



# **ACARS PROTOCOLS FOR AVIONIC END SYSTEMS**

## **ARINC SPECIFICATION 619-3**

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## FOREWORD

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An Errata Report solicits any corrections to the text or diagrams in this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any recommendations for addition of substantive material to this volume which would be the subject of a new Supplement.

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## 1.0 INTRODUCTION

### 1.1 Purpose of this Document

The purpose of this document is to delineate, in an organized fashion, the protocols used by Aircraft Communication Addressing and Reporting System (ACARS) Management Units (MU) defined in ARINC Characteristics 724B and 758 **Communication Management Unit** in their interactions with other onboard avionics equipment.

#### COMMENTARY

The interfaces described herein have evolved over time. The definitions are constrained to the most recent or most appropriate function. Some existing equipment, designed under earlier guidelines, will not comply with all of the provisions within this document. These interfaces should be updated by the user if practical, at his convenience, to the current standard to minimize interface incompatibilities.

**ARINC 597, adopted in 1978, and ARINC 724, adopted in 1979 have been superseded by ARINC 724B and ARINC 758. Consequently, their status has been downgraded from Active to Legacy.**

### 1.2 Organization of this Document

This Chapter outlines the organization of the document.

Chapter 2 of this Specification defines the character-oriented protocol, data format and network functions required to interface with the Optional Auxiliary Terminal (OAT).

Chapter 3 of this specification defines the character-oriented ARINC 429 protocol, data format and network functions required to interface with systems that use the character-oriented protocols, such as: ACARS, Airplane Condition Monitoring System (ACMS), Central Maintenance Computer (CMC), cabin terminal and Flight Management Computer (FMC).

Chapter 4 of this Specification defines the character-oriented protocol, data format and network functions required to interface with the 597/724 dedicated printer and the protocol, data formats and network functions required to interface with ARINC 740 Multiple-Input Cockpit Printer (MICP).

Chapter 5 of this Specification defines the bit-oriented ARINC 429 protocol to be used to interface avionic units, such as ACMS, CMC, cabin terminals and FMC. The ARINC 429 bit-oriented, file transfer protocol is included by reference. Chapter 5 also contains the description of the data formats and network functions required to interface with systems that use the ARINC 429 bit-oriented protocol.

As they are developed, new data formats for the bit-oriented protocol will be defined by the addition of new subsections to Chapter 5.

## 1.0 INTRODUCTION

### 1.3 LRU Interface Definitions

The ACARS MU will provide interfaces for the exchange of data with onboard systems. The physical connections for these interfaces are identified in the associated ARINC Characteristic (597, 724, 724B and 748).

The FMC provides interfaces for the exchange of data with onboard systems. The physical connections for these interfaces are identified in ARINC Characteristic 702.

The ACMS provides interfaces for the exchange of data with onboard systems. The physical connections for these interfaces are identified in ARINC Characteristic 717.

### 1.4 Protocol Application

The protocols for transferring data between Line Replacement Units (LRUs) have evolved over the years. The OAT protocol, which was originally documented in ARINC 597 and is now defined in Chapter 2, was the original protocol. The OAT protocol was superseded by variations of the ARINC 429 Mark 33 Digital Transfer Information System (DITS) protocol. The protocols defined in ARINC Characteristic 724 and 724B were unique character-oriented protocols derived from the general file data transfer protocol described in ARINC Specification 429. This protocol is now defined in Chapter 3.

The character-oriented protocol is now being superseded by a bit-oriented file transfer protocol, often referred to as the "Williamsburg" protocol, introduced into ARINC Specification 429 with Supplement 12. Additional supplements will revise the requirements of the bit-oriented file transfer protocol as needed.

If the Link layer protocol to be used is not known *a priori* then it can be determined as specified by ARINC 429. If the character-oriented protocol is to be used then the appropriate protocol, 724 or 724B as defined in Chapter 3, should be used.

### 1.5 Referenced Documents

**ARINC Specification 429:** *Mark 33 Digital Information Transfer System (DITS)* **Part 1 – Functional Description, Electrical Interface, Label Assignments and Word Formats**

**ARINC Specification 429:** *Mark 33 Digital Information Transfer System (DITS)* **Part 3 – File Data Transfer Techniques**

**ARINC Characteristic 597:** *Aircraft Communications Addressing and Reporting System (ACARS)*

**ARINC Specification 618:** *Air-Ground Character- Oriented Protocol Specification*

**ARINC Specification 620:** *Data Link Ground System Standard and Interface Specification (DGSS/IS)*

**ARINC Characteristic 702:** *Flight Management Computer*

**ARINC Characteristic 717:** *Flight Data Acquisition and Recording System*

## 1.0 INTRODUCTION

**ARINC Characteristic 724:** *Mark 2 Aircraft Communications Addressing and Reporting System (ACARS)*

**ARINC Characteristic 724B:** *Aircraft Communications Addressing and Reporting System (ACARS)*

**ARINC Characteristic 740:** *Multiple-Input Cockpit Printer*

**ARINC Characteristic 744:** *Full-Format Printer*

**ARINC Characteristic 758:** *Communications Management Unit (CMU) Mark 2*

## 1.6 Terminology

Various terms are used in this specification that may not be familiar to the reader or may be interpreted differently by readers experienced with the system. Therefore certain terms are defined below to remove any ambiguity as to the meaning to be applied within this specification.

Source/Sink:

In the context of this document, the terms "source" and "sink" refer to the two systems that are sending and receiving data over the interface. The source sends data to the sink, who receives it. The terms "source" and "sink" should not be confused with "origin" and "destination." The origin or originator is the system that created the message. The destination is the system for which the message is intended. The source is not necessarily the originator and the sink is not necessarily the destination.

Pass-Through/Store-and-forward:

If the MU does not attempt to buffer the individual blocks of a multi-block message before transferring the blocks, it is referred to as a pass-through system. An MU operating in this way will transfer each block of a message to the destination as soon as it is received from the source.

If the MU accumulates all blocks of a multi-block message before transferring the message to an end system or subnetwork, then the MU is said to be operating in a store-and-forward mode.

## 2.0 OPTIONAL AUXILIARY TERMINALS

### 2.1 Introduction

The Optional Auxiliary Terminal (OAT) interface is the original ACARS interface developed to extend access of data exchange to other airborne systems and input/output (I/O) terminal devices.

#### COMMENTARY

The OAT interface was derived from RS-232-C and modified to be compatible with the avionics environment. The ARINC 429 interfaces defined in Chapters 3 and 5 were added later as alternatives to the OAT interface.

ARINC 597 MUs support an interface with an OAT. Some ARINC 724 MUs and some ARINC 724B MUs support an interface with an OAT. When specified by the customer, the ACARS MU should be capable of transmitting and receiving file transfers using the OAT Protocol.

#### COMMENTARY

The OAT interface was preserved in ARINC Characteristics 724 and 724B to retain backward compatibility with ARINC 597 installations.

### 2.2 Management Unit/Optional Auxiliary Terminal Interface

Refer to Attachment 12 of this Specification for a detailed description of the OAT protocol.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

#### 3.1 ARINC 429 Character-Oriented File Transfer Protocol Characteristics

This chapter documents the character-based protocol and message formats that are used by ACARS Management Units designed to ARINC Characteristics 724 and 724B that interface with onboard end systems, such as FMCs, ACMS, Cabin Terminals, etc. This protocol is based on the character-oriented file transfer defined in ARINC Specification 429 (through Supplement 11).

##### COMMENTARY

Provisions for character-based file transfer were supported by Specification 429 up until Supplement 12 when they were replaced by the Williamsburg bit-oriented protocol. In Supplement 12, the earlier text describing character-oriented file transfer was moved to an Appendix to retain the documentation for existing interfaces such as those described in the following sections.

Section 3.3 and Section 3.4 of this Specification define the character-oriented ARINC 429 protocols. Section 3.6 describes the translation needed within the MU to convert uplink messages from the air/ground format to the output in a form compatible with the above ARINC 429 protocols. Section 3.8 describes the converse, preparing an ARINC 429 character-oriented file transfer input into a form compatible with an ACARS downlink. See Sections 3.5 and 3.7 for routing and Section 3.9 for the format of documentary data messages.

#### 3.2 Physical Interconnection

The interwiring will depend on whether the ARINC Characteristic 724 or 724B architecture is used.

##### COMMENTARY

An aircraft that was originally wired per ARINC 724 may be upgraded with new avionics (including an ARINC 724B MU). Sometimes portions of the wiring are modified per ARINC 724B while some of the existing wiring is retained in its original ARINC Characteristic 724 configuration.

The MU may be used to interface two LRUs that do not have a direct connection. The source will identify the desired sink by including the Destination code of the sink. The Origin/Destination codes are listed in Attachment 3.

##### COMMENTARY

This provision is not intended to support an expansion of the services provided by the MU. Some existing aircraft are already configured to take advantage of this facility within the MU to avoid additional wiring.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

The voltage levels, waveforms and signal-bit timing are as specified in ARINC Specification 429 Part 1. Twisted and shielded pairs of wires should be used to connect the ACARS MU to each End System, for the transfer of information in each direction.

#### 3.2.1 ARINC 724 Architecture

The primary feature of the ARINC 724 architecture is that the ACARS MU ARINC 429 wiring is point to point. In other words, each transmitter is connected to only one receiver as illustrated in Figure 3.2.1-1.

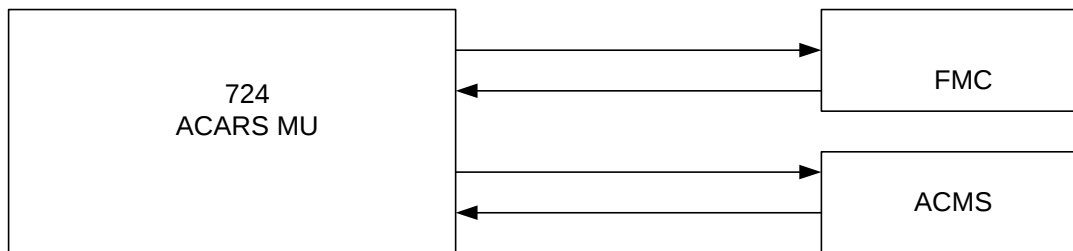


Figure 3.2.1-1 – Example of ARINC 724 Architecture

#### 3.2.2 ARINC 724B Architecture

The primary feature of the ARINC 724B architecture is that the ACARS MU ARINC 429 outputs are wired as buses as illustrated in Figure 3.2.2-1. In other words, each transmitter is connected to several receivers which necessitate the use of System Address Labels so that the receivers can determine which file transfers are for them.

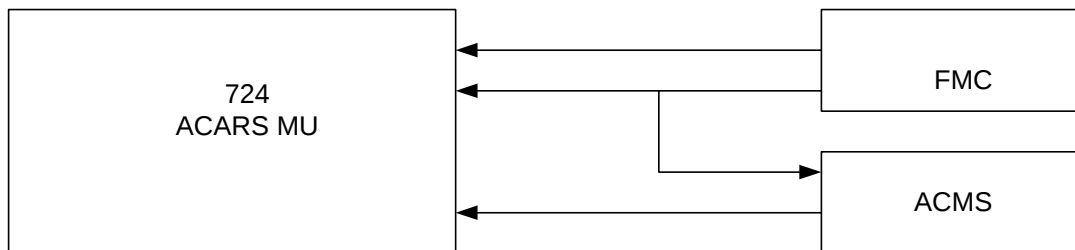


Figure 3.2.2-1 – Example of ARINC 724B Architecture

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

#### 3.2.3 ARINC 724-724B Determination Logic

The MU should attempt to determine the optimum protocol for the exchange of data. There is no absolute method of making a determination.

##### COMMENTARY

The technique described in this section will not suffice in all cases. There is no foolproof mechanism for determining whether the ARINC 724 or the ARINC 724B character-based file data-transfer protocol operation is appropriate due to the existence of numerous hybrid ACARS MUs. These MUs make it impossible to retroactively define a protocol determination logic that will work in all cases.

It is recommended that when an LRU (the MU or one of its peripherals) is capable of using the Characteristic 724B variant of the ARINC 429 protocol (which employs System Address Labels) it should broadcast Address word (label 172). The Address word should contain the originator's System Address Label (SAL) as defined in ARINC Characteristic 739. If Address words (label 172) are received then the initiating LRU should assume that ARINC 724B communications are possible. If the Address word is not received, the initiating LRU should conclude that the other LRU is only capable of exchanging data using the ARINC 724 protocol. A transfer using label 357 should be attempted to confirm that the LRU is indeed ARINC 724 compliant. If not, the link should be considered inoperative.

The logic needed by the ACARS MU to determine if a peripheral is using the protocol defined by ARINC Characteristic 724 or the protocol defined by ARINC Characteristic 724B described here may have to be customized depending upon the aircraft configuration and the LRUs installed per the above commentary.

### 3.3 Character Protocol, General Characteristics

The character-oriented file transfer protocol used for data transfer between the ACARS MU and the other on-board systems is based upon the guidelines provided in ARINC Specification 429-1 through 429-11, "Mark 33 Digital Information Transfer System (DITS)". The protocol documented in this Specification represents a variation of what was specified in ARINC Specification 429 and is not recommended for new systems.

#### 3.3.1 Coding

Messages should be coded per the ISO Alphabet #5 subset set forth in Table 1-1 or Table 1-2 of Attachment 1, as appropriate. Seven bits per character should be used, i.e., an eighth parity bit should not be added or checked. Three such characters will occupy the information field of each ARINC 429 32-bit word as shown in Table 3.3.1-1.

**3.0 CHARACTER-ORIENTED COMMUNICATIONS****Table 3.3.1-1 ARINC 429 Character Protocol Data Word Format**

| Bit   | Description                |
|-------|----------------------------|
| 1-8   | Label of Sink (357 or SAL) |
| 9-15  | Data Character 1           |
| 16    | Pad Bit                    |
| 17-23 | Data Character 2           |
| 24    | Pad Bit                    |
| 25-31 | Data Character 3           |
| 32    | Parity Bit, odd            |

Before binary data can be transmitted over this link it should be converted into the ISO #5 characters. The standard method of converting binary data is called bit-to-hex (ISO #5) encoding. Each octet of binary data is divided into 2 four-bit nibbles. Each nibble is encoded into a seven-bit character field using its equivalent ISO #5 hexadecimal character. The value of each character, which will fall within the numeric range 0 through 9 or the alpha range A through F, is encoded for transmission per the ISO Alphabet #5 convention in the manner described above for free text.

**COMMENTARY**

Although the airborne equipment, the air-ground-air link and some of the ground communications links connecting users' data sources/sinks to the ACARS controlling processor are capable of handling the full ISO Alphabet #5 code set, many ground links do not have this capability. The restricted code set has been specified to ensure that all messages originating in a ground-base computer for delivery via ACARS to an airborne computer, and vice versa, are transparent to all ground communications links through which they might pass.

**3.3.2 File Size**

The maximum number of characters in a file is 3520 (16 blocks x 220 characters per block). The file size and number of characters available on any particular interface for data may also be subject to other restrictions. See Section 3.8.2.

**3.3.3 Block Size**

Data should be transferred in blocks containing a maximum of 77 ARINC 429 words. Each block will begin with a Data Follows word (see Section 3.4.7), followed by two data words containing the five-character control/accountability header and the first text character. The block may contain up to 73 additional data words. Each block is terminated with either a "ETB" or "ETX" word. The total text handling capability will thus be 226 characters including all headers and a ETB/ETX character.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

#### COMMENTARY

The initializing word (Data Follows word, see Section 3.4.7), the Control/Accountability header, a full uplink message block or 220 text characters, and the message suffix character ("ETX" or "ETB") can be accommodated in 77 ARINC 429 words.

Note that when the Block size is 77 ARINC 429 words that the last two character positions in the last word shall not be used.

If the data is less than 220 characters, then the file length can be reduced. There is no need for the suffix character to be accorded an ARINC 429 word of its own in these cases. If there is room, the suffix character should be placed in the final ARINC 429 word containing text characters.

The limit of 77 ARINC 429 data words maximum is imposed by the VHF protocol, see ARINC Specification 618.

The number of blocks used to transfer a multiple block message should be minimized.

#### 3.3.4 Bit Rate and Word Timing

Data transfer should be conducted at the low bit rate defined in ARINC Specification 429 Part 1. The source should introduce a word gap of at least 4 bit times between words and the average word gap spacing should be less than 64 bit times over the entire block. The word gap is the time between the end of one ARINC 429 word transmitted and the beginning of the next.

The sink should be able to receive an entire block transmitted with the minimum word spacing of 4 bit times.

#### COMMENTARY

The message word gap spacings are provided to allow realistic message throughput calculations by the sink. They should not be used to monitor the message transfer.

#### 3.3.5 Labels

The Label field of the ARINC 429 word is used to identify the purpose of that word. There are two coding systems: Broadcast data and File Transfer. The file transfer mechanism is then divided into two implementations. Early units (units designed per the ARINC Characteristic 724 interface architecture of Figure 3.2.1-1) use a single predefined data label. Later units (units designed per the ARINC Characteristic 724B interface architecture of Figure 3.2.2-1) use the pre-assigned System Address Label (SAL) of the recipient.

### **3.0 CHARACTER-ORIENTED COMMUNICATIONS**

Each label must have a unique identity on the data bus. Thus, any one label can be used for only one purpose on an ARINC 429 bus; it cannot be used for both broadcast data and file transfer.

All ARINC 429 labels identified in this document (both broadcast and SALs) are expressed in octal with the least significant bit (LSB) displayed first in order to be consistent with the convention established in the ARINC Specification 429 Part 1.

#### **3.3.5.1 ARINC Broadcast Words**

ARINC 429 (Part 1) broadcast data words are used to transmit periodic data from one onboard system to one or more other onboard devices. Each broadcast word on an ARINC 429 data bus must have a unique label in order to uniquely identify it. Some broadcast data labels have multiple definitions. Since connection is limited to the physical interwiring, the same label may contain different data when used on a different interface (data bus).

The broadcast label identifies the data element (or elements) contained in the ARINC 429 word and the format in which the data element(s) is to be encoded. Refer to ARINC Specification 429 Part 1 for a list of the broadcast labels that have been defined.

#### **3.3.5.2 File Transfer Data Words - ARINC 724 MUs**

When performing a file transfer with an ARINC 724 ACARS MU, the ARINC 429 label 357 (octal) should be used in each file transfer data word. Label 357 is used for both transmitting messages to an ARINC 724 ACARS MU and when receiving messages from an ARINC 724 ACARS MU.

#### **3.3.5.3 File Transfer Data Words - ARINC 724B MUs**

The interfaces utilized in installations with an ARINC 724B MU use System Address Labels (SAL) in order to identify the onboard system receiving the file transfer. All file transfer words used for transmission of data to the ACARS MU should contain the ACARS MU's SAL of 304 Octal in the Label field (bits 1-8). The label code in the data words used for transmission of data from the ACARS MU to an on-board system will be the SAL of the recipient LRU. See Attachment 11 of ARINC Specification 429 Part 1 for a list of SAL assignments.

### **3.4 Character File Transfer Communications Protocol**

The protocol used in the transfer of ACARS air-ground messages is a special (customized) version of the file data transfer protocol described in ARINC Specification 429 (up to Supplement 12). The elements of the protocol which are common to message exchanges between the ACARS MU and other onboard systems is described in this Section. This protocol applies to data transfer in either direction. Therefore, the definition is written in terms of "source" and "sink" operations. An example of a typical protocol transaction is shown in Figure 3.4.1. Timing diagrams illustrating

3.0 CHARACTER-ORIENTED COMMUNICATIONS

the interaction possibilities described in the following subsections are provided in Attachment 10.

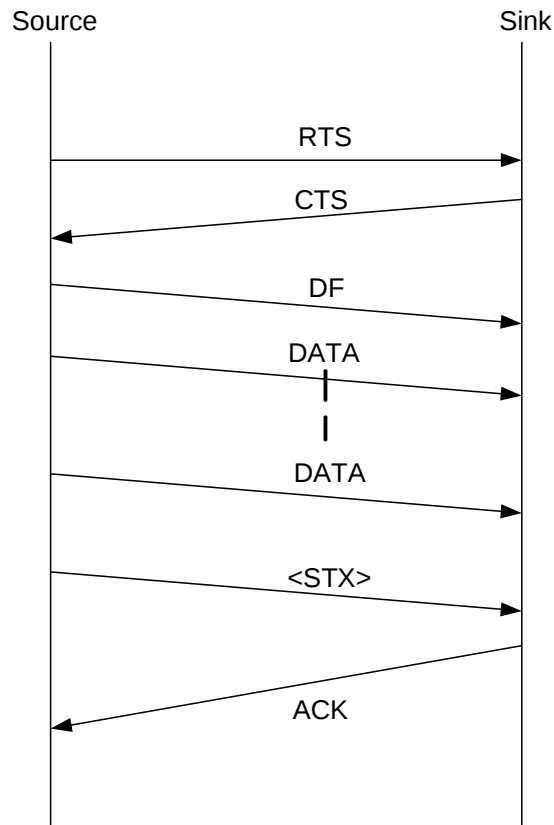


Figure 3.4-1 – Typical Character Protocol Block Transfer

3.4.1 Request to Send

A file transfer is initiated when a source sends a “Request to Send” (RTS) word to the sink. The RTS word is an ARINC 429 32-bit word having the format shown in Table 3.4.1-1.

Table 3.4.1-1 – RTS Word Format

| Bit Nos.   | Field Content                  |
|------------|--------------------------------|
| 1 thru 8   | Label                          |
| 9 thru 16  | Block Word Count (binary)      |
| 17 thru 24 | Destination Code               |
| 25 thru 31 | ISO #5 Control Character <DC2> |
| 32         | Odd Parity                     |

The Origin/Destination codes are listed in Attachment 3. The Block Word Count contains the binary value of the number of ARINC 429 data words the source wishes to send to the sink. The Block Word Count includes all of the words from the Data Follows (DF) word to the ETX/ETB word inclusive.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

A sink will ignore any file transfer words received that are not preceded by a valid RTS word.

The source starts timer T1 (see Section 3.4.13.1) when it transmits a RTS word. The source will restart timer T1 when it retransmits a RTS word. The RTS word is retransmitted up to C1 times, if acceptable responses are not received by the source. See Section 3.4.13 for timer and counter definitions. A timing diagram illustrating this block transfer interaction is provided as Figure 10-1 of Attachment 10.

#### 3.4.2 Normal Response to RTS

The sink's normal response to the RTS word is a "Clear To Send" (CTS) word within T1 milliseconds of receiving the RTS word. A timing diagram illustrating this interaction is provided as Figure 10-2 of Attachment 10.

The CTS word is an ARINC 429 32-bit word having the format shown in Table 3.4.2-1.

**Table 3.4.2-1 – CTS Word Format**

| Bit Nos.   | Field Content                  |
|------------|--------------------------------|
| 1 thru 8   | Label                          |
| 9 thru 16  | Sink Status (see below)        |
| 17 thru 24 | Pad (binary "Zero")            |
| 25 thru 31 | ISO #5 Control Character <DC3> |
| 32         | Odd Parity                     |

The sink Status field indicates to the source whether or not the sink can accept data. Valid values for the sink Status field are specified in Table 3.4.2-2.

**Table 3.4.2-2 – Sink Status Definition**

| Coding in Bits 9 thru 16         | Content Meaning                                            |
|----------------------------------|------------------------------------------------------------|
| Binary word count same as in RTS | Sink ready to accept block                                 |
| Binary zeros                     | Sink Not Ready – sink momentarily not ready to accept data |
| ISO # 5 Character "Q"            | Sink Busy (sink temporarily cannot accept file)            |

The sink should start timer T2 (see Section 3.4.13.3) when it transmits a CTS word indicating "ready to accept data" status. If the block transfer has not been completed before timer T2 expires, then the sink should send a NAK word to the source and discard that block.

A NAK response means Data Received Not OK. If a store-and-forward design is used then only the block which just timed out is discarded and any previously received blocks of the file are still stored.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

#### 3.4.2.1 Sink Ready

If the sink is capable of accepting all the data the source has to send, then the sink status field of the CTS word should contain the same value as the block word count field of the RTS word.

#### 3.4.2.2 Sink Not Ready

If the sink is not ready to accept all of the data, then the CTS Sink Status field should be filled with binary zeroes. The criteria for available buffer space that is used by the sink to determine if it can accept the file are: one block for a pass-through design and a 16-block file for a store-and-forward design.

#### 3.4.2.3 Sink Busy

If the sink temporarily, for reasons that will require longer than T1 milliseconds to resolve, cannot accept all of the data, then the Sink Status field of the CTS word should be coded with the ISO #5 character 'Q'.

The sink may not be able to accept a file for any one of several reasons, such as because its buffer is full with the previous file or the communication channel with the destination indicated in the RTS word is not functioning at this time.

A timing diagram illustrating this interaction is provided as Figure 10-3 of Attachment 10.

#### 3.4.3 Source Response to Sink Unavailable

Occasionally, as described above, the sink will not be able to accept the file. When the source is informed of the sink's status, an appropriate action should be taken.

##### 3.4.3.1 Source Response to Sink Not Ready

If the CTS word received by the source indicates that the sink is not ready to receive data (bits 9-16 are binary "zeros"), the source should wait T1 milliseconds from the time of the RTS transmission and then retransmit the RTS word and increment the

RTS retry counter C1. If the CTS response again indicates that the sink is not ready, the source should again wait T1 milliseconds and then retransmit the RTS word and increment the RTS retry counter C1. If a "ready" response is not received from the sink before the limit of counter C1 is reached then the source should deem the message undeliverable. If the ACARS MU is the source and the message is an uplink, then it should process the message as specified in ARINC Specification 618.

Note that the response indicated by ARINC Specification 618 is different for a pass-through implementation versus a store-and-forward implementation.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

If the source is an on-board computer, it should react to the situation in the manner specified by its users.

#### 3.4.3.2 Source Response to Sink Busy

The response of the source to a CTS word from the sink containing a Busy indication depends on whether the message is an uplink that the ACARS MU is trying to deliver to an on-board system or a message created onboard.

##### 3.4.3.2.1 Message is an Uplink

If the ACARS MU is the source, the message is an uplink and a CTS word received from the sink indicates that the sink is Busy then the ACARS MU should process the message as specified in ARINC Specification 618. If the ACARS MU is operating in the pass-through mode, then no on-board retransmissions should be attempted.

##### 3.4.3.2.2 Message is Not an Uplink

If the sink responds to the source with "Q" (destination Busy), then the source should increment the Busy Retry counter C3 and wait at least T4 seconds after receiving the CTS word before attempting to initiate the message transfer with a new RTS word. If this attempt also produces a "Q" response, then the source should increment the Busy retry counter C3 and wait a further T4 seconds before sending another RTS. If the limit of the Busy Retry counter, C3, is reached before a Sink Ready Clear To Send (CTS) response is received, then the message is deemed undeliverable.

The data throughput for VHF downlinks (2400 bps for MSK) used by the ACARS MU is substantially slower than either of the ARINC 429 data bus (12.0-14.5 kbps low speed or 100 kbs high speed) throughput rates. This means that the ACARS MU will end up storing a multiblock message for several minutes before it finishes downlinking all of the blocks. The data throughput differences are due to the different data rates and the fact that the VHF is a multiple user medium while the ARINC 429 bus is not. If an on-board system attempts to gain access to the ACARS MU while it is in the process of downlinking a multiblock message then the onboard system may receive enough busy responses to reach the retry limit. In this event, the originating system should react in the manner specified to its manufacturer by its users. Among the options are: (1) to re-initiate another sequence of access requests at some specified later time or (2) abandon altogether the attempt to downlink this particular message.

#### 3.4.4 Source Receives No Response to RTS

If the source does not receive a valid CTS word within T1 milliseconds (nominal) it should retransmit the RTS word and increment the RTS retry counter (C1). If this retransmission also elicits no response within T1 milliseconds, then another RTS transmission should be made and counter C1 should be incremented. If counter C1 reaches its limit and there is still no response from the sink, then the source should alert the message originator to the communications break-down. If the source

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

receives any response other than a valid CTS or conflicting RTS (see Section 3.4.5), it should ignore that response and continue waiting for a valid response. The source should only transmit the block when a CTS word containing the same block word count as the RTS is received.

A timing diagram illustrating this interaction is provided as Figure 10-5 of Attachment 10.

#### 3.4.5 Conflicting RTS Transmissions

If an onboard device detects an incoming RTS transmission from the ACARS MU it should abort any transmission in progress to the ACARS MU and respond as specified in Section 3.4.2 above. The aborted message may be retransmitted following the completion of the message being initiated by the ACARS MU. If the ACARS MU detects an RTS from an on-board device after having initiated an RTS to that device and prior to completing the message transaction, it should ignore the RTS and continue the transaction in progress.

The sink should not send an RTS after sending a CTS until the transfer of that block is completed, i.e. ACK or NAK word sent or timer T2 expires.

#### 3.4.6 RTS Response by Source to CTS Transmission

If a sink receives an RTS word in response to a CTS word, it should transmit a new CTS word to the source in response to the new RTS word as specified in Section 3.4.2 above. Any response by the source to the new CTS word other than a repeated RTS or a valid DF word should elicit a "NAK" response to the source as specified in Section 3.4.10.2.

#### 3.4.7 Data Follows Word

If the sink responds to an RTS word with a CTS word indicating that the sink is ready to accept data, then the source should send a DF word to the sink. The DF word is an ARINC 429 32-bit word having the format specified in the table below.

**Table 3.4.7-1 – Data Follows Word Format**

| Bit Nos.   | Field Content                                                  |
|------------|----------------------------------------------------------------|
| 1 thru 8   | Label                                                          |
| 9 thru 16  | Block Word Count should contain the same value as the RTS word |
| 17         | Optional Header Flag (see Section 3.8.1.1)                     |
| 18 thru 24 | Binary "Zeros"                                                 |
| 25 thru 31 | ISO #5 Control Character "STX"                                 |
| 32         | Odd Parity                                                     |

The Block Word Count field of the Data Follows (DF) word should contain the same value as the Block Word Count field of the RTS and CTS word.

**3.0 CHARACTER-ORIENTED COMMUNICATIONS****3.4.8 Data Word**

The data is transmitted in data words following the Data Follows (DF) word subject to the word spacing requirement specified in Section 3.3.4. The data words are ARINC 429 32-bit words with the format specified in Section 3.3.1.

The data characters should be transmitted in the order received by the ACARS MU in the case of uplinked data and in the order determined by the originator in the case of data originated on-board the aircraft. The binary states of the pad bits are immaterial.

**3.4.9 ETX/ETB Word**

The last data word transmitted should contain an <ETB> or <ETX> character in order to indicate the end of block or end of file, respectively. The data word is an ARINC 429 32-bit word with the format specified in Section 3.3.1.

**3.4.10 Sink Responses to Data Transfer**

The sink should respond to the data transfer as specified in the following paragraphs.

The sink should check parity on each word received. When the sink detects a word with a parity error then the sink should either:

- a. transmit a NAK word and discard the block
- b. discard the word containing the parity error and not include it in the word count

When the sink receives the final word or timer T2 expires then the sink should:

- a. Compare the number of words actually received with the word count transmitted in the DF word
- b. Generate either an ACK or NAK response, if a NAK has not all ready been sent.

**3.4.10.1 No Errors**

If none of the errors enumerated in Section 3.4.10.2 are detected, then the sink should send a "Data Received OK" (ACK) word to the source within T3 milliseconds of receiving the final word. The ACK word is an ARINC 429 32-bit word with the format specified in Table 3.4.10.1-1.

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Table 3.4.10.1-1 – ACK Word Format

| Bit Nos.   | Field Content                               |
|------------|---------------------------------------------|
| 1 thru 8   | Label                                       |
| 9 thru 16  | Block Word Count (binary) of words received |
| 17         | Binary "One"                                |
| 18 thru 24 | Binary "Zeros"                              |
| 25 thru 31 | ISO # 5 Control Character ACK               |
| 32         | Odd Parity                                  |

Upon receipt of an ACK word, the source should close out the communications transaction for that block and send the RTS for the next block, if there is one.

**PASS-THROUGH:** If the source is the ACARS MU and the delivered block is an uplink, then the ACARS MU should transmit the appropriate air-ground acknowledgment to the ground as specified in ARINC Specification 618.

**STORE-AND-FORWARD:** If the source is the ACARS MU and the delivered message is an uplink, then no additional action required.

## 3.4.10.2 Errors Detected

If any of the conditions listed below occur, then the sink should send the Data Received Not OK (NAK) word: 1) within T2 seconds (nominal) of transmitting the CTS word or 2) within T3 seconds of receiving a data word containing <ETB> or <ETX>, whichever occurs first. The error conditions are as follows:

- a. Word count in CTS word does not match word count in Data Follows word
- b. Actual word count does not match expected word count from CTS and Data Follows words
- c. Block received from source is not properly terminated with an <ETB> or <ETX>
- d. The final word is not received before timer T2 expires
- e. Word received by sink after transmitting a CTS word is not a RTS word or a DF word
- f. OPTIONAL: A NAK may be sent upon detection of a parity error

**COMMENTARY**

Some systems transmit a NAK when an invalid Control/Accountability header (see Section 3.5.1) is detected:

- a. Unit separator is not the value 1F (hex)
- b. Origin code not valid for originator
- c. Destination code not valid
- d. The Block Sequence Character is less than 40 (hex)

## 3.0 CHARACTER-ORIENTED COMMUNICATIONS

## COMMENTARY

Some sinks transmit a NAK when parity errors or invalid Control/Accountability header characters are detected in accordance with early versions of ARINC Characteristic 724 and 724B. It is recommended that checking to validate Control/Accountability header characters be done on a “reasonability” basis since each sink has expectations concerning the message Purpose/Nature and Origin codes of received transmissions. Also, the Unit Separator and Destination codes occur in fixed locations and have bit patterns known to each sink. Care should be taken, however, to avoid over-confidence in rejecting messages on the basis of a failure of the reasonability check alone.

NAK transmission immediately following sink power-up and resets will speed up the retransmission reinitiation process. Otherwise, the NAK will be sent to the source only when transmission of the now unusable message has been completed.

The NAK word is an ARINC 429 32-bit having the format shown in Table 3.4.10.2-1.

**Table 3.4.10.2-1 – ARINC 429 Character Protocol NAK Word Format**

| Bits  | Function                       |
|-------|--------------------------------|
| 1-8   | Label                          |
| 9-16  | Optional Error Code            |
| 17    | Binary “One”                   |
| 18-24 | Binary “Zeros”                 |
| 25-31 | ISO #5 Control Character <NAK> |
| 32    | Odd Parity                     |

Note: The Optional Error Code (bits 9-16) is for engineering purposes only and should not be examined by the source.

### 3.4.11 Source Response to a NAK Word

The source should be capable of receiving a NAK while in the process of transmitting a data block. If a NAK is received, the source should abort the block transmission in progress, increment the Block Retry counter (C2) and if C2 has not exceeded its limit then retransmit the complete block starting with the RTS word. If the limit of counter C2 is exceeded then the source should classify the block undeliverable.

In the case where the message is an uplink then the ACARS MU should respond according to ARINC Specification 618. ARINC Specification 618 specifies a different response for the store-and-forward and pass-through implementations.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

If the ACARS MU is relaying a message from an onboard source to an onboard sink, it should simply dump the message. The message originator, which is not necessarily the same as the source, should recognize the communications failure when it receives no response from the destination. If the message originator is an on-board device attempting to communicate with the ACARS MU, it should react to the situation in the manner specified by its users.

#### 3.4.12 No Sink Response to Data Transfer

If the source does not receive a valid ACK or NAK from the sink within T5 seconds of receipt of the CTS word, then the source should increment the block Retry Counter (C2) and if C2 has not exceeded its limit then the source should retransmit the complete block starting with the RTS word. If the limit of C2 is exceeded then the source should deem the message undeliverable.

**PASS-THROUGH:** If the source is the ACARS MU and the block is an uplink, then the ACARS MU should respond as specified in ARINC Specification 618 when the retries have been exhausted.

**STORE-AND-FORWARD:** If the source is the ACARS MU and the message is an uplink, then the ACARS MU should respond as specified in ARINC Specification 618 when the retries have been exhausted.

If the ACARS MU is relaying a message from an on-board source to an on-board sink, then it should discard the message. The message originator, which is not necessarily the same as the source, should recognize the communications failure. If the message originator is an on-board device attempting to communicate with the ACARS MU, then the source should react to the situation in the manner defined by its users.

If the source receives any response other than a valid ACK or NAK or conflicting RTS (see Section 3.4.5), it should ignore the response and continue waiting for a valid response until timer T5 expires.

#### 3.4.13 Summary of Character Protocol Timers and Counters

##### 3.4.13.1 Source Timers

| Name      | T1, RTS Retransmit Timer                      |
|-----------|-----------------------------------------------|
| Value     | 200 milliseconds                              |
| Start     | When RTS word is transmitted                  |
| Restart   | When RTS word is retransmitted                |
| Stop      | CTS word received or counter C1 limit reached |
| Reference | Section 3.4.1, 3.4.3.1, and 3.4.4             |

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**Name                      T4, Sink Busy Delay Timer**

|               |                                                                            |
|---------------|----------------------------------------------------------------------------|
| Value         | 15 seconds                                                                 |
| Start         | When a CTS word containing a "Q" in the block word count field is received |
| Restart       | None                                                                       |
| Stop          | None                                                                       |
| On Expiration | Retransmit RTS word and increment count C3 if limit not exceeded           |
| Reference     | Section 3.4.3.2.2                                                          |

**Name                      T5, Block Retransmission Timer**

|               |                                                                                                |
|---------------|------------------------------------------------------------------------------------------------|
| Value         | 1.7 seconds                                                                                    |
| Start         | When a CTS word is received                                                                    |
| Restart       | None                                                                                           |
| Stop          | When an ACK or NAK word is received                                                            |
| On Expiration | Increment C2 and retransmit block beginning with RTS if retry limit (C2) has not been reached. |
| Reference     | Section 3.4.12                                                                                 |

**3.4.13.2 Source Counters****Name                      C1, RTS Retry Counter**

|               |                                                                                                                                                                                                  |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Value         | 2                                                                                                                                                                                                |
| Enabled       | C1 is enabled and reset when the first RTS word is transmitted                                                                                                                                   |
| Count         | C1 is incremented by 1 when (the time the T1 timer expires) or (CTS word with a block word count is received and (the block word count does not match RTS word and block word count is not "Q")) |
| Stop          | C1 is stopped and reset when a CTS word with a block word count matching the RTS is received                                                                                                     |
| On Expiration | The block is considered undeliverable                                                                                                                                                            |
| Reference     | Sections 3.4.3.1 and 3.4.4                                                                                                                                                                       |

## 3.0 CHARACTER-ORIENTED COMMUNICATIONS

| Name          | C2, Block Retry Counter                                                     |
|---------------|-----------------------------------------------------------------------------|
| Value         | 2                                                                           |
| Enabled       | When a CTS word is received                                                 |
| Count         | Incremented by 1 when a NAK word is received or T5 expiration               |
| Stop          | C2 is stopped and reset when a ACK word is received or the limit is reached |
| On Expiration | The block is considered undeliverable                                       |
| Reference     | Section 3.4.11 and 3.4.12                                                   |

| Name          | C3, Busy Retry counter for Busy response.                                                                   |
|---------------|-------------------------------------------------------------------------------------------------------------|
| Value         | 2                                                                                                           |
| Enabled       | C3 is enabled and reset when the first RTS word is transmitted.                                             |
| Count         | C3 is incremented by 1 when a CTS word containing a "Q" character in the block word count field is received |
| Stop          | C3 is stopped and reset when a CTS word with a block word count matching the RTS is received.               |
| On Expiration | The block is considered undeliverable.                                                                      |
| Reference     | Section 3.4.3.2.2                                                                                           |

## 3.4.13.3 Sink Timers and Timing Constraints

| Name          | T2, NAK Timer                       |
|---------------|-------------------------------------|
| Value         | 1.5 seconds                         |
| Start         | When sink transmits CTS word        |
| Restart       | None                                |
| Stop:         | When ETX or ETB word is received.   |
| On Expiration | Transmit NAK word                   |
| Reference     | Sections 3.4.2, 3.4.5, and 3.4.10.2 |

**3.0 CHARACTER-ORIENTED COMMUNICATIONS**

| <b>Name</b>   | <b>T3, ACK/NAK Response Timer</b> |
|---------------|-----------------------------------|
| Value         | 100 milliseconds                  |
| Start         | When ETX/ETB is received          |
| Restart       | None                              |
| Stop          | When ACK/NAK word is transmitted  |
| On Expiration | N/A                               |
| Reference     | Sections 3.4.10.2 and 3.4.10.1    |

**3.4.13.4 Sink Counters**

This is a placeholder to ease the documentation of any for future definition. However, there are no sink counters defined at this time, nor are any contemplated.

**3.4.14 Message Transfer Failure Notification**

Other than the protocols established in Section 3.4 for communications, there are no provisions for message transfer failure notification. It is the responsibility of the message originator to establish alternate communications or protect critical information when communications cannot be established.

When communications are established but the message text is not intelligible to the destination, then the destination may initiate a failure message to the originator.

**3.5 ARINC 429 Part 3 Character Message Routing**

The character protocol is used for several different types of messages: uplink to end system, end system to downlink, and end system to end system. Section 3.5.1 contains the Character protocol message format. Section 3.5.2 contains the end system to the downlink requirements. Attachment 6 contains character file transfer message formats for downlinks and uplinks between an FMC and ACARS MU.

**3.5.1 ARINC 429 Part 3 Character Protocol Message Format**

Each block of a Character protocol message has the format specified herein. The first five characters contain the character Control/Accountability header. The format of the character Control/Accountability header is defined in Table 3.5.1-1.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

**Table 3.5.1-1 – ARINC 429 Part 3 Character Control/Accountability Header**

| Character No. | Character Content           |
|---------------|-----------------------------|
| 1             | Unit Separator character    |
| 2             | Origin Code                 |
| 3             | Message Purpose/Nature Code |
| 4             | Destination Code            |
| 5             | Block Sequence Character    |

The Origin/Destination codes are listed in Attachment 3.

#### 3.5.1.1 Origin Code

The origin code is used to indicate where the message came from or originated. See Attachment 3 for a listing of Origin codes.

#### 3.5.1.2 Destination Code

The Destination code is used to indicate where the message should be sent. See Attachment 3 for a listing of Destination codes.

#### 3.5.1.3 Message Purpose/Nature Code

The Message Purpose/Nature code is used to indicate the message type to the destination. See Attachment 4 for the Message Purpose/Nature codes.

#### 3.5.1.4 Block Sequence Character

The Block Sequence character is used to detect duplicate blocks. The source should increment the Block Sequence character for each block. The initial value at power up should be hexadecimal 40. When value hexadecimal 7F has been used then the next value should be hexadecimal 41.

The sink should compare the Block Sequence character in the block received to the Block Sequence character contained in the previous block. Each time a sink receives a data block, it compares the Block Sequence character to that contained in the previous block. If the two Block Sequence characters are the same, then the sink treats the block as a duplicate and discards the duplicate block and sends an ACK, except for documentary data requests.

If the block is a Documentary Data Request then the Block Sequence character is not checked and the block is not considered a duplicate even if the Block Sequence character is the same as the previous block.

#### 3.5.2 Uplink to End System, ARINC 429 Part 3 Character Protocol

When the ACARS MU receives uplinks which should be delivered to an end system using the Character-oriented ARINC 429 Part 3 protocol then there is a one to one correspondence between uplink blocks and ARINC 429 blocks regardless of whether a pass-through or store-and-forward implementation is used.

**3.0 CHARACTER-ORIENTED COMMUNICATIONS**

The ACARS MU transmits the individual uplink blocks to the destination end system after reformatting the block according to Section 3.6.

**3.5.2.1 Uplink Routing**

See ARINC Specifications 618 and 620 for the format of uplinks blocks and messages respectively. Each uplink to be routed to an End System using the character protocol contains a sub-label per ARINC Specification 620. The sub-label indicates to which End System the message should be delivered (see Table 3.5.2.1-1). Table 3.5.2.1-1 specifies the sub-labels and corresponding End Systems that have been defined.

ARINC Specification 620 describes how to locate the sub-label within an uplink and which uplinks contain sub-labels.

**Table 3.5.2.1-1 – H1 Sub-Label**

| <b>Sub-label</b> | <b>Destination Code</b> | <b>End System</b>   |
|------------------|-------------------------|---------------------|
| CF               | F                       | CFDIU/CMC           |
| DF               | D                       | ACMS/DFDAU/DMU      |
| M1               | A                       | FMC Left (1)        |
| M2               | B                       | FMC Right (2)       |
| M3               | N                       | FMC Center (3)      |
| MD               | Note 1                  | Master FMC          |
| S2               | R                       | Right SDU           |
| S1               | Q                       | Left SDU            |
| SD               | Note 2                  | Master SDU          |
| T0               | Note 3                  | All Cabin Terminals |
| Tn               | Note 4                  | Cabin Terminal n    |

Note 1: This value will be the Destination code for current Master FMC (A, B, or N). The criteria for determining which FMC is master is specified in Section 3.5.2.2.1.

Note 2: This value will be the Destination code for current Master SDU (Q or R).

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

Note 3: The sub-label 'T0' can be used as a group address. The MU will treat such a message as an "All Call" and deliver a copy to every Cabin Terminal.

Note 4: This field is coded with a number n, where the value of n may range from 1 to 8.

The ACARS MU will respond to an uplink with an unknown sub-label as specified under Section 3.7 of ARINC Specification 618.

#### 3.5.2.2 Addressing Dual Systems

Some onboard systems have redundant components to ensure the availability of its function in the event that one unit fails. The FMC is typical of this class of equipment.

As reflected in Table 3.5.2.1-1, there can be left and right units installed. In addition, a message may be routed to a logical address, e.g., the unit that is currently active; the other unit is presumed to be in Standby mode.

##### 3.5.2.2.1 Master FMC Selection

If the MU receives an uplink message containing the Sub-label 'MD' then the ACARS MU should deliver the message to the active FMC. The MU determines the destination by examining the Master/Slave bit (Bit 17) in the Status words (Label 270) broadcast by the FMCs (at approximately 1 second intervals per ARINC Specification 429 Part 1 and ARINC Characteristic 702) and examining the FMC Select Discrete input at the service connector.

The incoming Label 270 broadcast Status word is considered reliable when it is received for at least 3 consecutive transmission periods and the SSM bits (bits 30-31) indicate Valid or Normal for the condition of the source.

Table 2-1 of Attachment 2 summarizes the logic for determining which FMC is the present master FMC for the purposes of routing uplink messages with Sub-label 'MD'. Table 2-2 of Attachment 2 describes the FMC Status word (Label 270).

The ACARS MU checks the activity of the Status words from the FMCs in order to determine the master FMC for the purpose of routing an uplink with the Sub-label 'MD'. The following hierarchy is used by the ACARS MU:

- a. If the Status word for all FMCs is inactive then the ACARS MU uses the discrete input FMC Active Port Select in order to determine which FMC the uplink should be routed to. When the discrete is open circuit then the uplink should be routed to FMC1. When the discrete is grounded then the uplink should be routed to FMC2.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

- b. If only FMC1 is active then FMC1 is considered the master regardless of the status of the discrete and regardless of the status of Bit 17.
- c. If only FMC2 is active then FMC2 is considered the master regardless of the status of the discrete and regardless of the status of Bit 17.
- d. If the Status word for all FMCs is active, then the ACARS MU will use Bit 17 in order to determine which FMC is the master regardless of the discrete input. If Bit 17 has the value 1 in one and only one Status word then the FMC which transmitted the word with Bit 17 set to one is considered the master.
- e. If the Status word for all FMCs is active, then the ACARS MU will use Bit 17 in order to determine which FMC is the master regardless of the discrete input. If Bit 17 has the value 1 in both words or neither word then the FMC 1 is considered the master.
- f. If only FMC 3 is active, then FMC3 is considered the Master.

#### 3.5.2.2 Master/Slave Swaps

From time to time the selection of the FMC to act as the master may be changed. This change may occur during the receipt of an uplink message and complicate the delivery if the designated recipient is the "active" FMC.

In a pass-through implementation, the ACARS MU may continue to route the remaining blocks of a message being transferred to either the old or the new master after a Master/Slave swap when the Sub-label is MD.

Master/slave swaps must be treated differently when store-and-forward is used on uplinks to end systems.

### 3.6 Translation of Uplink Message Text to ARINC 429 Character File Transfer Format

When an uplink message is received from one of the RF paths (currently VHF and Satellite), the ACARS MU will transfer the entire Text field of the uplink block to the text portion of the ARINC 429 block.

#### 3.6.1 Control/Accountability Header

The ACARS MU will insert the Control/Accountability header at the beginning of the ARINC 429 Text field. The format of the Control/Accountability header is defined in Table 3.5.1-1.

##### 3.6.1.1 Origin Code

The Origin code will be set to indicate which air/ground link delivered the message to the ACARS MU. See Table 3-1 of Attachment 3 for the Origin codes.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

#### 3.6.1.2 Destination Code

The Destination code will be set to the value determined by the sub-label as described in Section 3.5.2.1. See Attachment 3 for the Destination codes.

#### 3.6.1.3 Message Purpose/Nature Code

The ACARS MU will set the message Purpose/Nature code to "V" in order to indicate that the message is an uplink being relayed by the ACARS MU.

#### 3.6.2 Uplink Message Buffering

Two different buffering schemes have been implemented in ACARS MUs over the years.

##### 3.6.2.1 Uplink Pass-Through Buffering

Originally all ACARS MUs used pass-through buffering. Pass-through buffering means that the ACARS will transmit each uplink block as soon as it is received. When pass-through buffering is implemented then the ACARS MU should contain at least one buffer of sufficient size to accommodate a maximum size block. Additional buffers or larger buffers may be provided at manufacturer option.

When the block is successfully transmitted to the end system then the buffer is cleared. If the ACARS MU is unable to establish communications it will respond as specified in ARINC Specification 618.

##### 3.6.2.2 Uplink Store-and-Forward Buffering

Store-and-forward buffering means that the ACARS MU will store all of the blocks of an uplink until it has received the last block before starting to transmit the message to an end system. When Store-and-forward buffering is implemented then the ACARS MU should contain at least one buffer of sufficient size to accommodate the maximum file size.

When the file is successfully delivered then the buffer is cleared. If the ACARS MU is unable to establish communications it will respond as specified in ARINC Specification 618.

#### 3.7 Routing Messages Received From End Systems

The ACARS MU should route downlink messages generated by other onboard avionics systems. The ACARS MU will use the value in the Destination field of the RTS word to determine the proper routing of the downlink message. See Section 3.4.1 for the definition of the RTS word.

The Destination field in the Control/Accountability header should contain the same value as the RTS word. However, if the values in the two Destination fields do not match then the value in the RTS word should be used.

**3.0 CHARACTER-ORIENTED COMMUNICATIONS****3.7.1 Control/Accountability Header**

The originator, which creates the message, should divide the message into blocks. A Control/Accountability header should be inserted at the beginning of each block.

The format of the Control/Accountability header is shown in Table 3.5.1-1. The Origin code, Destination code and message Purpose/Nature code fields of each block of a multi-block message should contain the same value.

**3.7.1.1 Origin Code**

The originator should set the Origin code to the value assigned to it. The Origin codes are defined in table of Origin/Destination code list in Attachment 3. For example, the DFDAU would use the Destination code of 'D' as defined in Attachment 3.

When the message is sent to the ground, the ACARS MU receives an acknowledgment that the ground network received the message. The MU creates a Ground ACK message which contains the Origin code of the original message from the LRU. The ACARS MU uses the Origin code to determine where to deliver the Ground ACK message. See Figure 6-3 of Attachment 6.

**3.7.1.2 Destination Code**

The Destination code (character 4) in messages from a peripheral to the MU in the Control/Accountability header of a message may be used by the end system to specify the transmit medium/media to be used. Destination code assignments can be found in the of Origin/Destination code table in Attachment 3.

The end system (peripheral) that originates the message should code the Destination field in the RTS word and the Control/Accountability header with the appropriate character (e.g. V, S, G, H) to designate the selection criteria the ACARS MU should follow to route the message to its destination.

The ACARS MU uses the Destination code in the RTS word to determine where to send the block or file.

**COMMENTARY**

The ACARS MU will typically use the following type of routing logic for a downlink message with a Destination code of 'G':

- a. Use the VHF link if available
- b. If the VHF link is not available, then use the Satcom link if it is available

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

- c. If both the VHF and Satcom links are unavailable then the ACARS MU will save the message for transmission when the first qualified link becomes available

#### 3.7.1.3 Message Purpose/Nature Code

If the sink is the final destination then the Message Purpose/Nature code is used to indicate what data is being requested or delivered. The Message Purpose/Nature codes are listed in Table 4-1 of Attachment 4.

If the sink (the LRU which is receiving the message) is not the final destination, as specified in the RTS word, then it will ignore the Message Purpose/Nature code.

### 3.8 Downlinks

The ACARS MU will route files to the VHF and satellite air/ground channels. The message is downlinked using label H1 and the sub-label according to Table 3.5.2.1-1 unless a user defined format has been specified.

#### 3.8.1 Downlink File Format

Blocks which are to be downlinked should contain a downlink Message Sequence Number (MSN) immediately following the Block Sequence character. The message creator should fabricate a four-character downlink MSN according to the format specified in ARINC Specification 618. If the ACARS MU reblocks the downlink message then it must also create new downlink Message Sequence Numbers and save the original downlink MSN of the last block for use in the ground acknowledgment message. See Section 3.8.3.

The ACARS MU may start downlinking data before it has received all blocks of a file.

All characters between the Control/Accountability header and the ETX/ETB character should be mapped into the text field of the ACARS air/ground block.

##### 3.8.1.1 Downlink Header Options

Bit 17 of the Data Follows word indicates whether the ACARS MU or the originating End System supplies the downlink header on a file transfer from an end system to the ACARS MU. When Bit 17 is '0', the ACARS MU supplies the downlink header, and when Bit 17 is '1', the originating End System supplies the downlink header.

Some ARINC 724 MUs assume that Bit 17 is set to 1 and do not check its value.

Bit 17 is always set to 1 for file transfer from the ACARS MU to an end system.

## 3.0 CHARACTER-ORIENTED COMMUNICATIONS

## 3.8.1.1.1 ACARS MU Supplies Downlink Header (Bit 17 = 0)

When Bit 17 = 0, the ACARS MU inserts the Flight Number, Sub-label, and Message Type immediately after the downlink Message Sequence Number (MSN) of the block. The formats of these fields are shown in the table below.

Table 3.8.1.1.1-1 – ACARS MU Generated Downlink Header

| Character Position   |                        |                   |
|----------------------|------------------------|-------------------|
| ARINC 429 Data Field | Downlink RF Text Field | Description       |
| 6-9                  | 1-4                    | Downlink MSN      |
|                      | 5-10                   | Flight Identifier |
|                      | 11                     | Pound Sing <#>    |
|                      | 12-13                  | Sub-label         |
|                      | 14                     | Character B,B>    |
| 10                   | 15                     | Data              |

The Message Type field is as specified in ARINC Specification 620.

Some ARINC 724 MUs do not support this option.

The flight identifier format is specified in ARINC Specification 618. The maximum ARINC 429 block size is limited to 216 characters, including Control/Accountability header and ETB/ETX, when Bit 17 is '0', in order to leave room for the ACARS MU generated downlink header.

## 3.8.1.1.2 END SYSTEM Supplies Downlink Header (Bit 17 = 1)

When Bit 17 = 1, then the End System supplies the downlink header and no action is required by the ACARS MU. The format of the downlink header is the same as specified in Section 3.8.1.1.1. The maximum ARINC 429 block size is limited to 226 characters, including Control/Accountability header, MSN, downlink header and ETB/ETX, when Bit 17 is '1'.

Table 3.8.1.1.2-1 – Originator Generated Downlink Header

| Character Position   |                        |                   |
|----------------------|------------------------|-------------------|
| ARINC 429 Data Field | Downlink RF Text Field | Description       |
| 6-9                  | 1-4                    | Downlink MSN      |
| 10-15                | 5-10                   | Flight Identifier |
| 16                   | 11                     | Pound Sign <#>    |
| 17-18                | 12-13                  | Sub-label         |
| 19                   | 14                     | Character B <B>   |
| 20                   | 15                     | Data              |

## 3.8.2 Block Size

The maximum file size depends on whether the end system or the ACARS MU supplies the downlink header (see Sections 3.8.1.1.1 and 3.8.1.1.2). The maximum amount of data in a file is the same regardless of who supplies the downlink header.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

Each block of the file, with overhead, is constructed as follows:

|                      |                                  |                    |                        |
|----------------------|----------------------------------|--------------------|------------------------|
| Data<br>Follows word | Control/Accountability<br>Header | Optional<br>Header | 206 Data<br>Characters |
|----------------------|----------------------------------|--------------------|------------------------|

**Figure 3.8.2-1 – Block Structure**

The maximum number of data characters is 3296 (16 blocks x 206 data characters per VHF block). The file size and number of characters available on any particular interface for data may also be subject to other restrictions. It is the ACARS MU responsibility to ensure that it does not downlink a block that violates ARINC Specification 618. The ACARS MU should be prepared to cope with a block that exceeds the limits specified in Sections 3.8.1.1.1 and 3.8.1.1.2.

#### COMMENTARY

Several methods have been identified to handle a block that is too large:

- a. Divide the block into 2 blocks or reblock the entire message if store-and-forward is used
- b. Truncate the end of the block
- c. Discard the block

There may be other solutions also. It is left to the designer to select a solution to this problem.

### 3.8.3 Ground Acknowledgment

The ACARS MU should generate a ground acknowledgment message when the last block of a file is successfully downlinked to the ground.

The ground acknowledgment message consists of the Control/Accountability header followed by the downlink message sequence number of the last block. The format is shown in Table 3.8.3-1.

**Table 3.8.3-1 – Ground Acknowledgment Message**

| Character No. | Description                                                                                  |
|---------------|----------------------------------------------------------------------------------------------|
| 1             | Unit Separator character                                                                     |
| 2             | Origin Code                                                                                  |
| 3             | Message Purpose/Nature Code                                                                  |
| 4             | Destination Code                                                                             |
| 5             | Block Sequence Character                                                                     |
| 6-9           | Downlink Message Sequence Number created by the originator for the last block of the message |

The Origin code should be set depending on which air/ground link was used to deliver the message. The message Purpose/Nature code should be set to acknowledge ('K'). The Destination code, found in the table of Origin/Destination codes in Attachment 3, is set to the Origin code that was in the Control/Accountability header of the ARINC 429 message.

### **3.0 CHARACTER-ORIENTED COMMUNICATIONS**

If the ACARS MU is unsuccessful at delivering the ground acknowledgment message, then the ACARS MU will discard the message. The ACARS MU should not consider failure to deliver the ground acknowledgment message a communication failure.

#### **3.8.4 Flow Control**

For store-and-forward implementations the ACARS MU will regulate the flow of incoming data blocks in order to prevent one end system from consuming all of the available memory.

The ACARS MU should only open one downlink file for each end system. The end system should be prepared to buffer any additional downlink messages until the ACARS MU is ready. If an end system attempts to send another downlink message before the ACARS MU is ready, then the ACARS MU response to an RTS word is a CTS word containing the BUSY signal. The ACARS MU may accept other files, such as documentary data, even when it has a downlink message in its buffer.

#### **3.8.5 Downlink Message Buffering**

Two different buffering schemes have been implemented in ACARS MUs over the years. Originally all ACARS MUs used pass-through buffering. More recent ACARS MU are capable of store-and-forward operation.

#### **COMMENTARY**

Downlink pass-through buffering will result in a larger percentage of lost and incomplete messages. It is strongly recommended that store-and-forward be used.

##### **3.8.5.1 Pass-Through Buffering**

Pass-through buffering means that the ACARS will downlink each block as soon as it is received from the end system. When pass-through buffering is implemented then the ACARS MU should contain at least one buffer of sufficient size to accommodate a maximum size block. Additional buffers or larger buffers may be provided at manufacturer option.

When the block is successfully downlinked then the buffer is cleared. If the ACARS MU is unable to establish communications it will hold the undelivered message and respond "busy" to all block transfer requests until the block is delivered or cleared according to user defined requirements.

##### **3.8.5.2 Store-and-Forward Buffering**

Store-and-forward buffering means that the ACARS MU will store all of the blocks of a message until it has received the last block before starting to downlink the message. When Store-and-forward buffering is implemented then the ACARS MU should contain at least one buffer of sufficient size to accommodate the maximum file size. Additional buffers may be provided at manufacturer option.

### 3.0 CHARACTER-ORIENTED COMMUNICATIONS

When store-and-forward is implemented then the ACARS MU should buffer and hold a maximum of one and only one file per End System for downlink. When the file is successfully downlinked then the buffer is cleared. If the ACARS MU is unable to establish communications it will hold the undelivered file and respond "busy" to all file transfer requests from that end system until the file is delivered or cleared according to user defined requirements.

## 3.9 Documentary Data Function

Requests for, and transmission of, documentary data should always be responded to normally without regard to possible duplication. This will allow systems to send or request documentary data upon reinitialization after a power interrupt without the possibility of rejection due to the duplication of the initial block sequence character.

### 3.9.1 Documentary Data Request

An onboard avionics unit may request documentary data from the ACARS MU. The format of a documentary data request message is shown in Table 5-1 of Attachment 5 and consists of the Control/Accountability header and no additional data. The message Purpose/Nature code is set to 'D' in order to indicate documentary data and the Destination code is set to 'M' for ACARS MU. A documentary data request message can be distinguished from a documentary data message by whether the ACARS MU is transmitting or receiving the message. If the ACARS MU is receiving the message, then it is a documentary data request message. If the ACARS MU is transmitting the message, then it is a documentary data message.

### 3.9.2 Documentary Data Message Format

The ACARS MU will create and transmit a documentary data of the format specified herein when requested. The format for Version 1 of the standard documentary data message is shown in Table 5-2 of Attachment 5. Many existing systems use a different format because there was no standard format prior to this document.

## 4.0 PRINTERS

### 4.1 Introduction

This Chapter describes the interface to various printers for the three configurations of ACARS Management Units (MU) in service.

### 4.2 ARINC 597/724 Dedicated Printer Protocol

ARINC Characteristic 597 provides for an interface to an optional ACARS printer that has only one input port and is dedicated to an ARINC 597 or 724 ACARS Management Unit (MU). This section defines the protocol which should be used by those Management Units when communicating with the ARINC 597/724 dedicated single-port printer. Information regarding the electrical interface between the MU and the printer can be found in Section 4.1.5.5 of ARINC Characteristic 597. Information regarding the physical characteristics of the printer can be found in Chapter 6 of ARINC Characteristic 597.

The interaction with the printer is different if the MU is operating in "pass-through" mode than it is if the MU is operating in "store-and-forward" mode. See Section 1.6 for a description of these modes. Some MUs may have the capability to operate in different modes for each connected system.

#### COMMENTARY

The printer control and operational characteristics for ARINC 597 and 724 dedicated printers described in Section 4.2.4 below apply to a installation in which the ACARS MU is operating in a "pass-through" mode. Printer control and operation under "store-and-forward" mode operation will be provided in Section 4.2.5 in a future supplement.

#### 4.2.1 Printer Status

The dedicated printer may have one or three status lines. Single-status printers provide only a ready/busy indication. Three-status printers provide an indication of eight different status conditions by setting status lines A, B and C as shown in Table 4.2.1-1.

**Table 4.2.1-1 – Three-Status Printers**

| Status Lines |   |   |                            |
|--------------|---|---|----------------------------|
| A            | B | C | Status Condition           |
| 1            | 1 | 1 | Printer Power Off          |
| 1            | 1 | 0 | Error in Printer           |
| 1            | 0 | 1 | Printer Busy               |
| 1            | 0 | 0 | Printer in Local Test Mode |
| 0            | 1 | 1 | Printer Out of Paper       |
| 0            | 1 | 0 | Printer Buffer Overrun     |
| 0            | 0 | 1 | Printer Initialized        |
| 0            | 0 | 0 | Printer Ready              |

## 4.0 PRINTERS

### 4.2.1.1 Printer Off

A status of 1-1-1 will be indicated when the printer power is off or the printer is not installed or inoperative.

### 4.2.1.2 Error in Printer

A status of 1-1-0 will be indicated when the printer has detected an error in the transmission of the data from the MU. Errors may include parity or block check errors.

### 4.2.1.3 Printer Busy

A status of 1-0-1 will be indicated when the printer is busy. The printer will go busy after the start of the transmission of an individual character, and then return to ready when it has finished storing the character. If the character has triggered the printing of a single line or a buffer, the status will return to ready after the text has been printed.

### 4.2.1.4 Printer in Local/Test Mode

A status of 1-0-0 will be indicated when the printer is off-line or in test mode. The printer will return to ready when it goes back on line or completes the test.

### 4.2.1.5 Printer Out of Paper

If equipped with a paper sensor, a status of 0-1-1 will be indicated when the printer is out of paper.

### 4.2.1.6 Printer Buffer Overrun

A status of 0-1-0 will be indicated when the printer has received more data than it can hold in its buffer.

### 4.2.1.7 Printer Initialized

A status of 0-0-1 will be indicated when the printer is first powered up. This status is to be considered the same as ready when the MU wants to initiate a printout. This status is considered an error if it occurs during a transfer of data.

### 4.2.1.8 Printer Ready

A status of 0-0-0 will be indicated when the printer is on-line and ready to accept data.

## 4.2.2 Printer Data Transfers

When the MU has data to send to the printer, it must examine the printer status lines to determine the printer availability. If the printer is determined to be in the ready or initialized state, the MU will transfer one character at a time to the printer, pausing after each byte until the printer status indicates ready again. Each character is transmitted in a ten-bit word with

#### 4.0 PRINTERS

start and stop bits as defined in ARINC Characteristic 597. Data to the printer must be sent in blocks of text no greater than 220 characters and must be preceded by the control character STX (0/2) and followed by ETX (0/3) or ETB (1/7). If the message is greater than 220 characters long, each block but the last must terminate with ETB. The last block of text must terminate with ETX.

##### 4.2.2.1 Successful Printer Data Transfers

In order for a printer data transfer to be successful, the printer must begin in either ready (0-0-0) or initialized (0-0-1) state. Throughout the transfer, only the busy (1-0-1) and ready (0-0-0) states are valid. The MU must wait for the printer to complete its printing after each block of a multiblock printout.

##### 4.2.2.2 Unsuccessful Printer Data Transfers

If the MU detects a printer status other than ready or busy throughout the transfer of the data, the transfer is considered unsuccessful. Retransmissions may be attempted as required.

##### 4.2.3 Format Control

Most dedicated printers are capable of printing in 40-column, 66-column, or 80-column modes. The 80-column mode is printed sideways down the paper. In order to accommodate standard uplink printer message formats, the format control is determined by the content of the first two characters of the fourth line of text (following the third line feed). If the first four characters of the fourth line are a Dash (2/13) and Space (2/0), followed by two Slashes (2/15), then the printer will print in the 80-column side-writing mode. If the first character after the Dash and Space is a Slash but the next character is not, then the printer will print 66 characters per line. If the first character is not a Slash, then the printer will print 40 characters per line. In any case, the first three lines, including the Format Control characters, will always appear in the printout as normal text.

##### 4.2.4 Uplink Printer Messages Pass-Through MU Operation

Uplink printer messages can contain the label characters C1 or any other label designated by the user for passing messages directly to the printer. They can be single block or multiblock messages. Multiblock messages are delivered to the printer one block at a time, as received. A store-and-forward type operation is not normally used in conjunction with this type of printer.

#### COMMENTARY

Users of airborne printers should be aware that unless formatted otherwise at the airline source, messages for the printer may be uplinked in a format reflecting the international standard line length of 69 characters. If this is not compatible with the line length of the printer, line feed occurrence in the middle of a word can be expected. If this is to be avoided, users must format the messages prior to

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delivery to the Datalink Service Provider for uplink. It is only the users who have any knowledge of their printers' capabilities as the MU is insensitive to printer line length.

##### 4.2.4.1 Uplink Response Determination

When a block of an uplink printer message is received, the MU should deliver, or attempt to deliver, the block to the printer before responding to the ground. If an uplink printer message is received at a time the printer is unable to accept data, the MU should respond with a downlink containing label characters Q5 or other reject messages, as specified below.

##### 4.2.4.2 Uplink Message Transfers

The MU should deliver data to the printer only when the BCS check on the uplinked message shows it to be error-free and the printer status indicates the printer is ready to accept data. The MU should deliver only the text portion of the uplink block, starting with the STX character and ending with the ETX or ETB. However, some printers are designed to validate uplink blocks by recalculating and verifying the uplink block check sequence. When delivering an uplink message block to such a printer, the MU should send the entire transmission block, starting with the SOH character and terminating with the message suffix (ETX/ETB, Block Check Sequence, and DEL characters). This enables the printer to validate the message before printing. Only the text between the STX and ETX/ETB will be printed. If the BCS check fails, the printer status will indicate 1-1-0 instead of ready following the transfer of the final byte.

##### 4.2.4.3 Incomplete Printer Messages

In multiblock message uplinks to the printer, receipt of the control character <ETB> by the printer will immobilize the print head until released by the MU with the next message block. If such a message should be broken for any reason, the aircrew should be advised that the printed material constitutes an incomplete message. In order to do this, the MU should, on receipt of each <ETB> character, start a 1.5 minute timer. If the next block is not received by the end of this time, it should close out the current message and deliver an "incomplete message" advisory to the printer consisting of the control character <STX>, the text of the advisory, and the control character <ETX>. The text content of the advisory will be negotiated between each printer user and his avionics supplier. An example advisory follows:

```
<STX><CR><LF>***MESSAGE INCOMPLETE***<ETX>
```

##### 4.2.4.4 Successful Delivery to Printer

If the MU is successful in delivering the message block to the printer, it will then transmit an acknowledgment message to the ground as defined in ARINC Specification 618.

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## 4.2.4.5 Unsuccessful Delivery to Printer

If an error occurs in the transmission of the message block to the printer, or the block check sequence validation fails, the printer will set the status lines to 1-1-0 (error in printer) at the completion of the transfer of the block. If for this, or any other reason, the MU is not successful in delivering the message block to the printer, the MU will then transmit the appropriate Printer Reject Message. If the printer does not provide the ABC status lines, the MU should transmit the Unable to Deliver message (Label Q5) to the ground. If the ABC status lines are provided, then the appropriate printer reject message (Label CA thru CF) should be sent, according to the error condition indicated by the status lines as shown in Table 4.2.4.5-1. Refer to Section 3.7 in ARINC Specification 618.

Table 4.2.4.5-1 – Error Condition

| Status Lines |   |   |              |
|--------------|---|---|--------------|
| A            | B | C | Reject Label |
| 1            | 1 | 1 | Q5           |
| 1            | 1 | 0 | CA           |
| 1            | 0 | 1 | CB           |
| 1            | 0 | 0 | CC           |
| 0            | 1 | 1 | CD           |
| 0            | 1 | 0 | CE           |
| 0            | 0 | 1 | CF           |

## 4.2.5 Uplink Printer Messages Store-and-forward MU Operation

This section is a placeholder for text to be added in a future supplement.

## 4.3 ARINC 740/744 Printer Interface

The protocols that may be used for communicating with a Multiple-Input Cockpit Printer (MICP) are specified in ARINC Characteristics 740, 744 and 744A.

## 4.3.1 Uplink Message to ARINC 740/744 Printer

Uplink printer messages can be single block or multiblock. The MU must be operating in the store-and-forward mode to process multiblock messages. The ACARS MU collects all blocks of a multiblock uplink before sending the message to the printer.

The maximum number of uplink blocks is 16 ACARS RF blocks as defined in ARINC Specification 618.

## 4.3.1.1 Uplink Response Determination

When the ACARS MU receives an uplink to be printed, then the ACARS MU should generate a downlink response indicating its ability to process the individual blocks per ARINC Specification 618.

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### 4.3.1.1.1 Incomplete Printer Message

If the Message Assembly timer defined in ARINC Specification 618 expires, then the printer uplink message is classified as incomplete and the ACARS MU should perform the following:

- a. Print the partial message received thus far
- b. Treat the next printer uplink block as the first block of a new message

### 4.3.1.2 Attempt Delivery to Printer

When the ACARS MU has a complete message, identified by receipt of the final (ETX) block, then the ACARS MU will attempt to deliver the message to the printer. The following subsections describe the possible conclusion of this process.

#### 4.3.1.2.1 Delivery Successful

If the ACARS MU successfully delivers the message to the printer, then it may discard its internal copy of the message based on user requirements.

#### 4.3.1.2.2 Delivery Unsuccessful

If the ACARS MU is not successful in delivering the message to the printer then the ACARS MU should respond per Section 4.2.4.5. The ACARS MU may make additional attempts to deliver the message to the same printer or attempt to deliver the message to an alternate display device(s).

### 4.3.2 Non-Uplink Printer Messages

The ACARS MU may have the capability of generating printer messages from its own internal data. Furthermore, the ACARS MU may be programmed to accept printer messages from other end systems on the aircraft. When an end system routes a message to the printer via the ACARS MU then the destination code in the message should be set to 'P'.

When the ACARS MU is routing a message received from another end system to the printer then the Control/Accountability header(s) used to deliver the message to the ACARS MU should be removed by the ACARS MU before passing the message on to the printer. The ACARS MU should collect and store all of the blocks or LDUs (see Chapter 4) of the message before passing the message on to the printer. The message should be reblocked by the ACARS MU if the blocks or LDUs received by the ACARS MU are not compatible with the printer protocol as specified in ARINC Characteristics 740 and 744. The message originator should format the message for printing.

## 5.0 GENERAL BIT-ORIENTED COMMUNICATIONS PROTOCOL

### 5.1 Data Transfer System

The protocols defined in this chapter are intended to accommodate data transfer between the ACARS MU and other onboard End Systems such as the FMC, ACMS, SDU and Cabin Terminals using a Link layer protocol compatible with binary data. The protocol definition is patterned after the OSI model.

The interaction of the ACARS MU and an End System (ES) is illustrated in Figure 9-1 of Attachment 9. As seen in this diagram, the ACARS MU/ES interface concerns itself with the lower three layers of the OSI model, i.e., Physical, Link, and Network. These layer descriptions and assignments are given in the following sections.

### 5.2 Physical Medium

The physical interface is described in ARINC Specification 429 Part 1, "Mark 33 Digital Information Transfer System (DITS)". The definition includes connection via a two wire twisted shielded pair. Outgoing traffic is carried on a different wire pair than incoming traffic.

### 5.3 Physical Layer

The Physical Layer provides the functions necessary to activate, maintain and release the physical link which will carry the bit stream of the communication. The electrical interface, voltage, timing, etc. described in ARINC Specification 429 Part 1 is used by the ACARS MU when interfacing with the other onboard avionics systems.

#### 5.3.1 Bit Rate

ARINC Specification 429 provides for data transfer at two rates. Unless specified otherwise, the interface should operate at "Low Speed" as defined in ARINC Specification 429 Part 1.

#### 5.3.2 Word Timing

Word timing is as specified in ARINC Specification 429 Part 1.

### 5.4 Link Layer

The Link layer is responsible for transferring information from one logical network entity to another and for annunciating any errors encountered during transmission. The Data Link layer provides a virtual channel and some flow control mechanisms.

At the Link layer, data is transferred using a data transparent bit-oriented data file transfer protocol designed to permit the source to send and the sink to receive information in multiple word packets. It is structured to allow the transmission of any binary data organized into a data file composed of octets.

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The procedure for protocol determination is described in ARINC Specification 429 Part 3 starting with Supplement 12 in Section 2.5, Bit-oriented File Transfer Protocol. The bit-oriented protocol definition is commonly referred to as the "Williamsburg" protocol. There are several versions of the ARINC 429 Part 3 bit-oriented protocol. Each LRU should perform ARINC 429 bit-oriented protocol determination as specified in ARINC Specification 429 Part 3.

### 5.5 Network Layer

The Network layer functions require knowledge regarding the format of the Network header and data packets received from the Link layer. The bit-oriented protocol contains a field called the General Format Identifier (GFI) in the Start of Text (SOT) word so that the format of each packet can be explicitly identified. ARINC Specification 429 Part 3 contains a table listing all of the GFI values that have been allocated. ARINC Specification 429 Part 3 does not define the Network layer functions. It defines only the Link layer functions.

ARINC Specification 429 Part 3 has precedence over this specification if there are any discrepancies between ARINC Specification 429 Part 3 and this document. The formats which are defined in this document are listed in Table 5.5-1.

**Table 5.5-1 – General Format Identifier Table**

| GFI  | Title                                         |
|------|-----------------------------------------------|
| 0011 | General Purpose Bit-Oriented Protocol (GPBOP) |

The sink will determine the Network Header for data encoding schemes by examining the GFI field of the SOT word. Refer to ARINC Specification 618 for the definition of GFI '1110'.

#### 5.5.1 GPBOP 'GFI 0011' File Format

The GFI '0011' file format supports both single and multiple LDU files. The first LDU of every file contains a Control/Accountability header. The other LDUs in a multiple LDU file do not contain Control/Accountability headers. The smallest file that can be sent consists only of a Control/Accountability header. Example files in GPBOP format are provided in Attachments 7 and 8.

In some applications an end to end integrity check is desirable in order to validate the correct transfer of a data file from the message originator to its final destination. For further information the reader should refer to the applicable ARINC Equipment Characteristic, such as ARINC Characteristic 702, Flight Management Computer System.

##### 5.5.1.1 GPBOP Control/Accountability Header

Two versions of the Control/Accountability header have been defined. The original format (version 1) of the Control/Accountability header for

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GFI of '0011' is shown in Table 5.5.1.1-1. The new format (version 2) is depicted in Table 5.5.1.1-2.

**Table 5.5.1.1-1 – GFI 0011 Control Accountability Header - Version 1**

| Octet Number | Field Contents         | Attachment Reference |
|--------------|------------------------|----------------------|
| 1            | Origin                 | 3                    |
| 2            | Purpose/Nature         | 4                    |
| 3            | Destination            | 3                    |
| 4            | Reserved (binary zero) |                      |
| 5            | Reserved (binary zero) |                      |

Supplement 1 of ARINC 619 introduced a backward compatible modification to the format of the Control/Accountability header for GFI '0011', see Table 5.5.1.1-2. An end system may designate the preferred medium or media and assign a priority level and lifetime to each message that it generates. The capability to transfer this information to the MU has been integrated into Octets 4 and 5 of the Control/Accountability header. Refer to Table 11-1 of Attachment 11 for a depiction of the coding of Octets 4 and 5.

**Table 5.5.1.1-2 – GFI 0011 Control Accountability Header - Version 2**

| Octet Number | Field Contents         | Attachment Reference |
|--------------|------------------------|----------------------|
| 1            | Origin                 | 3                    |
| 2            | Message Purpose Nature | 4                    |
| 3            | Destination            | 3                    |
| 4            | Media Select           | 11                   |
| 5            | Priority and Lifetime  | 11                   |

The definitions of the new fields are such that when a LRU programmed to use the modified format shown in Table 5.5.1.1-2 receives a file containing the original format it can still be processed. Likewise, an LRU programmed to use the original format shown in Table 5.5.1.1-1 receives a file containing the modified format it can still process the file because the original fields in octets 1 through 3 were preserved.

**5.5.1.1.1 Origin Code**

The Origin code should be set to indicate the origin of the message. See Attachment 3 for a listing of Origin codes.

**5.5.1.1.2 Message Purpose/Nature Code**

The Message Purpose/Nature code indicates the message type. The source should set the Message Purpose/Nature code to indicate the message type. The Message Purpose/Nature codes are defined in Attachment 4.

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If the sink is not the final destination as specified in the Control/Accountability header, then it will ignore the Message Purpose/Nature code.

If the sink is also the destination, then the Message Purpose/Nature code indicates what data is being requested or delivered.

5.5.1.1.3 Destination Code

The Destination code should be set to indicate the end system to which the message should be delivered. The Destination field in downlink messages to the ACARS MU is used to indicate the preferred air/ground medium. See Attachment 3 for a listing of Destination codes.

5.5.1.1.4 Reserved Fields

For MUs that exercise the original Control/Accountability header format, the two Reserved octets will be coded with binary zeros as shown in Table 5.5.1.1-1. The modified format, introduced by Supplement 1, and shown in Table 5.5.1.1-2, replaces the two reserved octets with three new fields. The new fields are defined in the following sections and Attachment 11.

5.5.1.1.5 Media Selection Field

The Destination Code (Octet 3, as described in Section 5.5.1.1.3) in the Control/Accountability header may be used by the end system to specify the preferred transmit medium (or media) for a specific message.

Additional media selection capability has been introduced in Supplement 1 by defining eight bits in Octet 4 of the formerly Reserved fields as a Media Select field. Equipment designed to the earlier standard may not support the added function.

Bits for the designation of four different media are defined to transfer ACARS data. The remaining four bits of Octet 4 are reserved for future use. If media selection is supported, the end system can designate the media that are to be evaluated for use in Octet 4 of the Control/Accountability header. Table 11-1A of Attachment 11 lists the bit assignments for media selection.

If the Destination code in Octet 3 is 'G' (ground station), then the choice of medium/media should be attempted according to the Media Select bits in Octet 4. The bits of Octet 4 of the Control/Accountability header are used to indicate the air/ground links that may be used to deliver the message.

Only the four least significant bits have been assigned. Each bit position is assigned to a subnetwork. A bit set to 1 indicates permission to attempt transmission through the associated medium. A field coded '0000 0000' should be interpreted (as should the coding '1111 1111') as indicating that "any medium may be used". The preference of media is:

|                    |        |
|--------------------|--------|
| Default Preference | Medium |
|--------------------|--------|

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|   |          |
|---|----------|
| 1 | Gatelink |
| 2 | VHF      |
| 3 | HF       |
| 4 | SATCOM   |

Refer to Table 11-1A of Attachment 11 for a listing of the media indicator coding.

**5.5.1.1.6 Message Lifetime Field**

The Lifetime field (comprised of the first 4 bits in Octet 5 of the Control/Accountability header) in messages from a peripheral to the MU may be used by the end system to specify the period of time before the importance of the message falls to zero.

**COMMENTARY**

A substantial amount of data is time-critical. If the information is not delivered soon enough, the information becomes worthless. Messages that grow stale should be discarded.

Refer to Table 11-1B of Attachment 11 for the coding of time values.

When the MU receives a downlink message that contains a Lifetime field with a value other than 0000, then the MU should attempt to downlink the message until the time indicated in the Lifetime field has elapsed. The deletion of stale messages is considered a queue management function and not a Link layer protocol function. Therefore the general rule is that if the Link layer protocol is processing the message when the lifetime expires then the Link layer processing will continue to its natural conclusion. If the Link layer is not successful in transmitting the message then control of the message is transferred to the queue manger which will then detect that the message lifetime has expired and delete the message.

If message downlinking is in progress, but not completed, when the time expires, the MU should continue the downlink transmission until the air/ground protocol successfully completes the message transaction or message transmission is terminated. If the air/ground protocol does not successfully complete the message transmission then when the message is re-queued the queue management will delete the message.

Downlink messages, whose lifetime has expired, and which receive a NAK from the ground should be discarded rather than retransmitted.

When the MU has not been successful in initiating the downlinking of a message and the time value specified in the message has elapsed, then the MU should discard the message.

**COMMENTARY**

The designer is at liberty to determine the mechanism that best provides an evaluation of the elapsed time.

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If a message is discarded due to the expiration of its lifetime, the MU should send an ARINC 429 Status message to the originating peripheral with its Status Code field containing a value of '1' to report that the message was deleted. See Figure 8-2 of Attachment 8.

### 5.5.1.1.7 Message Priority

The Message Priority field (comprised of the last four bits in Octet 5 in the Control/Accountability header) in messages from a peripheral to the MU may be used by the end system to specify the priority of the message.

The format of the Priority field is shown in Table 11-1C of Attachment 11. There are 15 levels of priority and they are encoded into the four bits of the Priority field. When all bits are set to zero then the default priority for that LRU are used for all messages from that LRU. The priority field allows the end system to assign each downlink a different priority.

If priority is supported, the end system encodes the priority of each message in the most significant four bits of Octet 5 of the Control/Accountability header. The highest priority level is 0001 and the lowest priority is 1111. The value '0000' indicates to use the default values, see Table 11-1C.

## COMMENTARY

This approach allows a modified MU to interface with an LRU, which is still using version 1.

If particular applications see the need for a finer level of granularity for their messages beyond those provided in Table 11-1D, they should queue accordingly at the Application level, and then hand messages off to the MU in the desired order. When the message is passed to the MU, the message priority is also passed. Given equal message priority levels for messages from two different end systems, the MU should downlink the messages in a fixed order determined by the ranking of the source LRU. The proposed order (from first to last) is: FMC, MU, CFDIU/CMC, DFDAU/ACMS and Cabin Terminal.

### 5.5.1.2 Format of Data in Octets

Before binary data can be transmitted over this link it should be converted into the ISO #5 characters. The standard method of converting binary data is called bit-to-hex (ISO 5) encoding. Each octet of binary data is divided into 2 four-bit nibbles. Each nibble is encoded into a seven-bit character field using its equivalent ISO #5 hexadecimal character. The value of each character, which will fall within the numeric range 0 through 9 or the alpha range A through F, is encoded for transmission per the ISO Alphabet #5 convention in the manner described above for free text, except File Sequence Number and Octets 4 and 5 of the Control/Accountability header.

Data should be encoded such that only the subset of ISO Alphabet #5 characters identified in ARINC Specification 618 are transmitted across the air-ground data link. The ISO #5 character sets are reproduced in

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Attachment 1 of this specification for the reader's convenience. Seven bits per character should be used, i.e., an eighth parity bit should not be added. Instead, a pad bit should be used to complete the octet. Two and one half such characters will occupy the bit-oriented information field of each ARINC 429 32-bit word.

### COMMENTARY

Most ACARS MUs, air-ground-air links and some of the ground communications links connecting users' data sources/sinks to the ACARS controlling processor are capable of handling the full ISO Alphabet #5 code set. However, some ground links may not have this capability. Therefore, the restricted (baudot subset) code set (See Attachment 1) specified for the character-only environment have been retained in this definition to ensure that all messages originating in a ground-based computer for delivery via ACARS to an airborne computer, and vice versa, are transparent to all ground communications links through which they might pass.

#### 5.5.1.3 Uplinks to End Systems (GFI '0011')

The ACARS MU will gather all blocks of a file before attempting to deliver it using the bit-oriented, Link-layer protocol.

The ACARS MU will combine the data from all of the uplink blocks that constitute a message and divide the data into link data units (LDU) so that the number of LDUs is minimized.

LDUs do not have to be completely filled.

An octet (data byte) will not be split across a LDU boundary.

The ACARS MU will transfer the text field of the uplink message, removing the characters preceding and including the sublabel, to the text portion of the ARINC 429 bit file.

The ACARS MU will add the Control/Accountability header specified by GFI '0011' to the beginning of the text field of the first LDU.

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### 5.5.1.3.1 Routing Uplinks

Routing of uplinks is the same as Section 3.5.2.1 except as delineated below.

In a store-and-forward implementation, when a file transfer of an uplink with sublabel MD is in progress and a master/slave change is detected, then the MU should restart the file transfer with the new master.

If the ACARS MU detects a master/slave swap, while in the process of transmitting a file to the "master" end system and the sublabel is M1, M2 or M3, then the ACARS MU will ignore the master/slave swap and continue to try to deliver the file as directed by the sublabel.

### 5.5.1.3.2 Uplink Flow Control

If the previous file transfer has been completed, then the ACARS MU will accept and acknowledge the UPLINK blocks. If the ACARS MU has not delivered the previous file, then it will generate an Unable to Deliver Uplink Message (label Q5) downlink and reject the block.

A label 'HX' downlink should be sent when the ACARS MU has all ready ACKed all of the uplink blocks and then was unsuccessful at delivering the message. The undelivered message should be discarded.

### 5.5.1.3.3 Translation of an Uplink Message to a GPBOP Message

The end system does not need logic to skip over the service provider header, because it is removed from uplinks by the ACARS MU. The ACARS MU will strip out (remove) the dash (-), space ( ), pound sign (#) and sub-label from each block, including the first. All blocks are then combined to create a full message to the end system. The ACARS MU will add a five octet header containing: the Origin code, Purpose code, destination code and two reserved octets, set to zero, to the front of the message. The ACARS MU will transmit this message to the End System, employing the bit-oriented protocol, breaking the message into LDU's if necessary.

The header information is still considered to be a part of the data over which the ARINC 429 Link layer CRC is computed. The Link layer CRC value is found in the EOT word. If there is an end-to-end CRC then the header is not protected by the end-to-end CRC because the header is not part of the application message.

### 5.5.1.4 Downlinks From End Systems (GFI '0011')

The requirements specified in the following sections should be implemented in the End Systems and the ACARS MU in order to downlink a message from the End System.

Downlinks should employ the same convention as uplinks. The sequence number, the flight number and the sub-label are not included inside the message. The ACARS MU must add them (the sequence number, the

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flight number and the sub-label) prior to downlinking the message on VHF.

If the end system wants to add an address(es), then the address(es) should be preceded by a slash and terminated by a period. If multiple addresses are added, spaces are used as delimiters to separate the addresses. The slash should be the first character following the five-octet Control/Accountability header. The address (including the slash and the period) is not protected by the end-to-end CRC, if present; neither is the five-octet Control/Accountability header.

### 5.5.1.4.1 GPBOP File Size

The maximum file size delivered to the sink should not exceed 3296 characters. Sources should not create files larger than 3301 characters, including the Control/Accountability header.

#### COMMENTARY

Maximum file size was determined from 16 ACARS blocks times 206 characters/block per file yields 3301 characters.

If a file exceeds the maximum character limit, then the ACARS MU should not send a SYN word because that would cause the source to transmit the same file again. The ACARS MU may generate a status message per Figure 8-2 of Attachment 8 (status code = 'O') to be sent back to the originator. The ACARS should truncate the message to 3301 characters, add an <ETX> character and then downlink the modified message.

The ACARS MU should route the entire file to the destination specified by the destination field of the RTS word. The Destination field (Octet 3) of the Control/Accountability header in the first LDU should contain the same value as the RTS word. If the destination fields contain different values, then the value in the RTS word should be used.

#### 5.5.1.4.1.1 GPBOP Control/Accountability Header

Format of the control/accountability header specified by GFI '0011' is defined in Section 5.5.1.1.

#### 5.5.1.4.1.2 Origin Code

The end system should set the Origin code to the value assigned to it. The Origin codes are defined in Attachment 3.

#### 5.5.1.4.1.3 Message Purpose/Nature Code

The End System should set the Message Purpose/Nature code to indicate that this is a downlink message.

The Message Purpose/Nature codes are defined in Attachment 4.

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The End System should set the Destination code to indicate the desired routing of the message. The destination code in the Control/Accountability header should be the same as the Destination code in the RTS word.

**COMMENTARY**

A new field has been added by Supplement 1 to this specification to augment the Destination code. See Section 5.5.1.1.5.

**5.5.1.4.1.5 Media Select Field**

End systems, which support the control accountability header format shown in Table 5.5.1.1-2, can use the Media Select field to indicate which air-ground links can be used for delivering the message to the ground by setting the Destination field to G and setting one or more bits in the Media Select field to 1. The format of the Media Select field is shown in Table 11-1A of Attachment 11. Each bit in the field represents a separate air-ground link. For each air-ground link, which can be used for the message, the End System should set the corresponding bit in the Media Select field.

The Media Selection field is ignored when the Destination field contains a value other than G.

When the Destination field contains a value of G and all of the bits of the Media Selection field are 0, then the MU routes the message according to the default logic as in Section 5.5.1.1.5.

**5.5.1.4.1.6 Lifetime Field**

End systems, which support the control accountability header format shown in Table 5.5.1.1-2, can use the Lifetime field to indicate how long the MU will attempt to downlink the message before discarding it. The format of the Lifetime field is shown in Table 11-1B of Attachment 11. Each bit in the field is assigned a time value. The message lifetime is represented by the totals of the bits set to 1.

For example, if bits 2 and 4 are set to 1, then the message has a lifetime of 20 minutes. When all of the bits are set to zero, then the message lifetime is infinity.

**5.5.1.4.1.7 Priority Field**

End systems, which support the control accountability header format shown in Table 5.5.1.1-2, can use the Priority field to indicate the priority of the downlink. The format of the Priority field is shown in Table 11-1D of Attachment 11. There are 15 levels of priority and they are encoded into the 4 bits of the priority field. When all bits are set to zero, then the default priority for that LRU is used for all messages from that LRU. The priority field allows the End System to assign each downlink a different priority.

**5.0 GENERAL BIT-ORIENTED COMMUNICATIONS PROTOCOL****5.5.1.4.1.8 Air/Ground Downlink Message Format**

The ACARS MU will collect all LDUs before attempting to downlink the file.

The ACARS MU will remove the five character Control/Accountability header from the first LDU and append the data from the remaining LDUs. Then the ACARS MU should partition the data into the minimum number of 206 characters, or smaller, blocks as required by ARINC Specification 618.

The ACARS MU adds the downlink Message Sequence Number (Downlink Message Sequence Number is computed per ARINC Specification 618), Flight Number and Sublabel fields to the beginning of the Text field of each ACARS block.

The Sublabel field is a four character field composed of the poundsign '#', the two character Sublabel and the character 'B'. The Sublabel code indicates the origin of the message. Appendix C of ARINC Specification 620 contains the sublabels assigned to the various end systems. The 'MD' Sublabel is not used in Label H1 downlinks.

**COMMENTARY**

The character 'B' was used in previous formats and has been retained to promote interoperability with older units.

**5.5.1.4.2 Ground Acknowledgment Message**

The ACARS MU should send a Ground Acknowledgment message to an End System when the last block of a file it generated is successfully downlinked to the ground. For dual End-System configurations, the ACARS MU will route the ground acknowledgment file to the designated Master End System.

**COMMENTARY**

In a dual End System configuration, a "master/slave" swap may occur while the ACARS MU is downlinking the file to the ground. In this scenario, the ACARS MU will send the Ground Acknowledgment to the new Master End System.

The Ground Acknowledge file consists of a Control/Accountability header, with the origin set to the value of the ACARS MU and the message Purpose/Nature field with the code set to Acknowledge, followed by the File Sequence Number. See Figure 8-1 of Attachment 8 for a pictorial illustration of the coding of the Ground ACK Message.

The File Sequence Number can have a binary value between 0 and 255, therefore it is an exception to the GPBOP format of data specified in Section 5.5.1.2.

**5.0 GENERAL BIT-ORIENTED COMMUNICATIONS PROTOCOL****5.5.1.5 Documentary Data Function**

Requests for, and transmission of, documentary data should always be responded to normally without regard to possible duplication. This will allow systems to send or request documentary data upon reinitialization after a power interrupt without the possibility of rejection due to the duplication of the block file sequence number.

**5.5.1.5.1 Documentary Data Request**

An onboard avionic unit may request documentary data from the ACARS MU. The format of a GPBOP (GFI '0011') Documentary Data Request message, shown in Table 5-3 of Attachment 5, consists of the Control/Accountability header and no additional data.

The message Purpose/Nature code is set to 'D' in order to indicate documentary data and the destination code is set to M for ACARS MU.

A Documentary Data Request message can be distinguished from a Documentary Data message by whether the ACARS MU is transmitting or receiving the message. If the ACARS MU is receiving the message then it is a Documentary Data Request message. If the ACARS MU is transmitting the message then it is a Documentary Data message. See Table 5-3 for the format of GPBOP (GFI '0011') Documentary Data Request message.

**5.5.1.5.2 Documentary Data Message Format**

The ACARS MU will create and transmit a GPBOP (GFI '0011') Documentary Data message when a Documentary Data request is received. See Table 5-4 of Attachment 5 for the format of GPBOP Documentary Data response message.

**5.6 Delete Message Function**

The Message Delete function provides an End System with a means by which it can delete a message not yet transmitted by the MU, by sending a message to the MU with the format defined in Section 5.6.1.

**COMMENTARY**

The Message Delete function is a new feature introduced by Supplement 1 to this Specification. LRUs implemented prior to Supplement 1 do not support the Message Delete function. LRUs implemented after the release of Supplement 1 may, or may not, include the Message Delete function.

An MU that supports the Message Delete function will respond by deleting the message (if possible) and sending a response message to the end system. The format of the response message is defined in Section 5.6.2.

**5.0 GENERAL BIT-ORIENTED COMMUNICATIONS PROTOCOL**

If message downlinking is in progress, but not completed when the Delete command is received, then the MU should complete the downlink transmission and use the Message in Progress status code in the response message.

**5.6.1 Message Deletion Command**

The Message Deletion Command message consists of the Control/Accountability header followed by the downlink file sequence number and a Status field.

The Origin code should be set per Attachment 3 to the character representing the End System that is originating the message. The message Purpose/Nature code should be set to 'S'. The Destination code is set to 'M' for MU. The file sequence number should be set to the value of file that should be deleted. The status field should contain the character 'D' to indicate that this is a Message Deletion command. The format is shown in Table 5.6.1-1. See Figure 8-2 in Attachment 8.

**Table 5.6.1-1 – Message Deletion Command**

| Character | Description                                                                                  |
|-----------|----------------------------------------------------------------------------------------------|
| 1         | Unit Separator character                                                                     |
| 2         | Origin Code                                                                                  |
| 3         | Message Purpose/Nature Code                                                                  |
| 4         | Destination Code                                                                             |
| 5         | Block Sequence Character Sequence Number created for the message                             |
| 6-9       | Downlink Message Sequence Number created by the originator for the last block of the message |
| 10        | Command = D                                                                                  |

**5.6.2 File Status Message**

The MU should respond to a Message Deletion command with a File Status message indicating the status of the deletion action requested. The File Status message may also be sent to an end system in response to a downlink file that is too large for air/ground transmission, as specified in Section 5.5.1.4.1. The File Status message consists of a GPBOP Control/Accountability header followed by the downlink File Sequence Number and a Response Code.

The Origin code should be set to 'M' for MU. The message Purpose/Nature code should be set to 'S'. The Destination code is set to the code for the end system that originated a Message Deletion command or that created a downlink file too large for the MU to transmit. See Attachment 3 for a listing of Origin/Destination codes. The File Sequence Number should be set to the value of the message that has been requested to be downlinked by the end system. The Response Code should contain one of the codes defined in Table 5.6.2-2 below. The format of the File Status message is shown in Table 5.6.2-1. See Figure 8-3 in Attachment 8.

## 5.0 GENERAL BIT-ORIENTED COMMUNICATIONS PROTOCOL

Table 5.6.2-1 – File Status Message Format

| Octet No. | Description                                       |
|-----------|---------------------------------------------------|
| 1         | Origin                                            |
| 2         | Message Purpose/Nature                            |
| 3         | Destination                                       |
| 4         | Reserved (binary zeros)                           |
| 5         | Reserved (binary zeros)                           |
| 6         | File Sequence Number of original downlink message |
| 7         | Response Code                                     |

The Response codes to be used by the MU to report the status of the message are as follows:

Table 5.6.2-2 – Response Code

| Description                                                                     | Response Code |
|---------------------------------------------------------------------------------|---------------|
| Message file too large                                                          | 0             |
| Message discarded because lifetime expired                                      | 1             |
| Message discarded because a Message Delete command was received from end system | 2             |
| Message in Progress, cannot delete                                              | 3             |
| Message already downlinked (or not found), cannot delete                        | 4             |

## 6.0 CMU RECORDER PROTOCOL

## 6.1 Data Transfer System

The protocol defined in this chapter is intended to accommodate data transfer between the ACARS C/MU and the Cockpit Voice Recorder (CVR). The CMU-CVR interface is used to stream data to the CVR for recording as described in ARINC 758. The definition of the Physical and Data Link layers of this interface offer several options, which will be determined at system initialization. The options are enumerated in the following sections.

### COMMENTARY

The data link recording interface definition is primarily designed to operate with ARINC 758 CMUs but is intended to be flexible enough for operation in different architectures. For this purpose, the CVR supports low-speed and high-speed ARINC 429 links, as well as version 1 and 3 of ARINC 429 Williamsburg protocol, with the negotiation capabilities specified in ARINC 429, as well as the ability to default to version 3, if no ALO word is received from the CMU.

## 6.2 Physical Medium

The physical interface is described in **ARINC Specification 429: Mark 33 Digital Information Transfer System (DITS) Part 1 – Functional Description, Electrical Interface, Label Assignments and Word Formats**.

## 6.3 Physical Layer

The Physical layer provides the functions necessary to activate, maintain and release the physical link, which will carry the bit stream of the communication. The electrical interface, voltage, timing, etc. described in ARINC Specification 429 Part 1 is used.

The recorder should support both high-speed and low-speed ARINC 429. The source LRU should support either high-speed or low-speed ARINC 429. See the appropriate LRU specification.

### 6.3.1 Bit Rate

ARINC 429 provides for data transfer at two rates. Some devices will use low-speed as defined in ARINC 429 to send data to the recorder. Some devices will use high-speed as defined in ARINC 429 to send data to the recorder. See the appropriate LRU characteristic.

The recorder needs to be able to determine whether it is connected to an LRU that is using high-speed or low-speed by monitoring its ARINC 429 input.

### 6.3.2 Word Timing

Word timing is as specified in ARINC 429.

## 6.0 CMU RECORDER PROTOCOL

## 6.4 Link layer

The Link layer is responsible for transferring information from one LRU to another and for identifying any errors encountered during transmission. The Data Link layer provides a virtual channel.

At the Link layer, data is transferred using a data-transparent, bit-oriented, data-file transfer protocol designed to permit the source to send and the sink to receive information in multiple word packets. It is structured to allow the transmission of any binary data organized into a data file composed of octets.

There are several versions of the ARINC 429 bit-oriented protocol defined in ARINC 429. The recorder uses a modified procedure for protocol determination from the protocol described in ARINC 429 Part 3 because the recorder ARINC 429 transmitter is not wired to the ARINC 758 CMU. The recorder defaults to Williamsburg Version 3 without ALO/ALR.

If an LRU wants to use Williamsburg Version 1, then the LRU should initiate an ALO/ALR exchange with the recorder with the Version number set to 1.

The recorder should support both Williamsburg Version 3 and Williamsburg Version 1 protocols. This allows the source LRU to utilize either Williamsburg Version 3 or Williamsburg Version 1. See the appropriate LRU specification.

Part 3 of ARINC 429 defines Version 1 and Version 3 of the Williamsburg protocol for file data transfer. Both ARINC 429 file data transfer and conventional broadcast words are used to transfer information.

## 6.4.1 Williamsburg Version 3 Configuration

For a detailed explanation of the ARINC 429 Williamsburg protocol Version 3, as well as definitions of the ARINC 429 Version 3 word formats, refer to ARINC 429, "Mark 33 Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques," Section 3.

The Williamsburg Version 3, as used by the CMU-CVR interface, only uses Command frames. Info frames are not used for this interface.

The Option profile (see ARINC 429, Part 3, Attachment 10, Table 10-3b for a Williamsburg Version 3 implementation) is shown in Table 6.4.1-1.

**Table 6.4.1-1 – Bit-Oriented Protocol Options for Version 3**

| ARINC 429 Option                | Value               |
|---------------------------------|---------------------|
| O <sub>1</sub>                  | Half duplex         |
| O <sub>2</sub>                  | Note 1              |
| O <sub>3</sub> -O <sub>7</sub>  | N/A per 429         |
| O <sub>8</sub>                  | No                  |
| O <sub>9</sub> -O <sub>10</sub> | N/A per 429         |
| O <sub>11</sub>                 | No verification     |
| O <sub>12</sub>                 | No                  |
| O <sub>13</sub>                 | Command frames only |
| O <sub>14</sub>                 | No pausing          |
| O <sub>15</sub>                 | N/A (Note 2)        |

## 6.0 CMU RECORDER PROTOCOL

Notes:

1. ARINC 758 CMU uses low speed. Other devices may use high speed. The CVR supports both.
2. Command Frames use a 16-bit CRC. See ARINC Specification 429, Section 3.4.9.

## 6.4.2 Williamsburg Version 1

For a detailed explanation of the ARINC Specification 429 BOP Version 1, as well as definitions of the ARINC Specification 429 BOP Version 1 word formats, refer to **ARINC Specification 429: Mark 33 Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques**, Section 2.5.

The Option profile (see ARINC 429, Part 3, Attachment 10, Table 10-3a) for a Williamsburg Version 1 implementation is shown in Table 6.4.2-1.

The following options should be used in a Williamsburg Version 1 implementation (options described in ARINC Specification 429, Part 3, Table 10-3a):

**Table 6.4.2-1 – Williamsburg Version 1 Options**

| Option          | Description                                                | Default |
|-----------------|------------------------------------------------------------|---------|
| O <sub>1</sub>  | Half or Full Duplex                                        | Half    |
| O <sub>2</sub>  | High or Low Speed Bus                                      | High    |
| O <sub>3</sub>  | Automatic CTS When Ready                                   | Yes     |
| O <sub>4</sub>  | Accept Automatic CTS                                       | Yes     |
| O <sub>5</sub>  | SYS Priority to Resolve-Conflict                           | CMU     |
| O <sub>6</sub>  | Reserved                                                   |         |
| O <sub>7</sub>  | Reserved                                                   |         |
| O <sub>8</sub>  | Use of SOLO Word                                           | Yes     |
| O <sub>9</sub>  | Reserved                                                   |         |
| O <sub>10</sub> | Destination Code Required                                  | Yes     |
| O <sub>11</sub> | Bit-Protocol Verification (ALO/ALR Protocol Determination) | Yes     |
| O <sub>12</sub> | Use Subsystem SAL from ALO word                            | No      |

## 6.5 Network Layer

The Network layer functions require knowledge regarding the format of the Network header and data packets received from the Link layer. The bit-oriented protocol contains a field called the General Format Identifier (GFI) so that the format of each packet is explicitly identified. ARINC 429 contains a table listing all of the GFI values that have been allocated. ARINC 429 does not define the Network layer functions; it defines only the Link layer functions. The CMU-CVR interface uses a GFI value of 1111b, which indicates that the first octet of data contains an extended GFI to identify the data format.

**6.0 CMU RECORDER PROTOCOL****COMMENTARY**

This approach was chosen because the CMU-CVR interface is a virtual point-to-point connection and this is the only interface that will use this format. Changes to the format can be identified by a new value for the extended GFI.

**MORE COMMENTARY**

Section 6.5 is structured to gracefully accommodate additional versions. Section 6.5.1 defines extended GFI 01; Section 6.5.2 defines extended GFI 02. Section 6.5.3 would be added to define extended GFI 03, etc.

For Williamsburg Version 1 implementations, the GFI field is included as part of the Start Of Transmission (SOT) word which begins all Version 1 BOP file transfers.

For Williamsburg Version 3 implementations the GFI field is included as part of the SOF word which begins all Command Frame transfers.

A code of “F<sub>n</sub>” in the GFI field location indicates that an EGFI occupies the first data octet of the first data word in the file and that the file is an Extended BOP File. See Section 6.5.1.

**6.5.1 Extended GFI 01 Hex (Airbus)**

Provisions for both Version 1 and Version 3 implementation are included in this section.

In Williamsburg Version 3 implementations:

- Only Command frames are used to transport data from the CMU to the CVR.
- The I/C field of the SOF word is set to Command (01).
- The CT field of the SOF word is set to Data (01).
- ACARS Messages can be larger than a Williamsburg Version 3 Frame Data Unit (FDU). Two Williamsburg Version 3 FDUs are used to transport these large messages.

In Williamsburg Version 1 implementations:

- Destination code X is used in file transfer to the recorder.
- ACARS messages can be larger than a Williamsburg Version 1 Logic Data Unit (LDU). A multiple LDU file is used to transport these large messages.

**6.5.1.1 Extended GFI 01h Header Format**

The Extended GFI 01h header appears only in the first LDU of a Version 1 file. Subsequent LDUs do not contain the Extended GFI 01h header, only data. The Extended GFI 01h header is contained in every Version 3 frame data unit (FDU) because each FDU is a separate file transfer in Version 3.

The format of the header for extended GFI of 01h is shown in Table 6.5.1.1-1.

## 6.0 CMU RECORDER PROTOCOL

**Table 6.5.1.1-1 – Extended GFI Header Format**

| Octet No. | Octet Content                     |
|-----------|-----------------------------------|
| 1         | Extended GFI = 01h                |
| 2         | Input/output and multi frame bits |
| 3         | Source/destination                |
| 4-7       | Date/time stamp                   |
| 8         | Sequence number                   |

**6.5.1.1.1 Source/Destination Field**

The source/destination field should be set to indicate the origin or destination of the message. See Table 3-1 of Attachment 3.

**6.5.1.1.2 Input/Output and Multi-frame Fields**

Bit 1, (least significant bit of the octet) is the Input/Output bit. The Input/Output bit indicates how the source/destination field should be interpreted. If the input/output field has a value of zero then the source/destination field identifies the message source. If the input/output field has a value of one then the source/destination field identifies the message destination.

Bit 2, is the final frame bit. The final frame bit indicates the end of a message. A value of zero indicates that the frame is a single frame message or is the last frame of a multi-frame message. A value of one indicates that there is at least one more frame in the remainder of the message. This bit is always zero in a Version 1 file because a Version 1 file can contain the maximum size ACARS message.

Bits 3-5 are reserved and should be set to zero.

**6.5.1.1.3 Time Stamp**

The time stamp field should contain the number of seconds that have elapsed since midnight on 1 January 2000. From this information the UTC for the event may be derived. This is the time that the message was received, transmitted, initiated by crew, or printed. On 1 January 2100, the base time reference should be changed and the count restarted from 00:00:00.00. The format is shown in Table 6.5.1.1.3-1.

**Table 6.5.1.1.3-1 – Time Stamp Format**

| Octet Number | Value                   |
|--------------|-------------------------|
| 4            | Most significant octet  |
| 5            |                         |
| 6            |                         |
| 7            | Least significant octet |

## 6.0 CMU RECORDER PROTOCOL

## COMMENTARY

Examples: Octet order (4 5 6 7):

0000 0001h 1 Jan 2000 at 00:00:01

0000 0E10h 1 Jan 2000 at 01:00:00

0001 5F90h 2 Jan 2000 at 01:00:00

01E2 8500h 1 Jan 2001 at 00:00:00

## COMMENTARY

$(2^{32}-1) = (4,294,967,295)$  seconds is a long time or 1,193,046 hours or 49,710 days or about 136 years (ignoring leap years). Therefore, these four octets cover the range 1 Jan 2000 to about 1 Jan 2136, which is expected to be sufficient.

## COMMENTARY

A desire for a more accurate time stamp (1/4 second) for the data link recording message that is synchronized with other LRUs, such as recorders, has been expressed by some parties. When the system issues of accurately distributing time with a minimum or deterministic propagation delay have been solved, then a new data format should be developed.

**6.5.1.1.4 Sequence Number**

The last octet of the header is a sequence number, which is monotonically increased without skipping values for each frame transmitted to the CVR. The value 0 should only be used for the first frame sent after a CMU reset. The next sequence number value after 255 should be 1.

**6.5.1.2 Format of Data in Octets**

The message data is contained in the octets following the header. Two and one half such octets of data will occupy the bit-oriented information field of each Williamsburg binary data word.

The header information is considered to be part of the data over which the ARINC 429 Link layer CRC is computed. The Link layer CRC is found in the EOT/EOF word.

See the appropriate ARINC Characteristic (618, 619, 620) for the data format.

**6.5.2 Extended GFI 02 Hex (Boeing)**

The Extended Header format, as defined in Section 6.5.1.1, used with Extended GFI 02, is identical to that used with Extended GFI 01, but the use of Extended GFI 02 indicates that it will be immediately followed by an Implementation-Specific Header.

## 6.0 CMU RECORDER PROTOCOL

The first octet of the Implementation-Specific Header will be a Version Number. Version Number 01h indicates that it will be followed by a one-octet Message Type Code and a one-octet Display Type Code, as shown in Appendix B.

### 6.5.3 Reserved for Extended GFI 03 Hex

To be supplied in a future supplement.

**ATTACHMENT 1  
ISO 5 CHARACTERS**

**Table 1-1 – Baudot Subset ISO #5 Encoding**

|             |       |       |       |                      |           |           |           |         |         |         |         |           |
|-------------|-------|-------|-------|----------------------|-----------|-----------|-----------|---------|---------|---------|---------|-----------|
| BIT 7-----> |       |       |       |                      | 0         | 0         | 0         | 0       | 1       | 1       | 1       | 1         |
| BIT 6-----> |       |       |       |                      | 0         | 0         | 1         | 1       | 0       | 0       | 1       | 1         |
| BIT 5-----> |       |       |       |                      | 0         | 1         | 0         | 1       | 0       | 1       | 0       | 1         |
| BIT 4       | BIT 3 | BIT 2 | BIT 1 | Column<br>→<br>Row ↓ | 0         | 1         | 2         | 3       | 4       | 5       | 6       | 7         |
| 0           | 0     | 0     | 0     | 0                    | 00<br>NUL | 10<br>DLE | 20<br>SP  | 30<br>0 | 40<br>@ | 50<br>P | 60<br>' | 70<br>p   |
| 0           | 0     | 0     | 1     | 1                    | 01<br>SOH | 11<br>DC1 | 21<br>!   | 31<br>1 | 41<br>A | 51<br>Q | 61<br>a | 71<br>q   |
| 0           | 0     | 1     | 0     | 2                    | 02<br>STX | 12<br>DC2 | 22<br>"   | 32<br>2 | 42<br>B | 52<br>R | 62<br>b | 72<br>r   |
| 0           | 0     | 1     | 1     | 3                    | 03<br>ETX | 13<br>DC3 | 23<br>#   | 33<br>3 | 43<br>C | 53<br>S | 63<br>c | 73<br>s   |
| 0           | 1     | 0     | 0     | 4                    | 04<br>EOT | 14<br>DC4 | 24<br>\$  | 34<br>4 | 44<br>D | 54<br>T | 64<br>d | 74<br>t   |
| 0           | 1     | 0     | 0     | 4                    | 05<br>ENQ | 15<br>NAK | 25<br>%   | 35<br>5 | 45<br>E | 55<br>U | 65<br>e | 75<br>u   |
| 0           | 1     | 1     | 0     | 6                    | 06<br>ACK | 16<br>SYN | 26<br>&   | 36<br>6 | 46<br>F | 56<br>V | 66<br>f | 76<br>v   |
| 0           | 1     | 1     | 1     | 7                    | 07<br>EL  | 17<br>ETB | 27<br>,   | 37<br>7 | 47<br>G | 57<br>W | 67<br>g | 77<br>w   |
| 1           | 0     | 0     | 0     | 8                    | 08<br>BS  | 18<br>CAN | 28<br>(   | 38<br>8 | 48<br>H | 58<br>X | 68<br>h | 78<br>x   |
| 1           | 0     | 0     | 1     | 9                    | 09<br>HT  | 19<br>EM  | 29<br>)   | 39<br>9 | 49<br>I | 59<br>Y | 69<br>i | 79<br>y   |
| 1           | 0     | 1     | 0     | 10                   | 0A<br>LF  | 1A<br>SUB | 2A<br>*   | 3A<br>: | 4A<br>J | 5A<br>Z | 6A<br>j | 7A<br>z   |
| 1           | 0     | 1     | 1     | 11                   | 0B<br>VT  | 1B<br>ESC | 2B<br>+   | 3B<br>; | 4B<br>K | 5B<br>[ | 6B<br>k | 7B<br>{   |
| 1           | 1     | 0     | 0     | 12                   | 0C<br>FF  | 1C<br>FS  | 2C<br>,   | 3C<br>< | 4C<br>L | 5C<br>\ | 6C<br>l | 7C<br>    |
| 1           | 1     | 0     | 1     | 13                   | 0D<br>CR  | 1D<br>GS  | 2D<br>/   | 3D<br>= | 4D<br>M | 5D<br>] | 6D<br>m | 7D<br>}   |
| 1           | 1     | 1     | 0     | 14                   | 0E<br>SO  | 1E<br>RS  | 2E<br>. 1 | 3E<br>> | 4E<br>N | 5E<br>^ | 6E<br>n | 7E<br>~   |
| 1           | 1     | 1     | 1     | 15                   | 0F<br>SI  | 1F<br>US  | 2F<br>/   | 3F<br>? | 4F<br>O | 5F<br>_ | 6F<br>o | 7F<br>DEL |

Hex value  
Character

|     |   |
|-----|---|
| 04  | 1 |
| EOT |   |

Note

Characters not recommended in "Free Text"  
portion Uplink or Downlink messages

Note 1: Refer to ARINC Characteristic 597 for special uses of these characters.

Note 2: In case of any difference, the table in ARINC Specification 618 has precedence over the table shown above

**ATTACHMENT 1  
ISO 5 CHARACTERS**

**Table 1-2 ACARS Ground/Ground Subset ISO #5 Encoding**

|             |       |       |       |                      |           |           |              |         |         |             |         |             |
|-------------|-------|-------|-------|----------------------|-----------|-----------|--------------|---------|---------|-------------|---------|-------------|
| BIT 7-----> |       |       |       |                      | 0         | 0         | 0            | 0       | 1       | 1           | 1       | 1           |
| BIT 6-----> |       |       |       |                      | 0         | 0         | 1            | 1       | 0       | 0           | 1       | 1           |
| BIT 5-----> |       |       |       |                      | 0         | 1         | 0            | 1       | 0       | 1           | 0       | 1           |
| BIT 4       | BIT 3 | BIT 2 | BIT 1 | Column<br>→<br>Row ↓ | 0         | 1         | 2            | 3       | 4       | 5           | 6       | 7           |
| 0           | 0     | 0     | 0     |                      | 00<br>NUL | 10<br>DLE | 20<br>SP     | 30<br>0 | 40<br>@ | 50<br>P     | 60<br>, | 70<br>p     |
| 0           | 0     | 0     | 1     | 1                    | 01<br>SOH | 11<br>DC1 | 21<br>!      | 31<br>1 | 41<br>A | 51<br>Q     | 61<br>a | 71<br>q     |
| 0           | 0     | 1     | 0     | 2                    | 02<br>STX | 12<br>DC2 | 22<br>"      | 32<br>2 | 42<br>B | 52<br>R     | 62<br>b | 72<br>r     |
| 0           | 0     | 1     | 1     | 3                    | 03<br>ETX | 13<br>DC3 | 23<br>#      | 33<br>3 | 43<br>C | 53<br>S     | 63<br>c | 73<br>s     |
| 0           | 1     | 0     | 0     | 4                    | 04<br>EOT | 14<br>DC4 | 24<br>\$     | 34<br>4 | 44<br>D | 54<br>T     | 64<br>d | 74<br>t     |
| 0           | 1     | 0     | 0     | 4                    | 05<br>ENQ | 15<br>NAK | 25<br>%      | 35<br>5 | 45<br>E | 55<br>U     | 65<br>e | 75<br>u     |
| 0           | 1     | 1     | 0     | 6                    | 06<br>ACK | 16<br>SYN | 26<br>&      | 36<br>6 | 46<br>F | 56<br>V     | 66<br>f | 76<br>v     |
| 0           | 1     | 1     | 1     | 7                    | 07<br>BEL | 17<br>ETB | 27<br>'      | 37<br>7 | 47<br>G | 57<br>W     | 67<br>g | 77<br>w     |
| 1           | 0     | 0     | 0     | 8                    | 08<br>BS  | 18<br>CAN | 28<br>(      | 38<br>8 | 48<br>H | 58<br>X     | 68<br>h | 78<br>x     |
| 1           | 0     | 0     | 1     | 9                    | 09<br>HT  | 19<br>EM  | 29<br>)      | 39<br>9 | 49<br>I | 59<br>Y     | 69<br>i | 79<br>y     |
| 1           | 0     | 1     | 0     | 10                   | 0A<br>LF  | 1A<br>SUB | 2A<br>*      | 3A<br>: | 4A<br>J | 5A<br>Z     | 6A<br>j | 7A<br>z     |
| 1           | 0     | 1     | 1     | 11                   | 0B<br>VT  | 1B<br>ESC | 2B<br>+      | 3B<br>; | 4B<br>K | 5B<br>[     | 6B<br>k | 7B<br>{     |
| 1           | 1     | 0     | 0     | 12                   | 0C<br>FF  | 1C<br>FS  | 2C<br>,      | 3C<br>< | 4C<br>L | 5C<br>\<br> | 6C<br>l | 7C<br> <br> |
| 1           | 1     | 0     | 1     | 13                   | 0D<br>CR  | 1D<br>GS  | 2D<br>-      | 3D<br>= | 4D<br>M | 5D<br>]     | 6D<br>m | 7D<br>}     |
| 1           | 1     | 1     | 0     | 14                   | 0E<br>SO  | 1E<br>RS  | 2E<br>1<br>. | 3E<br>> | 4E<br>N | 5E<br>^     | 6E<br>n | 7E<br>~     |
| 1           | 1     | 1     | 1     | 15                   | 0F<br>SI  | 1F<br>US  | 2F<br>/      | 3F<br>? | 4F<br>O | 5F<br>_     | 6F<br>o | 7F<br>DEL   |

Hex value  
Character

04 1  
EOT

Note

Characters not recommended in "Free Text"  
portion Uplink or Downlink messages

Note 1: Refer to ARINC Characteristic 597 for special uses of these characters.

Note 2: In case of any difference, the table in ARINC Specification 618 has precedence over the table shown above

**ATTACHMENT 1**  
**ISO 5 CHARACTERS**

|      |                       |     |                      |
|------|-----------------------|-----|----------------------|
| NULL | Null, or all zeros    | DC1 | Device control 1     |
| SOH  | Start of heading      | DC2 | Device control 2     |
| STX  | Start of text         | DC3 | Device control 3     |
| ETX  | End of text           | DC4 | Device control 4     |
| EOT  | End of transmission   | NAK | Negative acknowledge |
| ENQ  | Enquiry               | SYN | Synchronous idle     |
| ACL  | Acknowledge           | ETB | End of transmission  |
| BEL  | Bell, or alarm        | CAN | Cancel               |
| BS   | Backspace             | EM  | End of medium        |
| HT   | Horizontal tabulation | SUB | Substitute           |
| LF   | Line feed             | ESC | Escape               |
| VT   | Vertical tabulation   | FS  | File separator       |
| F    | Form feed             | G8  | Group separator      |
| CR   | Carriage return       | R8  | Record separator     |
| SO   | Shift out             | US  | Unit separator       |
| SI   | Shift in              | SP  | Space                |
| DLE  | Data link escape      | DEL | Delete               |

**ATTACHMENT 2**  
**MASTER FMC SELECTION LOGIC**

**Table 2-1 – Master FMC Selection Logic**

| <b>FMC1<br/>Status</b>  | <b>FMC2<br/>Status</b>  | <b>Discrete<br/>Status</b> | <b>Master<br/>FMC</b>                    |
|-------------------------|-------------------------|----------------------------|------------------------------------------|
| inactive<br>status word | inactive<br>status word | Open                       | FMC1                                     |
| inactive<br>status word | inactive<br>status word | Ground                     | FMC2                                     |
| bit 17 = 1              | inactive<br>status word | don't care                 | FMC1                                     |
| bit 17 = 0              | inactive<br>status word | don't care                 | default to<br>FMC1 abnormal<br>condition |
| inactive<br>status word | bit 17 = 1              | don't care                 | FMC2                                     |
| inactive<br>status word | bit 17 = 0              | don't care                 | default to<br>FMC2 abnormal<br>condition |
| bit 17 = 1              | bit 17 = 0              | don't care                 | FMC1                                     |
| bit 17 = 0              | bit 17 = 1              | don't care                 | FMC2                                     |
| bit 17 = 1              | bit 17 = 1              | don't care                 | default to<br>FMC1 abnormal<br>condition |
| bit 17 = 0              | bit 17 = 0              | don't care                 | default to<br>FMC1 abnormal<br>condition |

Note:

1. FMC1 is the Left FMC. FMC2 is the Right FMC.

**ATTACHMENT 2  
MASTER FMC SELECTION LOGIC**

**Table 2-2 – Status Word from FMC**

|           |           |             |                                                                |                  |                                                  |                        |
|-----------|-----------|-------------|----------------------------------------------------------------|------------------|--------------------------------------------------|------------------------|
| <b>32</b> | <b>31</b> | <b>30</b>   | <b>2 2 2 2 2 2 2 2 2 1 1</b><br><b>9 8 7 6 5 4 3 2 1 0 9 8</b> | <b>17</b>        | <b>1 1 1 1 1 1 1 0</b><br><b>6 5 4 3 2 1 0 9</b> | <b>8 7 6 5 4 3 2 1</b> |
| P         | SSM       | STATUS DATA |                                                                | MASTER/<br>SLAVE | SOURCE SAL                                       | LABEL                  |

| BIT              | FUNCTION                   | LEFT FMC CODING                                |   | RIGHT FMC CODING                               |   | CENTER FMC CODING                              |   |
|------------------|----------------------------|------------------------------------------------|---|------------------------------------------------|---|------------------------------------------------|---|
| 1                |                            | 2                                              | 1 | 2                                              | 1 | 2                                              | 1 |
| 2                |                            |                                                | 0 |                                                | 0 |                                                | 0 |
| 3                |                            | 7                                              | 1 | 7                                              | 1 |                                                | 1 |
| 4                |                            |                                                | 1 |                                                | 1 | 7                                              | 1 |
| 5                | Label                      |                                                | 1 |                                                | 1 |                                                | 1 |
| 6                |                            | 0                                              | 0 | 0                                              | 0 |                                                | 0 |
| 7                |                            |                                                | 0 |                                                | 0 | 0                                              | 0 |
| 8                |                            |                                                | 0 |                                                | 0 |                                                | 0 |
| 9                |                            | 3                                              | 1 | 3                                              | 1 | 3                                              | 1 |
| 10               |                            |                                                | 1 |                                                | 1 |                                                | 1 |
| 11               |                            | 0                                              | 0 | 0                                              | 0 |                                                | 0 |
| 12               |                            |                                                | 0 |                                                | 0 | 3                                              | 1 |
| 13               | Source SAL                 |                                                | 0 |                                                | 0 |                                                | 1 |
| 14               |                            | 0                                              | 0 | 1                                              | 0 |                                                | 0 |
| 15               |                            |                                                | 0 |                                                | 0 | 0                                              | 0 |
| 16               |                            |                                                | 0 |                                                | 1 |                                                | 0 |
| 17               | Master/Slave<br>See Note 2 | 0 = Slave/Standby FMC<br>1 = Master/Active FMC |   | 0 = Slave/Standby FMC<br>1 = Master/Active FMC |   | 0 = Slave/Standby FMC<br>1 = Master/Active FMC |   |
| 18<br>thru<br>29 | Spare                      | Pad                                            |   | Pad                                            |   | Pad                                            |   |
| 30               | SSM                        | See Note 1                                     |   | See Note 1                                     |   | See Note 1                                     |   |
| 31               |                            |                                                |   |                                                |   |                                                |   |
| 32               | Parity                     | Odd                                            |   | Odd                                            |   | Odd                                            |   |

Notes:

## 1. SSM Coding:

| BIT |    | STATUS           | COMMENT                                            |
|-----|----|------------------|----------------------------------------------------|
| 31  | 30 |                  |                                                    |
| 0   | 0  | Normal Operation | Necessary for Master/Slave determination in Bit 17 |
| 0   | 1  | No Computed Data |                                                    |
| 1   | 0  | Functional Test  |                                                    |
| 1   | 1  | Failure          |                                                    |

2. There are only two FMC ports on the CMU. Connection to three FMCs is accomplished external to the CMU. Only one FMC can act as the “Master” FMC at any time.

**ATTACHMENT 3**  
**ORIGIN/DESTINATION CODES**

**Table 3-1 – Origin/Destination Codes**

| ORIGIN or DESTINATION                                         | CHAR CODE [1]     | NOTE        |
|---------------------------------------------------------------|-------------------|-------------|
| Cabin Terminal (1-4)                                          | 1-4               |             |
| User Terminal (5-8)                                           | 5-8               |             |
| <b>Dialogue Service Interface (DSI)</b>                       | <b>9</b>          | <b>5</b>    |
| FMC, Left Side (1)                                            | A                 |             |
| FMC, Right Side (2)                                           | B                 |             |
| Control/Display Unit                                          | C                 |             |
| DFDAU                                                         | D                 |             |
| <b>Cabin Packet Function</b>                                  | <b>E</b>          |             |
| CFDIU                                                         | F                 |             |
| Ground Station                                                | G                 |             |
| HF Link                                                       | H                 | 3           |
| EICAS/ECAM/EFIS                                               | I                 |             |
| ATSU (for ATS Messages)                                       | J                 |             |
| Keyboard/Display                                              | K                 |             |
| Not Assigned                                                  | L                 |             |
| ACARS Management Unit (MU or CMU<br>Or ATSU for AOC Messages) | M                 |             |
| FMC, Center (3)                                               | N                 |             |
| Optional Auxiliary Terminal (OAT)                             | O                 |             |
| Printer                                                       | P                 |             |
| Satellite Data Unit, Left Side (SDU 1)                        | Q                 | <b>2</b>    |
| Satellite Data Unit, Right Side (SDU 2)                       | R                 | 2           |
| Satellite Link                                                | S                 | <b>2, 4</b> |
| HF Data Radio, Left Side (HFDR 1)                             | T                 | 3           |
| HF Data Radio, Right Side (HFDR 2)                            | U                 | 3           |
| VHF Link (VDR)                                                | V                 |             |
| TAWS                                                          | W                 |             |
| Cockpit Voice Recorder (CVR)                                  | X                 |             |
| EFB #1                                                        | Y                 |             |
| EFB #2                                                        | Z                 |             |
| Inmarsat Satellite Link                                       | Control Code "VT" | 4           |
| <b>Iridium Satellite Link</b>                                 | Control Code "FF" | 4           |
| ICO Satellite Link                                            | Control Code "CR" | 4           |
| Globalstar Satellite Link                                     | Control Code "SO" | 4           |

Notes: See next page

**ATTACHMENT 3  
ORIGIN/DESTINATION CODES**

Notes:

1. The onboard message handling and accountability code assignments defined in this Attachment reflect the needs of ACARS applications identified so far. Additional assignments should be made as new applications arise. Please advise the AEEC staff of any new needs so that appropriate action may be taken. This list is provided for the reader's convenience. A more exhaustive, and perhaps more up-to-date, list is provided in ARINC Specification 429 Part 1. In case of any inconsistency, the data in Specification 429 has precedence over the information listed here.
2. Origin/Destination codes 'Q' and 'R' are used when the SDU transmits/receives onboard messages as an ACARS End System. The code 'S' is distinguished from codes 'Q' and 'R' in that the 'S' is used to designate the SATCOM as the downlink medium for a message, while the 'Q' and 'R' indicates that the message is to be consumed by the SDU.
3. Origin/Destination codes 'T' and 'U' are used when the HFDR transmits/receives onboard messages as an ACARS End System. The code 'H' is distinguished from codes 'T' and 'U' in that the 'H' is used to designate the HFDR as the downlink medium for a message, while the 'T' and 'U' indicate that the message is to be consumed by the HFDR.
4. Reference Attachment 1 for the specified ISO #5 control codes. Control codes VT, FF, CR and SO are used to indicate and command [with Origin and Destination codes, respectively] specific satellite links for equipment with multi-bearer system (MBS) capability (reference ARINC Characteristic 758, Section 5.2.6 and ARINC Characteristic 761 Attachment 2). Character code 'S' is used for any available non-specific satellite link.
5. **The DSI User is usually in the FMC and DSI provider is usually in the CMU or equivalent.**

**ATTACHMENT 4**  
**PURPOSE/NATURE CODES**

**Table 4-1 – Message Purpose/Nature Codes**

| PURPOSE/NATURE          | CODE | NOTES |
|-------------------------|------|-------|
| Flight Number           | A    |       |
| Aircraft Registration   | B    |       |
| Data Bus Check          | C    |       |
| Documentation Data      | D    |       |
| Engine Data             | E    |       |
| Failed Message          | F    |       |
| Fuel Data               | G    |       |
| AAC Downlink            | H    | 2, 3  |
| AOC Downlink            | I    | 2, 3  |
| ATC Downlink            | J    | 2, 3  |
| Acknowledgement         | K    |       |
| Landing Data            | L    |       |
| Reserved – APC Downlink | M    | 2, 3  |
| Not a Response          | N    |       |
| Position Report         | P    |       |
| Busy                    | Q    |       |
| Status Message          | S    |       |
| DABS/ASAS Uplink        | T    |       |
| Not Assigned            | U    |       |
| Uplink                  | V    |       |
| Downlink                | W    | 2     |
| User Defined            | X    |       |
| HF Downlink "NOCOMM"    | Z    |       |

**Notes:**

1. The onboard message handling and accountability code assignments defined in this Attachment reflect the needs of ACARS applications identified so far. Additional assignments should be made as new applications arise. Please advise the AEEC staff of any new needs so that appropriate action may be taken.
2. Initially only the code W was assigned for downlink. The codes H, I, J and M were added by Supplement 2. Equipment produced prior to the release of Supplement 2 will not support these values.
3. Note to integrators: make sure that the MU supports these codes before installing an ACARS peripheral that uses them.

**ATTACHMENT 5  
DOCUMENTARY DATA FORMATS**

**Table 5-1 – ARINC 429 File Transfer Documentary Data Request Message**

| Character | Content | Description                 |
|-----------|---------|-----------------------------|
| 1         | <US>    | Unit Separator character    |
| 2         | X       | Origin Code                 |
| 3         | D       | Message Purpose/Nature Code |
| 4         | M       | Destination Code            |
| 5         | X       | Block Sequence Character    |

**Table 5-2 – ARINC 429 File Transfer Documentary Data Message Format**

| Character | Content | Description                                                         |
|-----------|---------|---------------------------------------------------------------------|
| 1         | <US>    | Unit Separator character                                            |
| 2         | M       | Origin Code                                                         |
| 3         | D       | Message Purpose/Nature Code                                         |
| 4         | X       | Destination Code                                                    |
| 5         | X       | Block Sequence Character                                            |
| 6         | +       | (unique ID)                                                         |
| 7         | A       | Version Identifier, e.g., '1'                                       |
| 8-9       | ZZ      | Airline Identifier  See ARINC Specification 618                     |
| 10-13     | ZZZZ    | Flight Number  See ARINC Specification 618                          |
| 14-17     | XXXX    | Departure Station (IATA or ICAO)                                    |
| 18-21     | XXXX    | Destination Station (IATA or ICAO)                                  |
| 22-25     | NNNN    | Fuel on Board, units not specified                                  |
| 26-30     | NNNNN   | Boarded Fuel, units not specified                                   |
| 31-36     | YYMMDD  | Scheduled date of flight                                            |
|           |         | Y represents 2 least significant digits of year {98, 99, 00, 01...} |
|           |         | M represents month {01,02,03...12}                                  |
|           |         | D represents day {01,02,03...31}                                    |
| 37-42     | YYMMDD  | Actual date of flight (same as above)                               |
| 43-48     | HHMMSS  | Time {211234} where:                                                |
|           |         | H = hours, M = minutes and S = seconds                              |
| 49-55     | ZZZZZZZ | Aircraft Registration   See ARINC Specification 618                 |
| 56        | N       | OOOI state {1,2,3,4} where:                                         |
|           |         | 1 represents OUT,                                                   |
|           |         | 2 represents OFF,                                                   |
|           |         | 3 represents ON and                                                 |
|           |         | 4 represents IN                                                     |

Where:

A alphanumeric character, left justified and space filled

N numeric characters, right justified and zero filled

For example: a value of 93 in a NNNN field would be 0093

X alpha characters only, left justified and space filled

For example: a value of XY in a XXXX field would be XY.

Z see Section 2.2.3 of ARINC Specification 618 for format

**ATTACHMENT 5**  
**DOCUMENTARY DATA FORMATS**

**Table 5-3 – GPBOP (GFI 0011) Documentary Data Request Message Format**

| Character | Content | Description                 |
|-----------|---------|-----------------------------|
| 1         | X       | Origin Code                 |
| 2         | D       | Message Purpose/Nature Code |
| 3         | M       | Destination Code            |
| 4-5       | 00      | Reserved                    |

**Table 5-4 – GPBOP (GFI 0011) Documentary Data Message Format**

| Character | Content | Description                                                         |
|-----------|---------|---------------------------------------------------------------------|
| 1         | M       | Origin Code                                                         |
| 2         | D       | Message Purpose/Nature Code                                         |
| 3         | X       | Destination Code                                                    |
| 4-5       | 00      | Reserved                                                            |
| 6         | +       | (unique ID)                                                         |
| 7         | A       | Version Identifier, e.g., '1'                                       |
| 8-9       | ZZ      | Airline Identifier See ARINC Specification 618                      |
| 10-13     | ZZZZ    | Flight Number See ARINC Specification 618                           |
| 14-17     | XXXX    | Departure Station (IATA or ICAO)                                    |
| 18-21     | XXXX    | Destination Station (IATA or ICAO)                                  |
| 22-25     | NNNN    | Fuel on Board, units not specified                                  |
| 26-30     | NNNNN   | Boarded Fuel, units not specified                                   |
| 31-36     | YYMMDD  | Scheduled date of flight                                            |
|           |         | Y represents 2 least significant digits of year {98, 99, 00, 01...} |
|           |         | M represents month {01,02,03...12}                                  |
|           |         | D represents day {01,02,03...31}                                    |
| 37-42     | YYMMDD  | Actual date of flight (same as above)                               |
| 43-48     | HHMMSS  | Time {211234} where:                                                |
|           |         | H = hours, M = minutes and S = seconds                              |
| 49-55     | ZZZZZZZ | Aircraft Registration   See ARINC Specification 618                 |
| 56        | N       | OOOI state {1,2,3,4} where:                                         |
|           |         | 1 represents OUT,                                                   |
|           |         | 2 represents OFF,                                                   |
|           |         | 3 represents ON, and                                                |
|           |         | 4 represents IN                                                     |

Where:

A alphanumeric character, left justified and space filled

N numeric characters, right justified and zero filled

For example: a value of 93 in a NNNN field would be 0093

X alpha characters only, left justified and space filled

For example: a value of XY in a XXXX field would be XY

Z see Section 2.2.3 of ARINC Specification 618 for format

**ATTACHMENT 6**  
**CHARACTER FILE TRANSFER MESSAGE FORMATS**

The following is an example of a single block downlink message from an FMC to an ARINC 724 MU. The following coding rules apply: X = Pad bit, P = ARINC 429 word parity bit.

|                                                                            |                                                                           |                                                                  |                                                                    |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------|
| <STX><br>-----<br>P 0 0 0 0 0 1 0<br>-----                                 | Optional Header<br>Flag = 1<br>-----<br>0 0 0 0 0 0 0 1<br>-----          | Block Word<br>Count = 13<br>-----<br>0 0 0 0 1 1 0 1<br>-----    | System Address<br>Label (357)<br>-----<br>1 1 1 1 0 1 1 1<br>----- |
| Purpose/Nature<br>VHF Downlink = W<br>-----<br>P 1 0 1 0 1 1 1<br>-----    | Origin Code<br>Left FMC = A<br>-----<br>X 1 0 0 0 0 0 1<br>-----          | <US><br>-----<br>X 0 0 1 1 1 1 1<br>-----                        | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| Downlink Message<br>Sequence Code = F<br>-----<br>P 1 0 0 0 1 1 0<br>----- | Block Sequence<br>Character = 40 Hex<br>-----<br>X 1 0 0 0 0 0 0<br>----- | Destination<br>VHF Link = V<br>-----<br>X 1 0 1 0 1 1 0<br>----- | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| ONE<br>1<br>-----<br>P 0 1 1 0 0 0 1<br>-----                              | ZERO<br>0<br>-----<br>X 0 1 1 0 0 0 0<br>-----                            | ZERO<br>0<br>-----<br>X 0 1 1 0 0 0 0<br>-----                   | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| Flight Number<br>0<br>-----<br>P 0 1 1 0 0 0 0<br>-----                    | Flight Number<br>A<br>-----<br>X 1 0 0 0 0 0 1<br>-----                   | Flight Number<br>A<br>-----<br>X 1 0 0 0 0 0 1<br>-----          | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| Flight Number<br>5<br>-----<br>P 0 1 1 0 1 0 1<br>-----                    | Flight Number<br>6<br>-----<br>X 0 1 1 0 1 1 0<br>-----                   | Flight Number<br>4<br>-----<br>X 0 1 1 0 1 0 0<br>-----          | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| Sublabel Character #2<br>1<br>-----<br>P 0 1 1 0 0 0 1<br>-----            | Sublabel Character #1<br>M<br>-----<br>X 1 0 0 1 1 0 1<br>-----           | Poundsign<br>#<br>-----<br>X 0 1 0 0 0 1 1<br>-----              | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| PLAN<br>P<br>-----<br>P 1 0 1 0 0 0 0<br>-----                             | FLIGHT<br>F<br>-----<br>X 1 0 0 0 1 1 0<br>-----                          | MESSAGE TYPE<br>A<br>-----<br>X 1 0 0 0 0 0 1<br>-----           | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| COMPANY<br>C<br>-----<br>P 1 0 0 0 0 1 1<br>-----                          | SEPARATOR<br>/<br>-----<br>X 0 1 0 1 1 1 1<br>-----                       | REQUEST<br>R<br>-----<br>X 1 0 1 0 0 1 0<br>-----                | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| L<br>-----<br>P 1 0 0 1 1 0 0<br>-----                                     | K<br>-----<br>X 1 0 0 1 0 1 1<br>-----                                    | ROUTE<br>R<br>-----<br>X 1 0 1 0 0 1 0<br>-----                  | System Address<br>357<br>-----<br>1 1 1 1 0 1 1 1<br>-----         |
| K<br>-----<br>P 1 0 0 1 0 1 1<br>-----                                     | X<br>-----<br>X 1 0 1 1 0 0 0<br>-----                                    | A<br>-----<br>X 1 0 0 0 0 0 1<br>-----                           | System Address 357<br>-----<br>1 1 1 1 0 1 1 1<br>-----            |
| X<br>-----<br>P 1 0 1 1 0 0 0<br>-----                                     | H<br>-----<br>X 1 0 0 1 0 0 0<br>-----                                    | P<br>-----<br>X 1 0 1 0 0 0 0<br>-----                           | System Address 357<br>-----<br>1 1 1 1 0 1 1 1<br>-----            |
| <ETX><br>-----<br>P 0 0 0 0 0 1 1<br>-----                                 | 0<br>-----<br>X 0 1 1 0 0 0 0<br>-----                                    | 1<br>-----<br>X 0 1 1 0 0 0 1<br>-----                           | System Address 357<br>-----<br>1 1 1 1 0 1 1 1<br>-----            |

**Figure 6-1 – ARINC 724 Character File Format (Downlink)**

**ATTACHMENT 6**  
**CHARACTER FILE TRANSFER MESSAGE FORMATS**

The following is an example of a single block uplink message from an ARINC 724B MU to an FMC. The following coding rules apply: X = Pad bit, P = ARINC 429 word parity bit.

|                                                                |                                                                  |                                                              |                                                           |
|----------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------|
| <STX><br>-----<br>P 0 0 0 0 0 1                                | Value= 1<br>-----<br>0 0 0 0 0 0 1                               | Block Word<br>Count = 10<br>-----<br>0 0 0 0 1 0 1 0         | System Address<br>Label (300)<br>-----<br>0 0 0 0 0 0 1 1 |
| Purpose/Nature<br>VHF Uplink = V<br>-----<br>P 1 0 1 0 1 1 0   | Origin Code<br>VHF Link = V<br>-----<br>X 1 0 1 0 1 1 0          | <US><br>-----<br>X 0 0 1 1 1 1 1                             | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| First Character<br>of Preamble = -<br>-----<br>P 0 1 0 1 1 0 1 | Block Sequence<br>Character = 40 Hex<br>-----<br>X 1 0 0 0 0 0 0 | Destination Code<br>Left FMC = A<br>-----<br>X 1 0 0 0 0 0 1 | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Sublabel Character #1<br>M<br>-----<br>P 1 0 0 1 1 0 1         | Poundsign<br>#<br>-----<br>X 0 1 0 0 0 1 1                       | <sp><br>-----<br>X 0 1 0 0 0 0 0                             | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Wind<br>W<br>-----<br>P 1 0 1 0 1 1 1                          | Predicted<br>P<br>-----<br>X 1 0 1 0 0 0 0                       | Sublabel Character #2<br>1<br>-----<br>X 0 1 1 0 0 0 1       | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Descent<br>D<br>-----<br>P 1 0 0 0 1 0 0                       | SEPARATOR<br>/<br>-----<br>X 0 1 0 1 1 1 1                       | Data<br>D<br>-----<br>X 1 0 0 0 1 0 0                        | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Nine<br>9<br>-----<br>P 0 1 1 1 0 0 1                          | Flight Level Two<br>2<br>-----<br>X 0 1 1 0 0 1 0                | Winds<br>W<br>-----<br>X 1 0 1 0 1 1 1                       | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Seventy<br>7<br>-----<br>P 0 1 1 0 1 1 1                       | From One Hundred<br>1<br>-----<br>X 0 1 1 0 0 0 1                | Zero<br>0<br>-----<br>X 0 1 1 0 0 0 0                        | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| Sixty<br>6<br>-----<br>P 0 1 1 0 1 1 0                         | Magnitude Zero<br>0<br>-----<br>X 0 1 1 0 0 0 0                  | Five Degrees True<br>5<br>-----<br>X 0 1 1 0 1 0 1           | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |
| <NUL><br>-----<br>P 0 0 0 0 0 0 0                              | <ETX><br>-----<br>X 0 0 0 0 0 1 1                                | Two Knots<br>2<br>-----<br>X 0 1 1 0 0 1 0                   | System Address<br>300<br>-----<br>0 0 0 0 0 0 1 1         |

**Figure 6-2 – ARINC 724B Character File Format (Uplink)**

**ATTACHMENT 6**  
**CHARACTER FILE TRANSFER MESSAGE FORMATS**

Notes:

1. The range of data characters is limited to those identified in ARINC Specification 618 and reproduced here as Table 1-1 of Attachment 1.
2. The example data used in this figure is fictional and does not imply any actual implementation.

The following is an example of an Acknowledgement Report uplink message, in character format, from an ARINC 724B MU to an FMC. The following coding rules apply: X = Pad bit, P = ARINC 429 word parity bit.

|                                                             |                                                             |                                                             |                                                     |
|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------|
| <b>&lt;STX&gt;</b><br><hr/> P 0 0 0 0 0 1 0                 | Value = 1<br><hr/> 0 0 0 0 0 0 1                            | Block Word Count = 5<br><hr/> 0 0 0 0 0 1 0 1               | System Address Label (300)<br><hr/> 0 0 0 0 0 0 1 1 |
| Purpose/Nature<br>Ground ACK = K<br><hr/> P 1 0 1 0 1 1 0   | Origin Code<br>VHF Link = V<br><hr/> X 1 0 1 0 1 1 0        | <b>&lt;US&gt;</b><br><hr/> X 0 0 1 1 1 1 1                  | System Address 300<br><hr/> 0 0 0 0 0 0 1 1         |
| Message Sequence Code - Char 1= M<br><hr/> P 1 0 0 1 1 0 1  | Block Sequence Character = 40 Hex<br><hr/> X 1 0 0 0 0 0 0  | Destination Code<br>Left FMC = A<br><hr/> X 1 0 0 0 0 0 1   | System Address 300<br><hr/> 0 0 0 0 0 0 1 1         |
| Message Sequence Code - Char 4 = A<br><hr/> P 1 0 0 0 0 0 1 | Message Sequence Code - Char 3 = 1<br><hr/> X 0 1 1 0 0 0 1 | Message Sequence Code - Char 2 = 0<br><hr/> X 0 1 1 0 0 0 0 | System Address 300<br><hr/> 0 0 0 0 0 0 1 1         |
| <b>&lt;NUL&gt;</b><br><hr/> P 0 0 0 0 0 0 0                 | <b>&lt;NUL&gt;</b><br><hr/> X 0 0 0 0 0 0 0                 | <b>&lt;ETX&gt;</b><br><hr/> X 0 0 0 0 0 1 1                 | System Address 300<br><hr/> 0 0 0 0 0 0 1 1         |

**Figure 6-3 – Character Ground Acknowledgement to a Peripheral**

Notes:

1. The range of data characters is limited to those identified in ARINC Specification 618 and reproduced here as Table 1-1 of Attachment 1.
2. The example data used in this figure is fictional and does not imply any actual implementation.

ATTACHMENT 7  
GPBOP MESSAGE FORMATS

| LDU Word Count | Bit 32 | Bits 31 29 | Bits 28 25            | Bits 24 21           | Bits 20 17            | Bits 16 13          | Bits 12 9            | Bits 8 1 | Notes             |
|----------------|--------|------------|-----------------------|----------------------|-----------------------|---------------------|----------------------|----------|-------------------|
| 1              | P      | 110        | GFI 0011              | File Sequence Number |                       | LDU Sequence Number |                      | SAL      | SOT               |
| 2              | P      | 000        | Dest. Code            | Purpose/Nature       |                       | Origination Code    |                      |          | Cont/Acct Header  |
| 3              | P      | 000        | Reserved: Zero Filled |                      | Reserved: Zero Filled |                     | Dest. Code           |          |                   |
|                | P      |            | Char #3 L S Nibble    | Character #2         |                       | Character #1        |                      |          | Binary Data Words |
|                | P      |            | XXXXXXXX              |                      | Character #4          |                     | Char #3 M S Nibble   |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ... Message           |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ...                   |                      | ...                   |                     |                      |          |                   |
|                |        |            | ... Continued         |                      | ...                   |                     |                      |          |                   |
|                | P      |            | ...                   |                      | ...                   |                     |                      |          |                   |
| 251            | P      | 000        | Character #620        |                      | Character #619        |                     | XXXX                 |          |                   |
| 252            | P      | 000        | Char #623 L S Nibble  | Character #622       |                       | Character #621      |                      |          |                   |
| 253            | P      | 000        | Character #625        |                      | Character #624        |                     | Char #623 M S Nibble |          |                   |
| 254            | P      | 001        | 1011                  | Character #627       |                       | Character #626      |                      |          |                   |
| 255            | P      | 111        | 0001                  | Link Layer CRC       |                       |                     |                      | SAL      | EOT               |

**Figure 7-1 – GPBOP File Format, Version 1**

Notes:

1. The range of data characters is limited to those identified in ARINC Specification 618 and reproduced here as Table 1-1 of Attachment 1.
2. The Link layer CRC will be computed over the shaded area.

| LDU Word Count | Bit 32 | Bits 31 29 | Bits 28 25              | Bits 24 21           | Bits 20 17     | Bits 16 13          | Bits 12 9               | Bits 8 1 | Notes                      |
|----------------|--------|------------|-------------------------|----------------------|----------------|---------------------|-------------------------|----------|----------------------------|
| 1              | P      | 110        | GFI 0011                | File Sequence Number |                | LDU Sequence Number |                         | SAL      | SOT                        |
| 2              | P      | 000        | Dest. Code              | Purpose/Nature       |                | Origination Code    |                         |          | Cont/Acct Header           |
| 3              | P      | 000        | Priority                | Life Time            | Media Select   |                     | Dest. Code              |          |                            |
|                | P      | 000        | Char #3<br>L S Nibble   | Character #2         |                | Character #1        |                         |          | Binary Data Words<br><br>↓ |
|                | P      |            | XXXXXXXX                |                      | Character #4   |                     | Char #3<br>M S Nibble   |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | Message        | ...                 |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | ...            |                     |                         |          |                            |
|                |        |            | ...                     |                      | Continued      |                     | ...                     |          |                            |
| ↓              | P      |            | ...                     |                      | ...            |                     |                         |          |                            |
| 251            | P      | 000        | Character #620          |                      | Character #619 |                     | XXXX                    |          |                            |
| 252            | P      | 000        | Char #623<br>L S Nibble | Character #622       |                | Character #621      |                         |          |                            |
| 253            | P      | 000        | Character #625          |                      | Character #624 |                     | Char #623<br>M S Nibble |          |                            |
| 254            | P      | 001        | 1011                    | Character #627       |                | Character #626      |                         |          |                            |
| 255            | P      | 111        | 0001                    | Link Layer CRC       |                |                     |                         | SAL      | EOT                        |

**Figure 7-2 – GPBOP File Format, Version 2**

Notes:

1. The range of data characters is limited to those identified in ARINC Specification 618 and reproduced here as Table 1-1 of Attachment 1.
2. The Link layer CRC will be computed over the shaded area.

ATTACHMENT 8  
FORMAT OF WILLIAMSBURG SERVICE  
MESSAGES

| LDU Word Count | Bit 32 | Bits 31 29 | Bits 28 25            | Bits 24 21           | Bits 20 17            | Bits 16 13           | Bits 12 9  | Bits 8 1 | Notes             |
|----------------|--------|------------|-----------------------|----------------------|-----------------------|----------------------|------------|----------|-------------------|
| 1              | P      | 110        | GFI 0011              | File Sequence Number |                       | LDU Sequence Number  |            | SAL      | SOT               |
| 2              | P      | 000        | Dest. Code            | Purpose/Nature       |                       | Origination Code     |            |          | Cont/Acct Header  |
| 3              | P      | 000        | Reserved: Zero Filled |                      | Reserved: Zero Filled |                      | Dest. Code |          | Binary Data Words |
| 4              | P      | 001        | 1001                  | 0000                 | 0000                  | File Sequence Number |            |          |                   |
| 5              | P      | 111        | 0001                  | Link Layer CRC       |                       |                      |            |          | EOTs              |

**Figure 8-1 – Ground ACK Report from MU to End System Over ARNC 429W Version 1**

- Notes:
1. The Link layer CRC will be computed over the shaded area.
  2. The Origin Code will be M. The Purpose/Nature code will be K (ACK) and the Destination Code will be set to that of the downlink originator (see Attachment 3). The File Sequence number will reflect the FSN of the Williamsburg file as it was received by the ACARS MU.

The End System can send commands to the MU, such as discard a message that has not been forward to the DSP on the ground, using the following format:

| LDU Word Count | Bit 32 | Bits 31 29 | Bits 28 25            | Bits 24 21           | Bits 20 17            | Bits 16 13           | Bits 12 9  | Bits 8 1 | Notes             |
|----------------|--------|------------|-----------------------|----------------------|-----------------------|----------------------|------------|----------|-------------------|
| 1              | P      | 110        | GFI 0011              | File Sequence Number |                       | LDU Sequence Number  |            | SAL      | SOT               |
| 2              | P      | 000        | Dest. Code            | Purpose/Nature       |                       | Origination Code     |            |          | Cont/Acct Header  |
| 3              | P      | 000        | Reserved: Zero Filled |                      | Reserved: Zero Filled |                      | Dest. Code |          | Binary Data Words |
| 4              | P      | 001        | 1011                  | Status Code          |                       | File Sequence Number |            |          |                   |
| 5              | P      | 111        | 0001                  | Link Layer CRC       |                       |                      |            | ↓        | EOT               |

**Figure 8-2 – Message Deletion Command from End System to MU Over ARINC 429 Version 1**

Notes:

1. The Link layer CRC will be computed over the shaded area.
2. The Origin Code will be that of the End System. The Purpose/Nature code will be S and the Destination Code will be M for the MU. The File Sequence number will reflect the FSN of the Williamsburg file to be deleted by the End System.
3. Attention System Integrators - Some End Systems may not support this message. Some MUs may not support this message

The Status Code field will reflect the command and the file will be identified by the FSN. The defined command values for the Status Code are:

Status Code    Meaning

D                  Delete indicated file

The End System can send commands to the MU, such as discard a message tat has not been forwarded to the DSP on the ground, using the following format:

| LDU Word Count | Bit 32 | Bits 31 29 | Bits 28 25            | Bits 24 21           | Bits 20 17            | Bits 16 13           | Bits 12 9  | Bits 8 1    | Notes             |
|----------------|--------|------------|-----------------------|----------------------|-----------------------|----------------------|------------|-------------|-------------------|
| 1              | P      | 110        | GFI 0011              | File Sequence Number |                       | LDU Sequence Number  |            | SAL         | SOT               |
| 2              | P      | 000        | Dest. Code            | Purpose/Nature       |                       | Origination Code     |            | <div></div> | Cont/Acct Header  |
| 3              | P      | 000        | Reserved: Zero Filled |                      | Reserved: Zero Filled |                      | Dest. Code |             | Binary Data Words |
| 4              | P      | 001        | 1011                  | Status Code          |                       | File Sequence Number |            |             |                   |
| 5              | P      | 111        | 0001                  | Link Layer CRC       |                       |                      |            |             | EOTs              |

**Figure 8-3 – File Status Message from MU to End System**

- Notes:
1. The Link layer CRC will be computed over the shaded area.
  2. The Origin Code will be M. The Purpose/Nature code will be S and the Destination Code will be set to the downlink originator. The File Sequence number will reflect the FSN of the Williamsburg file as it was received by the ACARS MU.
  3. Attention System Integrators - Some End Systems may not support this message.

**Status Code**

**Meaning**

- |   |                                                                                 |
|---|---------------------------------------------------------------------------------|
| 0 | File too large – truncated and downlinked                                       |
| 1 | Message discarded because lifetime expired                                      |
| 2 | Message discarded because a Message Delete command was received from end system |
| 3 | Message in Progress, cannot delete                                              |
| 4 | Message not found (e.g., already downlinked), cannot delete                     |

ATTACHMENT 9  
INTERACTION OF END SYSTEMS

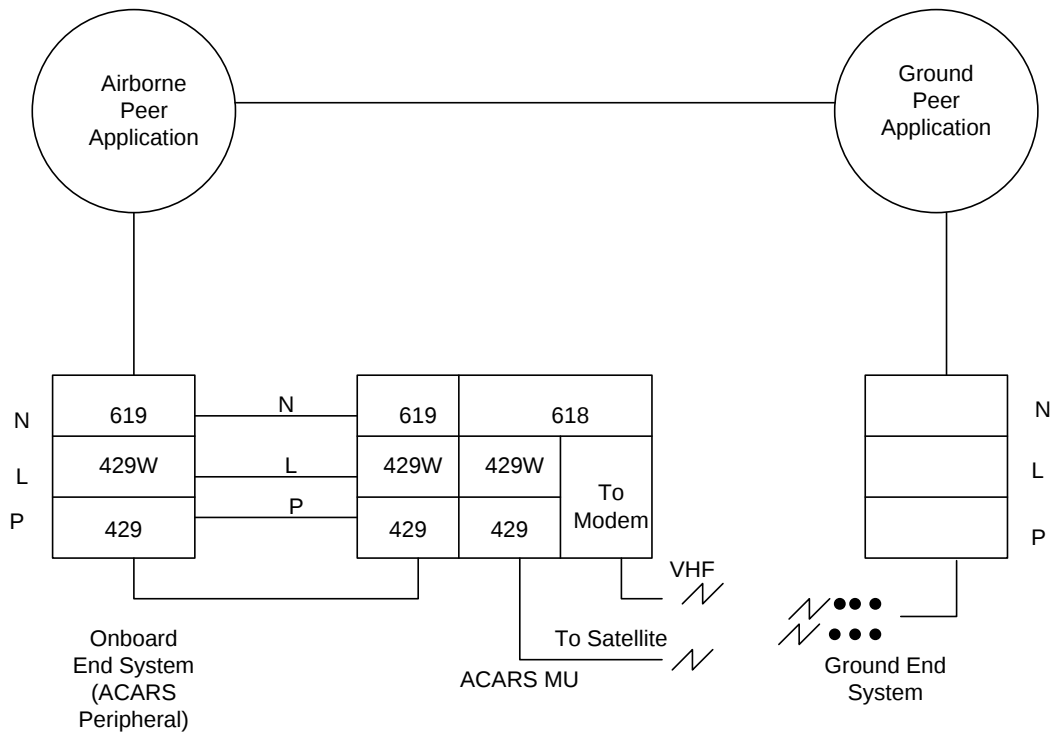


Figure 9-1 – Interaction of End Systems Through an MU – OIS Presentation

ATTACHMENT 10  
CHARACTER FILE TRANSFER PROTOCOL TIMING

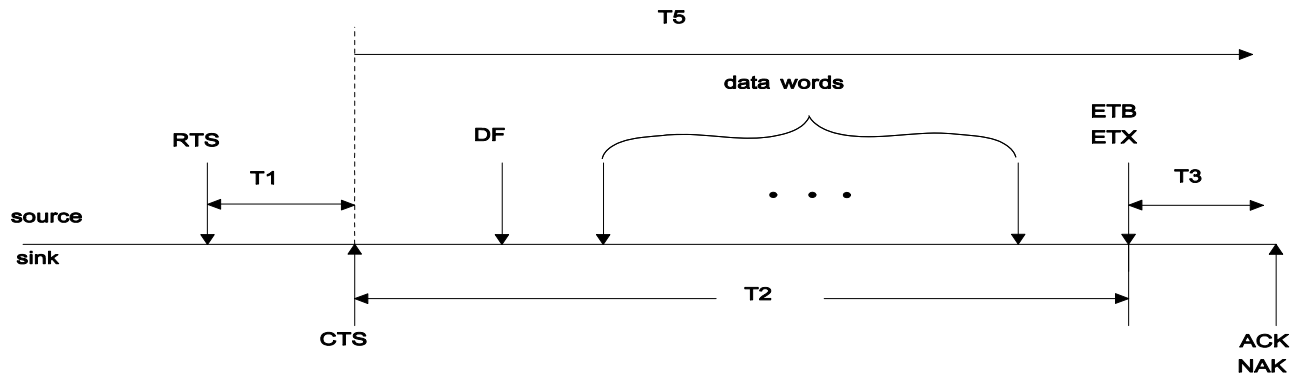


Figure 10-1 – Typical Block Transfer Timing

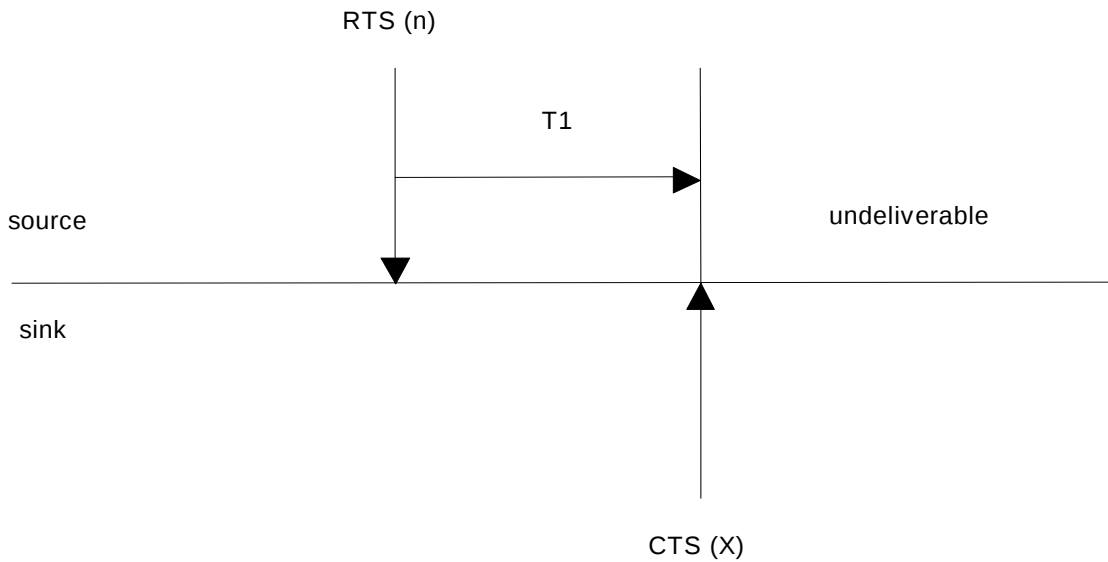


Figure 10-2 – CTS Response

ATTACHMENT 10  
CHARACTER FILE TRANSFER PROTOCOL TIMING

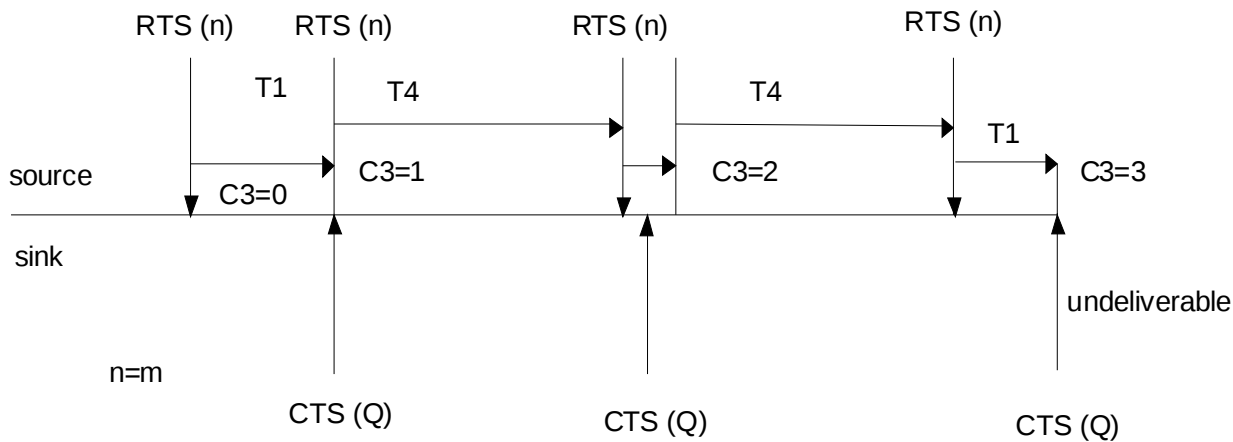


Figure 10-3 – Busy (Q) Response

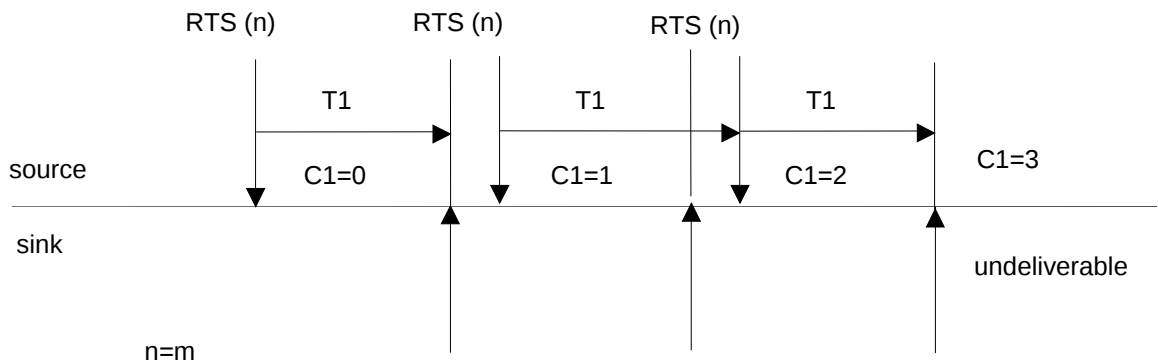


Figure 10-4 – CTS Not Matching and No Busy (Q) Response

ATTACHMENT 10  
CHARACTER FILE TRANSFER PROTOCOL TIMING

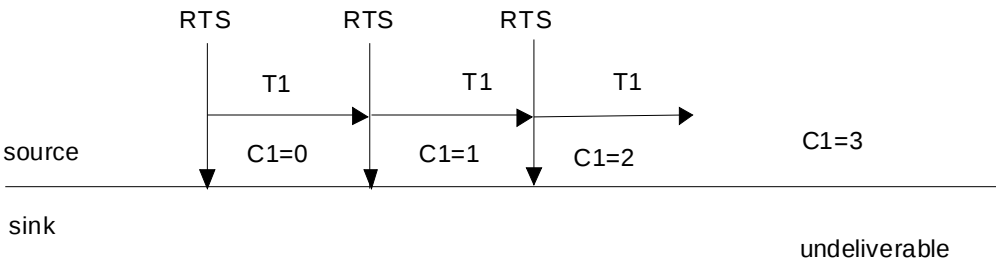


Figure 10-5 – No Response

**ATTACHMENT 11  
MESSAGE PRIORITY AND MEDIA SELECTION**

**Table 11-1 – Media Selection for GPBOP**

The following indicators are defined for use in the Octets 4 and 5 of the of the GPBOP Control/Accountability header for priority and medium selection.

| OCTET 5                      |   |   |   |                              |   |   |   | OCTET 4 |   |   |   |                                   |   |   |   |
|------------------------------|---|---|---|------------------------------|---|---|---|---------|---|---|---|-----------------------------------|---|---|---|
| 8                            | 7 | 6 | 5 | 4                            | 3 | 2 | 1 | 8       | 7 | 6 | 5 | 4                                 | 3 | 2 | 1 |
| PRIORITY<br>(See Table 11-C) |   |   |   | LIFETIME<br>(See Table 11-B) |   |   |   |         |   |   |   | MEDIA SELECT<br>(See Table 11-1A) |   |   |   |
| 0                            | 0 | 0 | 1 | 0                            | 0 | 1 | 1 | 0       | 0 | 0 | 0 | 1                                 | 1 | 1 | 0 |

Note: The bottom row of Table 11-1 contains example values and do not imply any specific implementation. The media selections depicted are VHF, SATCOM and HF. The Lifetime value represents 6 minutes. The priority indicated is 1.

**Table 11-1A – Medium Selection Coding**

The options for medium selection are coded by entering a 1 in the appropriate bit in Octet 4 of the Accountability header. A bit set to 1 indicates permission to attempt transmission through the specified medium. A value of all zeros in bits 1 through 5 indicates that the default medium should be used. The bit assignments are:

| BIT | DEFINITION            | NOTES |
|-----|-----------------------|-------|
| 1   | Gatelink              |       |
| 2   | VHF                   |       |
| 3   | SATCOM                |       |
| 4   | HF                    |       |
| 5   | Unassigned (set to 0) |       |
| 6   | Unassigned (set to 0) |       |
| 7   | Unassigned (set to 0) |       |
| 8   | Unassigned (set to 0) |       |

**Table 11-1B – Lifetime Value Coding**

When the field is coded entirely in zero's (0000), the value should be interpreted as infinite.

| BIT | VALUE IN MINUTES | NOTES |
|-----|------------------|-------|
| 1   | 2                |       |
| 2   | 4                |       |
| 3   | 8                |       |
| 4   | 16               |       |

**ATTACHMENT 11**  
**MESSAGE PRIORITY MEDIA SELECTION**

**Table 11-1C – Priority Indexing**

The 16 levels of message priority are coded in bits 5-8 of Octet 5 as:

| TRANSMIT<br>PRIORITY | OCTET 5 CODING |   |   |   | DESCRIPTION                                                                                                                                      | NOTES |
|----------------------|----------------|---|---|---|--------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|                      | 8              | 7 | 6 | 5 |                                                                                                                                                  |       |
| 1                    | 0              | 0 | 0 | 1 | Emergency Situation, Hijack Message<br>(Highest)                                                                                                 |       |
| 2                    | 0              | 0 | 1 | 0 | ATC Communication Message                                                                                                                        |       |
| 3                    | 0              | 0 | 1 | 1 | ADS Message (Media Advisory)                                                                                                                     |       |
| 4                    | 0              | 1 | 0 | 0 | AFN Message                                                                                                                                      |       |
| 5                    | 0              | 1 | 0 | 1 | AOC Message<br>Flight Plan Requests<br>Take-Off Data<br>Weight and Balance Requests<br>Flight Data Requests<br>Position Reports<br>Free Text     |       |
| 6                    | 0              | 1 | 1 | 0 | Aeronautical Information Service Message                                                                                                         |       |
| 7                    | 0              | 1 | 1 | 1 | Flight Regularity Message<br>Airline Flight Information<br>Aircraft Movement (OOOI/Delay/ETA)<br>LRU Failure Report<br>Exceedance/Problem Report |       |
| 8                    | 1              | 0 | 0 | 0 | Aeronautical Administrative<br>Crew-Entered Report<br>Free-Text Downlink<br>BITE History<br>Routine Performance Report                           |       |
| 9                    | 1              | 0 | 0 | 1 |                                                                                                                                                  |       |
| 10                   | 1              | 0 | 1 | 0 |                                                                                                                                                  |       |
| 11                   | 1              | 0 | 1 | 1 |                                                                                                                                                  |       |
| 12                   | 1              | 1 | 0 | 0 | Airline Administrative<br>Cabin Supply Request<br>Payroll Report                                                                                 |       |
| 13                   | 1              | 1 | 0 | 1 |                                                                                                                                                  |       |
| 14                   | 1              | 1 | 1 | 0 | Low Priority Administrative<br>Passenger Services                                                                                                |       |
| 15                   | 1              | 1 | 1 | 1 | (Lowest)                                                                                                                                         |       |
| User<br>Defined      | 0              | 0 | 0 | 0 | Default (See Table 11-1D)                                                                                                                        |       |

The priority coding of avionics equipment, based on the 16 levels of Priority shown in Table 11-1C, are:

**Table 11-1D – Default Priority Coding**

| LRU            | PRIORITY LEVEL |
|----------------|----------------|
| FMC            | 4              |
| SDU            | 5              |
| CFDIU          | 9              |
| DFDAU/ACMS     | 10             |
| Cabin Terminal | 13             |

## ATTACHMENT 12 OPTIONAL AUXILIARY TERMINAL (OAT)

### A12.1 Introduction

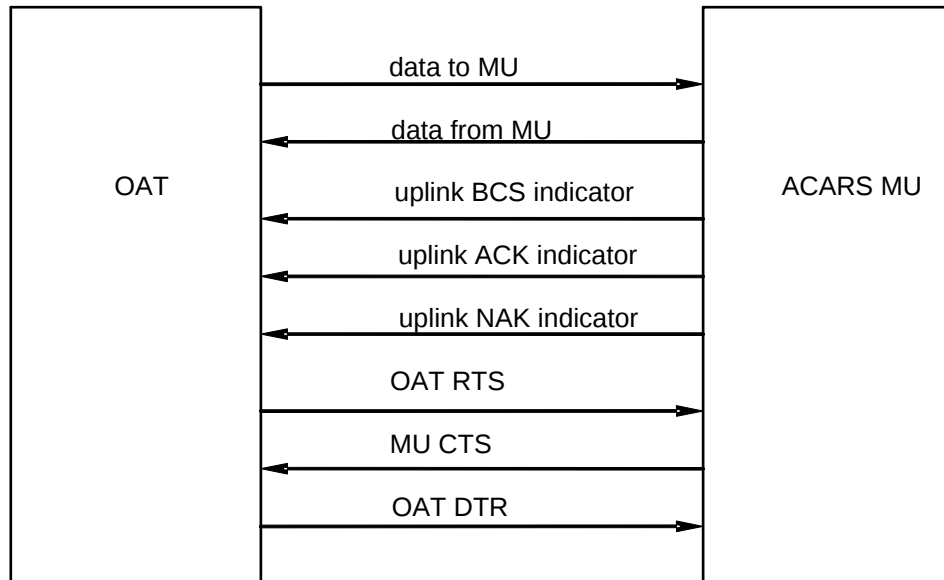
Section 12.2 defines the OAT physical Layer characteristics, Section 12.3 defines the Link layer protocol and Section 12.4 defines the message processing requirements.

#### COMMENTARY

Some aircraft still use the OAT interface to connect other computers to the ACARS MU, such as the Engine Life Computer (ELC) on the AVRO RJ. To give this Attachment greater relevance, references and examples of specific aircraft installations are included.

### A12.2 OAT/ACARS MU Physical Layer and Signals

The OAT/ACARS interface consists of 2 twisted shielded pairs of data lines and 6 discretes. Figure 12.2-1 depicts the signals between an OAT and an ACARS MU.



**Figure 12.2-1 – OAT/ACARS Interface**

The signal direction, input or output, is defined from the viewpoint of the ACARS MU. The discrete signals should conform to the requirements specified in Section 12.2.1. The rise time should not exceed 5 microseconds.

#### A12.2.1 OAT Physical Layer

The interface between the ACARS MU and OAT is defined as ARINC 419 AXA AAA CBCC CBCC XCXX. Each of the letters defines a different parameter of the interface.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**A12.2.1.1 A - Direction of Data Flow**

The LRU (MU and OAT) transmits on dedicated wires.

**A12.2.1.2 X - Frame Structure**

The data frame consists of up to 222 eight-bit bytes. Each byte contains one ISO #5 character and a parity bit. The parity bit is set for odd parity. The first byte of the frame contains the control character STX. Bytes 2 through n-1 contain the data characters. Byte n (where  $n \leq 222$ ) contains either an ETX or ETB character. When the entire message fits in one frame, then the byte following the last data character contains an ETX character. When a message is larger than one frame, then multiple frames are used. Only the last frame contains an ETX character. The last byte in each of the other frames contains an ETB character.

**A12.2.1.3 A - Information Identifier**

Does not apply.

**A12.2.1.4 A - Language Identifier**

Does not apply.

**A12.2.1.5 A - Sign Status Matrix**

Does not apply.

**A12.2.1.6 A - Data Standards**

Does not apply.

**A12.2.1.7 C - Transmission Interconnect**

Two cables, each consisting of one twisted shielded pair of wires. Plus 2 discrete inputs and 6 discrete outputs.

**A12.2.1.8 B - Modulation**

Tri-level state modulation consisting of HI, LOW and NULL states.

**A12.2.1.9 C - Voltage levels**

The differential output signal (A to B) for the HI state is  $+10 \pm 1$  volts. The differential output signal for the NULL state is  $0 \pm 1$  volts. The differential output signal for the LO state is  $-10 \pm 1$  volts.

The differential input signal for the HI state is  $+10 \pm 3$  volts. The differential input signal for the NULL state is  $0 \pm 3$  volts. The differential input signal for the LO state is  $-10 \pm 3$  volts.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**A12.2.1.10 C - Impedance Levels**

The transmitter paired output terminals (A and B) should be capable of driving loads within the ranges of 600 to 12,000 ohms balanced to ground and 1,000 to 3,000 picofarads.

The receiver should have a differential input resistance of at least 12,000 ohms. The receiver should have an input capacitance of 100 picofarads or less. The receiver input resistance to ground should be greater than or equal to the differential input resistance.

**A12.2.1.11 C - Digital Language**

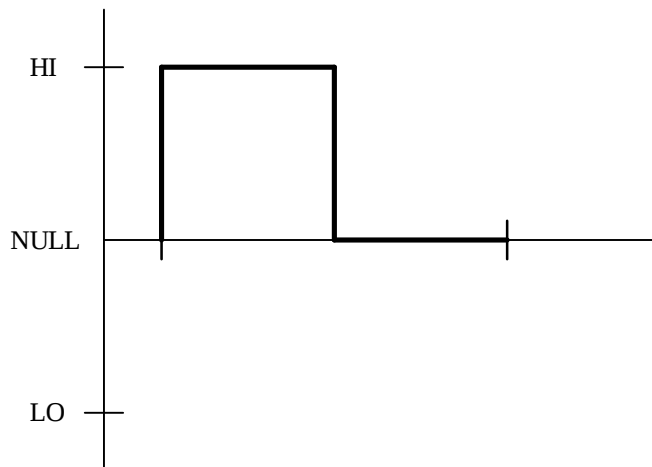
Data is encoded as character strings. Each data word should have odd parity. Data word shall be coded per the ISO Alphabet #5 subset.

**A12.2.1.12 B - Transmission Order**

The least significant bit of the least significant character is transmitted first.

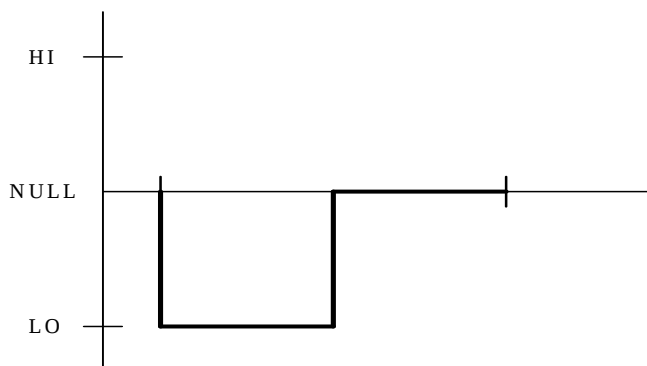
**A12.2.1.13 C - Data Bit Encoding**

Figure 12.2.1.13-1 defines the waveform for a one (1) and Figure 12.2.1.13-2 defines the waveform for a zero (0).



**Figure 12.2.1.13-1 – Waveform for a bit with value one (1)**

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**OPTIONAL AUXILIARY TERMINAL (OAT)**



**Figure 12.2.1.13-2 – Waveform for a bit with Value Zero (0)**

#### **A12.2.1.14 C - Error Detection and Correction**

Character parity is provided for detecting errors. Bit 8 is used as the parity bit. Parity should be odd. Receiving any data words with bad parity will cause the MU to respond by grounding the Uplink NAK line.

#### **A12.2.1.15 X - Bit Rate**

The bit rate is 2400 bits per second.

#### **A12.2.1.16 C - Clocking Method**

The clocking is provided in the signal data transmission, i.e. self clocking data. The beginning of the bit interval is identified by transition of the signal from the NULL state to either the HI or LO state.

#### **A12.2.1.17 X - Word/Frame Synchronization**

Synchronization is maintained via the MU to OAT data bus. Data on the MU to OAT data bus is self clocking. The MU transmits binary 1's when it is not transmitting a message to the OAT in order to provide a clock signal for the OAT to synchronize with.

#### **A12.2.1.18 X - Timing Tolerances**

The bit length is 416.7 microseconds  $\pm$  15%. The rise and fall times, measured between the 10% and 90% amplitude points, should be at least 5 microseconds and less than 50 microseconds.

### **A12.2.2 OAT Interface Signal Definitions**

#### **A12.2.2.1 ACARS Data to OAT**

The ACARS MU transmits data to the OAT encoded and modulated as specified in Section 12.2.1.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**A12.2.2.2 OAT Data to ACARS**

Bits transmitted by the OAT should be synchronized to the synchronization signal transmitted by the ACARS MU (see Section 12.2.1.1).

**A12.2.2.3 Uplink BCS Indicator Discrete Output**

The Uplink BCS Indicator Discrete Output is grounded by the ACARS MU within 10 milliseconds of transmitting the ETB/ETX word, when the BCS check on an uplink block to the OAT indicates that the block is error free.

The Uplink BCS Indicator Discrete Output is opened by the ACARS MU prior to starting the transmission of the next uplink block to the OAT.

If the Uplink BCS Indicator Discrete Output is not grounded within 10 milliseconds of the ETB/ETX word, then the OAT will assume that the block contains an error and will discard the block.

**A12.2.2.4 Uplink ACK Indicator Discrete Output**

If the OAT downlink block is error free, then the MU will ground the Uplink ACK Indicator discrete.

The Uplink ACK Indicator Discrete Output is opened by the ACARS MU when RTS discrete is grounded by the OAT.

The Uplink NAK Indicator Discrete Output AND the Uplink ACK Indicator Discrete Output should never both be grounded at the same time.

**A12.2.2.5 Uplink NAK Indicator Discrete Output**

If the OAT downlink block contains an error, then the ACARS MU should ground the Uplink NAK Indicator discrete.

The Uplink NAK Indicator Discrete Output is opened by the ACARS MU when RTS discrete is grounded by the OAT.

The Uplink NAK Indicator Discrete Output AND the Uplink ACK Indicator Discrete Output should never both be grounded at the same time.

**A12.2.2.6 Request To Send (RTS) Discrete Input**

The OAT will ground the RTS discrete when it has a block to transmit to the ACARS MU. The RTS discrete may go high after the CTS discrete is grounded or it may remain grounded until the ETX character in the last block of a multiblock message is transmitted.

**A12.2.2.7 Clear To Send (CTS) Discrete Output**

The ACARS MU grounds the CTS discrete when it detects a ground on the RTS discrete and the MU is prepared to receive a block from the OAT.

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A12.2.2.8 Data Terminal Ready (DTR) Discrete Input

The OAT grounds the Data Terminal Ready discrete whenever it is prepared to receive an uplink. The Data Terminal Ready discrete is open circuit when the OAT is not prepared to receive an uplink.

A12.3 OAT Link Layer Protocol

See Section 12.4 for the File format.

A12.3.1 OAT File Transfer Protocol from ACARS to a Peripheral

When the ACARS MU has a message to transfer to a peripheral using the OAT file transfer protocol, then it will follow the procedure specified herein. Figure 12.3.1-1 illustrates the normal sequence of events.

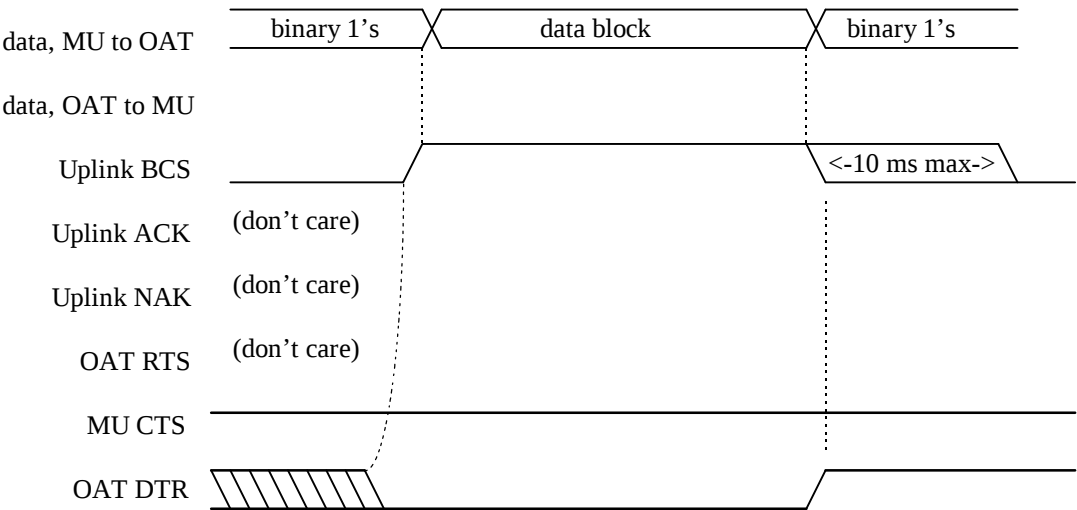


Figure 12.3.1-1 – Normal MU to OAT Timing

If the DTR signal is ground then the MU will respond to an uplink to the OAT with a acknowledgment downlink and the MU will transmit the uplink block to the OAT.

If the DTR signal is open then the MU will respond to an uplink to the OAT with a label Q5 (try again later) downlink and the MU will discard the uplink block.

When the OAT tries to send a message to the ACARS MU (grounds RTS discrete) while the MU is in the process of transmitting a message to the OAT, then the MU will continue to transmit its message and the CTS discrete will remain open indicating NOT clear to send.

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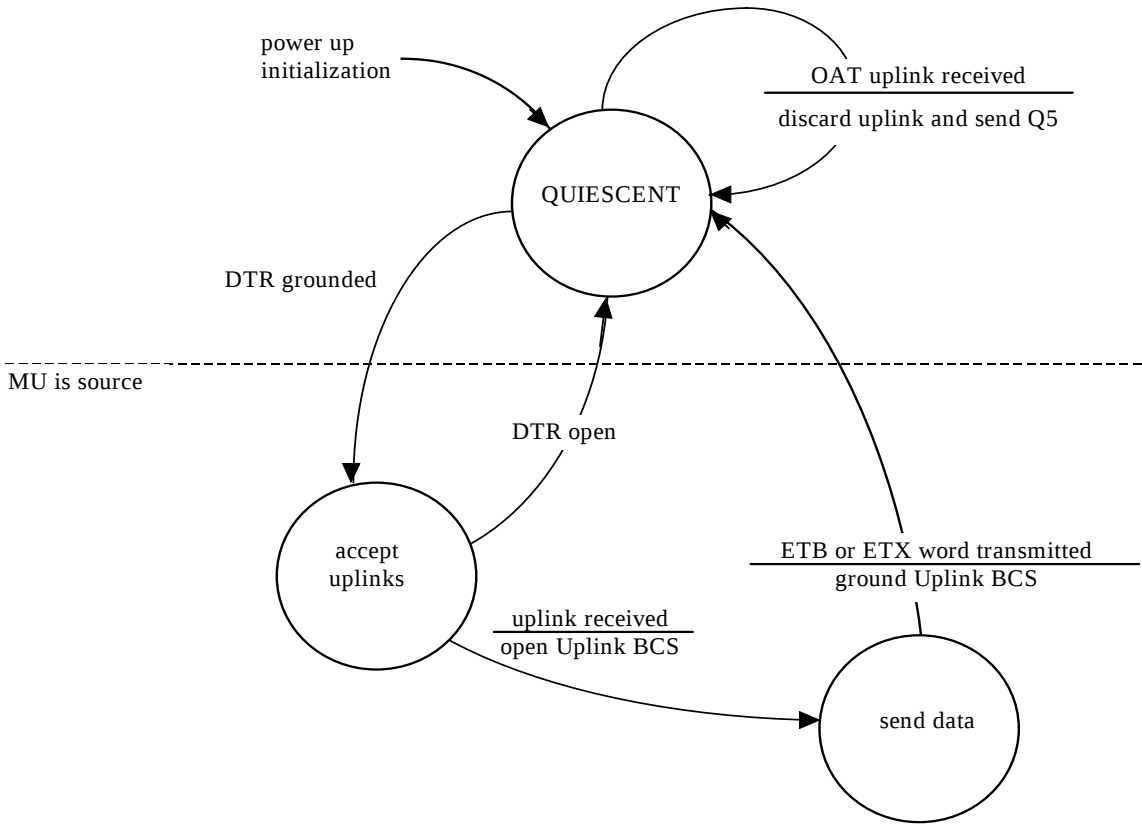
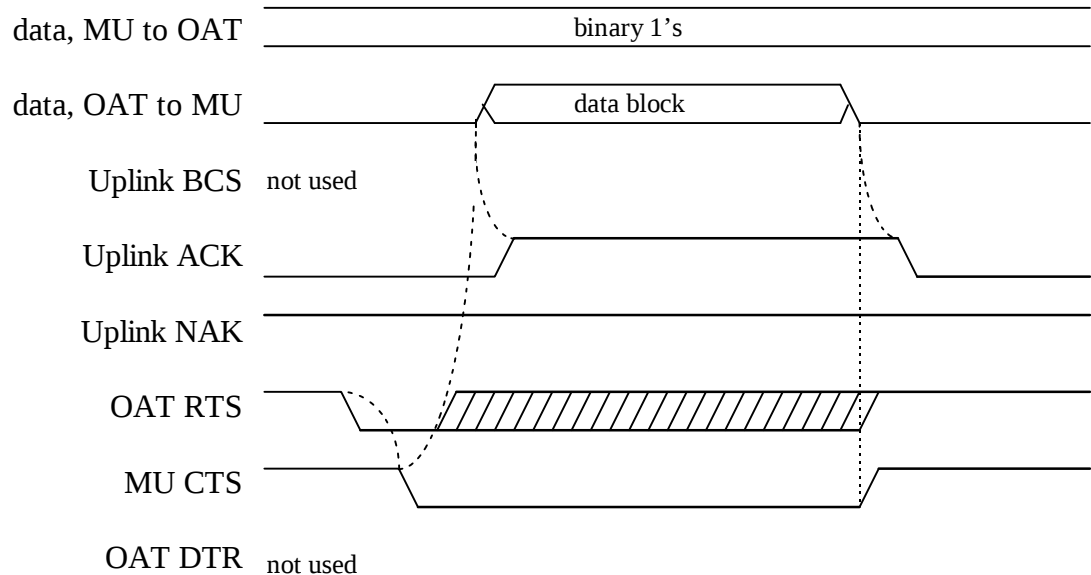


Figure 12.3.1-2 – OAT Protocol State Diagram for ACARS Transmit

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

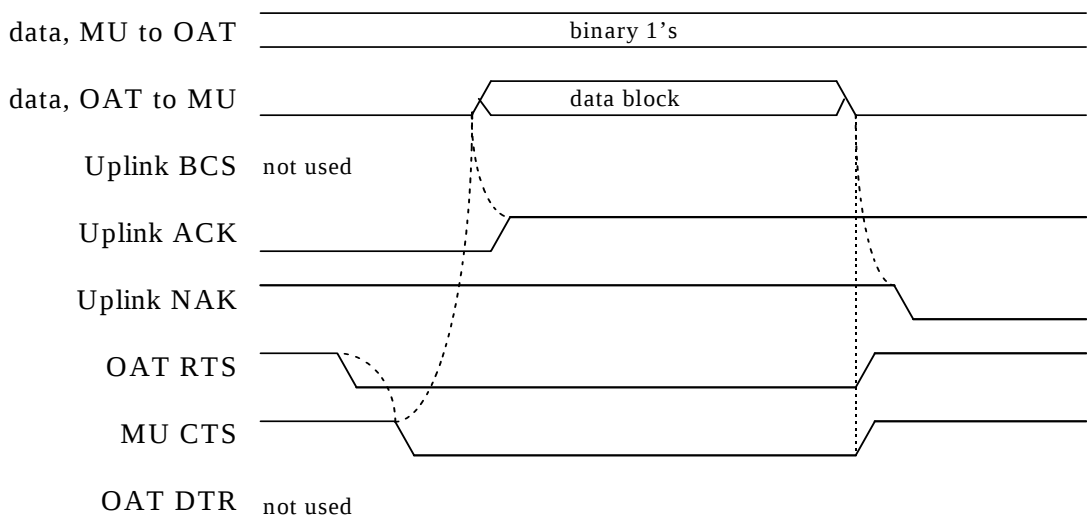
### A12.3.2 OAT File Transfer Protocol from a Peripheral to ACARS

When the OAT has a message to transfer to the ACARS MU, then it will follow the procedure specified herein. Figure 12.3.2-1 illustrates the normal sequence of events and Figure 12.3.2-2 illustrates the sequence of events for a block with an error.



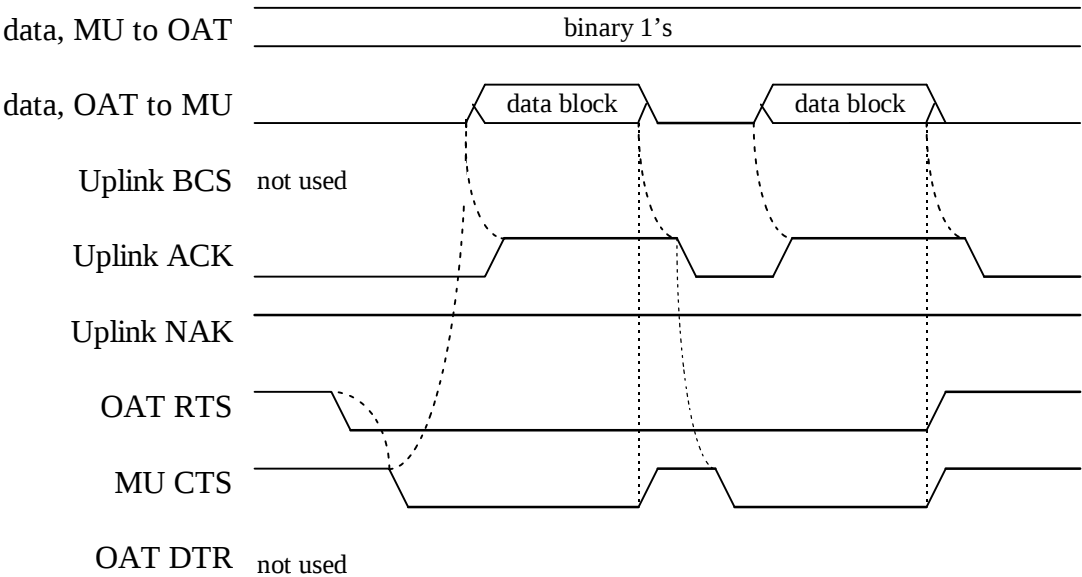
**Figure 12.3.2-1 – OAT to MU Timing for an Error Free Block and Previous Block was Error Free**

The OAT expects the CTS discrete to be grounded within 2 seconds of the falling edge of the RTS discrete. When the delay is longer than 2 seconds, then the OAT may open the RTS discrete. The OAT may open the RTS discrete after it detects the falling edge of the CTS discrete.



**Figure 12.3.2-2 – OAT to MU Timing For a Block Containing An Error and Previous Block was Error Free**

ATTACHMENT 12  
OPITIONAL AUXILIARY TERMINAL (OAT)

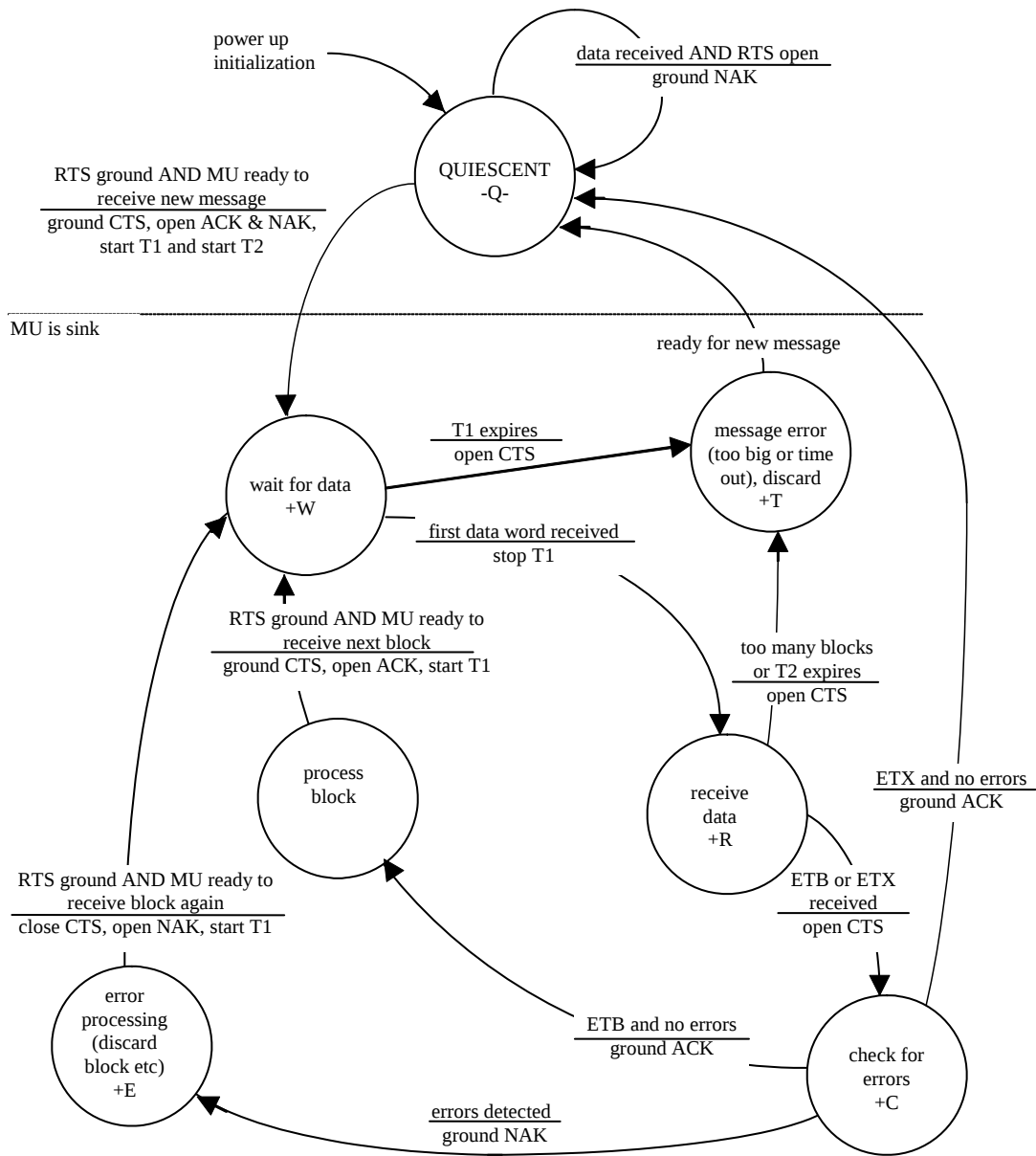


**Figure 12.3.2-3 – OAT to MU Timing for a 2 Block Message and Previous Block was Error Free**

The ACARS MU may be either a pass-through design (original design) or a store-and-forward design. An ACARS MU designed to pass through the blocks will buffer 1 block from the OAT and will not accept the next block until the block in the MU buffer has been successfully downlinked.

A store-and-forward MU buffers only 1 downlink message (a message may consist of several blocks) at a time. The message can contain up to 16 blocks. A store-and-forward MU stores all blocks of a message until the last block has been downlinked. The MU is ready to receive another message from the OAT when it has finished downlinking the previous message (or otherwise completed the message processing).

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**OPTIONAL AUXILIARY TERMINAL (OAT)**



**Figure 12.3.2-4 – OAT to MU Link Layer Protocol State Diagram**

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

### A12.3.3 OAT Timing Parameters

**Table 12.3.3-1 – OAT Timing Parameters**

| Timer  | Description                                                                             | MU Source/Sink | Value           |
|--------|-----------------------------------------------------------------------------------------|----------------|-----------------|
| OAT T1 | Maximum acceptable delay between RTS and first data word                                | sink           | 1 second        |
| OAT T2 | Maximum time MU will tolerate between the first block and the last block of one message | sink           | 600 seconds     |
| OAT T3 | Maximum delay allowed in activating Uplink ACK discrete after transmitting a block      | source         | 10 milliseconds |
| OAT T4 | Maximum time the MU will wait for DTR                                                   | source         | 60 seconds      |

### A12.4 OAT File format

A file transferred via the OAT interface consists of 1 or more blocks with the format specified herein. When a file is larger than 1 block, then only the last block contains an ETX character and all of the other blocks contain an ETB character. Each block of a file using the OAT protocol has the format shown in Table 12.4-1.

**Table 12.4-1 – OAT Message Block Format**

| Character No. | Description                            | Example        |
|---------------|----------------------------------------|----------------|
| 0             | Start of Text                          | <STX>          |
| 1-4           | Downlink Message Sequence Number (MSN) | 5959           |
| 5-10          | Flight Identifier                      | SS0999         |
| 11-220        | Data                                   |                |
| 221           | End of Text OR End of Block            | <ETX> or <ETB> |

Documentary data requests will have a different format, which is unique to the airframe in most cases.

Routing of OAT files is determined by the MU because the OAT message format does provide any routing information.

#### A12.4.1 OAT File Size

Maximum file size supported is 16 blocks.

When a file exceeds the 16-block limit, then the MU performs the following actions:

1. Log a BITE error
2. Truncate the message and forward it to the specified destination

The maximum block size is 220 characters, which exclude the <STX>, <ETB> and <ETX> characters. Characters 1 through 10 are reserved for messaging and routing information and cannot be used for data.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**A12.4.2 Destination VHF****A12.4.2.1 VHF Downlink File Format**

The MU collects all records before attempting to downlink the file (store-and-forward).

There is a one-to-one correspondence between OAT blocks and VHF blocks, i.e., the MU does not re-block messages.

All characters between the <STX> and the ETX/ETB character are copied to the text field of the VHF block.

A VHF Preamble is added to each downlink message block. Each VHF block must contain a Downlink Message Sequence Number and Flight Identifier at the beginning of the text field of each VHF block. The OAT should always provide the Downlink Message Sequence Number and Flight Identifier.

**Table 12.4.2.1-1 – OAT Downlink Format Conversion to VHF Downlink Format**

| OAT Record Fields                                              | Record Example |   | Downlink Example | Downlink Fields                                                |
|----------------------------------------------------------------|----------------|---|------------------|----------------------------------------------------------------|
|                                                                |                |   | <SOH>            | start of header                                                |
|                                                                |                |   | 2                | mode character                                                 |
|                                                                |                |   | .N123SS          | aircraft registration                                          |
|                                                                |                |   | <NAK>            | technical ACK                                                  |
|                                                                |                |   | H1               | label                                                          |
|                                                                |                |   | 1                | downlink block identifier                                      |
| <STX>                                                          | <STX>          |   | <STX>            | start of text character                                        |
| downlink message sequence number                               | 5959           | → | 5959             | downlink message sequence number                               |
| flight identifier                                              | SS0077         | → | SS0077           | flight identifier                                              |
| optional pound sign, sub label and message type identifier (B) | #EIB           | → | #EIB             | optional pound sign, sub label and message type identifier (B) |
| data                                                           | data           | → | data             | data                                                           |
| end of text/block                                              | <ETX>/<ETB>    |   | <ETX>/<ETB>      | end of text/block                                              |

**A12.4.3 Destination SDU (GFI 1110)****A12.4.3.1 SDU File Format**

The MU will format the downlink message as specified in Section 6.6.1.2.1 plus the additional processing specified in this section.

The MU adds the VHF HEADER (see Figure 6.6.1.3.1-1) immediately following the SOT word of each file transfer. Following the VHF HEADER is the End Of VHF Preamble character, the TEXT field, Suffix, BCS and BCS Suffix characters. The file is then terminated with a Williamsburg EOT word.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**Table 12.4.3.1-1 – OAT Downlink Format Conversion to Satellite Downlink Format**

| OAT Record Fields                                              | OAT Record Example |   | Satellite Downlink Example | Satellite Downlink Fields                                      |
|----------------------------------------------------------------|--------------------|---|----------------------------|----------------------------------------------------------------|
|                                                                |                    |   |                            | Williamsburg Start of Text Word, GFI=1110                      |
|                                                                |                    |   | <SOH>                      | start of header                                                |
|                                                                |                    |   | 2                          | mode character                                                 |
|                                                                |                    |   | .N123SS                    | aircraft registration                                          |
|                                                                |                    |   | <NAK>                      | technical ACK                                                  |
|                                                                |                    |   | H1                         | label                                                          |
|                                                                |                    |   | 1                          | downlink block identifier                                      |
| <STX>                                                          | <STX>              |   | <STX>                      | start of text character                                        |
| downlink message sequence number                               | 5959               | → | 5959                       | downlink message sequence number                               |
| flight identifier                                              | SS0077             | → | SS0077                     | flight identifier                                              |
| optional pound sign, sub label and message type identifier (B) | #EIB               | → | #EIB                       | optional pound sign, sub label and message type identifier (B) |
| data                                                           | data               | → | data                       | data                                                           |
| end of text/block                                              | <ETX>/<ETB>        |   | <ETX>/<ETB>                | end of text/block                                              |
|                                                                |                    |   | F3A4                       | VHF BCS characters                                             |
|                                                                |                    |   | <DEL>                      | Delete character                                               |
|                                                                |                    |   |                            | Williamsburg End Text Word                                     |

#### 12.4.4 Destination MU

There is no AEEC standard for routing OAT files to the MU. The AVRO RJ uses a <DC1> character in position 1 to indicate that the file should be routed to the MU.

##### 12.4.4.1 Avro RJ Doc data Request File Format

The Avro RJ aircraft Doc Data Request message has the format shown in Table 12.4.4.1-1.

**Table 12.4.4.1-1 – AVRO RJ Doc Data Request Format**

| Character | Description         | Example |
|-----------|---------------------|---------|
| 0         | Start of Text       | <STX>   |
| 1         | Doc Data Identifier | <DC1>   |
| 2-3       | Fixed Text          | YA      |
| 4         | End of Text         | <ETX>   |

The MU should respond to a Doc Data Request within 2 seconds with a Doc Data message.

**ATTACHMENT 12**  
**OPTIONAL AUXILIARY TERMINAL (OAT)**

**A12.2.1.1 Avro RJ Doc data File Format**

The AVRO RJ Doc Data message has the format shown in Table 12.4.4.2-1.

**Table 12.4.4.2-1 – AVRO RJ Doc Data Message Format**

| <b>Character</b> | <b>Description</b>  | <b>Example</b> |
|------------------|---------------------|----------------|
| 0                | Start of Text       | <STX>          |
| 1                | Doc Data Identifier | <DC1>          |
| 2-3              | Fixed Text          | YB             |
| 4-9              | Flight Identifier   | SS0023         |
| 10-12            | Origin              | SEA            |
| 13-15            | Destination         | LAX            |
| 16-20            | Zero Fuel Weight    | 35000          |
| 21-24            | Date (mmdd)         | 0831           |
| 25-30            | Spare               | 000000         |
| 31               | End of Text         | <ETX>          |

**APPENDIX A  
LIST OF ACRONYMS**

|         |                                                              |
|---------|--------------------------------------------------------------|
| ACARS   | Aircraft Communication Addressing and Reporting System       |
| ACK     | Data Received OK                                             |
| ACMS    | Airplane Condition Monitoring System                         |
| CFDIU   | Central Fault Display Indicator Unit                         |
| CMC     | Central Maintenance Computer                                 |
| CMU     | Communications Management Unit                               |
| CRC     | Cyclic Redundancy Check                                      |
| CT      | Command Type                                                 |
| CTS     | Clear To Send                                                |
| DF      | Data Follows                                                 |
| DFDAU   | Digital Flight Data Acquisition Unit                         |
| DGSS/IS | Data Link Ground System Standard and Interface Specification |
| DITS    | Mark 33 Digital Transfer Information System                  |
| DMU     | Digital Management Unit                                      |
| ELC     | Engine Life Computer                                         |
| EOF     | End of Field                                                 |
| EOT     | End of Transmission                                          |
| ES      | End System                                                   |
| FMC     | Flight Management Computer                                   |
| GFI     | General Format Identifier                                    |
| GPBOP   | General Purpose Bit Oriented Protocol                        |
| LDU     | Link Data Units                                              |
| LRU     | Line Replacement Unit                                        |
| LSB     | Least Significant Bit                                        |
| MAC     | Media Access Control                                         |
| MICP    | Multi Input Cockpit Printer                                  |
| MSB     | Most Significant Bit                                         |
| MSN     | Message Sequence Number                                      |
| MU      | Management Unit                                              |
| NAK     | Data Received Not OK                                         |
| NCTS    | Not Clear to Send                                            |
| OAT     | Optional Auxiliary Terminal                                  |
| RTS     | Request to Send                                              |
| SAL     | System Address Label                                         |
| SATCOM  | Satellite Communications                                     |

APPENDIX A  
LIST OF ACRONYMS

|     |                     |
|-----|---------------------|
| SDU | Satellite Data Unit |
| SOF | Start of Field      |
| SOT | Start of Text       |
| VHF | Very High Frequency |

## APPENDIX B DATA LINK RECORDING

Data link recording requirements include not only recording of messages as they are sent and received, but also recording significant events, such as when the crew review or print the messages.

Figure B1-1 conceptually shows the recording points in the Communication Management System associated with recording of these events.

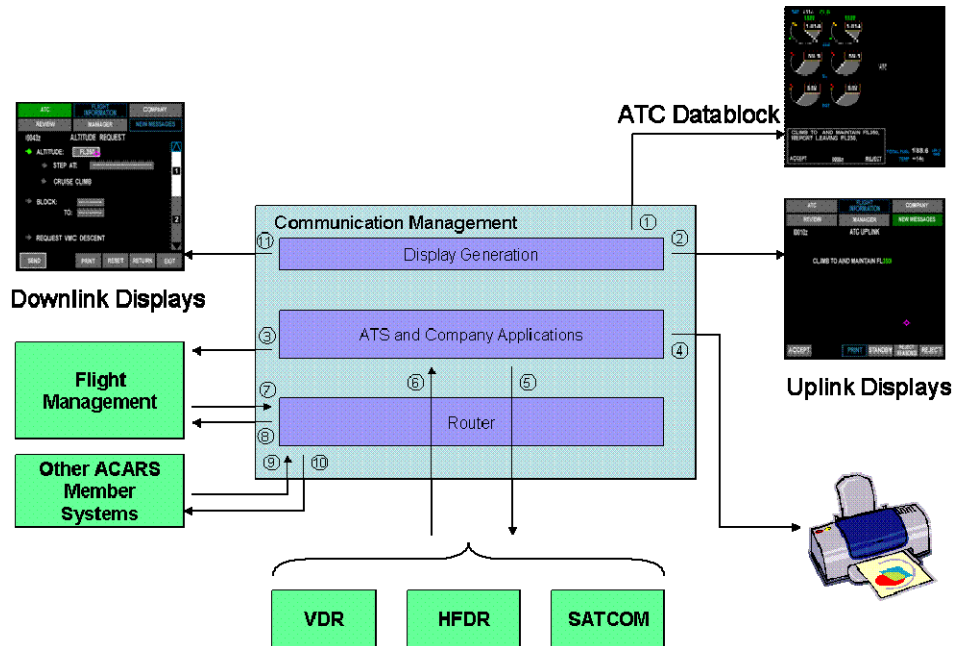


Figure B1-1 – Data Link Recording Points

The recording points (identified by the numbers in the figure) correspond to:

|    |                                                                              |
|----|------------------------------------------------------------------------------|
| 1  | Uplink message display on a dedicated ATC display (such as an ATC Datablock) |
| 2  | Uplink message display on MFD/MCDU                                           |
| 3  | ATC route loaded in FMC                                                      |
| 4  | Message sent to printer                                                      |
| 5  | Message sent to ground                                                       |
| 6  | Message received from ground                                                 |
| 7  | Message from FMC (including status change for recorder)                      |
| 8  | Message sent to FMC                                                          |
| 9  | Message from ACARS member system                                             |
| 10 | Message to ACARS member system                                               |
| 11 | Downlink message display on MFD/MCDU                                         |

The assumption in the figure is that the ATS applications reside in the Communication Management System. In some architectures, these are hosted externally, such as in the Flight Management Computer. In that case, the recording points associated with ATS messages effectively move to that external system, and that external system should use the on-board transfer mechanism to route a message via the Communication Management System to the recorders when one of these events occurs.

## APPENDIX B DATA LINK RECORDING

Several different types of data link message will need to be recorded, and these different message types will be transmitted or received in several different formats (some of which are encoded). The types of message include:

- FANS ATS messages (including AFN, ADS and CPDLC)
- ATN ATS messages (including Context Management, ADS, CPDLC and FIS)
- ARINC 623 messages
- ARINC 702A messages to/from the FMC
- ARINC 618/620 messages

At some of the recording points, it may be more appropriate to use a text format (e.g. to display what was displayed or printed as a result of receiving an encoded message). The approach defined here will allow the use of whichever format is most appropriate, and will provide a means for the user of the recorded data to identify the format used, and the appropriate technique for rendering it in a readable form.

Note that in the discussion that follows, some of the definition is left to the flight recorder documentation. For each installation, such documentation will be necessary to allow investigators and operators to extract usable information from the recordings. It may be part of the documentation provided by the recorder manufacturer, or may be prepared by the system integrator and/or CMU manufacturer as a supplementary document.

### RECORDING APPROACH

The message sent to the recorder will consist of a 3-part payload.

The first part is the Extended GFI header. This will consist of:

| Field                    | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Extended GFI             | 02h (as defined in Section 6.5.2, indicating that an Implementation-Specific Header follows)                                                                                                                                                                                                                                                                                                                                            |
| I/O and multi-frame bits | I/O bit indicates whether the source/destination code is to be interpreted as source or destination. This is generally 0 for downlinks and 1 for uplinks, but recording of display or printing of a message will generally use 1.<br>The multi-frame bit will be set as defined in 6.5.1.1.2, or, if used with a different physical link (e.g. an ARINC 664 databus) will indicate whether this is the final data block in the message. |
| Source/Destination       | Contains the origin/destination code (defined in Attachment 3) of the system to which the message was delivered or which originated the message.                                                                                                                                                                                                                                                                                        |
| Date/Time Stamp          | Contains the date and time (as defined in 6.5.1.1.3) of the recordable event.                                                                                                                                                                                                                                                                                                                                                           |
| Sequence Number          | As defined in 6.5.1.1.4.                                                                                                                                                                                                                                                                                                                                                                                                                |

The second part will be an implementation-specific header. This implementation-specific header should, in conjunction with the Extended GFI Header, provide sufficient information to define the format used for the recorded message, and enable the investigator (or automated data extraction/analysis software) to render the data in human-readable form.

## APPENDIX B DATA LINK RECORDING

The definition of the implementation-specific header, and the appropriate decoding techniques associated with each type of message format, should be included in the flight recorder documentation provided with the airplane.

The Version 1 implementation-specific header would consist of:

| Field          | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Version Number | 01h This is a number that is updated each time the recording definition is changed, allowing the investigator to determine which version of the standard was used for a particular recording.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Message Type   | This provides a code to indicate the type of message (and implicitly the means to decode it). For Version 1, the types include:<br>01h Uplink message to be routed to an end system or a downlink message from an end system to be routed to the ground<br>02h Message from end system directed to recorder<br>03h AOC message processed by CMU/CMF<br>04h FANS AFN message<br>05h FANS ADS message<br>06h FANS CPDLC message<br>07h ATN Context Management message<br>08h ATN ADS message<br>09h ATN CPDLC message<br>0Ah ARINC 623 message<br>0Bh ATN FIS message<br>0Ch System-generated message<br>0Dh Message loaded to FMC<br>0Eh Technical acknowledgement of downlink message<br>0Fh On-board transfer message to be routed to end system |
| Display Type   | Where multiple types of display presentation are provided (e.g. an MFD presentation and a separate datablock in the primary field of view), this would indicate which type of display was used (since the “C” indication in the origin/destination code would not provide complete information. For Version 1, these types would be:<br>01h The source/destination is not a display device<br>02h Message presented on MFD<br>03h Message presented on Datablock<br>04h Message presented on both MFD and datablock<br>05h Message presented on MCDU<br>06h Message presented on MCDU and datablock                                                                                                                                               |

The third part would consist of the recorded message itself

The recorded message content can be in several forms, including:

- ACARS Text Messages
- Character-oriented FANS messages (before or after bit-to-hex conversion)
- ATN bit data
- Displayed text
- Printed text

The format chosen may depend on the source/destination, and allows recording in a different format at different points in the process, such as when an uplink is received, when page 2 of 3 is displayed, etc.

## APPENDIX B DATA LINK RECORDING

The format would be defined explicitly in the flight recorder documentation, so that a particular installation could, for example record the complete message including the ARINC 618 header, whereas another installation (or a recording for a different type of message in the same installation) might not.

### EXAMPLES

As an example, consider the following uplink (of a FANS ATC message) directed to the CMU using the AA label:

<SOH>2.G-EASY<NAK>AAL<STX>/ATCCTR1.AT1. G-EASY212AA00532D0C25D<ETX>

This can be broken down as:

| ARINC Specification | Field                                       | Example      |
|---------------------|---------------------------------------------|--------------|
| 618                 | Start of Header                             | <SOH>        |
|                     | Mode                                        | 2            |
|                     | Address                                     | .G-EASY      |
|                     | ACK                                         | <NAK>        |
|                     | Label                                       | AA           |
|                     | Uplink Block Identifier (UBI)               | L            |
|                     | Start of Text                               | <STX>        |
| 622                 | /                                           | /            |
|                     | Center Address                              | ATCCTR1      |
|                     | .                                           | .            |
|                     | Imbedded Message Identifier (IMI)           | AT1          |
|                     | Aircraft registration                       | .G-EASY      |
|                     | Hex-Character Representation of ATC Message | 212AA00532D0 |
|                     | Cyclic Redundancy Check (CRC)               | C25D         |
| 618                 | End of Text                                 | <ETX>        |

When this arrives at the airplane, this would be recorded as follows, noting the Implementation-Specific Header and Recorded Message parts would depend on how the system integrator defined them:

| Part                           | Field                    | Example                             | Notes                                                            |
|--------------------------------|--------------------------|-------------------------------------|------------------------------------------------------------------|
| Extended GFI Header            | Extended GFI             | 02h                                 |                                                                  |
|                                | I/O and multi-frame bits | 0000 0001                           | Uplink, single frame                                             |
|                                | Source/Destination       | "M"                                 | Directed to CMU                                                  |
|                                | Date/Time Stamp          | 01E2 8500h                          | 1 Jan 2001 at 00:00:00                                           |
|                                | Sequence Number          | F5h                                 | Set by CMU                                                       |
| Implementation-Specific Header | Version Number           | 01h                                 | Version 1                                                        |
|                                | Message Type             | 06h                                 | FANS CPDLC                                                       |
|                                | Display Type             | 01h                                 | Not a display device                                             |
| Recorded Message               | Recorded Message         | ATCCTR1.AT1. G-EASY212AA00532D0C25D | Message contents as defined in the flight recorder documentation |

**APPENDIX B  
DATA LINK RECORDING**

If the system integrator elected to present displayed information by reference to the original uplink, then the message to the recorder could appear as follows, if this message is then presented on the ATC Datablock (displayed on an MFD):

| Part                                  | Field                           | Example                     | Notes                                                                                        |
|---------------------------------------|---------------------------------|-----------------------------|----------------------------------------------------------------------------------------------|
| <b>Extended GFI Header</b>            | <b>Extended GFI</b>             | <b>02h</b>                  |                                                                                              |
|                                       | <b>I/O and multi-frame bits</b> | <b>0000 0001</b>            | <b>Uplink, single frame</b>                                                                  |
|                                       | <b>Source/Destination</b>       | <b>“C”</b>                  | <b>Directed to MFD</b>                                                                       |
|                                       | <b>Date/Time Stamp</b>          | <b>01E2 850Ah</b>           | <b>1 Jan 2001 at 00:00:10</b>                                                                |
|                                       | <b>Sequence Number</b>          | <b>F6h</b>                  | <b>Set by CMU</b>                                                                            |
| <b>Implementation-Specific Header</b> | <b>Version Number</b>           | <b>01h</b>                  | <b>Version 1</b>                                                                             |
|                                       | <b>Message Type</b>             | <b>06h</b>                  | <b>FANS CPDLC</b>                                                                            |
|                                       | <b>Display Type</b>             | <b>03h</b>                  | <b>Presented on ATC datablock</b>                                                            |
| <b>Recorded Message</b>               | Message Time Stamp              | 00:00:00                    | Time of arrival of original message, encoded as defined in the flight recorder documentation |
|                                       | Recorded Message                | CLIMB TO AND MAINTAIN FL390 | Message contents as defined in the flight recorder documentation                             |

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

## C1.0 Frame Definition

Data link recording requirements include not only recording of messages as they are sent and received, but also recording significant events, such as when the crew reviews or prints a message.

## C1.1 General Data structure

Data to be recorded are defined in the following paragraph, whatever the source (i.e. ATC application) of the data.

Table C1-1 – General Frame Structure

|                               |                      |                   |
|-------------------------------|----------------------|-------------------|
| ARINC 619 Extended GFI Header | Airbus Common Header | Information Field |
|-------------------------------|----------------------|-------------------|

## C1.2 Detailed Data Structure

### C1.2.1 ARINC 619 Extended GFI Header (for EGFI=01h)

The ARINC 619 header has the following structure: The first part is the Extended GFI header. This will consist of:

Table C1-2 – ARINC 619 Extended GFI Header

| ARINC 619 Extended GFI Header Structure |                                                                                                              |               |                 |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| Field                                   | Contents                                                                                                     | Size in Bytes | Offset in Bytes |
| Extended GFI                            | 01h (as defined in Section 6.5.1, indicating that an Implementation-Specific Header follows)                 | 1             | 0               |
| I/O and multi-frame bits                | I/O (Source/Destination) indicator and Final Frame indicator                                                 | 1             | 1               |
| Source/Destination                      | Origin or Destination code of the system which originated the message or to which the message was delivered. | 1             | 2               |
| Date/Time Stamp                         | Contains the date and time (as defined in Section 6.5.1.1.3) of the recordable event.                        | 4             | 3               |
| Sequence Number                         | As defined in Section 6.5.1.1.4.                                                                             | 1             | 7               |

#### C1.2.1.1 Extended GFI

The 'Extended GFI' field is used to identify the format of the ARINC 619 Extended GFI Header. The 'Extended GFI' field has the value 1 (01h).

#### C1.2.1.2 Input / Output and Multi-frame bits

Bit 1, (the least significant bit of the octet) is the Input / Output (I/O) bit. The I/O Bit indicates whether the source/destination code is to be interpreted as a source or a destination. (See Section 6.5.1.1.2). The Input / Output bit indicates how the Source / Destination field should be interpreted.

Bit 2, the multi-frame bit, is used to indicate whether this is the final data frame in the message (as defined in Section 6.5.1.1.2).

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

### C1.2.1.3 Source / Destination

The 'Source/Destination' field is set to indicate the origin or destination of the message. The 'Source / Destination' field is set to the value of the source or sink of the recorded message. The table below gives the different values defined for this field. A subset of the Origin/Destination codes specified in Attachment 3 is defined here.

Table C1-3 – Source / Destination Value

| Source / Destination |       |        |
|----------------------|-------|--------|
| Source / Sink        | Value | Coding |
| Router               | J     | 4A     |
| Display              | K     | 4B     |
| Printer              | P     | 50     |

### C1.2.1.4 Date / Time stamp

The 'Date Time Stamp' field is the time that the message was received, transmitted, initiated by the crew or printed. This field contains the number of seconds that have elapsed since midnight on January 1, 2000.

### C1.2.1.5 Sequence Number

The 'Sequence Number' is monotonically increased without skipping values for each frame transmitted to the CVR.

The 'Sequence Number' value of 0 is only used for the first frame sent after an ATC reset.

The next 'Sequence Number' value after 255 is 1.

## C1.2.2 Airbus Common Header (Specific to Airbus)

The common header has the following structure:

Table C1-4 – Common Header Structure

| Common Header structure       |               |                |                |                    |
|-------------------------------|---------------|----------------|----------------|--------------------|
| Content                       | Size in Bytes | Offset in Byte |                |                    |
|                               |               | ATC Designator | NSP Designator | ATC ATN Designator |
| Recording Source              | 1             | 0              |                |                    |
| Ground center Designator Type | 1             | 1              |                |                    |
| Ground center Designator      | 4-8           | 2              |                |                    |
| Message Status Type           | 1             | 6              | 9              | 10                 |
| Message Status Number         | 1             | 7              | 10             | 11                 |
| Encoding Type                 | 1             | 8              | 11             | 12                 |
| Padding-PER                   | 1             | 9              | 12             | 13                 |

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

### C1.2.2.1 Recording Source

The 'Recording Source' field defines the Data-link application related to the message to record. The table below gives the different recording sources that are defined:

Table C1-5 – Recording Source Value

| RECORDING SOURCE |       |
|------------------|-------|
| Application      | Value |
| CPDLC            | 0     |
| ADS-C            | 1     |
| ARINC 623: DC    | 2     |
| ARINC 623: OC    | 3     |
| ARINC 623: ATIS  | 4     |
| AFN              | 5     |
| DISPLAY SERVER   | 6     |
| CPDLC-ATN        | 7     |
| CMA              | 8     |

### C1.2.2.2 Ground Center Designator Type

The 'Ground Center Designator Type' field gives the type of designator used for identification of the ground center. The table below gives the different values defined for this field.

This ground center can be encoded in 4 characters (ICAO convention), 7 characters for Networks Service Provider address (NSP- e.g. SITA address), or 8 characters for ATN type address.

Table C1-6 – Ground Center Designator Type

| Ground center Designator Type |       |
|-------------------------------|-------|
| Ground center address         | Value |
| ICAO type                     | 0     |
| NSP type                      | 1     |
| ATN type                      | 2     |

### C1.2.2.3 Ground Center Designator

The value of the field identifies the ground end user with which the plane has exchanged the message.

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

#### C1.2.2.4 Message Status Type

The 'Message Status Type' field identifies the type of the message status. The table below gives the different values defined for this field.

Table C1-7 – Message Status Type

| Message Status Type |       |
|---------------------|-------|
| Type                | Value |
| Received            | 0     |
| Queued              | 1     |
| Displayed           | 2     |
| Sent                | 3     |
| PrintRequested      | 4     |

#### C1.2.2.5 Message Status Number

There is one message status definition for each type of 'Message Status Type' definition

The 'Message Status Number' field specifies the identification number of the detailed event that triggered the recording (e.g. status number = '00h' means 'SEND key was pressed'. In this case, the message will be recorded with 'message status type = 'Displayed').

#### C1.2.2.6 Encoding Type

The 'Encoding Type' field describes the type of encoding used for the 'Data-Link Message'. The table below gives the different values defined for this field.

Table C1-8 – Different Types of Encoding Used

| TYPE OF ENCODING  |       |
|-------------------|-------|
| Type of encoding  | Value |
| ASCII encoding    | 0     |
| unaligned PER     | 1     |
| bit encoding      | 2     |
| unaligned PER ATN | 3     |

#### C1.2.2.7 Padding-PER number

The 'Padding PER number' field is filled in only when the 'Type of encoding' field is set to the relevant value 'unaligned Packed Encoding Rules'. In all other cases this field is set to FFh.

#### C1.2.2.8 Information Field

The information field is specific for each ATC application.

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

## C2.0 Examples of Recorded Frame

### CPDLC Uplink Message Received

| Part                 | Field                         | Example    | Notes                                                            |
|----------------------|-------------------------------|------------|------------------------------------------------------------------|
| Extended GFI Header  | Extended GFI                  | 01h        |                                                                  |
|                      | I/O and multi-frame bits      | 00h        |                                                                  |
|                      | Source/Destination            | 4Ah        | From Router (code J)                                             |
|                      | Date/Time Stamp               | 01E2 8500h | Reception Date and Time                                          |
|                      | Sequence Number               | 03h        |                                                                  |
|                      | Recording Source              | 00h        | CPDLC                                                            |
| Airbus Common Header | Ground Center Designator Type | 00h        | ICAO Type                                                        |
|                      | Ground Center Designator      | 4B415A41h  | ICAO Center (code KAZA)                                          |
|                      | Message Status Type           | 00h        | Received                                                         |
|                      | Message Status Number         | 00h        | Data Id                                                          |
|                      | Encoding Type                 | 01h        | Unaligned PER                                                    |
|                      | Padding-PER                   | 00h        |                                                                  |
| Recorded Message     | Information Field             | XXXXXXXX   | Message contents as defined in the flight recorder documentation |

APPENDIX C  
AIRBUS DATA LINK RECORDING EXAMPLE

Display server – ATCCOM INIT: CONNECTION Page Display

| Part                 | Field                         | Example      | Notes                                                            |
|----------------------|-------------------------------|--------------|------------------------------------------------------------------|
| Extended GFI Header  | Extended GFI                  | 01h          |                                                                  |
|                      | I/O and multi-frame bits      | 00h          |                                                                  |
|                      | Source/Destination            | 4Bh          | From Display (code K)                                            |
|                      | Date/Time Stamp               | 01E2 85A0h   | Reception Date and Time                                          |
|                      | Sequence Number               | C5h          |                                                                  |
|                      | Recording Source              | 06h          | Display Server                                                   |
| Airbus Common Header | Ground Center Designator Type | 00h          | ICAO Type                                                        |
|                      | Ground Center Designator      | 20 20 20 20h | No value: 4 spaces                                               |
|                      | Message Status Type           | 02h          | Displayed                                                        |
|                      | Message Status Number         | B3h          | Init Connection Displayed                                        |
|                      | Encoding Type                 | 00h          | Not Used                                                         |
|                      | Padding-PER                   | FFh          | Not Used                                                         |
| Recorded Message     | Information Field             | XXXXXX       | Message contents as defined in the flight recorder documentation |



AERONAUTICAL RADIO, INC.  
2551 Riva Road  
Annapolis, Maryland 24101-7465

SUPPLEMENT 1  
TO  
ARINC SPECIFICATION 619  
ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

Published: January 27, 1997

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee:

October 26, 1996



## **A. PURPOSE OF THIS DOCUMENT**

This Supplement introduces several changes. Most notable is the introduction of priority and media selection. The coding of Origin/Destination codes was revised to uniquely identify the left and right Satellite Data Units (SDU). The changes also include adding documentation of the already installed use of the MU as an intermediary to connect two onboard systems. However, continuation of this practice is discouraged.

## **B. ORGANIZATION OF THIS SUPPLEMENT**

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

## **C. CHANGES TO ARINC SPECIFICATION 619 INTRODUCED BY THIS SUPPLEMENT**

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

### **1.5 Referenced Documents**

Updated CMU entry from Characteristic 748 to 758.

### **2.1 Introduction**

Previously a place holder, this Section was expanded.

### **2.2 Management Unit/Optional Auxiliary Terminal Interface**

New Section added. Additional new provisions were added as Attachment 12.

### **3.1 ARINC 429 Character-Oriented File Transfer Protocol Characteristics**

Editorial change.

### **3.2 Physical Interconnection**

Text and commentary were added to describe an existing capability that some users have installed to avoid interwiring changes. The ACARS MU is used as a forwarding agent between two LRUs that are not connected to each other directly. This capability is not recommended for new equipment.

#### **3.2.3 ARINC 724-724B Determination Logic**

New section added.

### **3.3 Character Protocol, General Characteristics**

Editorial clarifications were made.

#### **3.3.1 Coding**

Editorial clarification: "Label" was change to "Label of Sink".

#### **3.3.5 Labels**

Editorial change.

### **3.4.10.2 Errors Detected**

Editorial change.

### **3.4.12 No Sink Response to Data Transfer**

Editorial change.

### **3.5.1.1 Origin Code**

Editorial change.

### **3.5.1.2 Destination Code**

Editorial change.

### **3.5.2 Uplink Routing**

New Destination assignments for the Satellite Data Unit (SDU) were added to enable messages to be delivered to the SDU as a recipient. Provisions for an "all call" delivery of messages to Cabin Terminals was added. An assignment for a third FMC was added.

#### **3.5.2.2.1 Master FMC Selection**

Text was changed and Note 6 was added to recognize a third FMC.

### **3.6.1.1 Origin Code**

Editorial change.

### **3.6.1.2 Destination Code**

Editorial change.

### **3.7 Routing Messages Received From End Systems**

New first paragraph was revised to clarify the use of the Destination field.

#### **3.7.1 Control/Accountability Header**

Text changed to enable nesting of multiblock messages. Also, an editorial change was made.

##### **3.7.1.1 Origin Code**

New text added to second paragraph to describe the protocol and use of the Origin Code.

##### **3.7.1.2 Destination Code**

Text was deleted from Note 3 of the commentary. Description was expanded.

##### **3.7.1.3 Message Purpose/Nature Code**

Editorial change to clarify the meaning of 'sink'.

### **3.8.1 Downlink File Format**

Editorial change to add "(MSN)".

#### **3.8.1.1 Downlink Header Options**

Text added to note that ACARS MUs may not inspect the status of bit 17 of incoming Data Follows words.

##### **3.8.1.1.1 ACARS MU Supplies Downlink Header (Bit 17 = 0)**

Editorial change: Added "When Bit 17 = 0", at the beginning of the first sentence.

#### **4.2.2.1 Successful Printer Data Transfers**

Editorial change: “Repeated transmission” changed to “Retransmissions.”

#### **4.3.1.2.2 Delivery Unsuccessful**

A reference to Specification 618 was replaced by a reference to Section 4.2.4.5.

#### **5.5.1.1 GPBOP Control/Accountability Header**

New Table 5.5.1.1-2, GF1 001 Control Accountability Header - Version 2, was added. Definitions of the new fields described.

##### **5.5.1.1.3 Destination Code**

Definition was expanded to enable a peripheral to designate a preferred air/ground medium.

##### **5.5.1.1.4 Reserved Fields**

New Section added.

##### **5.5.1.1.5 New Transmission Media Selection Field**

New Section added.

##### **5.5.1.1.6 Message Text Field**

New Section added.

##### **5.5.1.1.7 Message Priority**

New Section added.

#### **5.5.1.2 Format of Data in Octets**

Editorial changes. Reference to ISO Alphabet #5 was deleted.

##### **5.5.1.3.1 Routing Uplinks**

Reference to sublabel M3 was added.

##### **5.5.1.4.1 GPBOP File Size**

Editorial clarification added “(octet 3)” in last paragraph.

###### **5.5.1.4.1.4 Destination Code**

Commentary added.

###### **5.5.1.4.1.5 Media Select Field**

New Section inserted. The previous title “Air/Ground Downlink Message Format” was renumbered Section 5.5.1.4.1.8.

###### **5.5.1.4.1.6 Lifetime Field**

New Section added.

###### **5.5.1.4.1.7 Priority Field**

New Section added.

###### **5.5.1.4.1.8 Air/Ground Downlink Message Format**

This Section was previously numbered 5.5.1.4.1.5.

#### **5.5.1.4.2 Ground Acknowledgment Message**

Reference to Section 5.5.1.2 was added.

### **5.6 Delete Message Function**

New Section added.

#### **5.6.1 Message Deletion Command**

New Section added.

#### **5.6.2 MU Response to a Deletion Command**

New Section added.

### **Attachment 3**

The Origin/Destination identifier for the SDU was generalized to define the Satellite link. Two new Origin/Destination values were entered to uniquely identify the left and right SDU. A new entry was added to identify FMC, Center (3). The ADS entry was expanded to include ATSU. The Transponder (XPDR) entry (assigned Code T) was deleted.

### **Attachment 6**

Editorial changes to Figures 6-1, 6-2 and 6-3.

### **Attachment 7**

Editorial change - added '0011' to the first GFI field.

### **Attachment 8**

Editorial Change to figure 8-1, 8-2 and 8-3 - to add GFI to the first GFI field.

### **Attachment 11**

New Attachment added.

### **Attachment 12**

New Attachment added.

AERONAUTICAL RADIO, INC.  
2551 Riva Road  
Annapolis, Maryland 24101-7465

SUPPLEMENT 2  
TO  
ARINC SPECIFICATION 619  
ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

Published: March 11, 2005

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee:

October 26, 2004



## **A. PURPOSE OF THIS DOCUMENT**

This Supplement introduces an expansion of media to include UHF and completes documentation of the HF air/ground link.

Section 6, which has been added, defines the CMU to Recorder protocol. Support for Williamsburg Version 1 and Version 3 protocol is included.

## **B. ORGANIZATION OF THIS SUPPLEMENT**

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

## **C. CHANGES TO ARINC SPECIFICATION 619 INTRODUCED BY THIS SUPPLEMENT**

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

### **3.2 Physical Interconnection**

Added a reference to Attachment 3.

#### **3.4.1 Request to Send**

Added a reference to Attachment 3.

#### **3.5.1 ARINC 429 Character Protocol Message Format**

Added a reference to Attachment 3.

##### **3.5.1.1 Origin Code**

Added a reference to Attachment 3.

##### **3.7.1.1 Origin Code**

Added a reference to Attachment 3.

##### **3.7.1.2 Destination Code**

Added a reference to Attachment 3.

#### **3.8.3 Ground Acknowledgment**

Added a reference to Attachment 3.

##### **5.5.1.1.5 Media Selection Field**

The number of media selection options was increased from 4 to 6. The new medium, UHF, will be used by the U.S. Air Force.

##### **5.5.1.4.1 GPBOP File Size**

Added a reference to Figure 8-3 of Attachment 8. Also, editorial clarifications were added.

#### **5.6.1 Message Deletion Command**

The contents of Table 5.6.1-1, Message Deletion Command, were revised.

## **5.6.2 File Status Message**

New Section title was added. The previous title was “MU Response to a Deletion Command.” Text was added to provide for a response when the MU received a file that was too large to downlink. Table 5.6.2-1 was revised and Table 5.6.2-2 was added.

## **6.0 CMU-RECORDER PROTOCOL**

Section 6.0 is a totally new section to ARINC Specification 619. This section defines the interface between the CMU and the recorder.

### **ATTACHMENT 2 – MASTER FMC SELECTION LOGIC**

Table 2-2 was updated to include Flight Management Computer (FMC) number 3 status reporting. Note 2 was added to clarify the status of the Master FMC with regard its connectivity and to its selection in a 3-FMC configuration.

### **ATTACHMENT 3 – ORIGIN/DESTINATION CODES**

Changed the title of Table 3-1 from “Destination Codes” to “Origin/Destination Codes.” This table is being adjusted to align with Table 11A of Attachment 11 to Part 3 of ARINC Specification 429. HF Data Radio entries Q, T, and U were added to Table 3-1. Also, related Notes 3 and 4 were added and the notes renumbered.

A line was added to the table between Printer and Satellite Data Unit. Left Side (SDU 1).

In Table 3-1 for Character code Y, the Origin/Destination assignment changed from “Not assigned” to “EFB 1”.

In Table 3-1 for Character code Z, the Origin/Destination assignment changed from “Not assigned” to “EFB 2”.

### **ATTACHMENT 4 – PURPOSE/NATURE CODES**

Added four new assignments (H, I, J, and M) to Table 4-1.

Notes 2 and 3 were removed from the Landing Data line.

Notes 2 and 3 were added to the Reserved-APC Downlink line.

### **ATTACHMENT 5 – DOCUMENTARY DATA FORMATS**

The example of two digit year coding was advanced to show the year 2000 in Tables 5-2 and 5-3.

### **ATTACHMENT 8 – FORMAT OF WILLIAMSBURG SERVICE MESSAGES**

The order of Attachment 8-2 and 8-3 were reversed. The titles of figures 8-1 through 8-3 were expanded to identify only Version 1 of the ARINC 429 Williamsburg protocol. The figures do not apply to Version 3.

In Figure 8-1 Notes column, “EOTs” was changed to “EOT.”

In Figure 8-3 Notes column, “EOTs” was changed to “EOT.”

### **ATTACHMENT 11 – MESSAGE PRIORITY AND MEDIA SELECTION**

In Table 11-1A, Medium Selection Coding, Bit 5 was assigned to UHF.

### **APPENDIX A – LIST OF ACRONYMS**

Appendix A added.

### **APPENDIX B – DATA LINK RECORDING**

Appendix B was added.

AERONAUTICAL RADIO, INC.  
2551 Riva Road  
Annapolis, Maryland 24101-7435

SUPPLEMENT 3  
TO  
ARINC SPECIFICATION 619  
ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

Published: June 5, 2009

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

September 21, 2008



## **A. PURPOSE OF THIS DOCUMENT**

This Supplement provides corrections or updates to Attachment 3 to ARINC Specification 619.

## **B. ORGANIZATION OF THIS SUPPLEMENT**

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current Supplement only.

## **C. CHANGES TO ARINC SPECIFICATION 619 INTRODUCED BY THIS SUPPLEMENT**

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

### **1.5 Referenced Documents**

ARINC Specification 429 was divided into 3 separate parts by its Supplement 12. The text of this specification was modified to acknowledge this delineation. The generic title was revised in this section resulting in two separate entries – ARINC 429 Part 1 and ARINC 429 Part 3. References were made more precise in the text of subsequent chapters as an editorial change and are not shown as a revision.

### **6.5 Network Layer**

New text inserted in Commentary to identify the newly-defined Extended GFI 02.

#### **6.5.1. Extended GFI 01 Hex (Airbus)**

Title revised: “(Airbus)” added. The definition of the GFI 01 is now implementation-specific.

#### **6.5.2 Extended GFI 02 Hex (Boeing)**

New text inserted: the newly-defined Extended GFI of 02 will be used to indicate that it will be immediately followed by an implementation-specific header. This is a format unique to Boeing.

#### **6.5.3 Reserved for Extended GFI 03 Hex**

Placeholder Section title increased from GFI 02 to GFI 03.

## **ATTACHMENT 3, ORIGIN/DESTINATION CODES**

Three new assignments were made:

9 = Dialogue Service Interface (DSI), reference new Note 5

E = Cabin Packet Function

FF = Iridium Satellite Link

A reference to Note 2 was added to Code Character Q and a reference to Note 4 was added to Code Character S.

New Note 5 was added.

## **APPENDIX B, DATALINK RECORDING**

New content was inserted.

## **APPENDIX C, AIRBUS DATA LINK RECORDING EXAMPLE**

New Appendix was added.

# ARINC Standard – Errata Report

**1. Document Title**

**ARINC Specification 619-3: ACARS Protocols for Avionic End Systems**  
Published: June 25, 2009

**2. Reference**

Page Number: \_\_\_\_\_ Section Number: \_\_\_\_\_ Date of Submission: \_\_\_\_\_

**3. Error**

*(Reproduce the material in error, as it appears in the standard.)*

**4. Recommended Correction**

*(Reproduce the correction as it would appear in the corrected version of the material.)*

**5. Reason for Correction (Optional)**

*(State why the correction is necessary.)*

**6. Submitter (Optional)**

*(Name, organization, contact information, e.g., phone, email address.)*

Please return comments to fax +1 410-266-2047 or [standards@arinc.com](mailto:standards@arinc.com)

Note: Items 2-5 may be repeated for additional errata. All recommendations will be evaluated by the staff. Any substantive changes will require submission to the relevant subcommittee for incorporation into a subsequent Supplement.

**[To be completed by IA Staff ]**

**Errata Report Identifier:** \_\_\_\_\_ **Engineer Assigned:** \_\_\_\_\_

**Review Status:** \_\_\_\_\_



## ARINC IA Project Initiation/Modification (APIM)

- 1.0 Name of Proposed Project** **APIM #:** \_\_\_\_\_  
*(Insert name of proposed project.)*
- 2.0 Subcommittee Assignment and Project Support**
- 2.1 Identify AEEC Group  
*(Identify an existing or new AEEC group.)*
- 2.2 Support for the activity  
Airlines: *(Identify each company by name.)*  
Airframe Manufacturers:  
Suppliers:  
Others:
- 2.3 Commitment for resources *(Identify each company by name.)*  
Airlines:  
Airframe Manufacturers:  
Suppliers:  
Others:
- 2.4 Chairman: *(Recommended name of Chairman.)*
- 2.5 Recommended Coordination with other groups  
*(List other AEEC subcommittees or other groups.)*
- 3.0 Project Scope** *(why and when standard is needed)*
- 3.1 Description  
*(Insert description of the scope of the project. Use the following symbol to check yes or no below. ☒)*
- 3.2 Planned usage of the envisioned specification
- New aircraft developments planned to use this specification      yes ☐ no ☐
- Airbus:                      *(aircraft & date)*
- Boeing:                      *(aircraft & date)*
- Other:                      *(manufacturer, aircraft & date)*
- Modification/retrofit requirement      yes ☐ no ☐
- Specify:                      *(aircraft & date)*
- Needed for airframe manufacturer or airline project      yes ☐ no ☐
- Specify:                      *(aircraft & date)*

Mandate/regulatory requirement yes ☐ no ☐

Program and date: *(program & date)*

Is the activity defining/changing an infrastructure standard? yes ☐ no ☐

Specify *(e.g., ARINC 429)*

When is the ARINC standard required?  
*(month/year)*

What is driving this date? *(state reason)*

Are 18 months (min) available for standardization work? yes ☐ no ☐

If NO please specify solution: \_\_\_\_\_

Are Patent(s) involved? yes ☐

If YES please describe, identify patent holder: \_\_\_\_\_

### 3.3 Issues to be worked

*(Describe the major issues to be addressed.)*

## 4.0 Benefits

### 4.1 Basic benefits

Operational enhancements yes ☐ no ☐

For equipment standards:

a. Is this a hardware characteristic? yes ☐ no ☐

b. Is this a softwareware characteristic? yes ☐ no ☐

c. Interchangeable interface definition? yes ☐ no ☐

d. Interchangeable function definition? yes ☐ no ☐

If not fully interchangeable, please explain: \_\_\_\_\_

Is this a software interface and protocol standard? yes ☐ no ☐

Specify: \_\_\_\_\_

Product offered by more than one supplier yes ☐ no ☐

Identify: *(company name)*

### 4.2 Specific project benefits

*(Describe overall project benefits.)*

#### 4.2.1 Benefits for Airlines

*(Describe any benefits unique to the airline point of view.)*

#### 4.2.2 Benefits for Airframe Manufacturers

*(Describe any benefits unique to the airframe manufacturer's point of view.)*

#### 4.2.3 Benefits for Avionics Equipment Suppliers

*(Describe any benefit unique to the equipment supplier's point of view.)*

## 5.0 Documents to be Produced and Date of Expected Result

### 5.1 Meetings and Expected Document Completion

The following table identifies the number of meetings and proposed meeting days needed to produce the documents described above.

| Activity          | Mtgs        | Mtg-Days<br>(Total) | Expected Start<br>Date | Expected<br>Completion Date |
|-------------------|-------------|---------------------|------------------------|-----------------------------|
| <i>Document a</i> | # of mtgs   | # of mtg days       | mm/yyyy                | mm/yyyy                     |
|                   | # of mtgs * | # of mtg days *     |                        |                             |
|                   |             |                     |                        |                             |
| <i>Document b</i> | # of mtgs   | # of mtg days       | mm/yyyy                | mm/yyyy                     |
|                   | # of mtgs * | # of mtg days *     |                        |                             |

\* Indicate unsupported meetings and meeting days, i.e., technical working group or other ad hoc meetings that do not requiring IA staff support.

## 6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

### ***For IA Staff use***

Date Received: \_\_\_\_\_

IA Staff Assigned: \_\_\_\_\_

Estimated Cost: \_\_\_\_\_

Potential impact: \_\_\_\_\_

(**A.** Safety      **B.** Regulatory      **C.** New aircraft/system      **D.** Other)

Forward to committee(s) (AEEC, AMC, FSEMC): \_\_\_\_\_ Date Forwarded: \_\_\_\_\_

Committee resolution: \_\_\_\_\_

(**0** Withdrawn    **1** Authorized    **2** Deferred    **3** More detail needed    **4** Rejected)

Assigned Priority: \_\_\_\_\_ Date of Resolution: \_\_\_\_\_

(**A** High - execute first      **B** Normal - may be deferred.)

Assigned to SC/WG: \_\_\_\_\_

