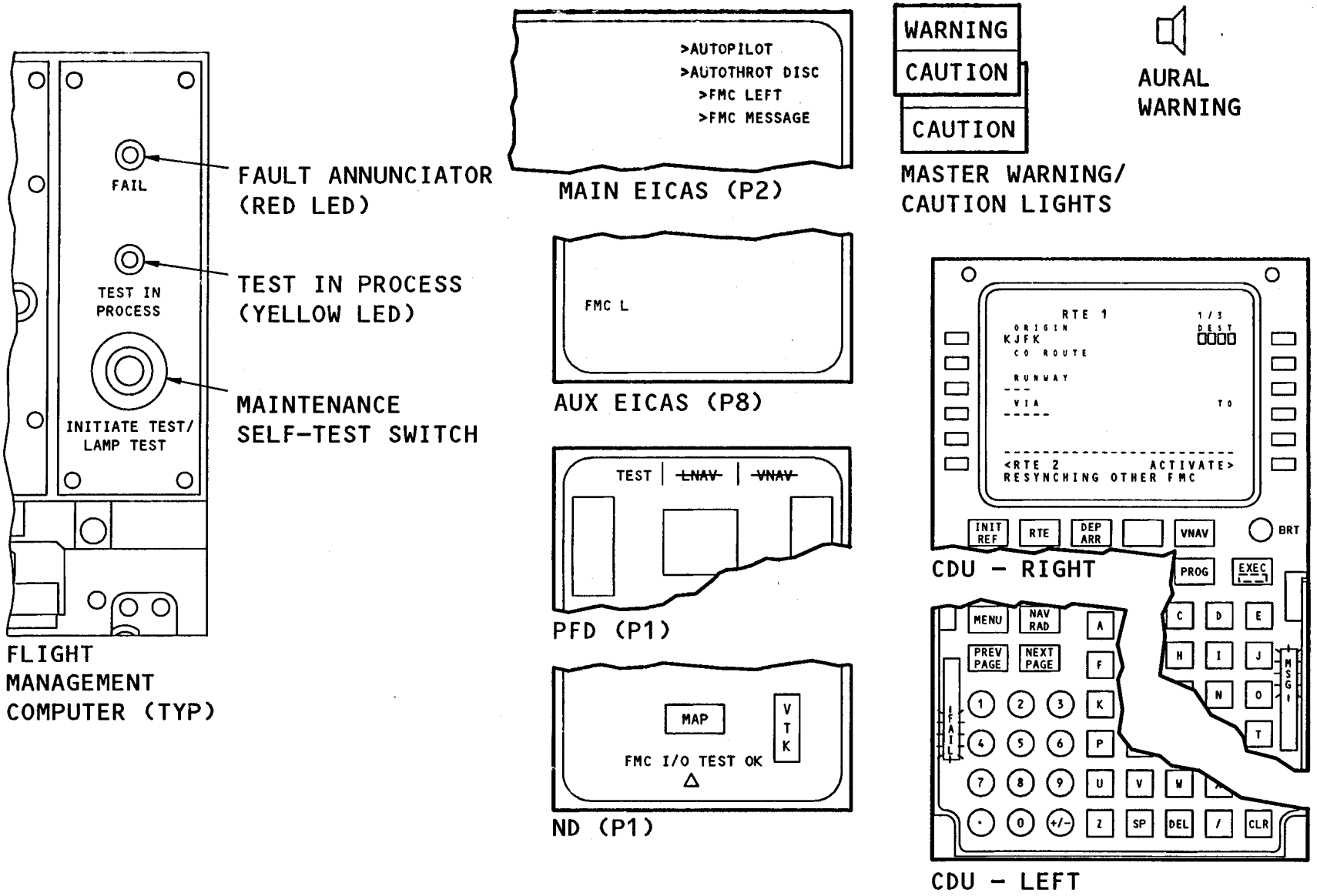


Figure 106 BITE AND FAILURE DISPLAYS

FMC GROUND TESTS (SH 1)

General

Two tests of the FMC can be done from the CMC. These are:

- Flight management computer
- Flight management computer servo loop

These tests are inhibited if:

- The engines are not shut off.
- The autothrottle servo is engaged.
- The airplane is in the air.
- The master FMC is not tested.
- The A/T ARM switch is off.

When CMC on the MENU page is selected, it shows the CMC MENU page. When GROUND TESTS is selected, the GROUND TESTS MENU page shows. When 34 FLIGHT MANAGEMENT is selected GROUND TESTS MENU page 1/1 shows.

Flight Management Computer Ground Test

All LRUs that have interface with the FMC must operate correctly for this to pass. IDS and CDU displays for test results are the same as described for FMC system test.

An autothrottle servo communication (FMC system test) and power up are then started. Some throttle motion may occur in the communication test. The CMC shows test pass/fail data after 45 seconds from the results of the communication test, the FMC BITE, and LRU status.

SERVO LOOP Test

This test causes large throttle movements and includes part of the previous test. The throttles move aft to the idle position then forward for 5 seconds. Aft throttle travel occurs again for 5 seconds to conclude the test. The SERVO LOOP test passes if throttle rate is between 6-10 degrees per second.

FMC - ENABLE Page

The FMC TO ENABLE TEST page shows the FMC INHIBITED for three conditions:

- The FMC is not the master as defined by the master switch on P2.
- Any engine in the run condition (RPM).
- Airplane in the air (AIR/GND logic).

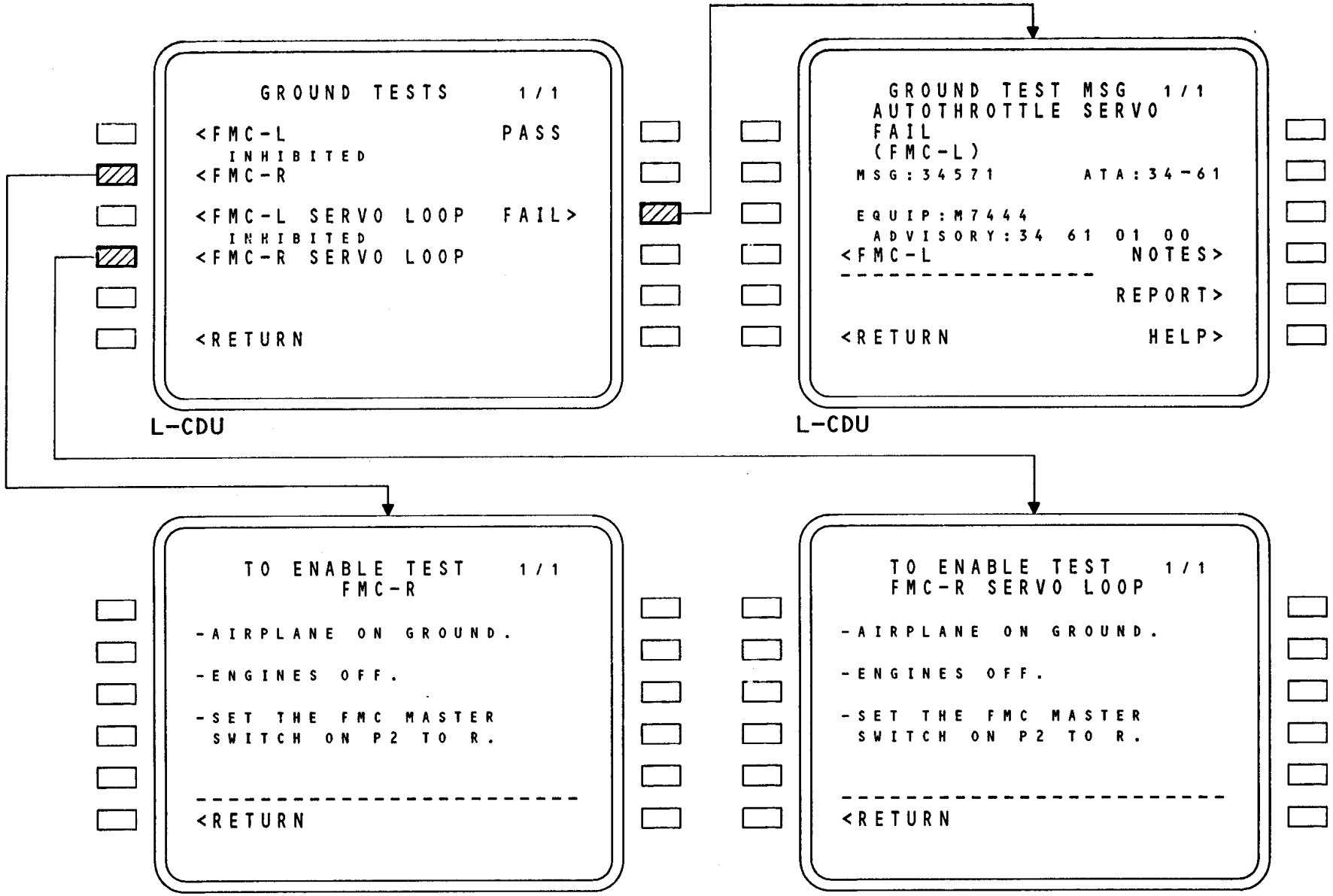


Figure 107 FMC GROUND TESTS (SH 1)

FMC GROUND TESTS (SH 2)

General

Push the line select key next to the desired test to start the ground test. If the test is not inhibited, a test preconditions page shows. The operator must verify the airplane meets these test preconditions for the test to work properly.

Operation

Push the line select key next to CONFIRM to begin the ground test. An IN PROGRESS screen shows for approximately 45 seconds. At test completion, the ground tests page shows with the test results. If FAIL> shows, push the line select key to show the ground test message page.

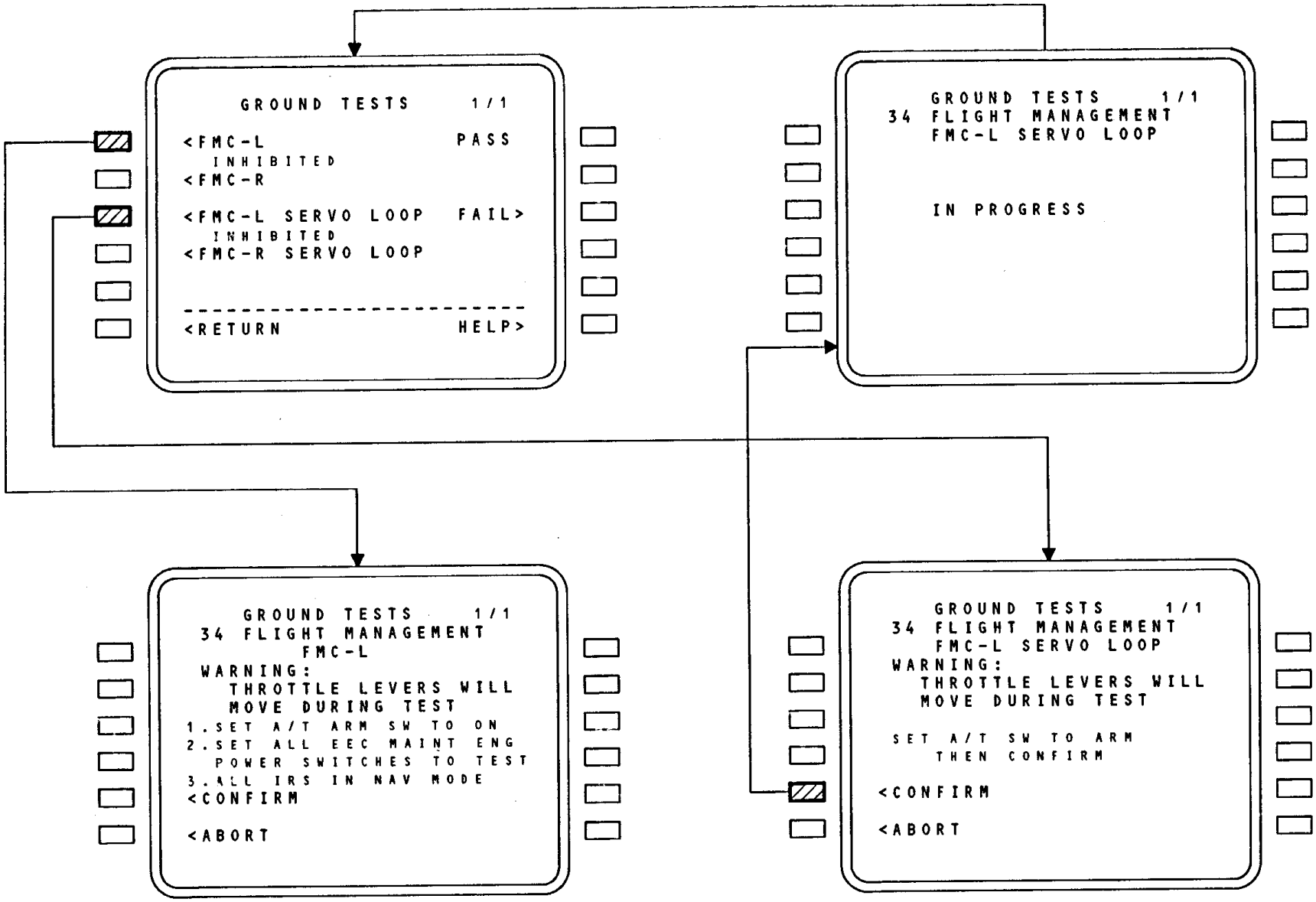


Figure 108 FMC GROUND TESTS (SH 2)

MODE CONTROL PANEL GROUND TEST (SH 3)

General

A test of the AFCS mode control panel is done to examine the FMC interface with the MCP and the operation of FMC functions on the MCP. A maintenance person must do many steps during this test. Only a few of the steps are FMC functions.

When the key next to 22 AUTOPILOT FLT DIR is pushed, the AUTOPILOT FLT DIR ground test menu shows. The AUTOPILOT FLT DIR tests can not be done if the airplane is in the air or if an autopilot servo is engaged. The key next to MODE CONTL PANEL is pushed to start the MCP test.

Mode Control Panel Test

During the test, the MCP thrust and speed select switches and the autothrottle arm switch are tested along with other AFDS functions. Pass/fail data is sent to the CMC and shows on the CDU.

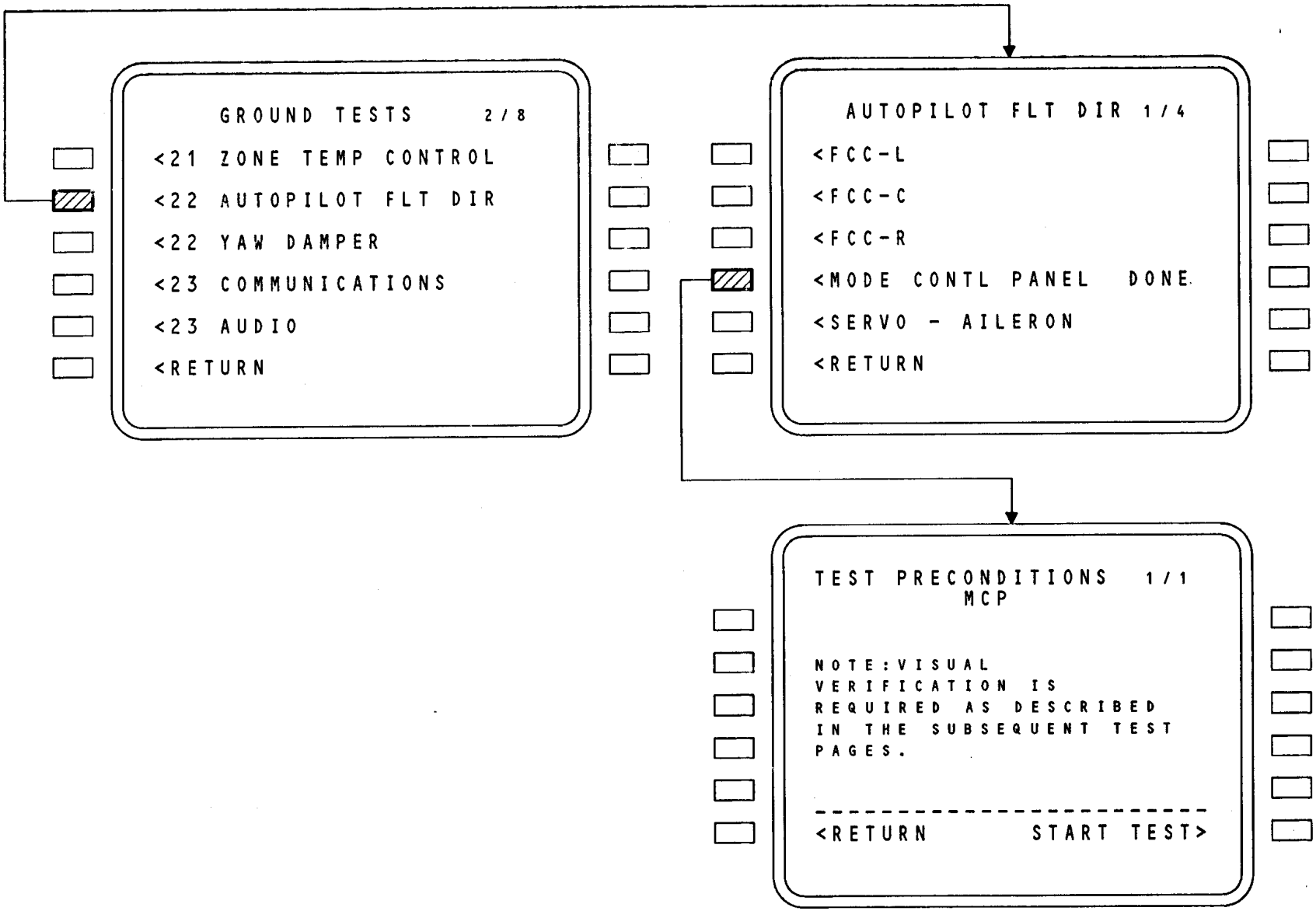


Figure 109 MODE CONTROL PANEL GROUND TEST (SH 3)

CDU BITE AND FAULT MONITOR

General

CDU BITE operates almost the same as FMC BITE. There is a power up part and a continuous monitor part. A difference is that detected failures are stored in volatile RAM for CDU BITE instead of in nonvolatile memory for FMC BITE.

Power-Up BITE Tests

Power-up BITE is a group of tests that are done when the CDU is turned on or if BITE requests a restart. The tests are done on memory, processors, transmitters and computation functions.

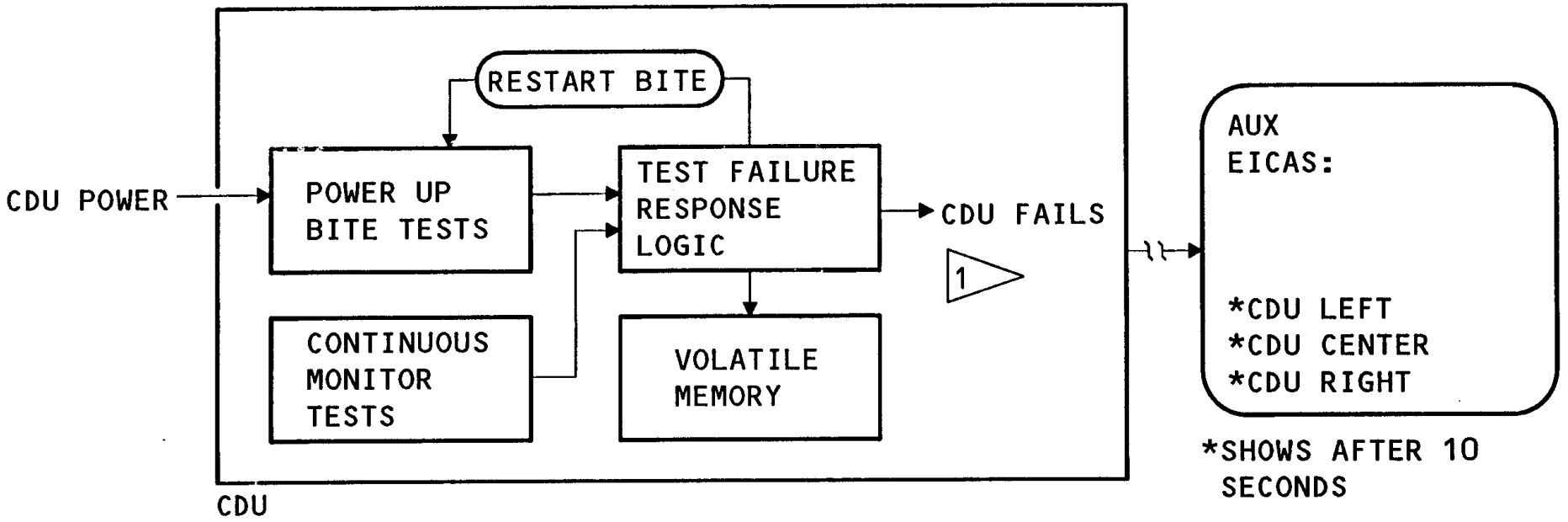
Continuous Monitor Tests

Monitor tests are done during normal CDU operation. These tests do not affect normal operation. These tests include some of the power-up BITE tests. They also include hardware tests and a heartbeat monitor.

Test Failure Response Logic

Failures detected by power-up BITE and by continuous monitor cause a request to rerun BITE, or cause the CDU to fail if repeated failures have occurred. Test results are stored in RAM (volatile memory) for shop inspection. CDU failure status is shown on the auxilliary EICAS if the CDU is selected on the NAV source select switch.

CDU test failures cause the CDU screen to go blank.



1 CDU FAILURE RESULTS IN A BLANK CDU SCREEN

Figure 110 CDU BITE AND FAULT MONITOR

DATA LOADER OPERATION

General

The airborne data loader (ADL) installs software into loadable LRUs. The FMC navigation data base (NDB) and the operational program are both loaded with the ADL. The FMC shuts off it's output busses during a data load, which in the flight deck appears as FMC failure indications.

FMC Data Load Procedure (NDB)

These are the steps in the data load procedure:

- Ensure the circuit breakers for FMCs, CDUs (P7) and data base loader (P6) are closed.
- Open the circuit breaker for the FMC that is no'- to be loaded
- Select the FMC that is to be loaded with the ADL selector switch
- Insert the proper diskette into the ADL.
- Remove the diskette and insert the second diskette (for NDB load) when indicated in the ADL alphanumeric display.
- Monitor the ADL alphanumeric display for a transfer complete message (total load time is approximately 20 minutes).
- Remove the diskette from the ADL Select NORMAL with the ADL selector switch
- Close the circuit breaker for the FMC that was not to be loaded
- Verify the data base was properly loaded by viewing the dates of the active and inactive NAV data on the IDENT page of the CDU
- Load the other FMC using either the crossload or the above procedure

NOTE: FOR CROSSLOAD PROCEDURE, ALIGN THE IRUS TO THE NAV MODE OR SELECT THE TRANSMITTING FMC AS THE MASTER.

Do not stop the crossload procedure once it is started. If stopped, the receiving FMC will latch on the crossload page. The crossload procedure must be repeated to unlatch the display of the crossload pages.

Data Load Indications

These onside flight deck display indications occur when the ADL selector switch selects the FMC to be loaded:

- The FAIL Light on the CDU comes on
- The MENU page shows on the CDU but the FMC prompt (<) and <ACT> (if it was present) do not show
- The FMC LEFT or FMC RIGHT advisory messages show on EICAS after 30 seconds
- The MAP and VTK flags show on ND after 30 seconds
- The NO V SPD and SPD LIM flags show on the PFD

These ADL indications may occur during a data load:

- DOWNLOADING shows during the loading process
- INSERT DISK #n indicates a disk change is required in a multiple disk loading sequence
- WRONG DISK SEQ # shows when a disk is inserted out of it's loading sequence
- DNLD COMPLETE shows for a successful load
- TRANSFER FAIL shows when four attempts to transfer data to/from the target LRU have all failed (communication failure)
- R/W FAIL shows when the loader is unable to access disk data (bad disk or misaligned head in the ADL)
- The ADL FAIL light comes on when the ADL system test fails

FMC Data Load Procedure (OP PROGRAM)

The procedure to load the FMC operational program is similar to the nav data base loading procedure except for:

- Each FMC must be loaded with the ADL
- Load time is approximately 10 minutes
- Verify the operational program was properly loaded by viewing line 4L on the IDENT page of the CDU.

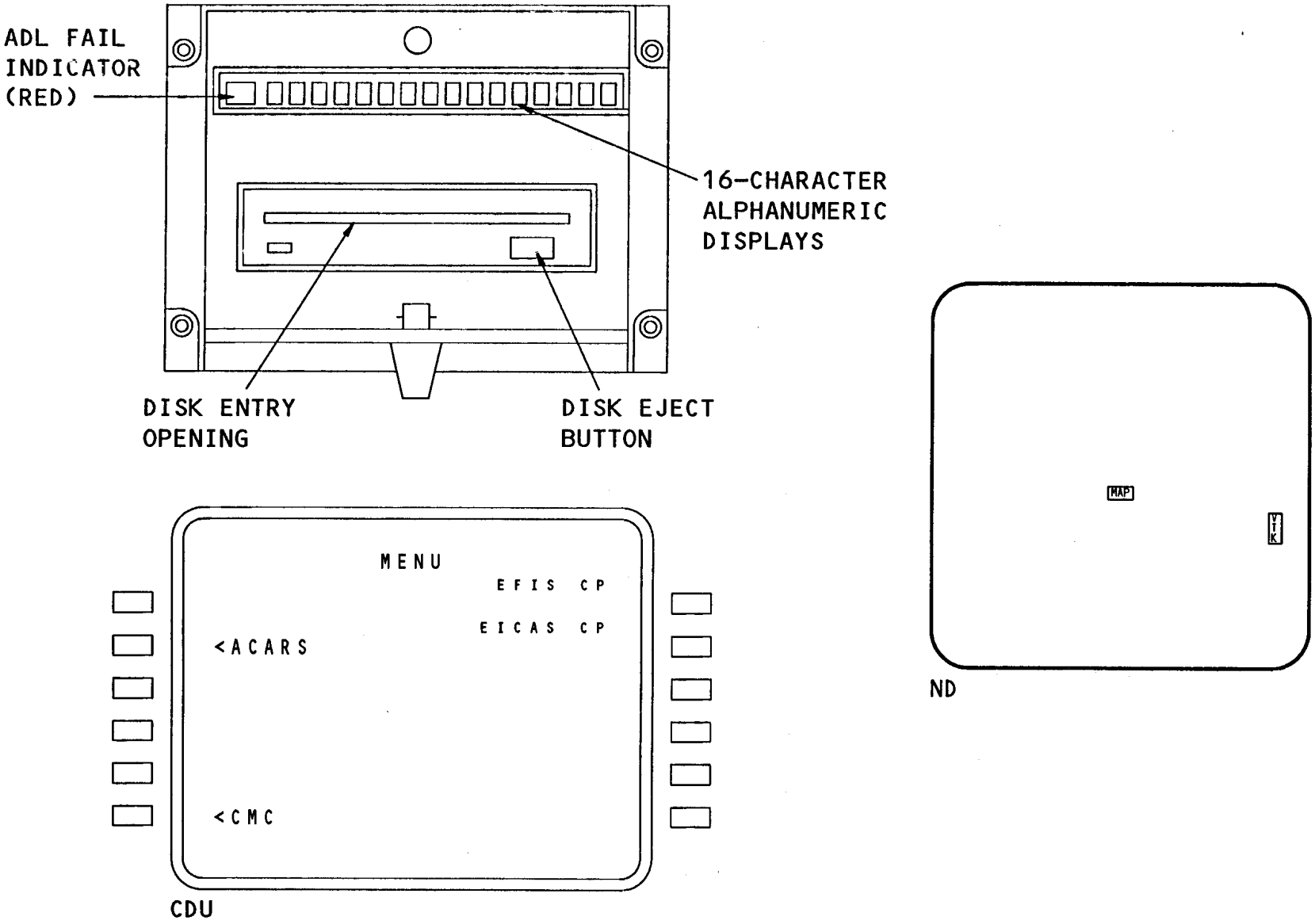


Figure 111 DATA LOADER OPERATION

FLIGHT DECK EFFECTS

General

This is a summary of all maintenance related flight deck effects for this system.

Flight Deck Effects

These EICAS messages may show when the FMC detects a non-normal condition:

- >PILOT RESPONSE (warning/advisory>: this shows when the flight crew activity monitor is tripped.
- >AUTOTHROT DISC (caution): this shows when the master FMC detects a manual or automatic autothrottle disengage (except when the autothrottle disengages on landing with thrust reverser applied).
- >UNABLE RNP (caution): 'this shows when the ANP becomes greater than RNP during approach.
- >FMC LEFT/RIGHT (advisory): this shows after 30 seconds when a FMC detects an internal failure.

>FMC MESSAGE (advisory): this shows when an alert message is in the CDU scratch pad.

>UNABLE RNP (advisory): this shows when the ANP becomes greater than the RNP, not during approach.

FMC LEFT/RIGHT (status): this shows after 60 seconds with an FMC failure and is latched for maintenance action.

CDU LEFT/CENTER/RIGHT (status): this shows a CDU latched fault after 10 seconds.

Other Fault Indications

These EFIS displays show when the FMC detects a non-normal condition:

- The PFD shows a blank A/T flight mode annunciator (FMA).
- The ND shows MAP and VTK flags

The CDU FAIL light comes on when the master or NAV switch selected FMC fails. CDU scratch pad messages can also indicate faults in the FMCS. Refer to Appendix C for a list of CDU scratch pad messages.

FLIGHT DECK EFFECT	TYPE	DESCRIPTION
>PILOT RESPONSE	WARNING	NO MCDU, EFIS/EICAS CONTROL PANEL, MCP ACTIVITY AND NO HF/VHF FLIGHT DECK TRANSMISSION DETECTED FOR 25 MINUTES, OR IN COUPLED LNAV/VNAV CRUISE OPERATION, NAV INTEGRITY IS SUSPECT OF EXCESSIVE DEV FROM LAT FLT PLAN, CRUISE ALT, PREDICTED THRUST OR TARGET A/S IS DETECTED, OR REACHING TOD AND NO CREW ACTIVITY IN LAST 10 MINUTES
>AUTOTHROT DISC	CAUTION	MANUAL OR AUTOMATIC DISENGAGEMENT OF AUTOTHROTTLE
>UNABLE RNP	CAUTION	ANP BECOMES GREATER THAN RNP DURING APPROACH
>FMC X 1	ADVISORY	A FLIGHT MANAGEMENT COMPUTER (FMC) FAILS TO TRANSMIT FOR 30 SECONDS OR MORE
>FMC MESSAGE	ADVISORY	AN FMC CAUSES ONE OF SEVERAL MESSAGES ON THE CDU
>UNABLE RNP	ADVISORY	ANP BECOMES GREATER THAN RNP, NOT DURING AN APPROACH
>PILOT RESPONSE	ADVISORY	NO MCDU, EFIS/EICAS CONTROL PANEL OR MCP ACTIVITY AND NO HF/VHF FLIGHT DECK TRANSMISSION HAS BEEN DETECTED FOR 20 MINUTES
FMC X	STATUS	AN FMC FAULT FOR 60 SECONDS OR MORE
CDU Y 2	STATUS	A CDU FAULT FOR 10 SECONDS OR MORE

1 X = LEFT OR RIGHT 2 Y = LEFT, CENTER OR RIGHT

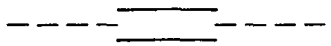
Figure 112 FLIGHT DECK EFFECTS

APPENDIX – A

SYMBOL	COLOR	PARAMETER
———	M (MAGENTA)	VECTOR – ACTIVE FLIGHT PLAN
- - - - - - -	W (WHITE)	VECTOR – PROVISIONAL FLIGHT PLAN
	G (GREEN)	TUNED STATION OR SRP RADIAL AND ID
– – – –	C (CYAN)	VECTOR – INACTIVE FLIGHT PLAN
— — —	M	OFFSET PATH AND ID
	C	SYMBOL – VORTAC + ID
	G	SYMBOL – TUNED VORTAC + ID
	C	SYMBOL – VOR + ID
	G	SYMBOL – TUNED VOR + ID
	C	SYMBOL – DME/TACAN + ID
	G	SYMBOL – TUNED DME/TACAN + ID
	W	SYMBOL – WAYPOINT + ID
	M	SYMBOL – ACTIVE WAYPOINT + ID + DATA
	C	SYMBOL – AIRPORT + ID
	C	SYMBOL – ORIGIN/DESTINATION AIRPORT + ID
	C	SYMBOL – GEOGRAPHIC REF POINT (GRP) + ID
	G	SYMBOL – ALTITUDE PROFILE POINT + ID
	W	SYMBOL – COND WAYPOINT + ID + ROUTE DATA
	M	SYMBOL – ACTIVE COND W/P + ID + ROUTE DATA
	G	SYMBOL – SELECTED REF POINT (SRP)
	C	SYMBOL – NONDIRECTIONAL BEACON + ID
	G	SYMBOL – SRP DISTANCE + ID

Figure 113 FMCS - NAVIGATION DISPLAY DATA - 1

APPENDIX - A

SYMBOL	COLOR	PARAMETER
	W	SYMBOL - RUNWAY + ID + CENTERLINE
	W	SYMBOL - AIRPORT + RUNWAY + ID
	W	SYMBOL - MARKER BEACON + ID
	*	SYMBOL - HOLDING PATTERN - RIGHT
	*	SYMBOL - HOLDING PATTERN - LEFT
	*	SYMBOL - PROCEDURE TURN - RIGHT
	*	SYMBOL - PROCEDURE TURN - LEFT

* HOLDING PATTERN AND PROCEDURE TURN COLOR:

TYPE	COLOR
ACTIVE	M - MAGENTA
INACTIVE	C - CYAN
PROVISIONAL	W - WHITE

Figure 114 NAVIGATION DISPLAY DATA - 2

APPENDIX - B

NUMBER OF MANUAL, ROUTE OR PROCEDURE (M,R,P) STATIONS TUNED	NUMBER OF DME PAIRS AVAILABLE	DME CHANNELS FOR POSITION UPDATE	DME CHANNELS FOR DISPLAY 1
0	2	1 & 2 (3 & 4 HAVE SECOND BEST PAIR)	1 FROM L DME 2 FROM R DME
	1	1 & 2 (3 & 4 BOTH HAVE CLOSEST VOR/DME)	1 FROM L DME 2 FROM R DME
	0	1 (VOR/DME)	1 FROM L DME 1 FROM R DME
1 (LEFT VOR)	2	1 & 2 (4 PAIRED WITH M,R,P FOR BEST GEOMETRY)	3 FROM L DME 4 FROM R DME
	1	1 & 2 (IF DME PAIR DOES NOT HAVE M,R,P) 3 & 4 (IF DME PAIR HAS M,R,P)	3 FROM L DME 4 FROM R DME
	0	3 (VOR/DME)	3 FROM L DME 3 FROM R DME
2	ANY (DOES NOT INVOLVE M,R,P)	1 & 2	3 FROM L DME 4 FROM R DME
	ANY (DOES INVOLVE M,R,P)	1 & 2 (IF NOT SAME AS M,R,P) 3 & 4 (IF SAME AS M,R,P)	3 FROM L DME 4 FROM R DME
	0	3 OR 4 (VOR/DME) (CLOSER OF THE TWO)	3 FROM L DME 4 FROM R DME

1 FMC SETS DISPLAY BIT ON TUNING WORD TO DME

Figure 115 VOR/DME AUTOTUNE AND DISPLAY LOGIC

APPENDIX - C

ALERT MESSAGES	CONDITION
1. END OF ROUTE	PASSING LAST ROUTE LEG TERMINATION
2. END OF OFFSET	5 NM PRIOR TO PASSING LAST OFFSET LEG TERMINATION
3. DISCONTINUITY	PASSING LAST WAYPOINT PRIOR TO A DISCONTINUITY (EXCEPT WHEN THE THE WAYPOINT IS FOLLOWED BY A MANUALLY TERMINATED LEG)
4. NO ACTIVE ROUTE	NO ACTIVE LATERAL ROUTE AND LNAV SELECTED ON MCP
5. PERF/VNAV UNAVAILABLE	INSUFFICIENT PERFORMANCE DATA IN FMC OR AIRCRAFT IS GREATER THAN LIMIT ALTITUDE AND VNAV SELECTED ON MCP
6. FUEL DISAGREE - PROG 2/2	FUEL QUANTITY TOTALIZER AND FMC COMPUTED FUEL QUANTITY DISAGREE BY 9000 POUNDS (4091 KILOGRAMS) FOR MORE THAN 5 MINUTES
7. IRS NAV ONLY	FMC IN IRS ONLY MODE OF NAVIGATION
8. VERIFY POSITION	THE DIFFERENCE BETWEEN GPS OR COMPUTED RADIO POSITION AND FMC POSITION OR THE DIFFERENCE BETWEEN FMC POSITIONS EXCEEDS COMPARISON THRESHOLD
9. NAV INVALID - TUNE XXXX	VOR OR RNAV APPROACH PROCEDURE REQUIRES A SPECIFIC NAVAID BE TUNED AND IT IS EITHER NOT TUNED OR A VALID SIGNAL IS NOT BEING RECEIVED
10. DRAG REQUIRED	DUE TO UNFORECAST TAILWIND, AIRCRAFT IS UNABLE TO MAINTAIN TRACK OF NOMINAL DESCENT PATH AND STAY WITHIN SPEED TOLERANCE

Figure 116 CDU MESSAGES - 1

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
11. THRUST REQUIRED	THE AIRCRAFT IS UNABLE TO MAINTAIN DESIRED DESCENT PATH WITHOUT INCREASING THRUST AND AUTOTHROTTLE IS NOT ENGAGED
12. UNABLE NEXT ALT	NEXT CLIMB RESTRICTION IN CLIMB PROFILE CANNOT BE MET DUE TO UNDERSHOOT
13. RESET MCP ALT	2 MINUTES BEFORE TOP OF DESCENT POINT WITHOUT LOWERING MCP ALTITUDE WINDOW
14. INSUFFICIENT FUEL	A CHANGE IN FLIGHT CONDITION OCCURS OR A CHANGE IN THE ROUTE IS MADE WHICH CAUSES THE CALCULATED FUEL BURN TO EXCEED THE TOTAL FUEL ON BOARD, LESS RESERVES
15. CHECK ALT TGT	VNAV IS SELECTED OR ENGAGED WHEN THE AIRCRAFT IS BETWEEN THE MCP ALTITUDE AND FMC TARGET ALTITUDE. VNAV HOLDS LEVEL FLIGHT
16. DESCENT PATH DELETED	THE LAST ALTITUDE CONSTRAINT REQUIRED TO DEFINE THE DESCENT PROFILE IS DELETED (NOTE: MESSAGE IS DISPLAYED PRIOR TO EXECUTION OF THE MODIFICATION WHICH DELETES THE DESCENT PATH)
17. LIMIT ALT FLXXX	FMC ATTEMPTS TO ATTAIN, OR VNAV IS SELECTED AT, AN ALTITUDE GREATER THAN THE VNAV LIMIT ALTITUDE (NOTE: VNAV LIMIT ALTITUDE IS DEFINED AS THE PEAK OF THE MANEUVER ENVELOPE USING EITHER FAA OR CAA MANEUVER CRITERIA, AS APPLICABLE)

Figure 117 CDU MESSAGES - 2

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
18. RESYNCING OTHER FMC	OFFSIDE FMC HAS JUST POWERED UP OR FAILED COMPARISON DATA CHECK AND IS BEING RESYNCHRONIZED TO ONSIDE FMC
19. RESYNC FAIL - SINGLE FMC	FMCS RESYNCRONIZATION ATTEMPTS ARE UNSUCCESSFUL
20. SINGLE FMC OPERATION	ONSIDE FMC HAS DETERMINED THAT OFFSIDE FMC IS NOT AVAILABLE
21. NAV DATA OUT OF DATE	CLOCK DATE EXCEEDS ACTIVE NAV DATA BASE CALENDAR CYCLE
22. IRS POS/ORIGIN DISAGREE	ANY VALID IRS POSITION DIFFERS FROM ACTIVE ORIGIN AIRPORT BY 6 NMI OR MORE
23. ENTER IRS POSITION	5 SECONDS AFTER LINE SELECTION OF POSITION LAT/LONG INTO CDU FOR IRS INPUT, POSITION DATA OTHER THAN THAT CORRESPONDING TO THE SET IRS POSITION IS RECEIVED BACK FROM ANY IRS. OR AFTER ENTRY INTO 4R OF THE POS INIT PAGE, THE FMC DETECTS AN IRS IN THE ALIGN MODE THAT REQUIRES A POSITION ENTRY. OR IRS MESSAGE LOGIC IS SET
24. CYCLE IRS OFF-NAV	IRS ALIGN PROBLEM REQUIRES CYCLING THE IRS MODE SWITCH
25. PURGE UPDATES POS 2/2	FMC HAS REJECTED MULTIPLE NAVAIDS FOR RADIO UPDATING DUE TO A FAILURE OF DME DISTANCE REASONABLENESS CHECKS
26. RW/ILS FREQ (CRS) ERROR	WHEN THE AIRCRAFT IS WITHIN ILS AUTO TUNING RANGE AND EITHER THE TUNED ILS FREQUENCY (COURSE) DOES NOT MATCH THE FREQUENCY (COURSE) FOR THE ACTIVE ARRIVAL ILS EQUIPPED RUNWAY OR THE FMC IS NOT RECEIVING VALID FREQUENCY (COURSE) DATA

Figure 118 CDU MESSAGES - 3

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
27. SPLIT IRS OPERATION	NUMBER OF IRUs BEING USED FOR NAVIGATION CHANGES FROM THREE TO TWO DUE TO SOFT FAULT OR POLAR NAVIGATION
28. FMC L(R) OUTPUT LOSS	SINGLE FMC TRANSMITTER (NON-CDU, NON INTERSYSTEM TRANSMITTER) FAILURE DETECTED BY BITE
29. ILS TUNE INHIBITED - MCP	THE FLIGHT CONTROL COMPUTERS ARE INHIBITING CHANGES IN ILS TUNING, AND EITHER A MANUAL OPERATION IN THE ILS TUNING FIELD IS ATTEMPTED OR A NEW ARRIVAL ILS EQUIPPED RUNWAY IS ACTIVATED
30. VERIFY RNP - POS REF 2	THE MANUALLY ENTERED REQUIRED NAVIGATION PERFORMANCE VALUE EXCEEDS THE DEFAULT VALUE, UPON CHANGE IN DEFAULT VALUE BASED ON FLIGHT PHASE
31. UNABLE RTA	THE REQUIRED TIME OF ARRIVAL IS NOT ACHIEVABLE WITHIN THE APPLICABLE ARRIVAL TIME TOLERANCE
32. UNABLE FLXXXX AT RTA FIX	THE PREDICTED CROSSING ALTITUDE AT THE RTA FIX IS LESS THAN FLXXXX, PREDICTED ETA STILL WITHIN TOLERANCE
33. RTA FIX DELETED	THE RTA FIX HAS BEEN DELETED FROM THE MOD FLIGHT PLAN
34. ROUTE X UPLINK READY	UPON RECEIPT OF AN AOC FPN (FLIGHT PLAN) UPLINK MESSAGE CONTAINING ROUTE DATA, HAS PASSED ERROR CHECKS, AND IS READY TO BE LOADED INTO THE APPROPRIATE RTE (1 OR 2)

Figure 119 CDU MESSAGES - 4

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
35. PARTIAL ROUTE X UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING ROUTE DATA WHICH CONTAINS ERRORS WHICH DO NOT CAUSE TOTAL REJECTION, AND PART OF THE DATA IS LOADED
36. RTE X UPLINK LOADING	AOC UPLINK MESSAGE CONTAINING ROUTE DATA WHICH IS CURRENTLY BEING LOADED INTO THE INACTIVE ROUTE. MESSAGE IS REISSUED IF A CDU BUTTON PUSH OCCURS THAT WOULD AFFECT THE FLIGHT PLAN BEING LOADED
37. WIND DATA UPLINK READY	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING WAYPOINT WIND DATA AND IS READY TO BE LOADED
38. DESCENT FORECAST UPLINK READY	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING DESCENT FORECAST DATA AND IS READY TO BE LOADED
39. FLT NUMBER UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING FLIGHT NUMBER DATA AND IS READY TO BE LOADED
40. INVALID ROUTE UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING ROUTE DATA AND ALL DATA HAS BEEN REJECTED DUE TO DETECTED ERRORS
41. INVALID FLIGHT NO UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING ROUTE DATA WHICH IS AT LEAST PARTIALLY LOADED OR UPLINK OF JUST FLT NO., AND FLIGHT NUMBER DATA IS REJECTED DUE TO ERRORS

Figure 120 CDU MESSAGES - 5

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
42. INVALID WIND DATA UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING WIND DATA, NONE OF WHICH CAN BE LOADED DUE TO ERRORS
43. INVALID FORECAST UPLINK	UPON RECEIPT OF AN AOC UPLINK MESSAGE CONTAINING DESCENT FORECAST DATA WHICH IS REJECTED DUE TO ERRORS
44. SET CLOCK TO UTC TIME	AT ENTRY OF INTITIAL POSITION CAPTAIN'S (F/O'S) CLOCK DISAGREES WITH GPS TIME BY MORE THAN 12 SECONDS
45. ATC REPORT LIST FULL	NINE (9) REPORTS HAVE BEEN GENERATED IN RESPONSE TO ATC REPORT OR CONFIRM MESSAGES AND A 10TH IS RECEIVED
46. INVALID ATC UPLINK	UPON RECEIPT OF AN ATC UPLINK MESSAGE THAT CONTAINS FORMAT OR OTHER ERRORS
47. PARTIAL CLEARANCE LOADED	ONLY A PORTION OF THE LOADABLE DATA CONTAINED IN AN ATC UPLINK MESSAGE WAS LOADED WHEN SELECTED
48. ATC MSG NOT ACKNOWLEDGED	AN ATC DOWNLINK MESSAGE WAS SENT AND NO NETWORK ACKNOWLEDGEMENT WAS RECEIVED BEFORE THE TIMEOUT PERIOD
49. RE-LOGON TO ATC COMM	AN ATC LOGON MESSAGE WAS SENT AND THE ATC CENTER DID NOT SEND A POSITIVE RESPONSE MESSAGE, OR THE ATC CENTER SENT A NEGATIVE RESPONSE, OR AN END SERVICE MESSAGE IS RECEIVED WHICH CAUSES TERMINATION OF ATC DL CONNECTION

Figure 121 CDU MESSAGES - 6

APPENDIX - C

ALERT MESSAGES	CONDITION (CONTINUED)
50. UNABLE TO LOAD CLEARANCE	NONE OF THE ATC UPLINK MESSAGE DATA RECEIVED WAS ABLE TO BE LOADED WHEN SELECTED
51. UNABLE TO SEND MESSAGE	TRANSMISSION OF A MESSAGE WAS SELECTED ON THE CDU, BUT THE MESSAGE COULD NOT BE DELIVERED TO THE ACARS MANAGEMENT UNIT
52. ATC COMM ESTABLISHED	AN ACTIVE ATC DATA LINK CONNECTION IS SUCCESSFULLY ESTABLISHED
53. MESSAGE LIMIT EXCEEDED	THE PILOT ATTEMPTS TO SELECT MORE THAN FIVE (5) MESSAGE ELEMENTS FOR INCLUSION IN AN ATC DOWNLINK MESSAGE

Figure 122 CDU MESSAGES - 7

APPENDIX - C

ENTRY ERROR ADVISORY MESSAGES	CONDITION
1. NOT IN DATA BASE	A SEARCH OF THE NAV DATA BASE AND ROUTE DID NOT RESULT IN FINDING THE REQUIRED DATA
2. RUNWAY N/A FOR SID	RUNWAY SELECTED IS NOT COMPATIBLE WITH DEPARTURE
3. ARR N/A FOR RUNWAY	RUNWAY/APPROACH SELECTED IS NOT COMPATIBLE WITH ARRIVAL SELECTED
4. STANDBY ONE	THE FMC REQUIRES MORE THAN 4 SECONDS TO DISPLAY DATA
5. INVALID ENTRY	THE ENTRY HAS AN INCORRECT FORMAT AND/OR RANGE FOR THE SELECTED CDU FIELD
6. INVALID DELETE	DELETION OF DATA DISPLAYED IN THE SELECTED FIELD IS NOT ALLOWED
7. ROUTE FULL	ROUTE FILLED TO ALLOWABLE CAPACITY (120 WAYPOINTS)
8. CRS REVERSAL AT FINAL APPROACH (FA) FIX	A CONFLICT EXISTS BETWEEN THE DEFAULT FINAL APPROACH (FA) WAYPOINT (AS A RESULT OF A RUNWAY OR VFR APPROACH SELECTION) AND THE PRECEDING FLIGHT PLAN WAYPOINT SUCH THAT A COURSE REVERSAL OCCURS
9. KEY/FUNCTION INOP	SHOWS WHEN AN UNUSED CDU MODE KEY IS PUSHED
10. VERIFY RNP ENTRY	THE MANUALLY ENTERED RNP EXCEEDS THE DEFAULT RNP VALUE

Figure 123 CDU MESSAGES - 8

APPENDIX - C

ADVISORY MESSAGES	CONDITION
1. MAX ALT FLXXX	ALTITUDE ENTRY ON ANY PAGE IS ABOVE THE PERFORMANCE COMPUTED MAXIMUM ALTITUDE. NOTE: MAXIMUM ALT IS DEFINED AS THE ALTITUDE OPERATIONALLY LIMITED BY THRUST LIMITS OF THE SELECTED CLIMB AND CRUISE MODE, BUT MAY BE LIMITED BY APPROPRIATE MANEUVER REQUIREMENTS. MAXIMUM ALT IS LOWER THAN THE VNAV LIMIT ALT. MESSAGE LOGIC IS EXECUTED WHENEVER A VERTICAL FLIGHT PLAN CHANGE OR CHANGE TO COST INDEX, GROSS WEIGHT OR CRUISE ALTITUDE IS PERFORMED
2. NOT ON INTERCEPT HEADING	LNAV SELECTED ON MCP BUT AIRCRAFT IS NOT WITHIN THE CAPTURE CRITERIA OF ACTIVE LEG AND CURRENT HEADING WILL NOT INTERCEPT THE ACTIVE LEG
3. DELETE	DEL KEY IS PRESSED
4. UNABLE CRZ ALT	PERFORMANCE PREDICTS A ZERO CRUISE TIME AT THE ENTERED CRUISE ALTITUDE

Figure 124 CDU MESSAGES - 9

APPENDIX - C

CDU GENERATED MESSAGES	CONDITION
1. TIMEOUT - RESELECT	COMMUNICATION BETWEEN CDU AND ACTIVE OR REQUESTED USER SUBSYSTEM FAILED
2. ROUTE FULL	ROUTE FILLED TO ALLOWABLE CAPACITY
3. END OF ROUTE	PASSING LAST ROUTE LEG TERMINATION
4. INVALID ENTRY	THE ENTRY HAS AN INCORRECT FORMAT AND/OR RANGE FOR THE SELECTED CDU FIELD OR AIRWAY ENTRY RELATIONSHIP TO THE PREVIOUS AIRWAY OR TO THE ENTRY OR DEPARTURE WAYPOINT DOES NOT PERMIT CORRECT FLIGHT PLAN STRINGING
5. DISCONTINUITY	PASSING LAST WAYPOINT PRIOR TO DISCONTINUITY (EXCEPT WHEN THE WAYPOINT IS FOLLOWED BY A MANUALLY TERMINATED LEG, e.g. FM, VM OR HM LEGS)
6. INVALID DELETE	DELETION OF DATA DISPLAYED IN THE SELECTED FIELD IS NOT ALLOWED
7. DELETE	DEL KEY IS PUSHED

Figure 125 CDU MESSAGES - 10

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF FIGURES