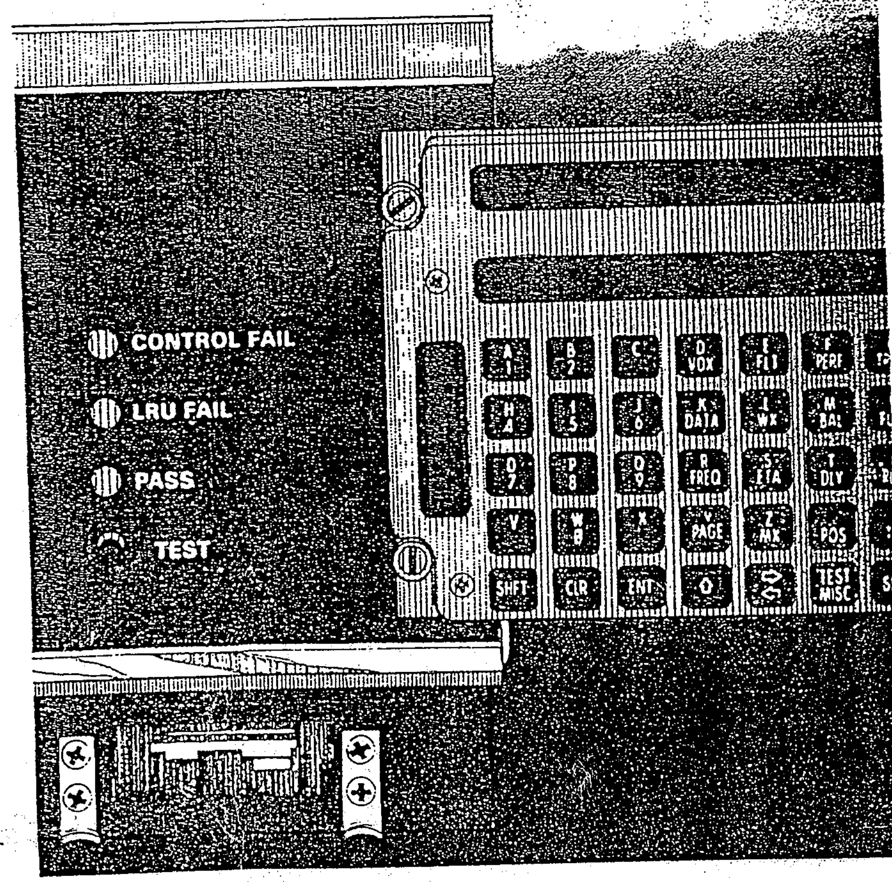
Rockwell International

instruction guide

Collins Air Transport Division

# What Is ACARS?



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# List of Illustrations





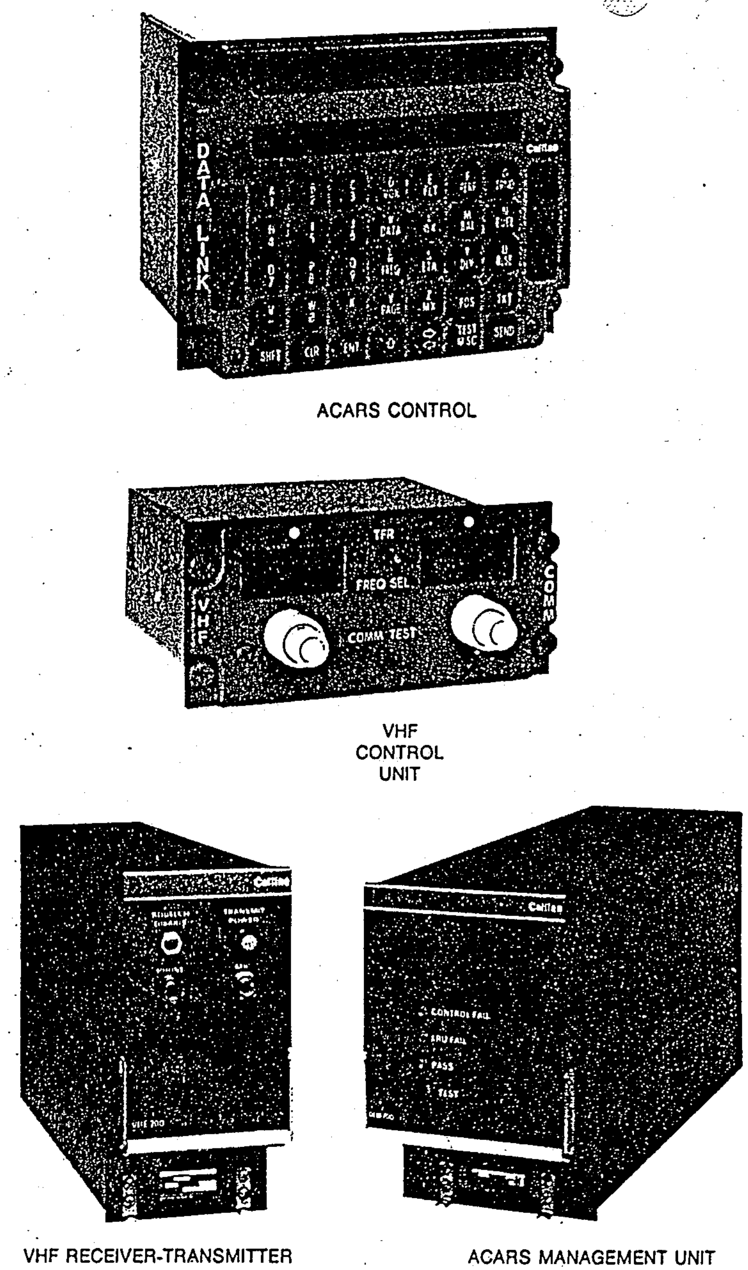
# Glossary

| | |
|---|---|
| ACARS | Abbreviation for ARINC communications addressing and reporting system. |
| ACK | ACK is the control character indicating technical acknowledgement of the previous uplink or downlink. |
| AFEPS | Abbreviation for ACARS front-end processing system. |
| AIDS | Abbreviation for aircraft integrated data system. |
| ARINC | Abbreviation for Aeronautical Radio, Inc. |
| ATCSS | Abbreviation for air traffic control signaling system. |
| BCS | Abbreviation for block check sequence. BCS is a cyclic code that is used as reference bits in an error detection process. |
| CU | Abbreviation for control unit. |
| Data Link | A system that allows exchange of digital data over an rf link. ATCSS is a data link system used by the air traffic control system. ACARS is a data link system used by airline command, control, and management system, using vhf communication frequencies. |
| DEFDARS | Abbreviation for digital expandable flight data acquisition and recording system. |
| Demand Mode | An ACARS mode of operation in which communications may be initiated by the ground processor or the airborne system. |
| DFDAU | Abbreviation for digital flight data acquisition unit. The DFDAU samples, conditions, and digitizes the flight data. |

| | |
|---|---|
| DFDR | Abbreviation for digital flight data recorder. The DFDR is the flight recorder with the crash-protected medium required by most countries on board large passenger-carrying aircraft. |
| Downlink | The radio transmission path downward from the aircraft to the earth. |
| FDEP | Abbreviation for flight data entry panel. The FDEP may allow recording of manual or other data from the cockpit, and also provide data display and system test and control functions of the DFDAU. |
| FMC | Abbreviation for flight management computer. |
| GMT | Abbreviation for Greenwich mean time. GMT is a universal time scale based upon the mean angle of rotation of the earth about its axis in relation to the sun. It is referenced to the prime meridian that passes through Greenwich, England. |
| LRU | Abbreviation for line replaceable unit. |
| MU | Abbreviation for management unit. |
| NAK | Control character indicating negative technical acknowledgement of the previous uplink or downlink. |
| NO COM | Abbreviation for no communication. A NO COM annunciation indicates that a downlink message has not been acknowledged (after several retransmissions). |
| OAT | Abbreviation for optional auxiliary terminal. The OAT may be in the form of a crt/keyboard device capable of interfacing with other sources of data on the aircraft and supplying data to a hard copy printer. |



| | |
|---|---|
| OOOI | Abbreviation for OUT-OFF-ON An event is recorded as part of the ACARS opera The OUT event is recorded when the aircraf clear of the gate and ready to taxi. The OFF event occurs when the aircraft has lifted off the runway. The ON event occurs when the aircraft has landed. The IN event occurs when the aircraft has taxied to the ramp area. |
| Polled Mode | An ACARS mode of operation in which the airborne system transmits only in response to received uplink messages (polls). |
| RTCA | Abbreviation for Radio Technical Commission for Aeronautics. |
| SMI | Abbreviation for standard message identifiers. |
| TEI | Abbreviation for text element identifiers. |
| Uplink | The radio transmission path upward from the earth to the aircraft. |
| VOX | Abbreviation for voice transmission. |




*Typical Airborne ACARS Subsystem*
*Figure 1*

# Introduction

A system to enhance the effectiveness of air/ground airline operational control communications has been considered for implementation since 1947. This type of information control system is most often referred to as a data link system. Currently, the data link system has been implemented in the form of ACARS. This instruction guide presents the theory and principles of ACARS operation, and answers common questions about ACARS or data link systems.

## What Is ACARS?

ACARS is an abbreviation for ARINC communication and reporting system. The system is designed to reduce the requirement of voice communications by reporting automatically the arrival and departure times of the aircraft and other operational flight data. The system uses an assigned vhf airborne frequency to transmit and receive data from a ground station that is similarly equipped.

## Why Use ACARS?

For many years it has been desirable to provide current up-to-date information to the aircrew without increasing the workload of voice communication systems. The ACARS allows the aircrew to send information such as departure time, arrival time, fuel status, and flight delay information to the airline command center. In essence, the ACARS system provides an information service to the aircrew and the airline command while still maintaining a manageable workload for the aircrew. Other benefits of ACARS would include ground monitoring capability of aircraft engines and other parameters, more efficient exchange of information concerning arrival and connecting flights, reduction of multiple frequency changes in the aircraft, and a more reliable aircraft selective calling system.



# The ACARS System

The ACARS system consists of an airborne subsystem and a ground-station network. The airborne ACARS subsystem consists of a vhf transceiver, vhf antenna, vhf control unit, an ACARS management unit (MU), and an ACARS control unit (CU). The ground-station network consists of a vhf ground station, a central processing computer, and a switching network connected to individual airline computer systems. Refer to figure 1 for a view of a typical airborne ACARS.

### VHF Communications Subsystem

ACARS uses or shares one of the vhf communications systems that exist aboard the aircraft. The vhf communications system consists of a vhf transceiver, a vhf antenna, and a vhf control unit. Currently, one frequency is assigned to ACARS operation (131.550 MHz). Additional frequencies will be assigned as the demand increases. For more details on vhf communications, refer to the Guide to HF/VHF Communications (CPN 523-0773795).

### Management Unit

The management unit receives the ground-to-air digital messages from the vhf transceiver, and controls the transmission of air-to-ground messages through the vhf transceiver. The management unit (MU) contains the circuits required to control peripheral devices and the transmission and reception of digital data, and to provide a continuous GMT clock for internal and external operations. The MU will also contain self-test circuits to verify the operation and reliability of the MU.

### Control Unit

The control unit provides the pilot interface with ACARS. The CU provides the necessary controls and switches to allow the pilot to enter the text portions of the departure/arrival reports, ETA reports, and the addresses of persons with whom voice communications are desired. The CU will also contain a display that can be used to review the previously mentioned text information and display flight number, radio frequency, GMT, and OOOI time events. The control unit is one of many sources of data with which the MU interfaces in ACARS.

### Printer

The printer provides a hard copy printout of data collected by the management unit. Data that will be printed includes uplinked printer messages and data entered into the CU not queued for transmission. Uplinked messages might include weather reports and dispatch messages.

### Optional Components

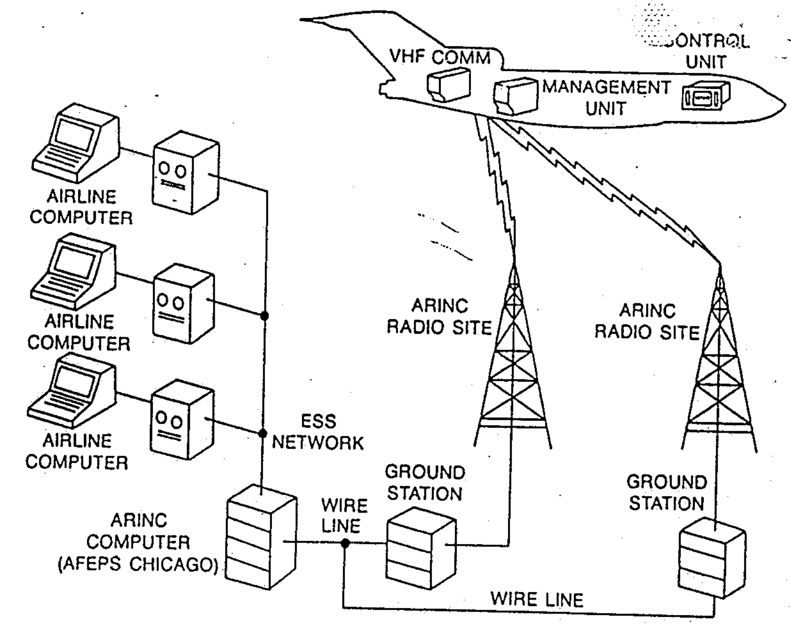
In addition to the system components previously mentioned, the MU is also capable of interfacing with other optional system components. These components could be an additional hard-copy printer, an optional auxiliary terminal (OAT), or an integrated data system (AIDS).

## ACARS Ground Facilities

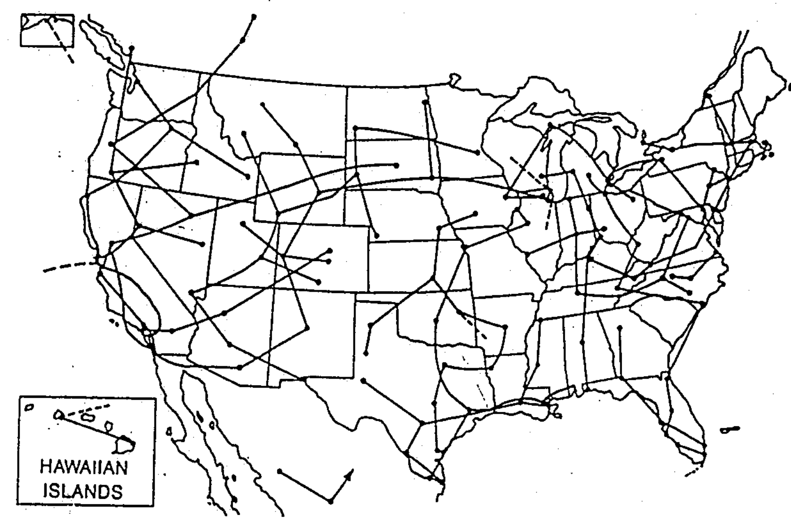
The ACARS ground facilities consist of a vhf radio station, a central computer processor (AFEPS), a switching system (ESS), and airline computer systems. Refer to figure 2 for a diagram of the ACARS system.

The ARINC electronics switching systems (ESS) network provides vhf radio coverage to enroute aircraft and terminal coverage at more than 150 airports in North America. The network covers all of the United States, some US possessions, and portions of Mexico and Canada. Figure 3 shows a map of the ACARS network coverage operated by Aeronautical Radio, Inc (ARINC).





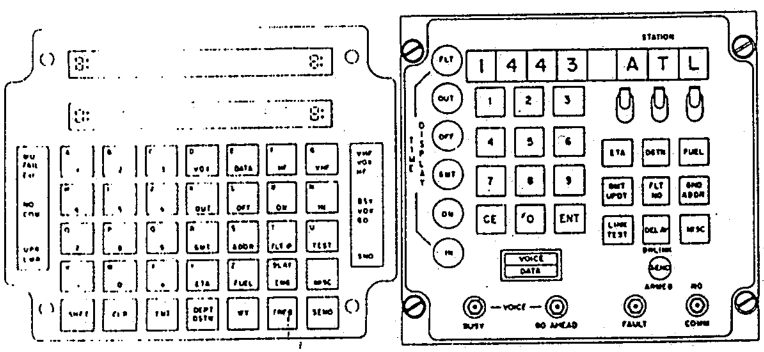

*ACARS System Diagram*
*Figure 2*




*ACARS Ground Facilities Coverage*
*Figure 3*

A description of the typical operation of an ACARS system is difficult because of the number of functions the ACARS system can perform currently, in addition to the number of functions that can and will be added in the future. The operation of the ACARS system is mostly automatic, because one of the purposes of the ACARS system was to reduce the workload of the aircrew. A description of the automatic functions is summarized in the principles of operation paragraphs.

The aircrew interfaces with ACARS through the control unit. The control unit provides a method for entering information into the data link system or displaying information which is uplinked or already exists within the airborne data link system. The control will contain an alphanumeric keyboard for entering information or responding to a function query. Refer to figure 4 for a view of examples of airborne ACARS control units. The control units for ACARS systems are typically designed to suit a particular user's system. Because of the many operations and messages the ACARS system is capable of reporting, the user often elects to utilize a few of these capabilities and the control unit is designed with these selected functions in mind.




*Typical Control Unit Layouts*
*Figure 4*



## Principles of ACARS Operation

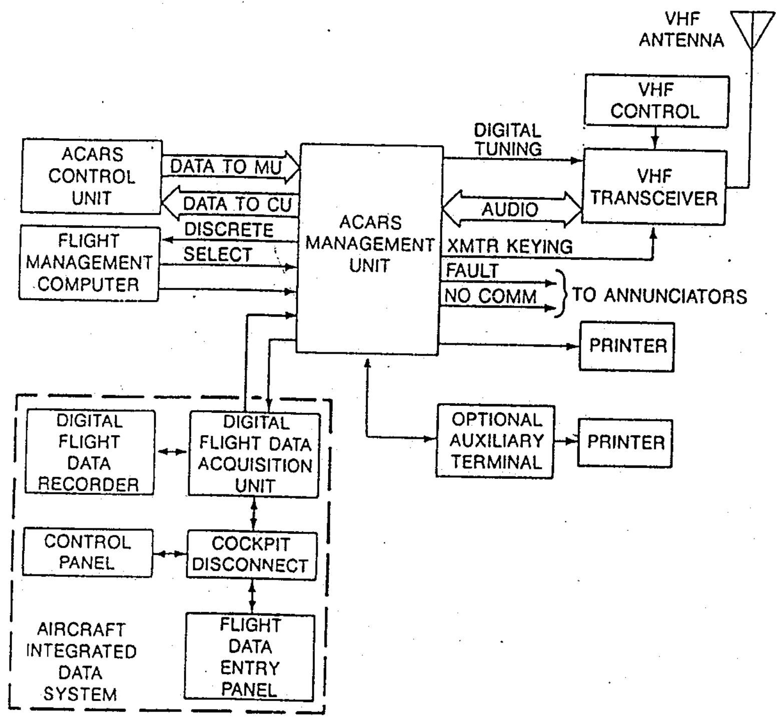
The ACARS network provides a general-purpose data link capable of handling a wide variety of messages. ACARS is a cooperative system that provides air-to-ground and ground-to-air voice and digital-data communications. The ACARS management unit provides control of the transmit and receive operations of the airborne system. The following paragraphs describe the operation of the airborne ACARS system.

### How ACARS Works

ACARS is an air/ground communication network that enables the aircraft to function as a mobile terminal associated with airline command, control, and management systems. Data concerning departure and arrival times, flight-delay information, fuel status, and other flight-related data are automatically collected or entered into the system via the control unit. The system utilizes the ISO alphabet no 5 character set with formats developed to be fully compatible with ATA/IATA protocols. Maximum message block length is 220 characters of text. Messages longer than one block are divided into a number of blocks which do not exceed the 220-character limit. The message format is composed of characters coded according to the 7-unit convention specified in ICAO. An eighth bit is added to each character to provide a parity bit.

The information is transmitted from the aircraft to an ACARS ground radio station via a data link transmitted at 131.550 MHz. The information is relayed to a central computer processor, where it is converted into airline operations messages. The airline operations messages are then sent to the respective airlines by the ARINC electronic switching system (ESS).

Refer to the block diagram of figure 5. The ACARS system operates in two modes: the demand mode and the polled mode. The demand mode allows either the airborne station or the ground processor to initiate communications. The airborne system will arm itself for transmission when a predefined event or a pilot-entered command to transmit occurs. The management unit will then transmit messages after the MU determines the ACARS channel is free of communications traffic. If there is traffic on the ACARS channel, the system will wait for the traffic to clear before transmitting the message. If two or more airborne systems select the same instant to transmit, the message[illegible]l be garbled. But subsequent retransmissions of the messages will be transmitted at random intervals, avoiding a synchronization of the transmissions.




*Airborne ACARS Subsystem Block Diagram*
*Figure 5*

Upon receiving the transmission, the ground station processor performs a block check sequence (BCS) error check. If the message is free from errors, the processor routes the message to its proper destination. The ground-station processor also generates an acknowledgement signal (ACK) which notifies the airborne system to clear the original message and return to normal operations. If the message is not free from errors, no acknowledgement signal will be sent and the airborne system will retransmit the message. If after six attempts the message is not acknowledged, the airborne system will alert the aircrew. A similar process occurs for uplink transmissions (ground-to-air transmissions). However, if the uplink message is found to contain errors, a negative acknowledgement (NAK) is sent for the downlink message.



The polled mode allows only the ground processor to i[illegible]te communications. During the polled mode, the airborne ACARS system may respond to received uplink messages (polls) only. Once the airborne system is in the polled mode, the ground processor maintains continuous communications with the airborne system by transmitting general polls to it. When the radio channel is clear, the airborne system will respond to these polls or, if no messages are present, will respond with the polled mode general response. BCS error checks are performed on all messages (uplink and downlink) and an acknowledgement message (ACK or NAK) is generated to be included in the next transmission. The ground processor will command the airborne system to transfer to the demand mode of operation by transmitting a demand-mode general response. An airborne system operating in the polled mode will automatically enter the demand mode when the ON event occurs (aircraft landed).

The ACARS management unit acts as an organizer or formatter for all the flight data that is sampled during the course of the flight. The MU collects data from the control unit, aircraft sensors, and OOOI event sensors. The OOOI event sensors determine the arrival, departure, and flight times of the air flight. The MU generates a GMT clock which is used in recording the time of the OOOI events. Upon request of the ground processor, the flight information accumulated from the flight management computers (FMC), the aircraft integrated data system (AIDS), and flight-entry terminals in the cockpit is formatted into a digitally coded signal that will be transmitted to the ground processor by the vhf transceiver.

All ground-to-air (uplink) transmissions are monitored by the MU to determine the address of the uplink message. The address identifies the destination of the message by aircraft registration mark or flight number. The aircraft registration mark is identified by a unique strapping of the aircraft's wiring harness. The flight number is entered into the MU memory by the aircrew prior to the flight. The MU will not react to any uplink messages unless the registration mark or flight number of the address matches the aircraft designation.

ACARS as currently defined uses a line-of-sight vhf radio frequency of 131.550 MHz. Additional frequencies may be added as the demand increases. There is an interest in using ACARS in the hf frequency range to extend the digital ground/air data service to oceanic flights, but at the time of publication the hf ACARS system characteristics are still being defined.

## How the Ground Network Works

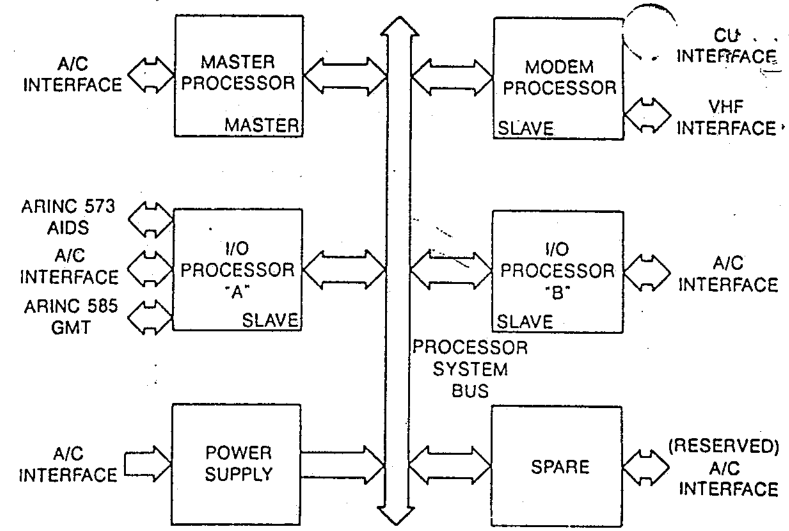
Downlink transmissions from an airborne ACARS unit, received by one or more of the remote site radio terminals, are demodulated at the radio terminal and stored in a local memory buffer. The central processor, known in the USA as AFEPS (ACARS front-end processing system), sequentially interrogates each radio terminal buffer to gather the received messages. The message structure is the same as the message structure in the radio link. Messages between the AFEPS and the ESS utilize the ATA/IATA synchronous link-control protocol. Each message consists of the necessary addressing and routing information, plus the free text (if utilized), with the message structure arranged in accordance with the standard message identifiers (SMI) and text element identifiers (TEI). The AFEPS performs all functions associated with communications line control, link control, message format conversion, message queuing, and network monitoring. The AFEPS both receives and transmits messages from ESS.

## How the Airborne Management Unit Works

The management unit is a processor of data received from many sources. The management unit must also be capable of future expansion as the data link system functions are expanded. For this reason, the management unit is basically a central computer or processor that interfaces with various other data processors. These data processors are slaved to the master processor so that the master processor can assemble all the flight data, organize it, and format the data without conflicts occurring within the unit. Refer to figure 6 for a simplified block diagram of a typical ACARS MU.

The master processor uses bus arbitration logic to communicate with the slaved processors. This form of handshaking control allows the master processor to read data from the slave and transfer it to the master processor's memory. In addition, the master processor generates a continuous, accurate GMT clock for both external and internal use and communicates with the control unit. Display and keyboard information is received via the serial input bus and held in a data buffer. Once the data buffer is filled, the master processor performs an error check on the display information. The master processor controls the CU display by constructing and then transmitting data to the CU on a serial output bus. The display information includes bits assigned to annunciate MU or CU failures.






*Management Unit Block Diagram*
*Figure 6*

The I/O processors are used to monitor the OOOI event inputs and to access strapped information from the aircraft wiring system. This information includes the aircraft registration mark, airline identification, OOOI sensor program pins, and management unit program pins. The I/O processors are also used to pass GMT information to the control unit for display or to a serial output bus for use outside the data-link system. In the block diagram, I/O processor B is used in ACARS systems designed to comply with ARINC specification 724. The I/O processor B interfaces the data-link system with a weather radar indicator (ARINC specification 708), vhf communications system (ARINC specification 716), a flight-management computer (ARINC specification 702), an aircraft integrated data system (ARINC specification 717), and an electronic chronometer equivalent output (ARINC specification 731).

The modem processor is used to interface the data-link system with the vhf communications system. The modem processor would consist of a demodulator and modulator through which the uplinked and downlinked messages are coded or decoded. The modem processor also must examine the uplink messages for proper parity, proper address (valid flight number or aircraft identification) and BCS code.

# Character Codes and Message Text Formats

This section of the instruction guide defines the character codes and message text formats used in ACARS.

## Character Codes

Character codes are 7-bit characters with an eighth bit added later for parity. Figure 7 shows the standard 7-unit code. The following is a key to the 7-unit coded character set.

| | |
|---|---|
| ACK | Acknowledge |
| BEL | Bell |
| BS | Backspace |
| CAN | Cancel |
| CR | Carriage return |
| DC | Device control |
| DEL | Delete |
| DLE | Data-link escape |
| EM | End of medium |
| ENQ | Enquiry |
| EOT | End of transmission |
| ESC | Escape |
| ETB | End of transmission block |
| ETX | End of text |
| FF | Form feed |
| FS | File separator |
| GS | Group separator |
| HT | Horizontal tabulation |
| LF | Line feed |
| NAK | Negative acknowledge |
| NUL | Null |
| RS | Record separator |
| SI | Shift in |
| SO | Shift out |
| SOH | Start of heading |
| SP | Space |
| STX | Start of text |
| SUB | Substitute |
| SYN | Synchronous idle |
| US | Unit separator |
| VT | Vertical tabulation |

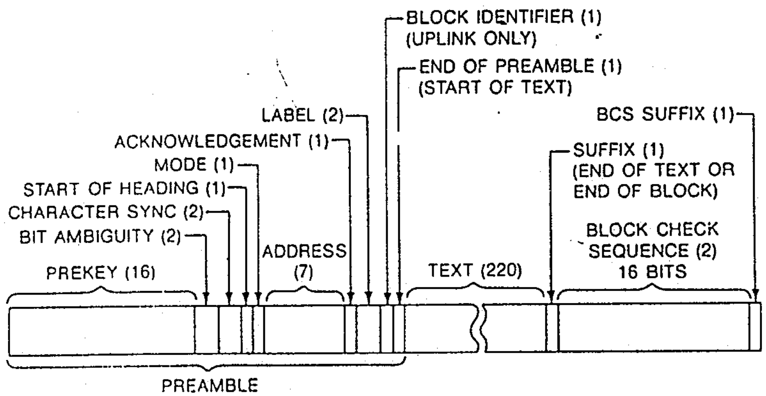


| Bits | | | | $b_7$ $b_6$ $b_5$ → | 0 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1 0 0 | 1 0 1 | 1 1 0 | 1 1 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $b_4$ ↓ | $b_3$ ↓ | $b_2$ ↓ | $b_1$ ↓ | Column → / Row ↓ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 0 | 0 | 0 | 0 | NUL | DLE | SP | 0 | @ | P | ` | p |
| 0 | 0 | 0 | 1 | 1 | SOH | DC1 | ! | 1 | A | Q | a | q |
| 0 | 0 | 1 | 0 | 2 | STX | DC2 | " | 2 | B | R | b | r |
| 0 | 0 | 1 | 1 | 3 | ETX | DC3 | # | 3 | C | S | c | s |
| 0 | 1 | 0 | 0 | 4 | EOT | DC4 | $ | 4 | D | T | d | t |
| 0 | 1 | 0 | 1 | 5 | ENQ | NAK | % | 5 | E | U | e | u |
| 0 | 1 | 1 | 0 | 6 | ACK | SYN | & | 6 | F | V | f | v |
| 0 | 1 | 1 | 1 | 7 | BEL | ETB | ' | 7 | G | W | g | w |
| 1 | 0 | 0 | 0 | 8 | BS | CAN | ( | 8 | H | X | h | x |
| 1 | 0 | 0 | 1 | 9 | HT | EM | ) | 9 | I | Y | i | y |
| 1 | 0 | 1 | 0 | 10 | LF | SUB | * | : | J | Z | j | z |
| 1 | 0 | 1 | 1 | 11 | VT | ESC | + | ; | K | [ | k | { |
| 1 | 1 | 0 | 0 | 12 | FF | FS | , | < | L | \ | l | \| |
| 1 | 1 | 0 | 1 | 13 | CR | GS | - | = | M | ] | m | } |
| 1 | 1 | 1 | 0 | 14 | SO | RS | . | > | N | ∧ | n | ~ |
| 1 | 1 | 1 | 1 | 15 | SI | US | / | ? | O | — | o | DEL |

*Standard 7-Unit Code*
*Figure 7*

# Uplink/Downlink Message Formats

The format of the uplink and downlink messages consists of a preamble, text, and block check sequence. Refer to figure 8 for a diagram depicting the uplink message format. The numbers in parentheses adjacent to each function name in figure 8 indicate the number of characters used to implement that function. The following paragraphs describe the various portions of the uplink and downlink messages.




*Message Format*
*Figure 8*

**Preamble**

The preamble consists of the prekey, address, mode, acknowledgement, label, SOH character, bit ambiguity characters, character sync, uplink block identifier, and end of preamble character functions. The preamble identifies the message and the process to be performed, and provides synchronization of the message.

Prekey

The prekey consists of 16 characters, with each character represented by 7 bits of logic 1's. The prekey allows the MU to establish bit and character synchronization with the transmitted data. Parity rules are waived for the characters in this function.



Bit Ambiguity

The bit ambiguity function consists of two characters (+, *) that are transmitted to assure that the process (bit resolution) of identifying character bits is operating properly.

Character Synchronization

Two consecutive synchronization characters (SYN) are transmitted to establish character synchronization.

Start of Heading (SOH)

A start-of-heading character is transmitted to indicate the start of the message heading. It also indicates the start of the block check sequence (BCS), but will not be included among the characters on which the check is based.

Mode

The mode character is transmitted to assure conformance with RTCA (Radio Technical Commission of Aeronautics) standard message structure. Currently, the mode character performs no system function. However, as part of future growth of the system, this character will allow the MU to differentiate between system functions.

Address

The address portion of the uplink message identifies the destination of the message. The destination may be identified by the registration mark of the aircraft or the flight number. The MU performs a recognition of own address procedure and will inhibit any further processing of the message (and cancel any processing already initiated by the SOH character) should the address not match the aircraft identification. The address portion of the downlink message identifies the aircraft originating the downlink.

Acknowledgement

The acknowledgement character is used to indicate that the receiving terminal has received a valid uplink or downlink message. The MU clears from memory store the last downlinked message, after receipt of the ACK character. Upon receipt of the NAK character, the ground network will cause the retransmission of the last uplinked message. Receipt of a NAK indicates that the aircraft has received a correct address but the BCS check has failed.

Label

The label consists of two characters that identify the message type and routing. The MU determines which function to perform by reference to the label. Labels are divided into two categories: system-essential labels and service-related labels. The first category concerns the operations of the system as a digital-communications system. The second category relates to service functions performed by the system. An airborne subsystem may recognize, respond to, or generate as many or as few of the service-related labels as the user (airline) specifies. Figure 9 shows a table of system-essential labels and the functions which correspond to each label. Figure 10 shows a table of service-related labels and the functions which correspond to each label.

| LABEL | FUNCTION |
|---|---|
| — j | General poll/response (no information to transmit) |
| — DEL | General response demand mode |
| 54 | Ground party address (downlink)/voice go-ahead (uplink) |
| Q4 | Voice circuit busy |
| Q5 | Unable to deliver uplinked messages |
| Q6 | Voice to ACARS channel changeover |
| :; | Data transceiver automatic tuning |
| 5P | Temporary suspension |

*System-Essential Labels*
*Figure 9*



| LABEL | FUNCTION | LABEL | FUNCTION |
|---|---|---|---|
| Q0 | Link test | H1 | OAT message |
| Q1 | Departure/arrival report | C1 | Optional cockpit printer message |
| QA | Out/fuel report | F3 | Dedicated data transceiver advisory |
| QB | Off report | CA | Error in printer |
| QC | On report | CB | Printer busy |
| QD | In/fuel report | CC | Printer in local test mode |
| QE | Out/fuel/destination report | CD | Printer out of paper |
| QF | Off/destination report | CE | Printer buffer overrun |
| QG | Out/return in report | CF | Unassigned |
| QH | Out report | RA | Command/response uplink |
| Q2 | ETA report | RB | Command/response downlink |
| Q3 | GMT clock update | 5D | ATIS request |
| 51 | Ground GMT request/delivery | 5R | Aircrew-initiated position report |
| Q7 | Delay message | 5Y | Aircrew revision to previous ETA or diversion |
| 5Z | Airline designated downlink | 00 | Emergency-situation report |
| 5U | Weather request | QL | Arrival report |
| 7A | Aircrew-initiated engine data takeoff thrust report | QN | Diversion report |
| 7B | Aircrew-entered misc message | | |
| QK | Landing report | | |
| QM | Arrival information report | | |

*Service-Related Labels*
*Figure 10*

Uplink Block Identifier

The ground-based processor changes the bit pattern in this character position each time a general response or new message is uplinked to the aircraft. The function of the uplink block identifier character is to enable the airborne system to detect duplicate messages or message blocks.

End of Preamble

The end of the preamble is indicated by the ETX character for messages containing no text; by STX for messages in which text is present.

### Text

The text, when present, will be transmitted in a block not exceeding 220 characters in length. Free talk is included among the text characters after the transmission of service-related reports such as the departure/arrival report. Free talk allows other messages to be included in the text field when the text field would otherwise contain far fewer than 220 characters.

### Suffix

The suffix character indicates the end of the text (ETX) or the end of a message block (ETB) in multiblock messages. In multiblock messages, all text blocks will be terminated with the control character ETB except for the final block, which will be terminated with ETX.

### Block-Check Sequence

The block-check sequence portion of the message format uses 16 reference bits in an error-detection process. This error-detection process controls the generation of ACK or NAK characters. The BCS is initiated by, but does not include, the SOH character and is terminated by, and does include, the ETB or ETX character.

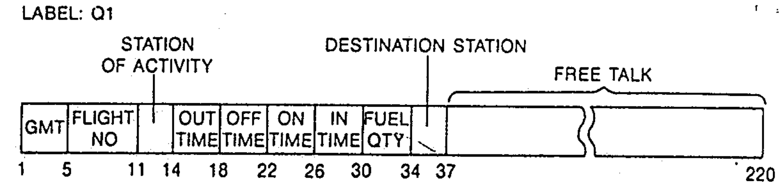
## Command/Response Message Text Formats

Aircraft movement data, OOOI events, and GMT data are transmitted automatically from the aircraft without need of pilot intervention. The flight crew may also enter manually into reports, the flight number, destination, final load, ETA updates, and more, depending upon the system design. This information is transmitted in reports identified by the labels of figure 10. The formats of the text field contents are defined by the system user (airline).

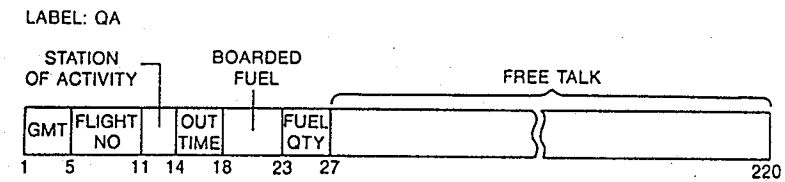
## Downlink Message Formats

There are two groups of ACARS functions. These two groups are the system-essential group and the service-related group. System-essential downlink labels are listed in figure 9, and service-related downlink labels are listed in figure 10. The text fields of the reports transmitted in these messages must adhere to a prescribed format. The following diagrams, figures 11 through 25, illustrate a few of the formats used in downlink service-related messages. The numbers appearing below each text field represent a character position.

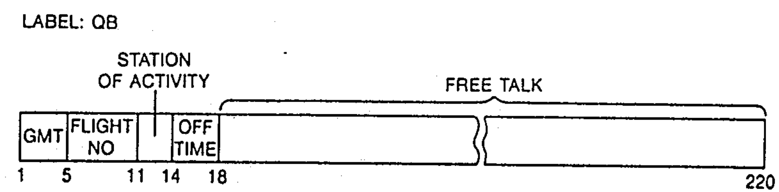




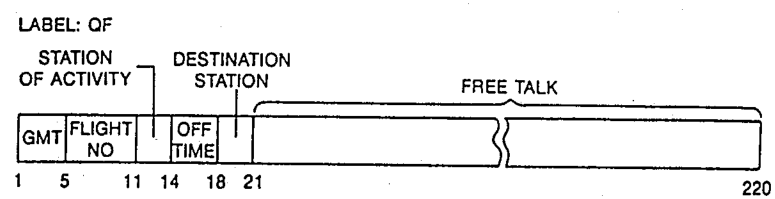

*Departure/Arrival Report Message Format*
*Figure 11*



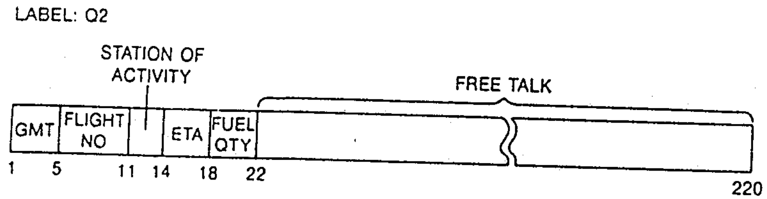

*OUT/Fuel Report Message Format*
*Figure 12*



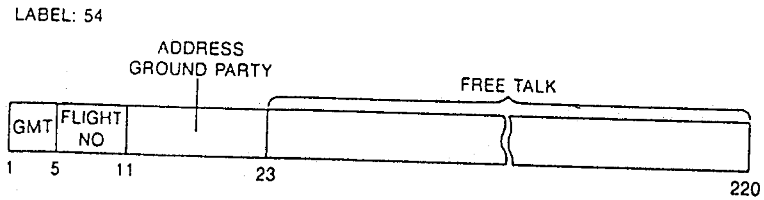

*OFF Report Message Format*
*Figure 13*



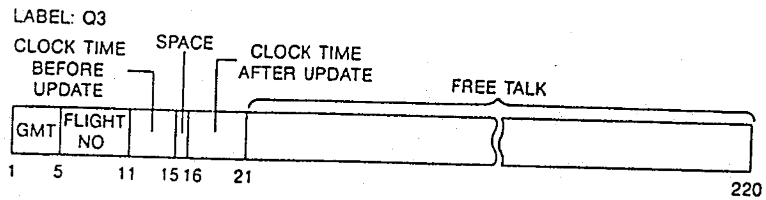

*OFF/Destination Report Message Format*
*Figure 14*



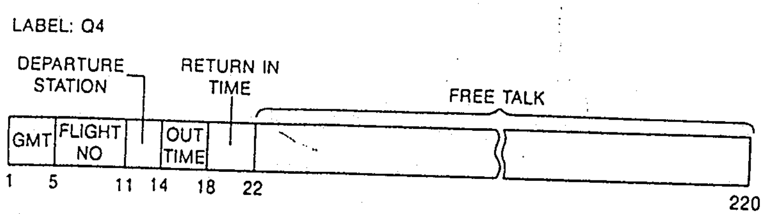

*ETA Report Message Format*
*Figure 15*




*Voice Contact Request Message Format*
*Figure 16*

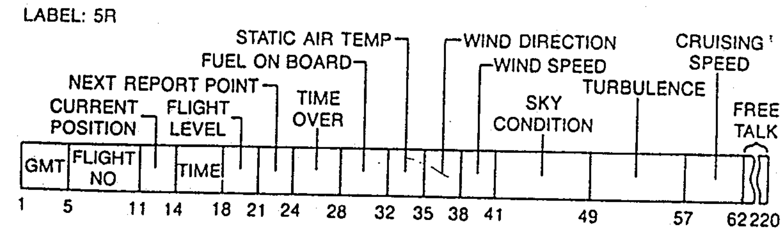



*Clock Update Advisory Message Format*
*Figure 17*

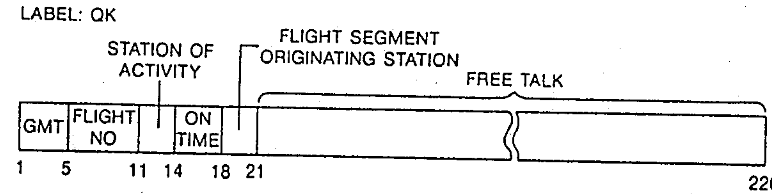



*OUT/Return In Report Message Format*
*Figure 18*

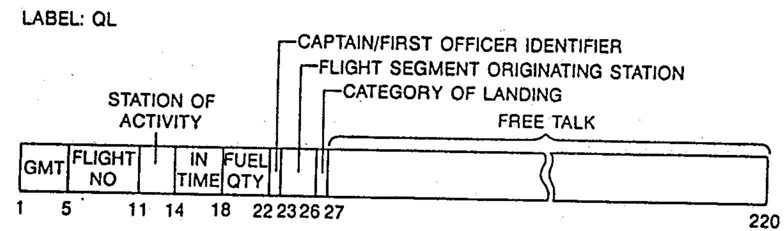




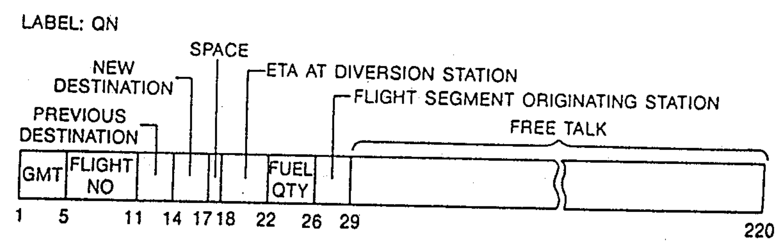

*Aircrew-Initiated Position Report Message Format*
*Figure 19*



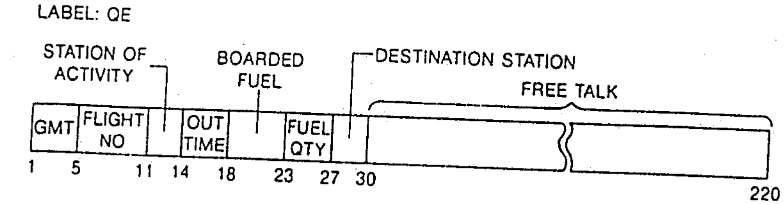

*Landing Report Message Format*
*Figure 20*



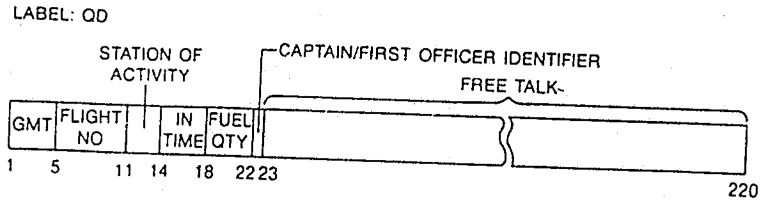

*Arrival Report Message Format*
*Figure 21*



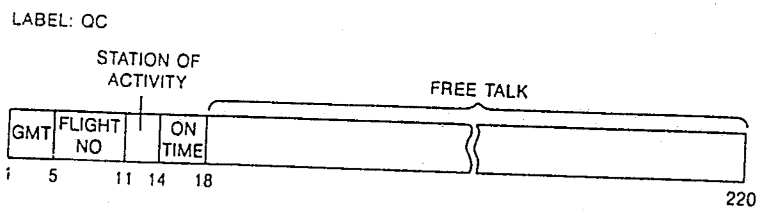

*Diversion Report Message Format*
*Figure 22*




*OUT/Fuel/Destination Report Message Format*
*Figure 23*




*IN/Fuel Report Message Format*
*Figure 24*




*ON Report Message Format*
*Figure 25*



# Troubleshooting

The most important aspects of troubleshooting a system are to understand the operation of the system and to determine the state of operation at the time of failure. It is much easier to locate the faulty unit when all the operating conditions have been defined. Basically, troubleshooting a system is a process of elimination. The technician must determine which units within the system are functioning and then eliminate those units from the list of suspected faulty units.

The ACARS system is a data-gathering system, so if a unit fails, the first thing to be determined is whether all the data input/output lines are operational and system power is present. If the input/output lines are operational, the next step should be to check the timing circuits and operation of the microprocessor within the suspected faulty unit. Timing errors, improperly matched bus lines, and marginal power supplies account for most of the failures observed in digitally based equipment. A marginal power supply will cause many integrated circuits to function erratically.

Much of the data gathered by the management unit (MU) originates from transducers or switch sensors. If the system is failing to report a certain monitored condition, the appropriate sensor should be checked. In addition, connectors between the sensor and the MU should be checked for corrosion and proper mating. Another possibility to check would be the existence of an improper ground or an interruption of power to the sensor.

If the observed fault condition does not easily identify a particular unit within the system, the operation of the MU should be checked before checking the operation of peripheral system components. Once the operation of the MU has been verified, trace the input or output lines to the peripheral device and verify the operation of the peripheral device and the connecting lines. Once again, check the connectors for proper mating or for signs of corrosion. Also ensure that the connecting lines are properly insulated.

The troubleshooting hints discussed so far do not cover all possible problems, but do indicate the type of information and troubleshooting clues that should be looked for. More specific troubleshooting aids are presented in the maintenance manuals of each particular component within the ACARS airborne subsystem.

# Questions and Answers

This section of the instruction guide is intended to answer commonly asked questions about ACARS operation and principles.

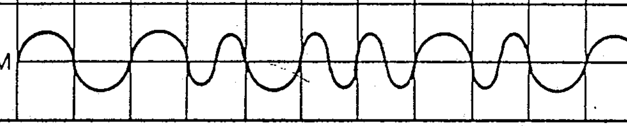
**Q. What specifications govern ACARS performance?**

A. The ACARS system performance is defined in ARINC characteristics no 597 and 724. These documents define the performance parameters of the airborne ACARS subsystem. The difference between ARINC characteristic 597 and ARINC characteristic 724 is the performance requirement contained in ARINC characteristic 724 which requires that the management unit be able to interface with flight management computers conforming to ARINC characteristic 702, aircraft integrated data systems (AIDS) conforming to ARINC characteristic 717, weather radar indicators conforming to ARINC characteristic 708, and an aircraft network controller (ANC). The limits of the airborne ACARS subsystem operating environment are defined in RTCA document DO-160A or Eurocae documents ED-14A and ED-35. The transfer of digital data between avionics systems is defined in ARINC characteristic 429.

**Q. How is the digital data encoded for transmission?**

A. The digital data from the ACARS subsystem is differentially encoded to provide the modulation signal for the vhf transceiver. Data 1's and 0's are encoded by differentially encoding 1200-Hz and 2400-Hz tones. Data 1's are represented by the negative half-cycle of the 1200-Hz tone and data 0's are represented by the positive half-cycle of the 1200-Hz tone. To provide a continuous waveform during transmission, the 2400-Hz tone is transmitted to indicate that there is no bit change. Refer to figure 26 for an example of the ACARS encoded subcarrier waveform. A demodulator at the receiving end of the signal decodes the modulated analog vhf signal to produce the digital signal.

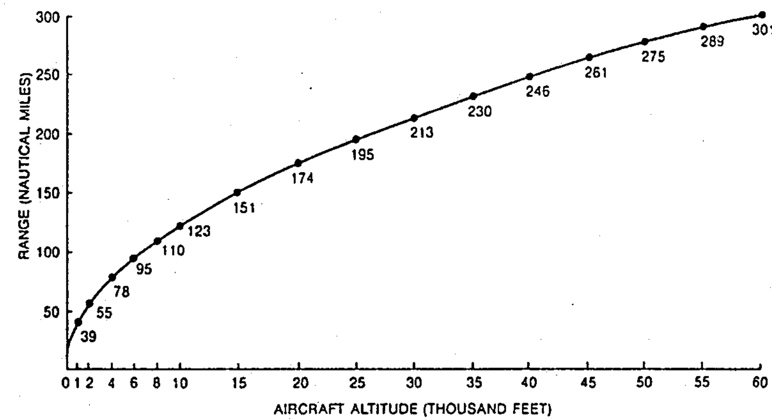
| BIT ORDER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MESSAGE | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| WAVEFORM | | | | | | | | | | | |



*ACARS Encoded Subcarrier Waveform*
*Figure 26*

**Q. What are the range limitations of the ACARS transmission?**

A. The ACARS transmission currently is transmitted at 131.550 MHz in the vhf frequency range. The space wave or line-of-sight wave is characteristic of the vhf frequency range. A space wave is not refracted or hindered by atmospheric noise, so it travels in a straight line. The range at which such a wave can be received is limited by the line of sight between the transmitter and the receiver and the curvature of the earth. Figure 27 shows a graph of the operating range of line-of-sight equipment aboard the aircraft versus the aircraft altitude. The graph line represents the distance to the horizon at various aircraft altitudes.




NOTES:
1. DISTANCE CALCULATED AS FOLLOWS:
   DISTANCE (NMI) = $1.23 \sqrt{\text{AIRCRAFT ALTITUDE (FT)}}$
2. GRAPH REPRESENTS FLIGHT OVER LEVEL TERRAIN WITH GROUND STATION AT SEA LEVEL.
3. GRAPH PROVIDES OPTIMUM DISTANCES WHICH ARE NOT ALWAYS ATTAINABLE DUE TO TERRAIN AND INSTALLATION VARIABLES.

*Operating Range Vs Aircraft Altitude*
*Figure 27*

This instruction guide has been prepared to provide a basic understanding of the ARINC Communications Addressing and Reporting System (ACARS). We welcome your comments concerning the contents of this instruction guide. Although every effort has been made to keep it free from errors, some may occur. When reporting a specific problem, describe it briefly and include the instruction guide part number (523-0773841), the figure number, and the page number.

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•523-0773841-00111R 2-1-85 Printed in USA