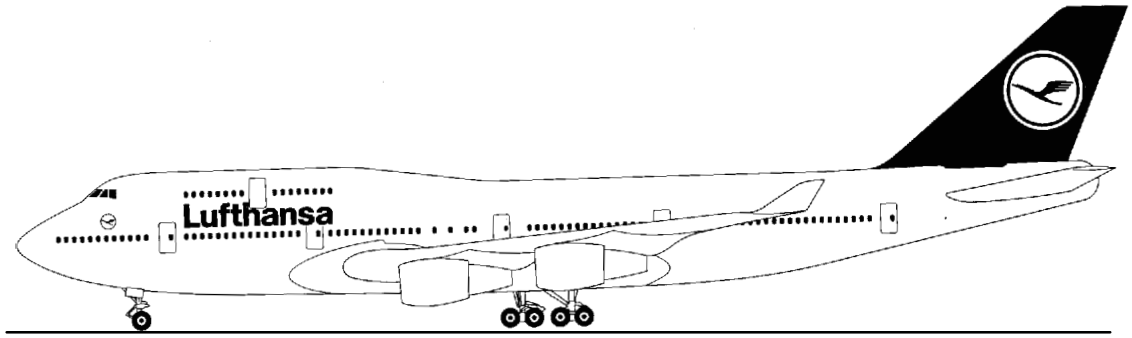
Lufthansa Technical Training

Training Manual
B 747-400



ATA 23-27
ACARS

ATA Spec 104 Level 3

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ATA 23-27 ACARS

ACARS - INTRODUCTION

The ARINC communication addressing and reporting system (ACARS) enhances air-ground communications and reduces flight crew work load through the use of highspeed, digital data link messages. These messages downlink from an airplane to airline operations facilities by way of VHF radio, land lines, and the ARINC data link control station. Messages can uplink to an airplane through this same network.

Voice communication between an airplane and ground telephone circuits is also possible.

The network covers the continental United States, parts of Canada, Australia, Mexico, Europe, and in many other countries around the world.

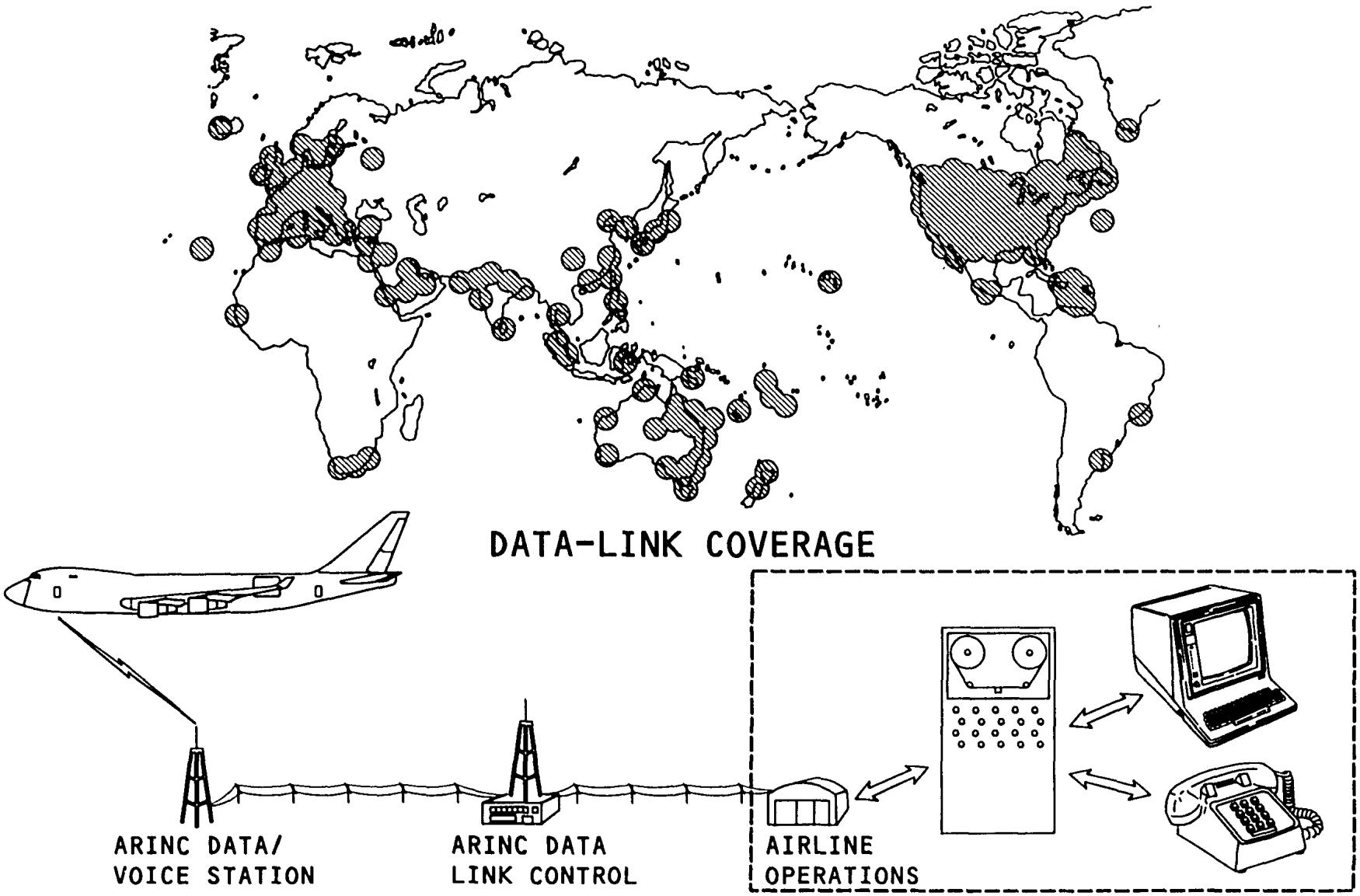


Figure 1 ACARS - INTRODUCTION

ACARS

ACARS consists of an ACARS management unit (MU) and related airplane systems interfaces.

The ACARS MU:

- Collects data from airplane systems automatically or on command.
- Sends data used to tune a VHF transceiver.
- Sends and receives data between the airplane and ground stations.
- Alerts the flight crew, through the modularized avionics and warning electronics assembly (MAWEA), with a chime that a voice call is ready.

The control display units (CDUs) are used for:

- Control and downlink data input to the ACARS MU
- Voice or data mode selection
- Uplink message display

The EFIS/EICAS interface units (EIUs) inputs to the ACARS MU are:

- Out-of-gate, off-ground, on-ground, in-gate (0001) status information.
- Airplane identification

The airborne data loader (ADL) loads the ACARS MU software.

The central maintenance computer (CMC) sends system's fault data to the ACARS MU for downlink and receives ACARS fault data.

The data management unit (DMU) sends airplane condition monitoring system (ACMS) report data to the ACARS MU for downlink.

The flight management computer (FMC) interface is not used at this time.

The audio management unit (AMU) turns on the VHF call lights on the audio control panels (ACPs) when a voice call is ready.

ACARS can send data to the flight deck printer. Print status is sent to the ACARS MU during print operations.

The VHF transceiver:

- Downlinks data from the airplane to the ground station.
- Receives uplink data from the ground station to the airplane.

The radio communication panels (RCPs) are used for voice or data mode selection.

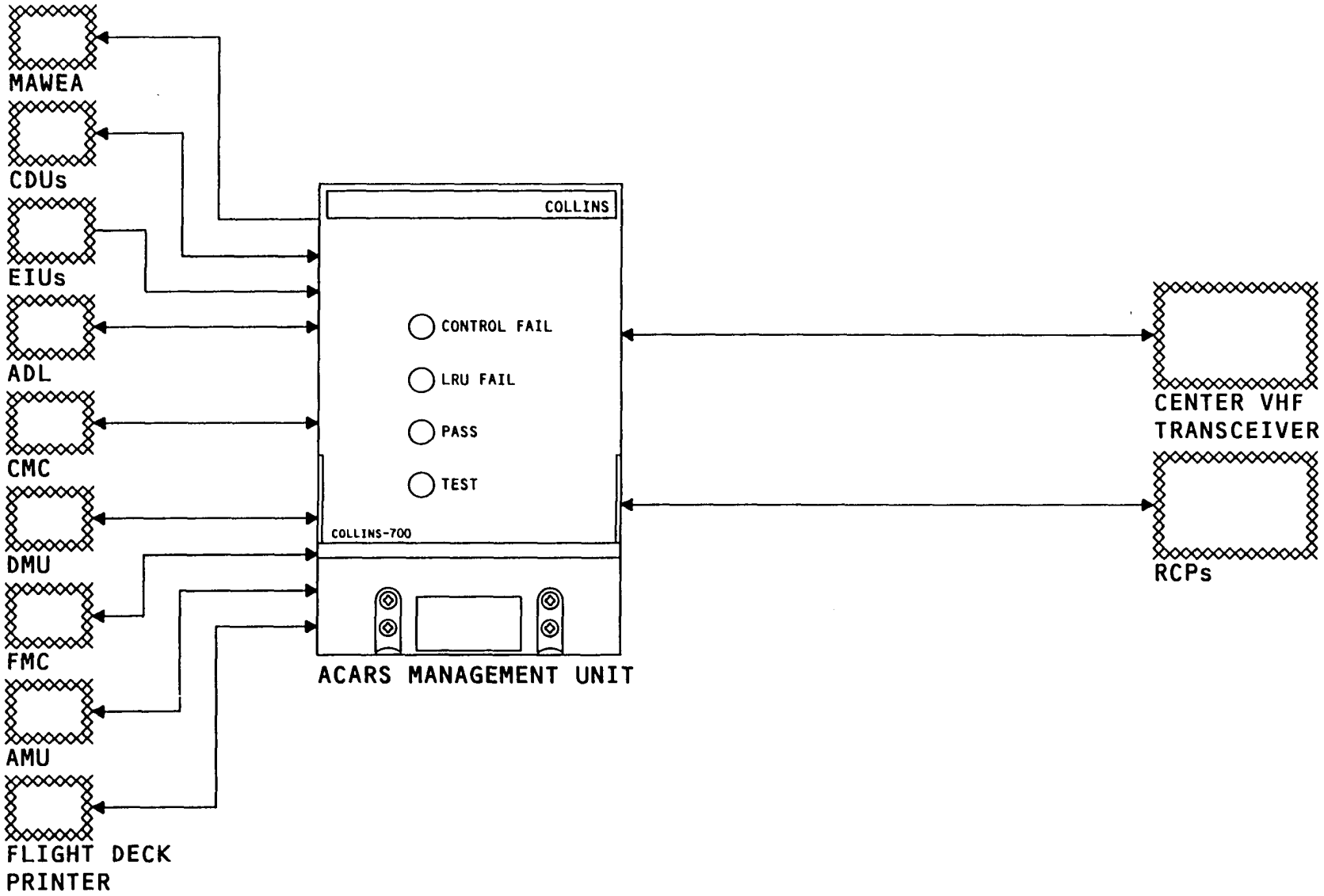


Figure 2 ACARS

COMPONENT LOCATIONS - FLIGHT DECK

The ACARS components and interfacing components located in the flight deck are:

- Control display units (CDUs)
- Radio communication panels (RCPs)
- ACARS ac circuit breaker
- ACARS dc circuit breaker

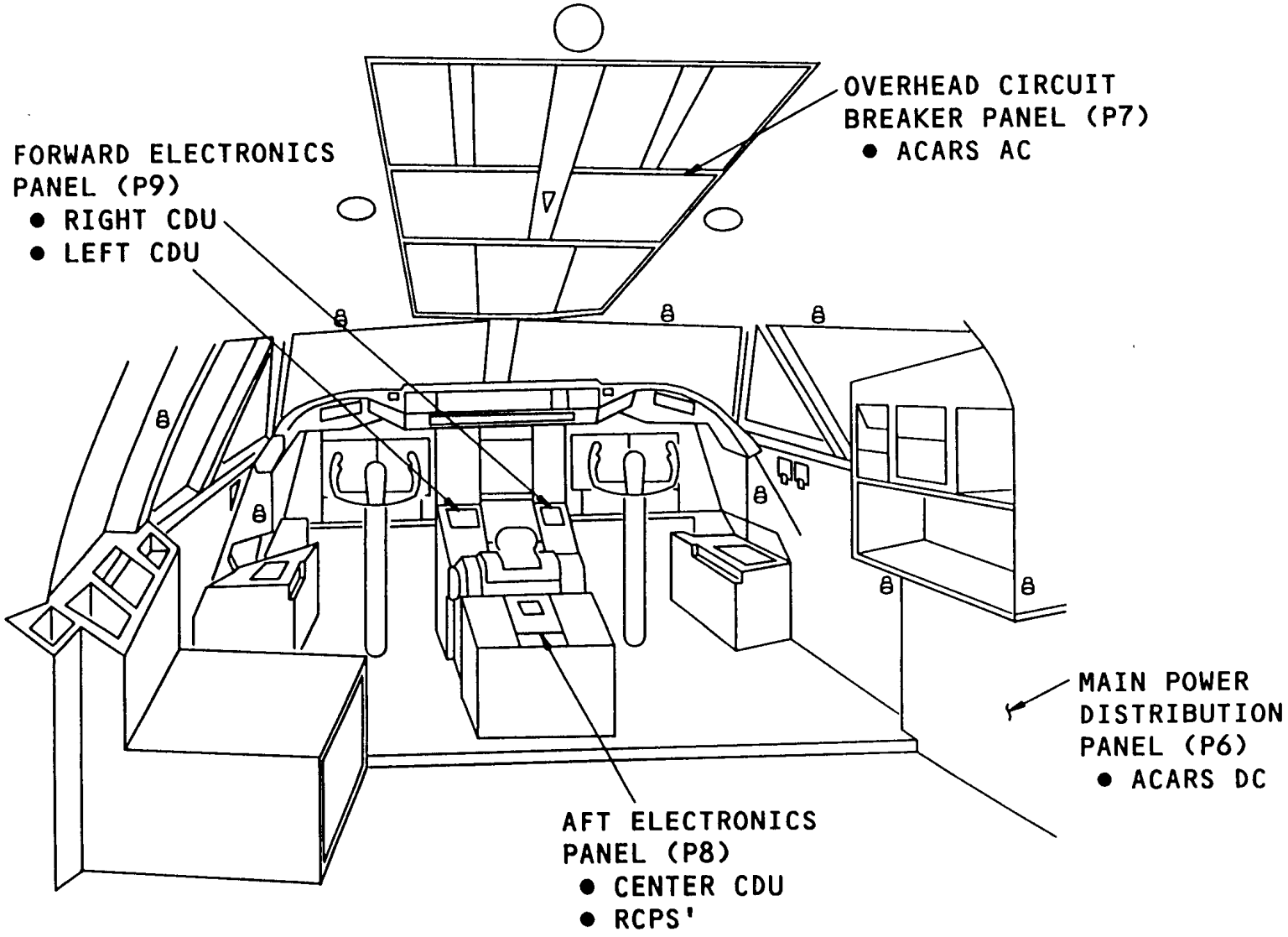


Figure 3 COMPONENT LOCATIONS - FLIGHT DECK

COMPONENT LOCATIONS - MEC

The ACARS management unit (MU) is located in the main equipment center (MEC) on the E2-5 rack.

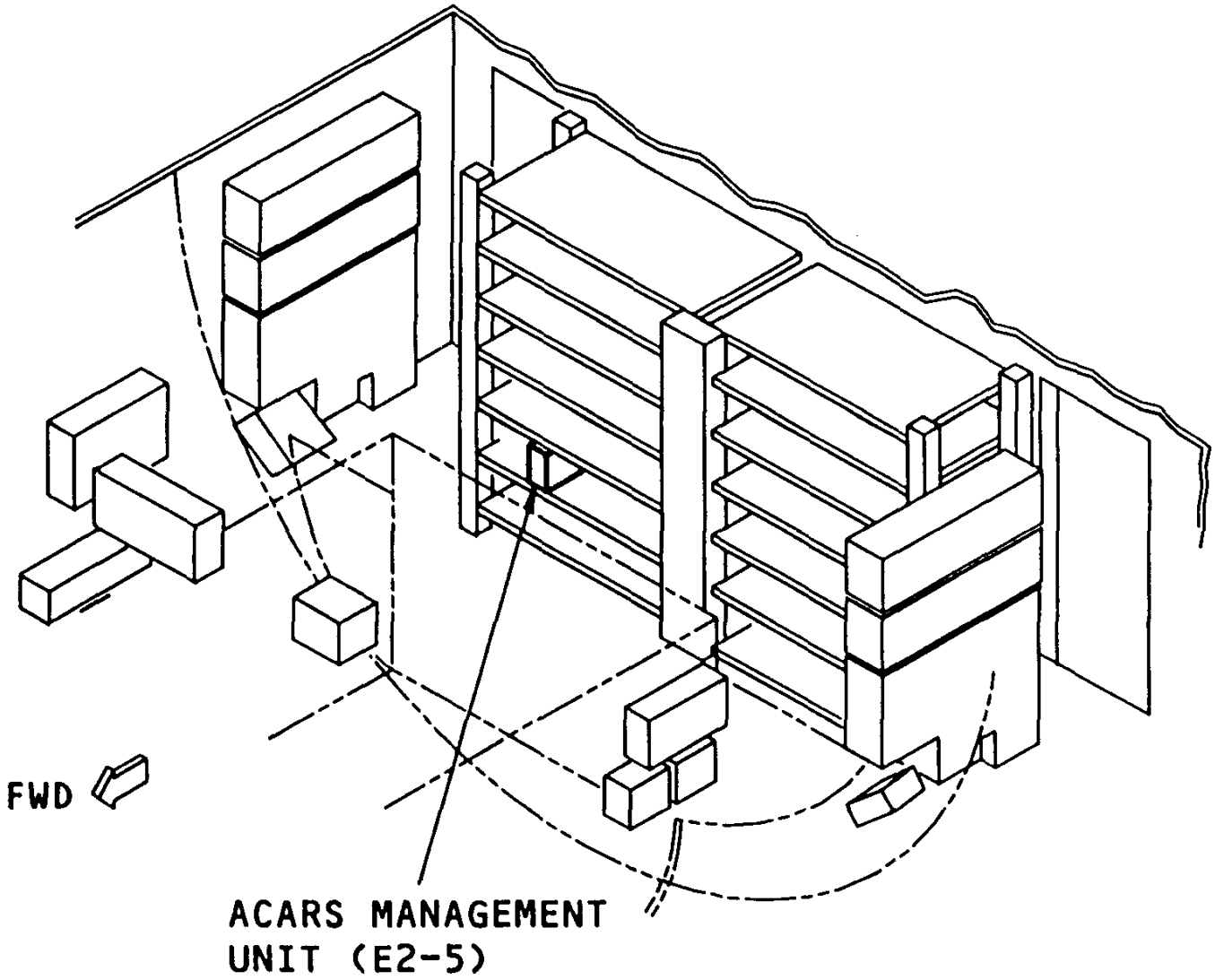


Figure 4 COMPONENT LOCATIONS - MEC

POWER INTERFACE

The ACARS AC circuit breaker supplies 115v ac from the 115v ac BUS 3 directly to the ACARS management unit.

The ACARS dc circuit breaker supplies 28v dc from the 28v dc HOT BAT BUS directly to the ACARS management unit for time base power.

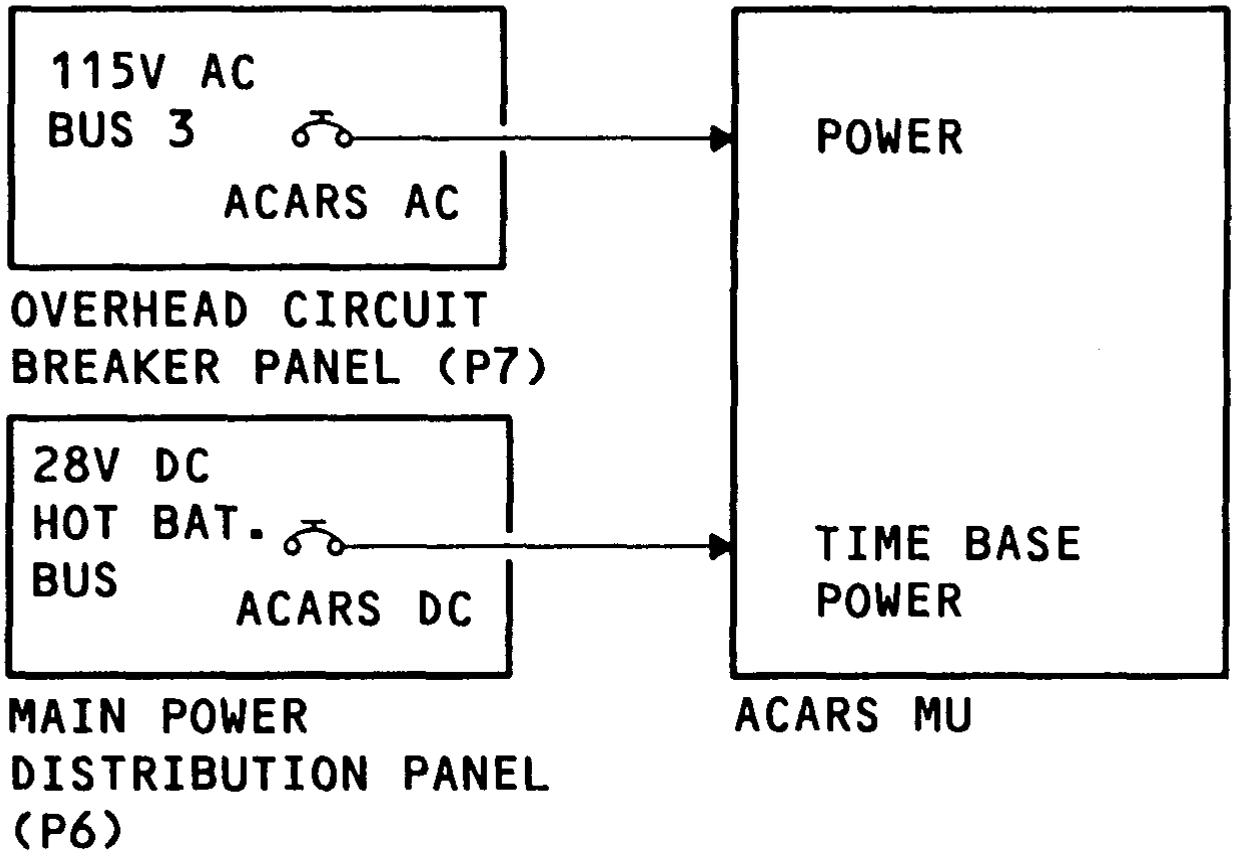


Figure 5 POWER INTERFACE

ARINC 429 INPUTS

The ARINC 429 inputs to the ACARS management unit (MU) are:

- Left control display unit (L CDU)
- Center control display unit (C CDU)
- Right control display unit (R CDU)
- Left flight management computer (L FMC)
- Right flight management computer (R FMC)
- Left EFIS/EICAS interface unit (L EIU)
- Right EFIS/EICAS interface unit (R EIU)
- Data management unit (DMU)
- Multi-input printer
- Left central maintenance computer (L CMC)
- Software data loader panel

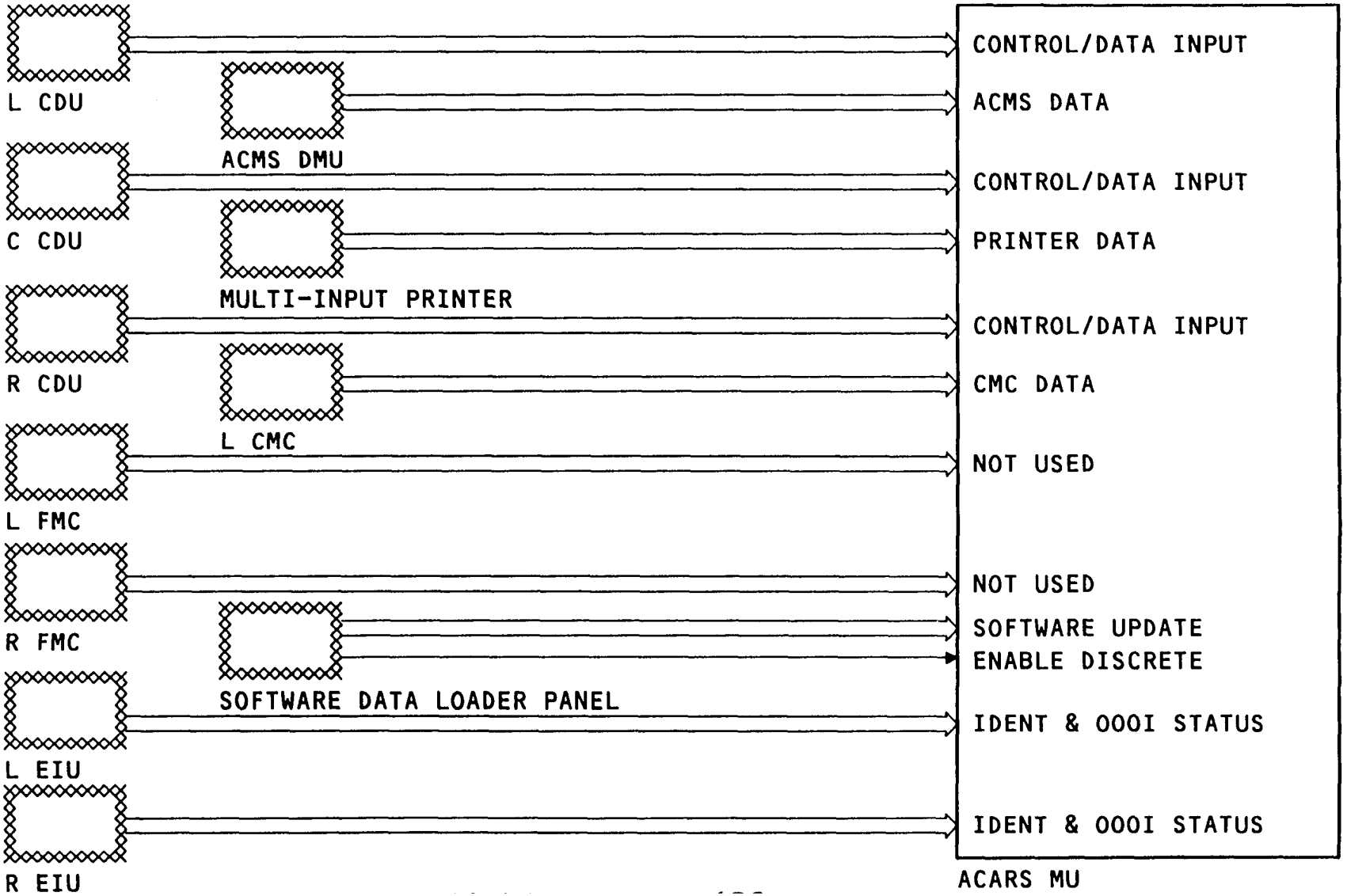


Figure 6 ARINC 429 INPUTS

ARINC 429 OUTPUTS

The ACARS MU has two general purpose ARINC 429 output buses, and buses for specific functions.

The outputs of the ACARS MU go to:

- Left control display unit (L CDU)
- Center control display unit (C CDU)
- Left flight management computer (L FMC)
- Multi-input printer
- Left central maintenance computer (L CMC)
- Right central maintenance computer (R CMC)
- Software data loader panel
- Right control display unit (R CDU)
- Right flight management computer (R FMC)
- Data management unit (DMU)
- Modularized avionics and warning electronics assembly (MAWEA) (The MAWEA then gives data to the EIUs for generating various ACARS EICAS messages)

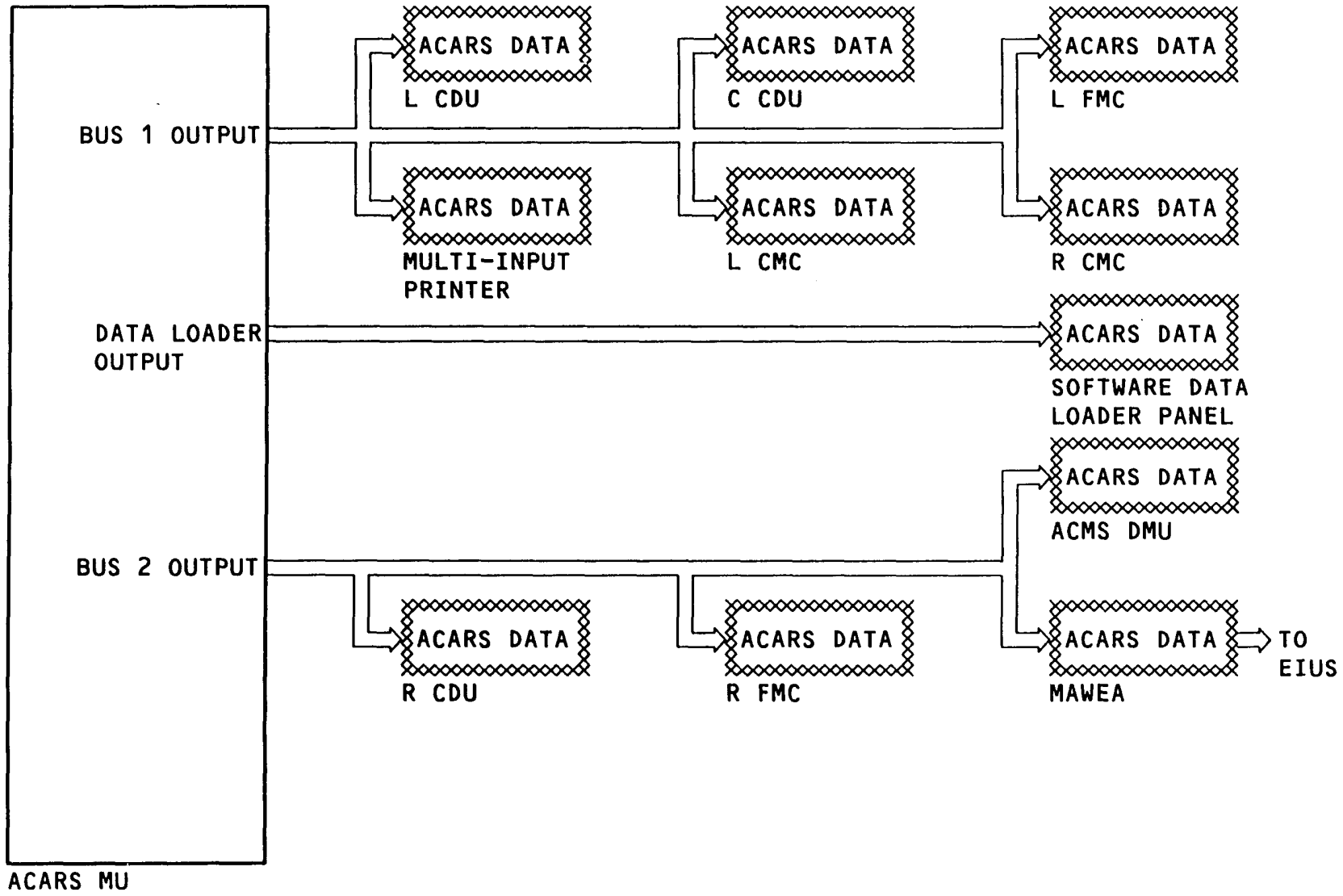


Figure 7 ARINC 429 OUTPUTS

VHF INTERFACE

The ACARS MU sends these outputs to the center VHF communications transceiver:

- Voice/data annunciation output; this output goes to the center VHF as the voice/data select
- Data tones (1200 Hz, 2400 Hz)
- Data keyline
- Port select discrete (The radio communication panels (RCPs) also get the port select discrete output of the MU).
- Frequency (ARINC 429 tuning data)

The ACARS MU gets data from the center VHF communications transceiver.

The RCP transfer switch can override ACARS. The ACARS override output is the remote voice/data select input to the MU.

The RCPs have a program pin for a dedicated ACARS installation. With this pin grounded, ACARS always appears on the RCP display whether active or not.

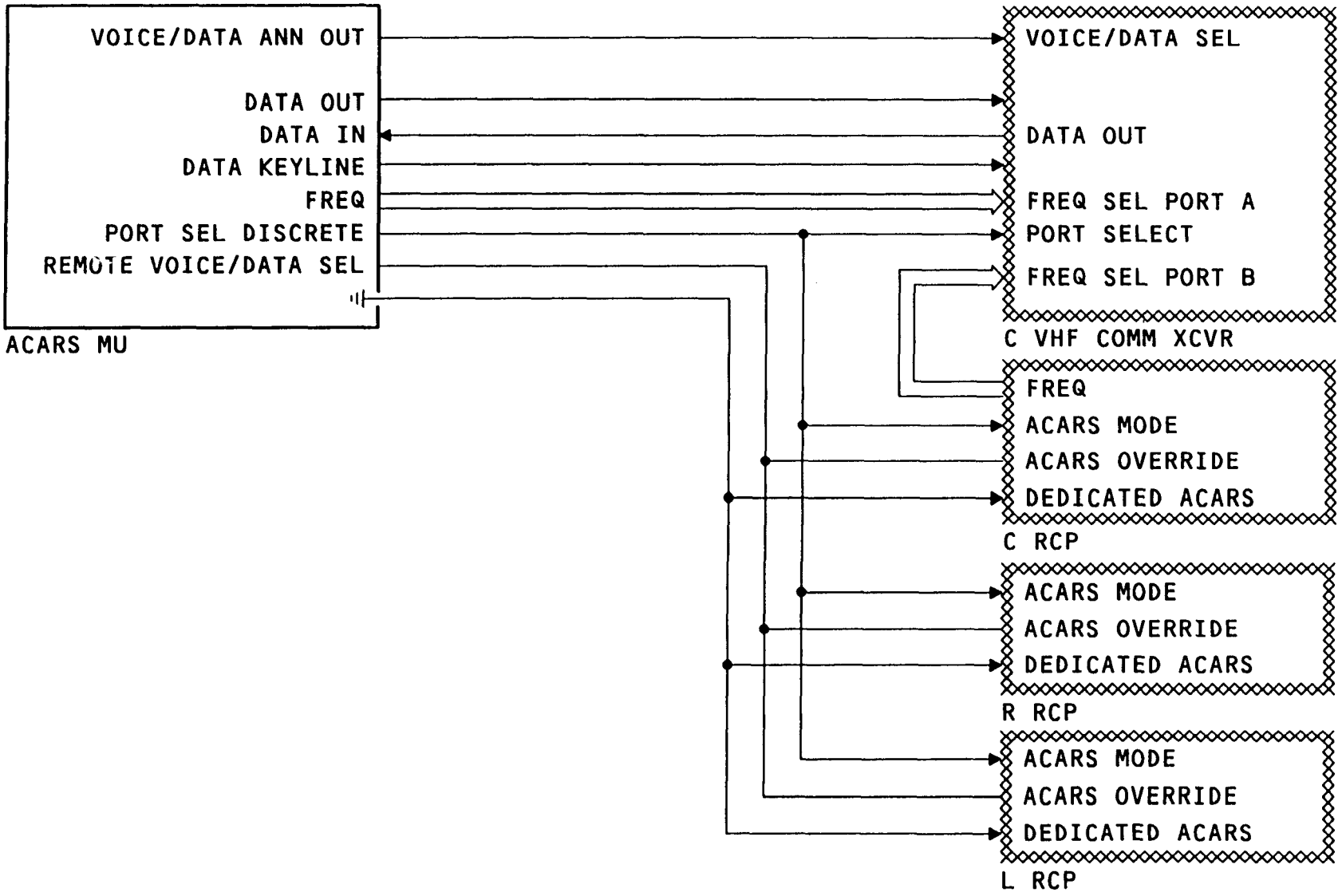


Figure 8 VHF INTERFACE

VOICE GO-AHEAD

The voice go-ahead output from the ACARS MU goes to the audio management unit (AMU). It turns on the center VHF call lights on the audio control panels (ACPs) when a request for voice contact occurs.

This output also goes to the modularized avionics warning electronics assembly (MAWEA) to generate a low chime in the flight deck.

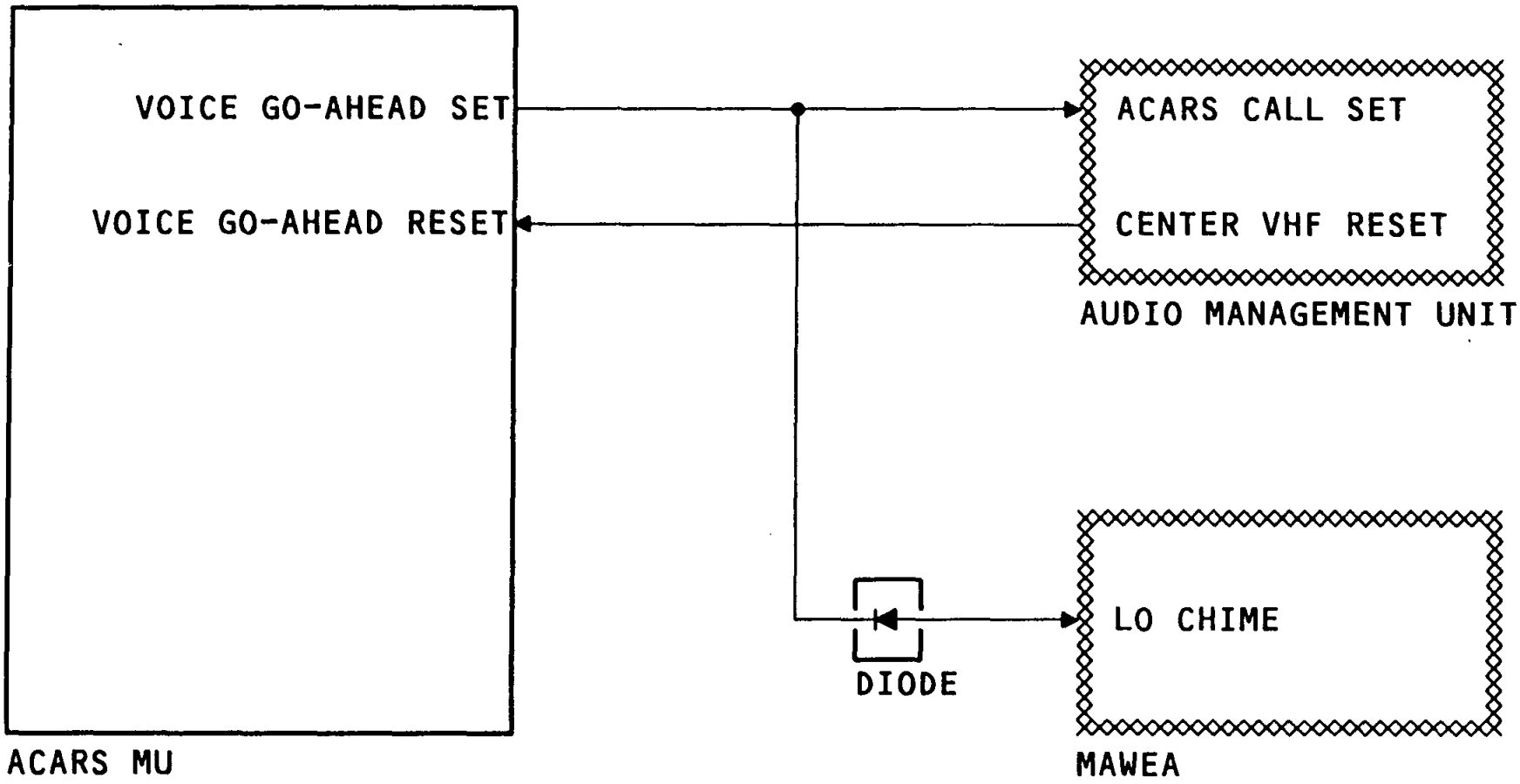


Figure 9 VOICE GO-AHEAD

ACARS MANAGEMENT UNIT

Characteristics

The ACARS management unit (MU) has three LEDs and a test pushbutton on the front panel.

Operation

The microprocessor-based MU controls all datalink functions. Using an internal oscillator, it provides all timing functions for ACARS and maintains correct UTC with an internal clock. It interfaces with and processes data between on-board systems and the ground network. The MU stores and encodes/decodes messages, and initiates data transmissions. It only accepts uplink commands and messages addressed to the airplane in which the unit is installed. It accepts inputs from the control display unit (CDU) and controls the different modes of operation.

Maintenance Practices

The MU continuously tests its own circuits and the integrity of the control inputs.

To test the MU:

- Assure that the ac and dc circuit breakers are closed and that power is applied.
- Press and hold the momentary test switch on the front panel of the MU.

These indications occur during test:

- All three LEDs come on for 3 seconds.
- All three LEDs go off for 3 seconds.
- The proper status LED will stay on until the test switch is released.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

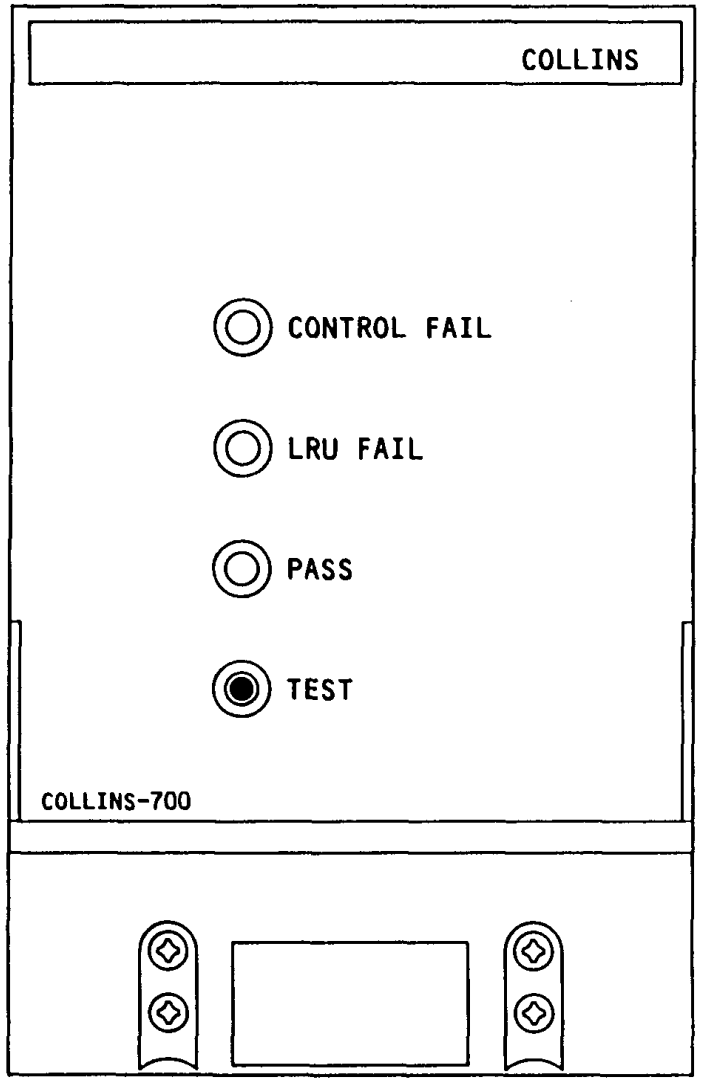


Figure 10 ACARS MANAGEMENT UNIT

RADIO COMMUNICATION PANEL

General Description

The radio communication panel (RCP) sends tuning data to the communication radios. It allows for selection of the active or standby frequency for each radio.

When ACARS is active, the MU tunes the VHF communications transceiver. When ACARS is not active, or in the voice mode, the RCP tunes the VHF communications transceiver.

Controls and Indications

The active and standby frequency indicators are LED displays.

For the center VHF when ACARS is active:

- The active frequency display shows the word ACARS.
- The standby frequency display shows the last active frequency.

For the center VHF when ACARS is not used:

- The active frequency display shows the active frequency.
- The standby frequency display shows the word ACARS. (Thus the center VHF active frequency can only be changed when ACARS is used)

Push the transfer switch to override ACARS on the active frequency indicator. The RCP then returns to voice operation. The word ACARS shows in the standby window.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

DISPLAY ON RCP WHEN SELECTED TO THE CENTER VHF WHILE IN THE ACARS MODE

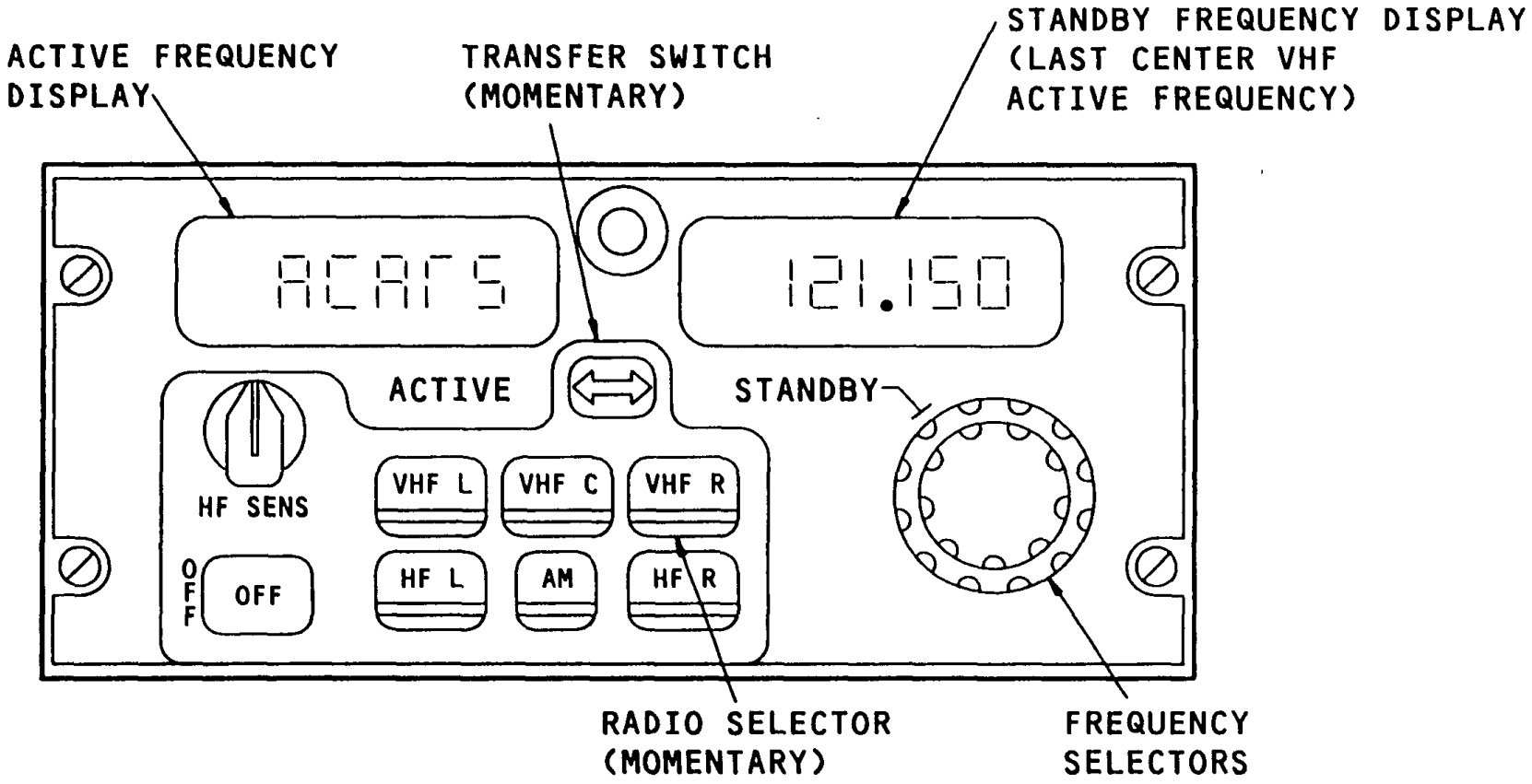


Figure 11 RADIO COMMUNICATION PANEL

CONTROL DISPLAY UNIT

General

The CDU contains these items:

- Keyboard for data entry or display selection
- Cathode ray tube to show data
- Eight bit micro processor to control the operation of the CDU
- ARINC receivers to receive data from ACARS and other sources
- ARINC transmitters to send data to ACARS and other users

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

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

Only keys relating to ACARS are discussed.

Function and Mode Keys

The function keys are:

- NEXT PAGE: used to look at the next page among many pages
- Previous page (PREV PAGE): used to look at the last among many pages

The MENU mode key selects the CDU MENU.

Line Select Keys

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

Alpha-numeric Keys

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

- 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 available. 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 for data entry or transfer and for messages to show.

ACARS MENU

The control display units (CDUs) are the primary crew interface with ACARS. ACARS operates with only one CDU at a time. To use ACARS, push the CDU MENU key. This shows the CDU MENU on the display. Push the line select key next to the ACARS prompt, to show the ACARS MENU. The ACARS MENU page gives access to the different ACARS functions.

ACARS MENU Selections

ACARS operates with menu driven system. Line select keys do different functions, depending on the page that shows. These are the selections/ functions on the ACARS MENU:

- PREFLIGHT; changes display to the PREFLIGHT MENU page
- INFLIGHT; changes display to the INFLIGHT MENU page
- POSTFLIGHT; changes display to the POSTFLIGHT MENU page
- MAINT; changes display to the MTNCE INDEX page
- MSGS; changes display to the MSGS MENU page
- VHF CNTRL; changes display to the VHF CONTROL page
- WXR REQ; changes display to the WEATHER REQUEST page
- EVENT TIMES; changes display to the EVENT TIMES page

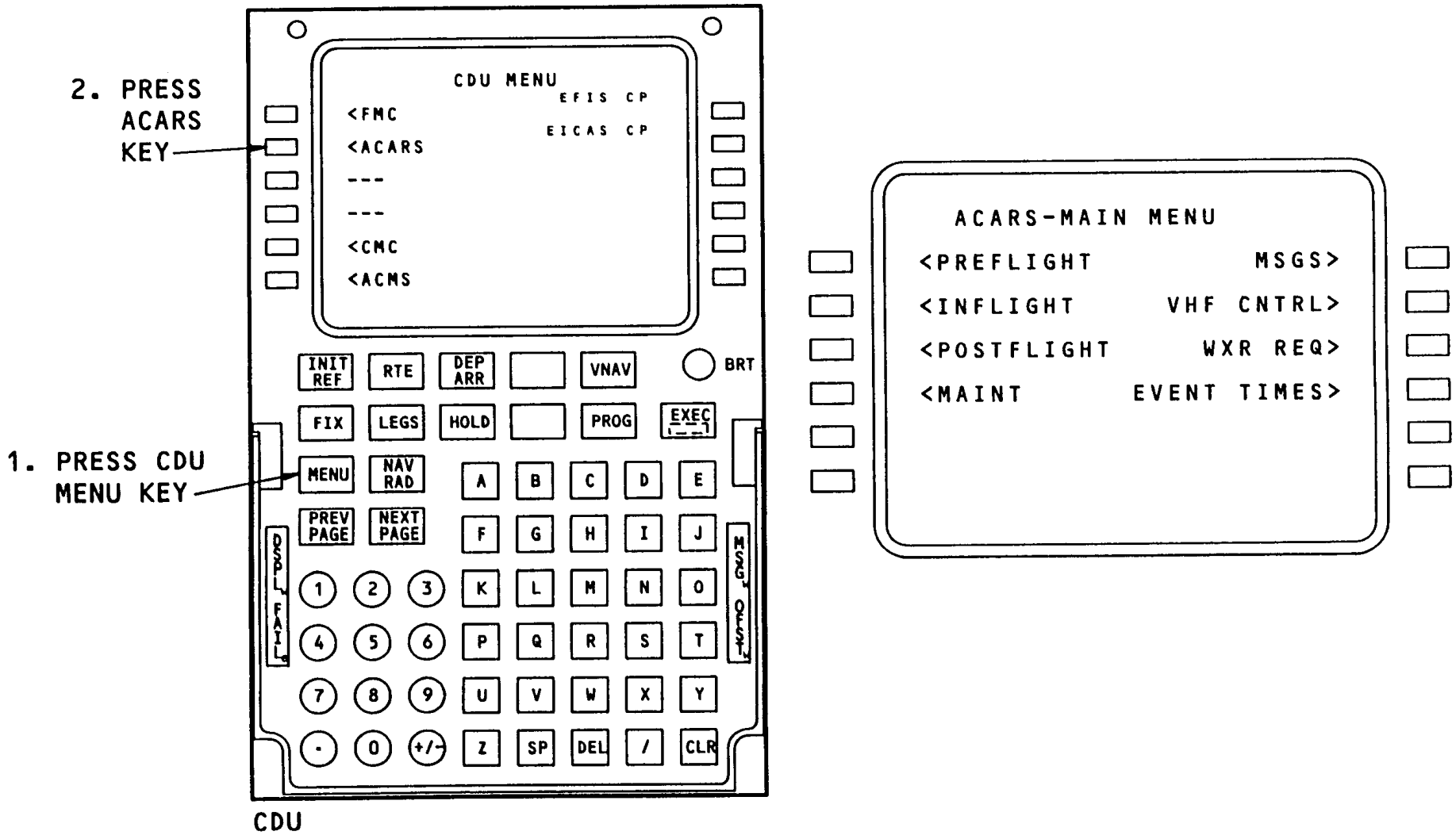


Figure 12 CONTROL DISPLAY UNIT

ACARS - INITIALIZATION

General

ACARS requires information about the present flight to perform various functions. This information is entered during preflight operations, and clears at the end of the flight.

Initialization

To initialize ACARS, push the line select key next to the prompt PREFLIGHT on the ACARS MAIN MENU. Next, push the line select key next to the prompt INITIALIZE. Initialization data is then entered on the INITIALIZATION page.

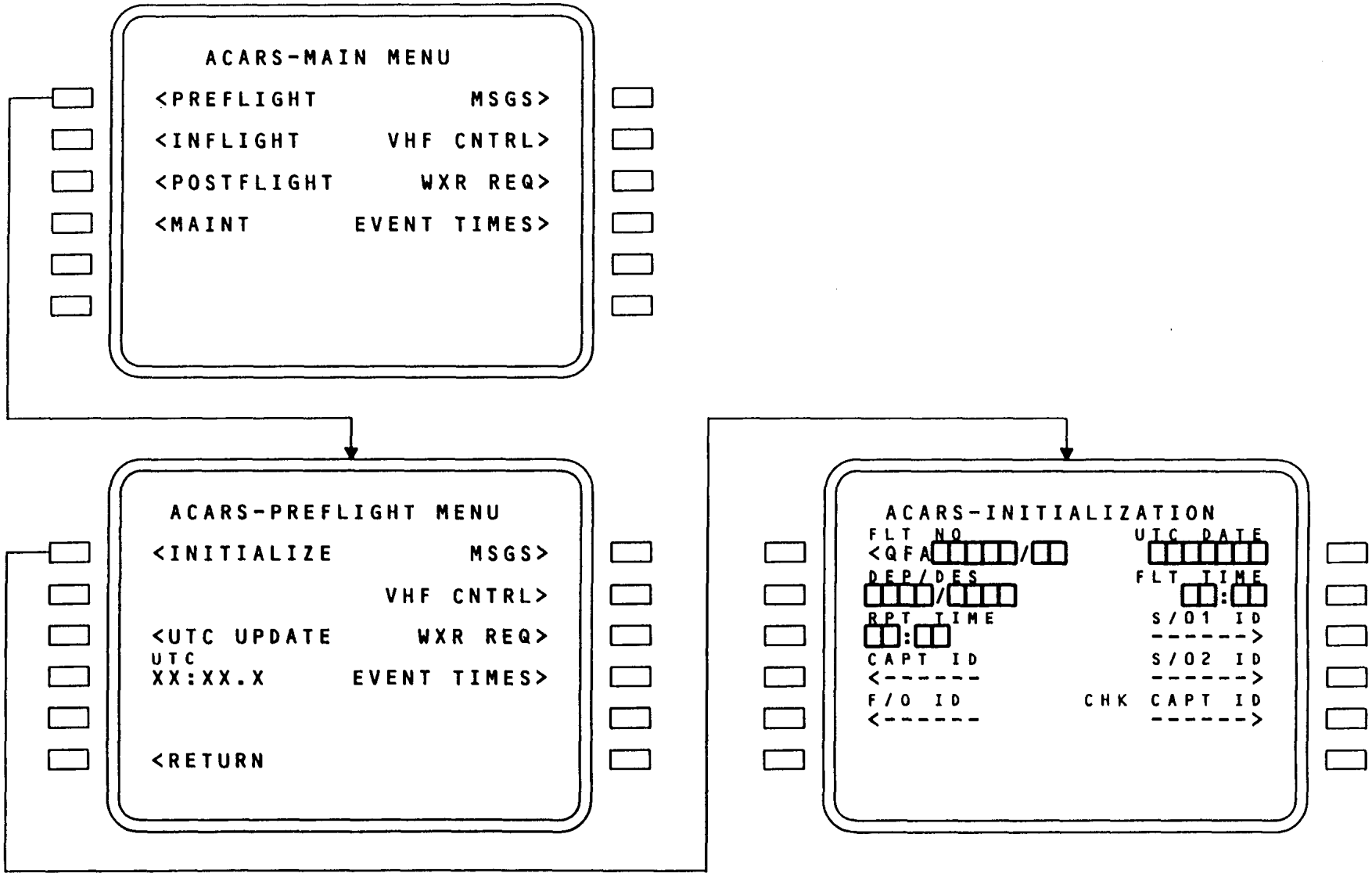


Figure 13 ACARS - INITIALIZATION

ACARS MESSAGES

General

ACARS sends and receives text messages, either manually or automatically. Manual operation requires the entry of a text message on the CDU and then initiating the downlink using a line select key. Automatic operation is determined by the software program. ACARS receives only those messages that are addressed to the airplane.

Messages

To send a message, push the line select key next to the prompt MSGS on the ACARS MAIN MENU. Next press the line select key next to the prompt MISC. A free text message can then be entered and sent using the MISC MSG page.

To show a received message, push the line select key next to the prompt UPLINK on the MSGS MENU. Select the desired message on the UPLINK MSG page.

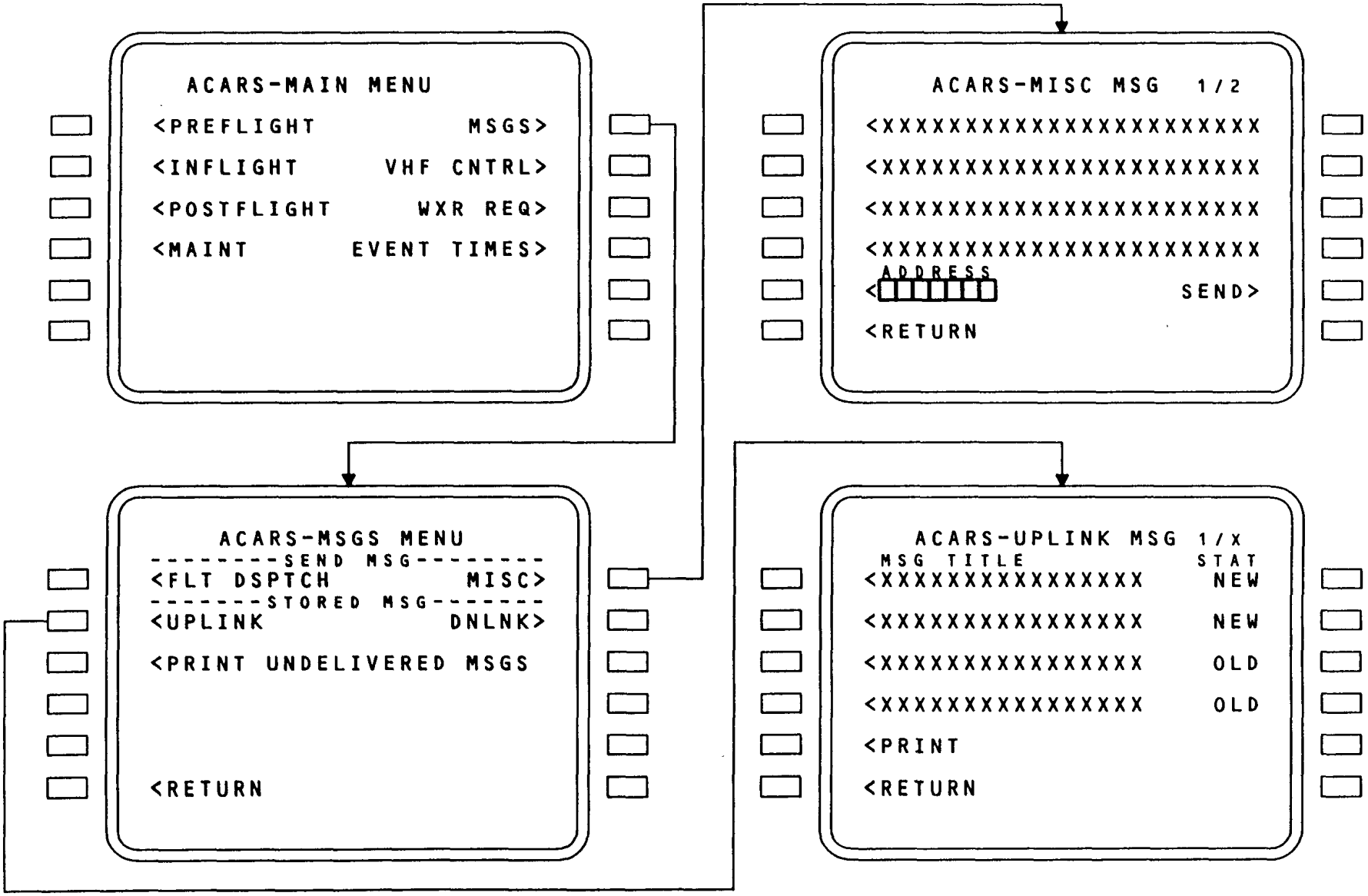


Figure 14 ACARS MESSAGES

VOICE MODE

General

ACARS has two basic modes of operation:

- Data mode
- Voice mode

Data mode operation uses the VHF COM transceiver to send and receive messages on an ARINC assigned frequency.

Voice mode operation provides voice communications using the VHF COM transceiver on an ARINC assigned voice frequency.

Both modes use the ARINC network of land lines to achieve reliable long range communications with the airplane.

Voice Mode

ACARS normally operates in the data mode. ACARS changes to the voice mode of operation either by a request from the ground to establish voice communication (voice go-ahead) or manually by the flight crew with the CDU.

To change ACARS to the voice mode, push the line select key next to the prompt VHF CNTRL on the ACARS MAIN MENU. If ACARS is in the data mode, push the line select key next to the prompt CHANGE MODE. ACARS then switches to the voice mode of operation. ,

ACARS can also receive a request for voice communications. In this uplink message will be the assigned voice frequency. When this message is received, the voice go ahead indications are a low chime and the appropriate call lights on the audio control panels.

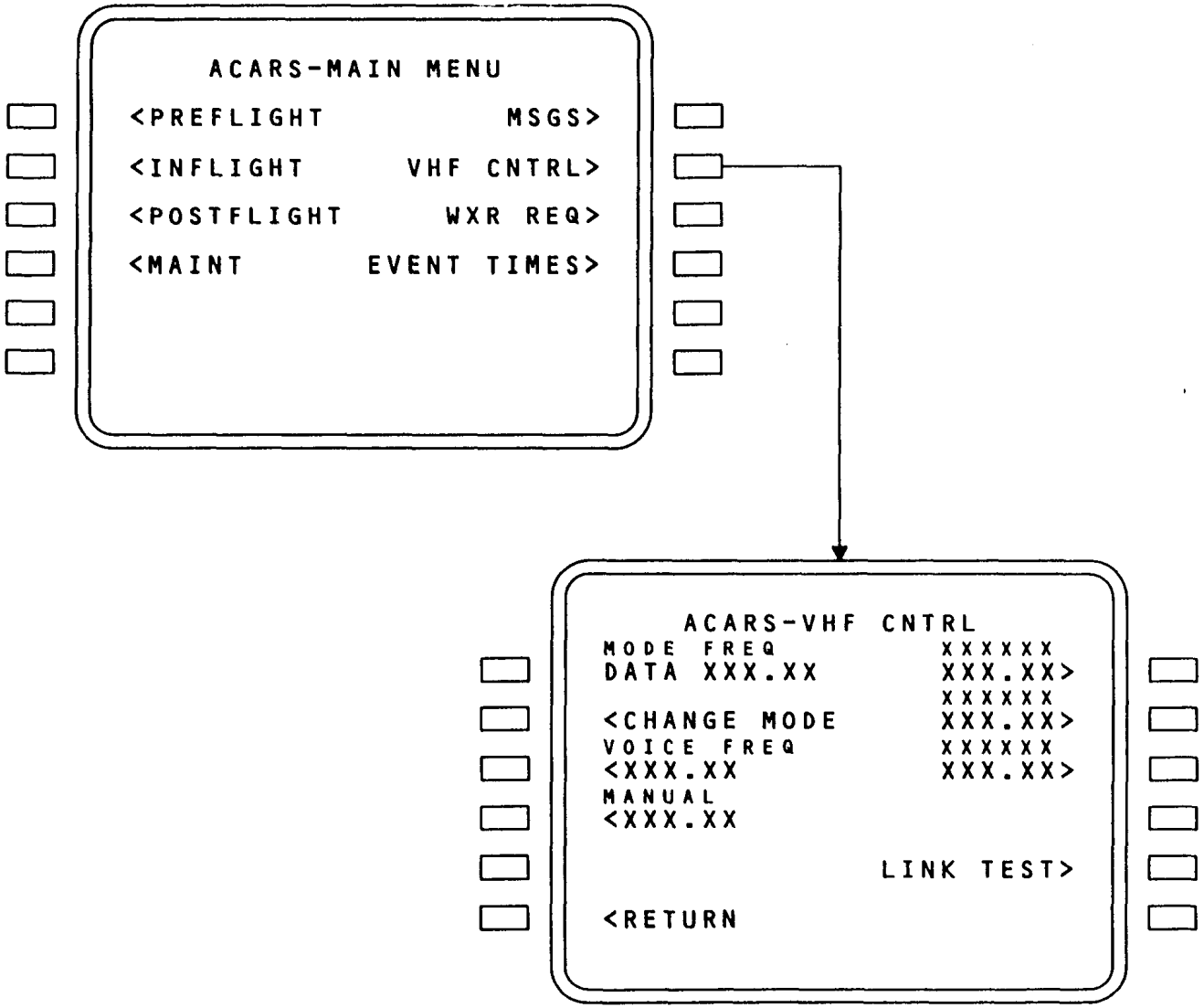


Figure 15 VOICE MODE

UTC UPDATE

General

ACARS has an internal UTC (universal coordinated time) clock, which is required for certain functions. This clock (time base) is maintained by the ACARS MU, which gets its time base power from the main hot battery bus. If power to the time base input to the ACARS MU or if main hot battery bus power is removed, the ACARS time base must be updated. A time base update is done in one of two ways;

- Manual Entry
- Time base update received along with uplink data. A link test response from a ground station includes UTC for time base update.

Manual Entry

To manually update the ACARS time base, push the line select key next to the prompt PREFLIGHT on the ACARS MAIN MENU. Next, push the line select key next to the prompt UTC UPDATE. The UTC UPDATE page allows manual entry of UTC in data field 4 right.

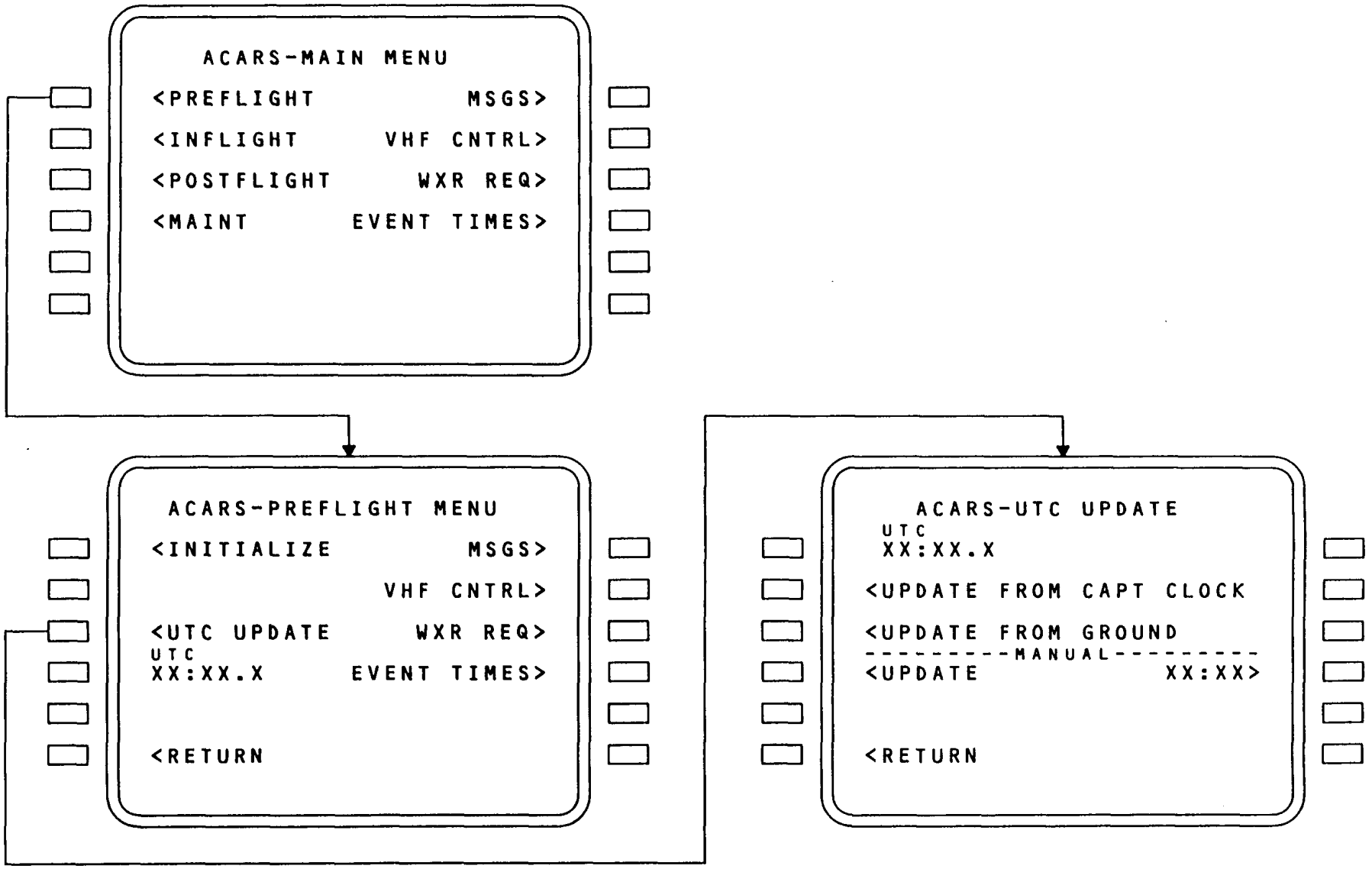


Figure 16 UTC UPDATE

PRESENT LEG FAULTS REPORT

General

These CMC fault reports can downlink through ACARS:

- Present leg fault report
- Fault history report
- Existing fault report
- Single present leg fault
- Single fault history
- Single existing fault
- Single ground test report

These EICAS maintenance pages can be downlinked through ACARS:

- Input monitoring
- Air conditioning system/Air supply system
- Electrical
- Flight control
- Fuel
- Hydraulic
- Gear
- APU
- Engine propulsion control system
- Engine performance
- Engine exceedance
- Configuration

All reports and maintenance pages listed above are downlinked the same way. The present leg fault report covered here is an example of the procedure.

Operational Sequence

To send a report or EICAS maintenance page, the CDU must first show the page you want to downlink. In our example, the PRESENT LEG FAULTS page shows.

Press the line select key next to the word REPORT to start the downlink. The CDU tells the operator the status of the downlink. The normal sequence of these status messages is:

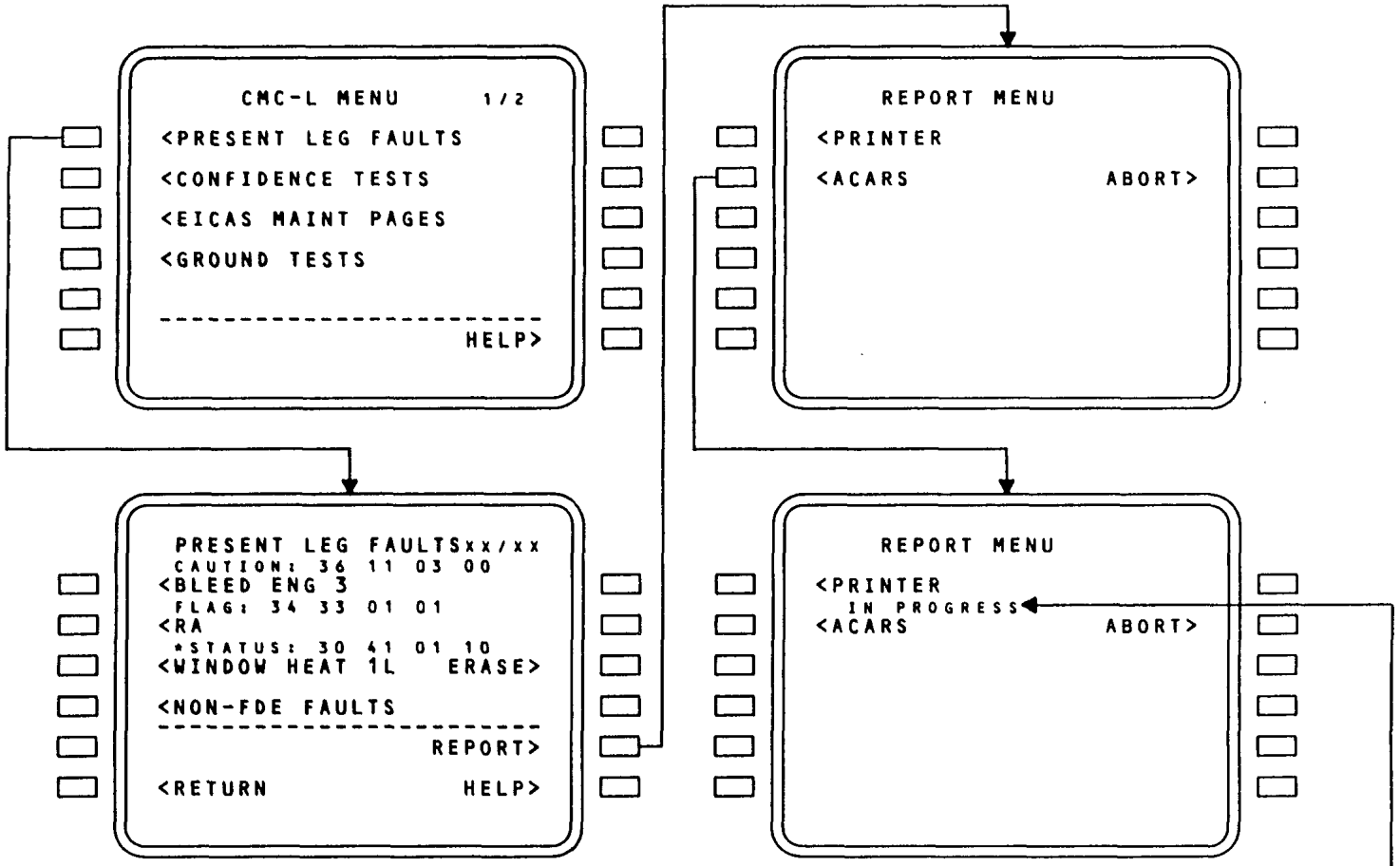
- IN PROGRESS
- COMPLETE TO MU
- COMPLETE TO GROUND

The CDU tells the operator of any faults that occur during the downlink. These fault messages are:

- NO RESPONSE: this message indicates the CMC has not properly sent the requested information to the MU.
- NO COM: this message indicates the VHF communications transceiver has not established a link with the ground station.
- MU FAIL

The CDU continues to show the report status message until:

- The downlink is cancelled, prior to completion, by pressing the line select key next to the word ABORT.
- An uplink ACARS report request has been received by the CDU, and the operator has paged away from the report menu page. If the operator re-selects the report menu page in this condition, the SERVICING UPLINK message will show.



POSSIBLE ANNUNCIATIONS:

1. IN PROGRESS - PRIORITY 3
2. COMPLETE TO MU - PRIORITY 4
3. COMPLETE TO GROUND - PRIORITY 4
4. NO RESPONSE - PRIORITY 3
5. NO COM - PRIORITY 2
6. SERVICING UPLINK - PRIORITY 3
7. MU FAIL - PRIORITY 1

Figure 17 PRESENT LEG FAULTS REPORT

EICAS MESSAGES

MEMO messages on the main EICAS display indicate operational difficulty or action required with the ACARS.

These MEMO EICAS messages can show:

- ACARS NO COMM indicates to the crew that there is a loss of ACARS communication between the airplane and the ground.
- ACARS CALL indicates to the crew that a message requesting voice communications has been received from the ground.
- ACARS MESSAGE indicates to the crew that an ACARS message has been received by the airplane.
- PRINTER MESSAGE indicates to the crew that an uplinked message has been sent to the printer.
- ACARS ALERT indicates to the crew that ACARS needs flight crew attention or action.
- ACARS VOICE BUSY indicates to the crew that the party on the ground with whom the flight crew desires voice communications cannot be reached because ground circuits are busy or his telephone is already in use.
- ACARS VOICE indicates to the crew that the VHF communications transceiver was operating in the voice mode when ACARS communications were interrupted.

If more than one of the above messages occur at the same time, they show in the order of priority determined by the ACARS MU.

POSSIBLE MESSAGES:

1. ACARS NO COMM
2. ACARS CALL
3. ACARS MESSAGE
4. ACARS VOICE
5. PRINTER MESSAGE
6. ACARS ALERT
7. ACARS VOICE BUSY

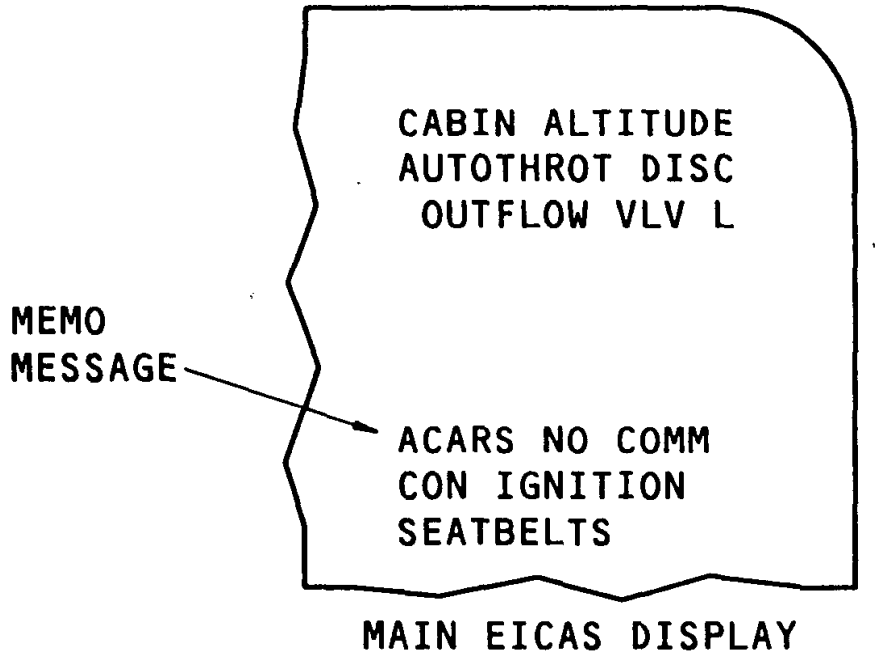


Figure 18 EICAS MESSAGES

ARINC 429 DATA INPUT SCHEMATIC

General

The ARINC 429 processor gets inputs which control and supply data to ACARS. The CPU module uses these inputs to perform the various ACARS functions.

ARINC 429 Inputs

The control display units (CDUs) send control and data information entered by the flight crew to the ACARS MU. Only one of the three CDUs can operate ACARS at a time.

The left and right flight management computers (FMCs) are connected to ACARS, but are not used at this time.

The left central maintenance computer sends information requested by the ACARS MU for downlink. This information can be reports like the present leg faults report.

The multi-input printer sends status information to ACARS during print operations.

The software data loader can update the ACARS software program. To allow this transfer of data, the software data loader panel sends an enable discrete to the discrete interface module when the select switch is in the ACARS position.

The airplane condition monitoring system data management unit (ACMS DMU) sends airplane systems information to ACARS to support various functions.

The left and right EFIS/EICAS interface units (EIUs) send airplane identification and 0001 status to ACARS.

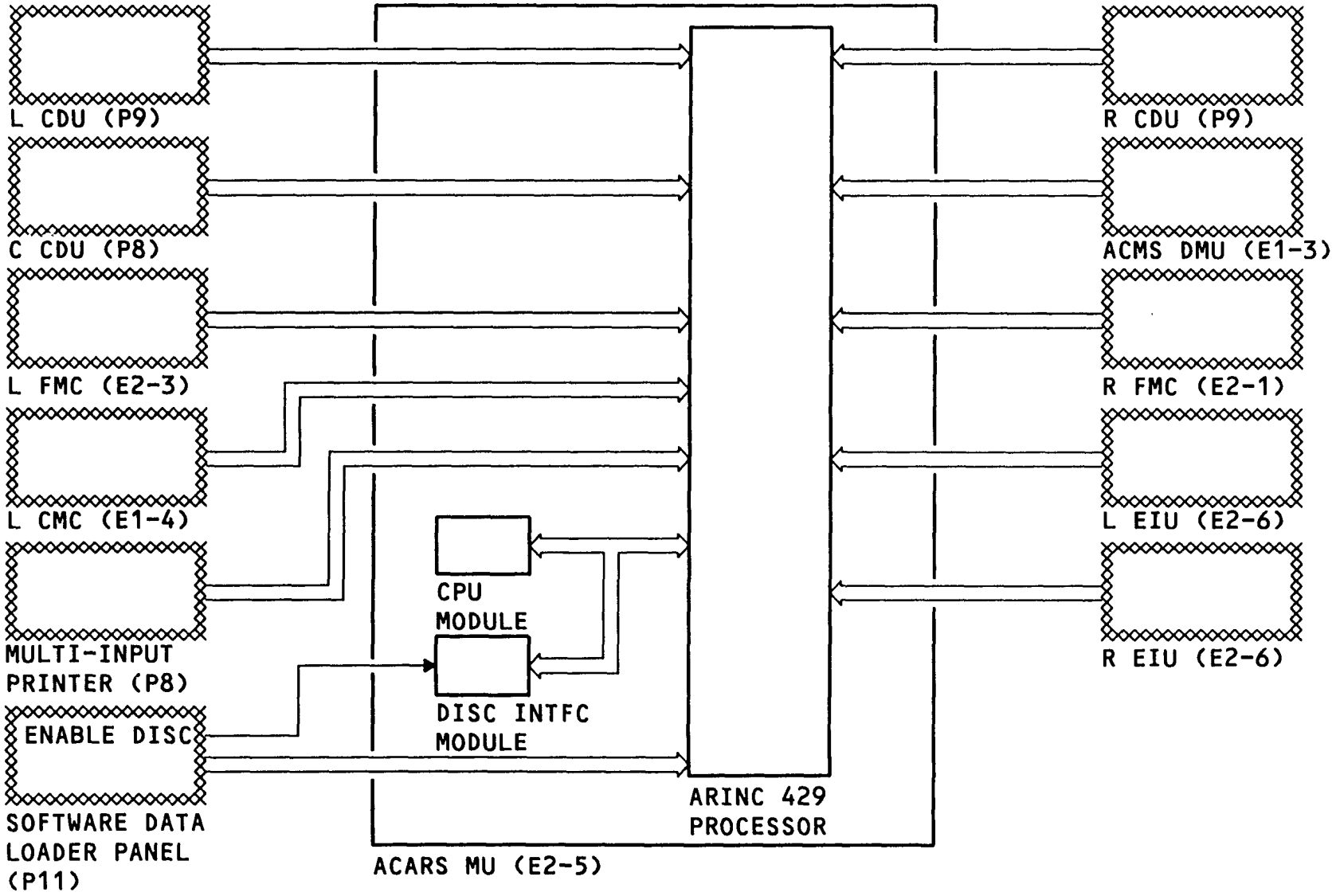


Figure 19 ARINC 429 DATA INPUT SCHEMATIC

ARINC 429 DATA OUTPUT SCHEMATIC

General

The ARINC 429 processor has both dedicated output buses and two general output buses. The CPU module controls all transfers of information.

ARINC 429 Outputs

The three control display units (CDUs) get display information from ACARS. This information is display formats and received messages.

The flight management computers (FMCs) are connected to ACARS, but do not use this data at this time.

The central maintenance computers (CMCs) get ACARS fault status and uplink requests for fault information.

The multi-input printer gets information like received messages to print out.

The software data loader gets handshaking data during a software program update.

The airplane condition monitoring system data management unit (ACMS DMU) gets requests for information from ACARS.

The modularized avionics and warning electronics assembly (MAWEA) gets ACARS status to send to the EIUs.

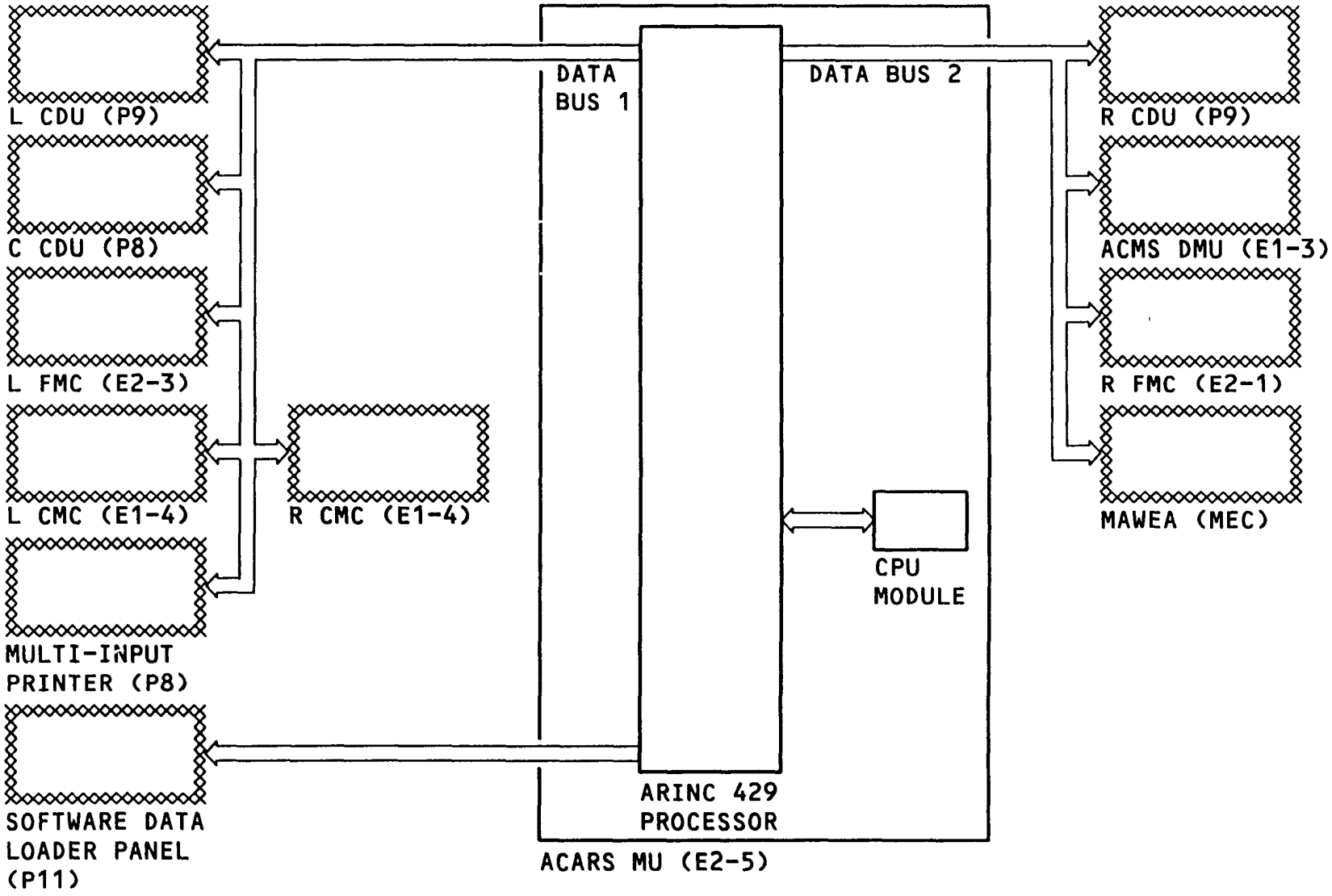


Figure 20 ARINC 429 DATA OUTPUT SCHEMATIC

VHF SCHEMATIC

The ACARS MU communicates with the ground with the following interfaces to/from the center VHF communications transceiver:

- Data out; 1200 and 2400 Hz tones carry the information encoded by the MU.
- Voice/data annunciation out; selects the voice or data mode of the VHF communications transceiver.
- Voice data monitor in; ACARS monitors the selection of voice or data mode.
- Data keyline; keys the VHF communications transceiver for a data transmission.
- Port select discrete; ACARS tunes the VHF communications transceiver through a dedicated port, selected by this discrete.
- Frequency; ACARS controls the frequency of the VHF communications transceiver using this data bus.
- VHF sidetone; ACARS listens for activity on a frequency with the sidetone input.
- Data in; 1200 and 2400 Hz tones carry information encoded by the ground station.

The radio communication panels (RCPs) send a remote voice/data select discrete to override ACARS when the transfer switch is pushed.

The RCPs have a program pin for dedicated ACARS operation. With this pin grounded, the word ACARS always shows in one of the RCP frequency displays, when selected to the center VHF communications transceiver.

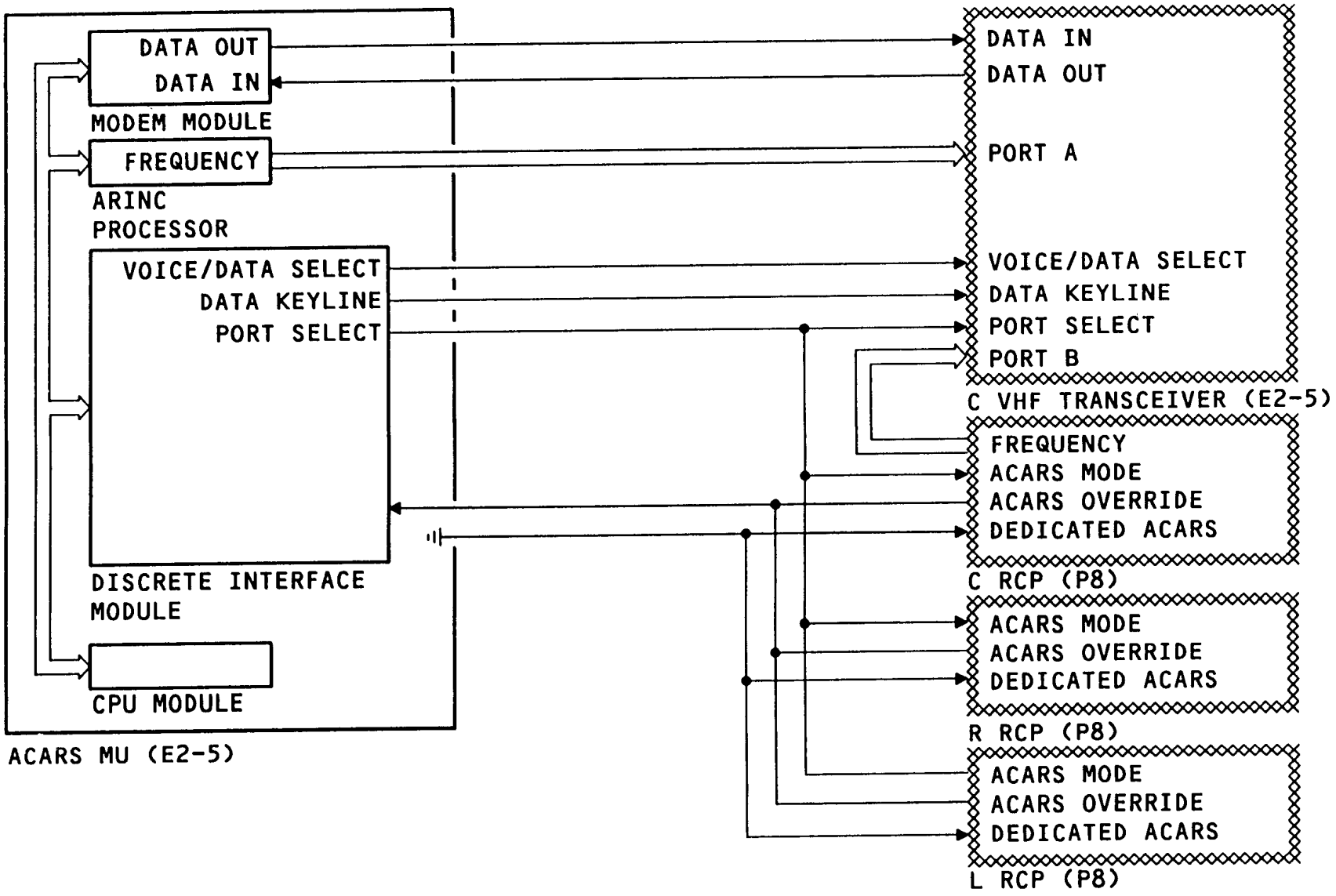


Figure 21 VHF SCHEMATIC

VOICE GO-AHEAD SCHEMATIC

When ACARS gets an uplink message with a request to establish voice communication, the MU sends out a voice go-ahead discrete. This discrete goes to the audio management unit, which tells the audio control panels (ACPs) to turn on the call light for the center VHF communications transceiver. The discrete also goes to the modularized avionics and warning electronics assembly (MAWEA), which sounds a low chime in the flight deck. Push the call light (transmit switch) on the ACP to reset the call light. If the transmit switch is already selected, push a PTT switch to reset the call light. This sends a discrete to the ACARS MU to cancel the voice go-ahead set output.

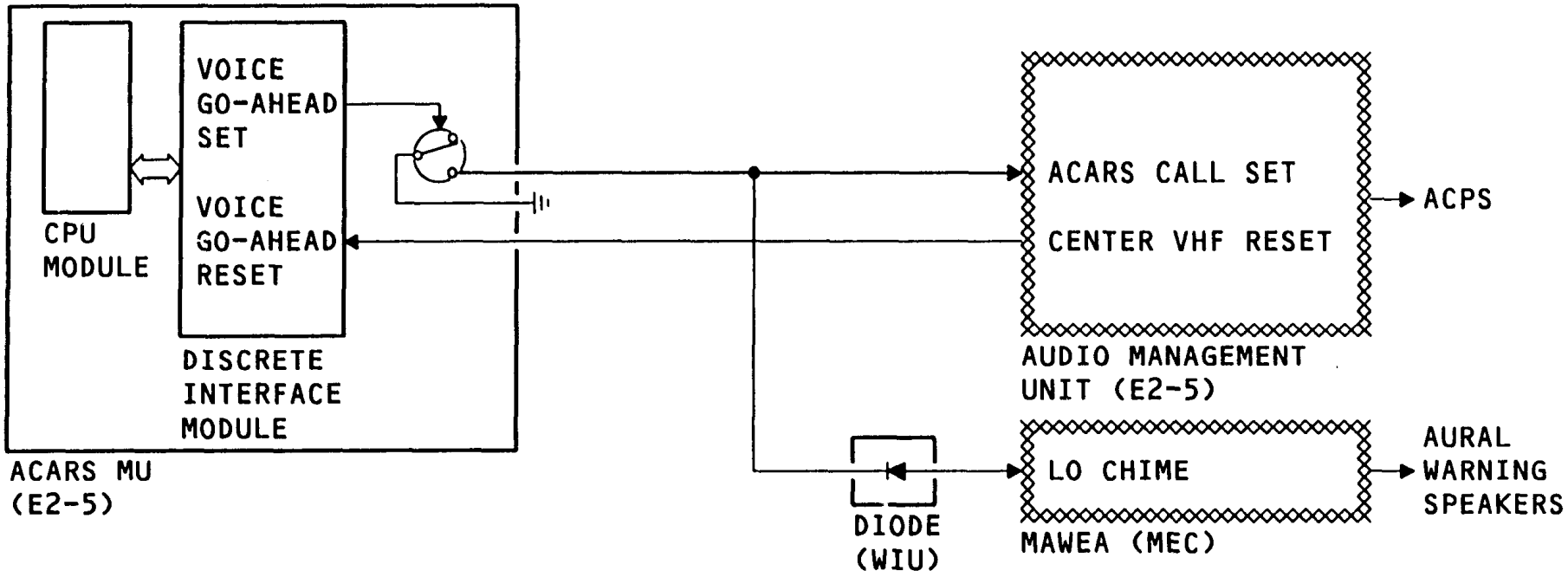


Figure 22 VOICE GO-AHEAD SCHEMATIC

ACARS MAINTENANCE PAGES

General

ACARS has maintenance pages and functions that help determine the operational status. A link test is done to test the entire data link capability.

Maintenance Pages

The ACARS maintenance pages show software configuration, BITE status, and allow tests to be run. To show the ACARS maintenance pages, select the ACARS MAIN MENU, and push the line select key next to the prompt MAINT. Next, push the line select key next to the prompt SYSTEM STATUS. The ACARS SYSTEM STATUS pages show the ACARS software part numbers and BITE status.

Link Test

A link test is done to check the operation of the ACARS data link. Push the link select key next to the prompt LINK STATUS on the MTNCE INDEX page. Push the line select key next to the prompt VHF DATA LINK on the ACARS LINK STATUS page to start the link test.

The link test is done in these steps:

- The ACARS MU transmits the downlink test message; up to six attempts are made to get an uplink reply from the ground station.
- The ACARS MU receives a test message uplink from the ground station.
- The ACARS MU sends out indications of a voice-go-ahead (low chime, and call light on the ACPs).

The airplane must be within range of an ARINC ground station to do the link test. If a link test is not successful, it may not be due to equipment failure. The airplane may be out of range or shielded from the ground station.

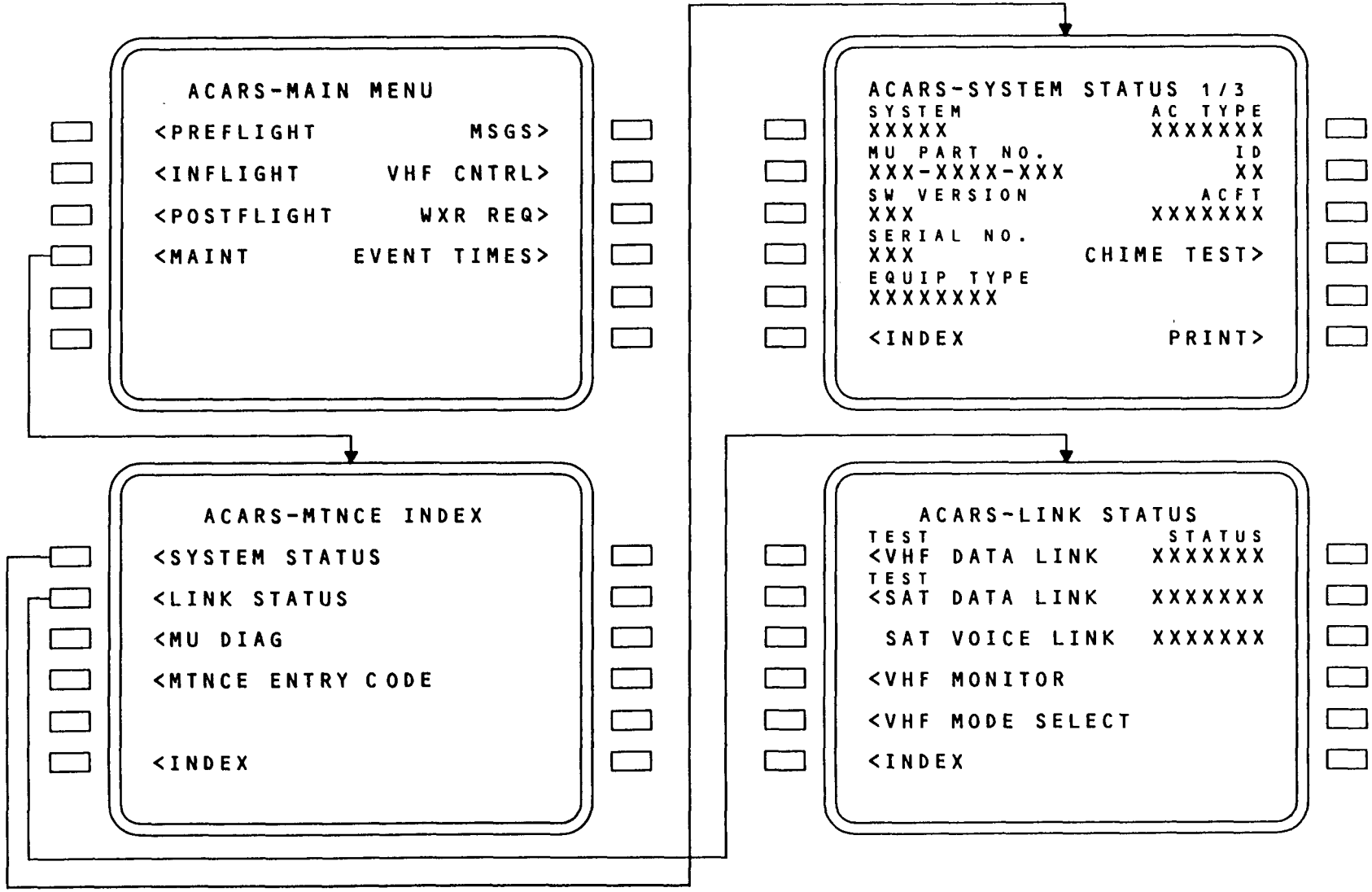


Figure 23 ACARS MAINTENANCE PAGES

SELF TEST

General

The ACARS MU has BITE which runs continuously to detect internal failures. The MU sends the fault status to the central maintenance computers (CMCs).

Test

Push the test switch on the front panel of the ACARS MU to run a test of the ACARS MU. Indications during test are:

- All LED status annunciators come on for three seconds.
- All LED status annunciators go off for three seconds.
- An LED status annunciator comes on to indicate the results of the test.

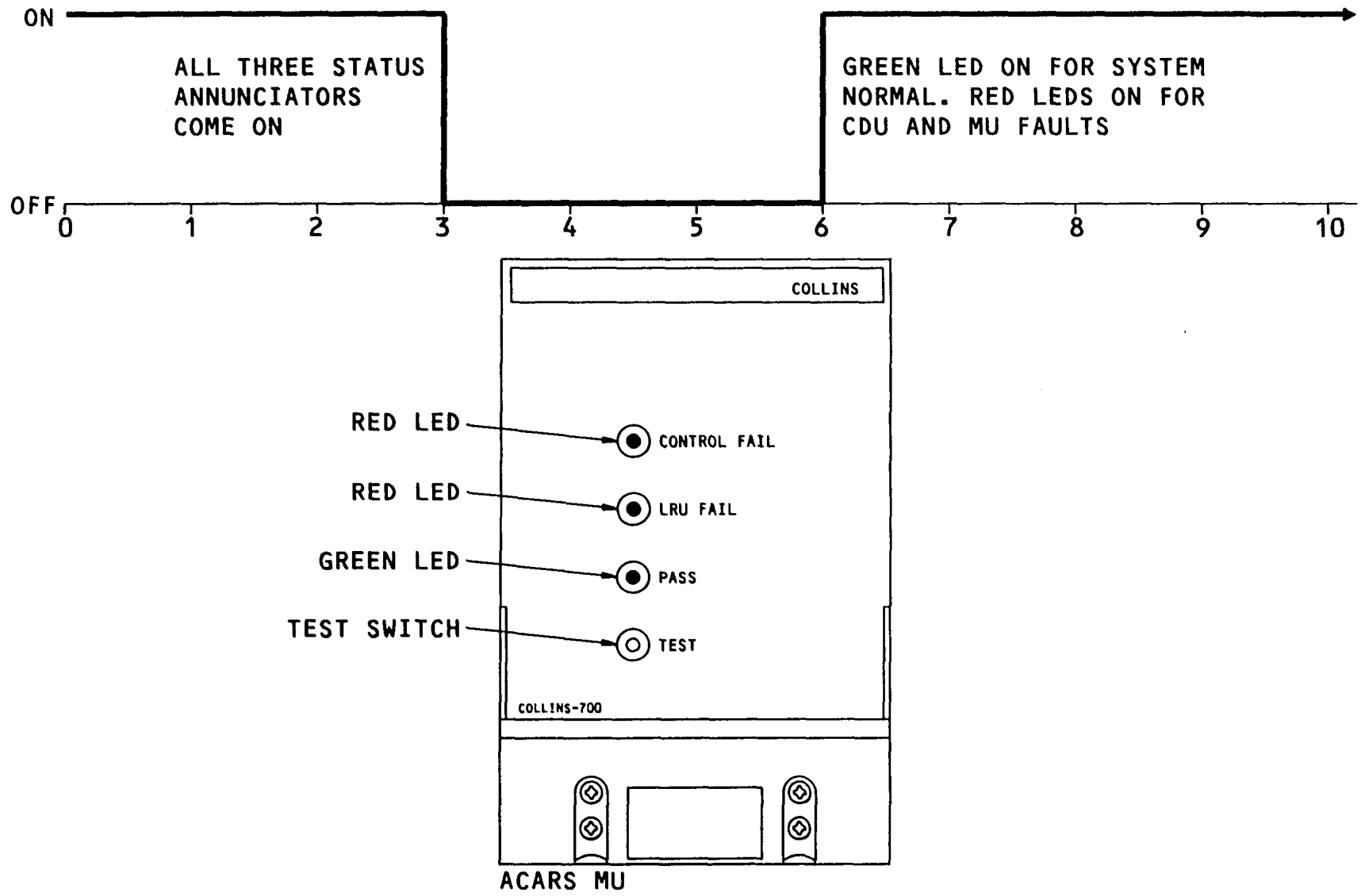


Figure 24 SELF TEST

FLIGHT DECK EFFECTS AND CMCS MESSAGES

General

This graphic is a summary of all maintenance related flight deck effects and CMCS fault messages associated with this system.

Flight Deck Effects

There are no flight deck effects for ACARS.

LRU Internal Fault Messages

These central maintenance computer system (CMCS) fault messages show when an LRU detects internal faults and reports them directly to the CMCS or EIUs:

- ACARS MU FAIL

Interface Fault Messages

The CMCS has logic to monitor the combination of interface faults reported to the CMCS. This logic determines the messages that show. The

CMCS fault messages associated with interface faults are:

- CMC--ACARS BUS FAIL
- CMC-L FAIL OR ACARS--CMC-L BUS FAIL
- CMC-R FAIL OR ACARS--CMC-R BUS FAIL
- ACARS--CMC BUS FAIL
- ACARS FAIL OR EIU-L/R--ACARS BUS FAIL
- CDU-L--ACARS BUS FAIL
- ACARS FAIL OR CDU-R--ACARS BUS FAIL
- CDU-C--ACARS BUS FAIL
- PRINTER--ACARS BUS FAIL
- DMU--ACARS BUS FAIL
- ACARS MU FAIL (NO BUS OUTPUTS)
- ACARS FAIL OR CDU-R--ACARS BUS FAIL

FLIGHT DECK EFFECTS	TYPE	DESCRIPTION
THERE ARE NO FLIGHT DECK EFFECTS FOR ACARS		

CMCS MESSAGES

LRU INTERNAL FAULT MESSAGES:

ACARS MU FAIL

INTERFACE FAULT MESSAGES:

CMC ~ ACARS BUS FAIL
CMC-L FAIL OR ACARS ~ CMC-L BUS FAIL
CMC-R FAIL OR ACARS ~ CMC-R BUS FAIL
ACARS ~ CMC BUS FAIL
ACARS MU FAIL (NO BUS OUTPUTS)
ACARS FAIL OR EIU-L ~ ACARS BUS FAIL
ACARS FAIL OR EIU-R ~ ACARS BUS FAIL
ACARS FAIL OR ACARS OUTPUT BUS 1 FAIL
ACARS FAIL OR ACARS OUTPUT BUS 2 FAIL
CDU-L ~ ACARS BUS FAIL
ACARS FAIL OR CDU-R ~ ACARS BUS FAIL
CDU-C ~ ACARS BUS FAIL
PRINTER ~ ACARS BUS FAIL
DMU ~ ACARS BUS FAIL

Figure 25 FLIGHT DECK EFFECTS AND CMCS MESSAGES

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