ARINC

ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

ARINC SPECIFICATION 619-4

PUBLISHED: August 15, 2014

Prepared by AEEC
Published by
SAE-ITC
16701 Melford Blvd., Suite 120, Bowie, Maryland 20715 USA

DISCLAIMER

THIS DOCUMENT IS BASED ON MATERIAL SUBMITTED BY VARIOUS PARTICIPANTS DURING THE DRAFTING PROCESS. NEITHER AEEC, AMC, FSEMC NOR SAE-ITC HAS MADE ANY DETERMINATION WHETHER THESE MATERIALS COULD BE SUBJECT TO VALID CLAIMS OF PATENT, COPYRIGHT OR OTHER PROPRIETARY RIGHTS BY THIRD PARTIES, AND NO REPRESENTATION OR WARRANTY, EXPRESS OR IMPLIED, IS MADE IN THIS REGARD.

ARINC INDUSTRY ACTIVITIES USES REASONABLE EFFORTS TO DEVELOP AND MAINTAIN THESE DOCUMENTS. HOWEVER, NO CERTIFICATION OR WARRANTY IS MADE AS TO THE TECHNICAL ACCURACY OR SUFFICIENCY OF THE DOCUMENTS, THE ADEQUACY, MERCHANTABILITY, FITNESS FOR INTENDED PURPOSE OR SAFETY OF ANY PRODUCTS, COMPONENTS, OR SYSTEMS DESIGNED, TESTED, RATED, INSTALLED OR OPERATED IN ACCORDANCE WITH ANY ASPECT OF THIS DOCUMENT OR THE ABSENCE OF RISK OR HAZARD ASSOCIATED WITH SUCH PRODUCTS, COMPONENTS, OR SYSTEMS. THE USER OF THIS DOCUMENT ACKNOWLEDGES THAT IT SHALL BE SOLELY RESPONSIBLE FOR ANY LOSS, CLAIM OR DAMAGE THAT IT MAY INCUR IN CONNECTION WITH ITS USE OF OR RELIANCE ON THIS DOCUMENT, AND SHALL HOLD SAE-ITC, AEEC, AMC, FSEMC AND ANY PARTY THAT PARTICIPATED IN THE DRAFTING OF THE DOCUMENT HARMLESS AGAINST ANY CLAIM ARISING FROM ITS USE OF THE STANDARD.

THE USE IN THIS DOCUMENT OF ANY TERM, SUCH AS SHALL OR MUST, IS NOT INTENDED TO AFFECT THE STATUS OF THIS DOCUMENT AS A VOLUNTARY STANDARD OR IN ANY WAY TO MODIFY THE ABOVE DISCLAIMER. NOTHING HEREIN SHALL BE DEEMED TO REQUIRE ANY PROVIDER OF EQUIPMENT TO INCORPORATE ANY ELEMENT OF THIS STANDARD IN ITS PRODUCT. HOWEVER, VENDORS WHICH REPRESENT THAT THEIR PRODUCTS ARE COMPLIANT WITH THIS STANDARD SHALL BE DEEMED ALSO TO HAVE REPRESENTED THAT THEIR PRODUCTS CONTAIN OR CONFORM TO THE FEATURES THAT ARE DESCRIBED AS MUST OR SHALL IN THE STANDARD.

ANY USE OF OR RELIANCE ON THIS DOCUMENT SHALL CONSTITUTE AN ACCEPTANCE THEREOF “AS IS” AND BE SUBJECT TO THIS DISCLAIMER.

ARINC SPECIFICATION 619-4

ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

Published: August 15, 2014

Prepared by the Airlines Electronic Engineering Committee (AEEC)
Adopted by the AEEC Executive Committee

	Adoption Date	Published Date
Specification 619	October 19, 1993	December 31, 1993
Supplements to this ARINC Standard		
Specification 619-1	October 22, 1996	January 27, 1997
Specification 619-2	October 26, 2004	March 11, 2005
Specification 619-3	September 21, 2008	June 25, 2009
Specification 619-4	April 15, 2014	August 15, 2014

A summary of the changes introduced by each supplement is included at the end of this document.

FOREWORD

SAE-ITC, the AEEC, and ARINC Standards

ARINC Industry Activities, an industry program of SAE-ITC, organizes aviation industry committees and participates in related industry activities that benefit aviation at large by providing technical leadership and guidance. These activities directly support aviation industry goals: promote safety, efficiency, regularity, and cost-effectiveness in aircraft operations.

ARINC Industry Activities organizes and provides the secretariat for international aviation organizations (AEEC, AMC, FSEMC) which coordinate the work of aviation industry technical professionals and lead the development of technical standards for airborne electronic equipment, aircraft maintenance equipment and practices, and flight simulator equipment used in commercial, military, and business aviation. The AEEC, AMC, and FSEMC develop consensus-based, voluntary standards that are published by SAE-ITC and are known as ARINC Standards. The use of ARINC Standards results in substantial technical and economic benefit to the aviation industry.

There are three classes of ARINC Standards:

a) ARINC Characteristics – Define the form, fit, function, and interfaces of avionics and other airline electronic equipment. ARINC Characteristics indicate to prospective manufacturers of airline electronic equipment the considered and coordinated opinion of the airline technical community concerning the requisites of new equipment including standardized physical and electrical characteristics to foster interchangeability and competition.

b) ARINC Specifications – Are principally used to define either the physical packaging or mounting of avionics equipment, data communication standards, or a high-level computer language.

c) ARINC Reports – Provide guidelines or general information found by the airlines to be good practices, often related to avionics maintenance and support.

The release of an ARINC Standard does not obligate any organization or SAE-ITC to purchase equipment so described, nor does it establish or indicate recognition or the existence of an operational requirement for such equipment, nor does it constitute endorsement of any manufacturer’s product designed or built to meet the ARINC Standard.

In order to facilitate the continuous product improvement of this ARINC Standard, two items are included in the back of this volume:

An Errata Report solicits any corrections to existing text or diagrams that may be included in a future Supplement to this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any proposals for the addition of technical material to this ARINC Standard.

TABLE OF CONTENTS

ATTACHMENTS

APPENDICES

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 Characteristic 724B and Communications Management Unit (CMU) defined in ARINC Characteristic 758, 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 Characteristic 597, adopted in 1978, and ARINC Characteristic 724, adopted in 1979, have been superseded by ARINC Characteristic 724B and ARINC Characteristic 758. Consequently, their status has been downgraded from Active to Legacy.

1.2 Organization of this Document

This section outlines the organization of the document; it provides the document purpose and overview.

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

Section 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, Aircraft Condition Monitoring System (ACMS), Central Maintenance Computer (CMC), cabin terminal and Flight Management Computer (FMC).

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

Section 5 of this specification defines the bit-oriented ARINC 429 protocol required to interface with avionic units, such as ACMS, CMC, cabin terminals, and FMC. The ARINC 429 bit-oriented, file transfer protocol is included by reference. Section 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 (BOP).

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

Section 6 of this specification defines the protocol intended to accommodate data transfer between the ACARS CMU/MU and the Cockpit Voice Recorder (CVR) including physical layer, link layer, and network layer definitions.

1.0 INTRODUCTION

1.3 LRU Interface Definitions

The ACARS **CMU/**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 (e.g., 597, 724, 724B and 758).

The FMC **is an onboard system that typically acts as an end system, sending and receiving ACARS messages via the CMU/MU**. The physical connections for this interface are identified in ARINC Characteristic 702.

The ACMS **is another onboard system that may act as an end system, sending and receiving ACARS messages via the CMU/MU**. The physical connections for this interface are identified in ARINC Characteristic 717.

The CVR receives and records datalink message traffic and events from the CMU, for use in accident investigation. The physical connections for this interface are identified in ARINC Characteristic 757.

1.4 Protocol Application

The protocols for transferring data between Line Replacement Units (LRU) have evolved over the years. The OAT protocol, which was originally documented in ARINC Characteristic 597 and is now defined in Section 2, was the original protocol. The OAT protocol was superseded by variations of the ARINC 429 Digital Transfer Information System (DITS) protocol. The protocols defined in ARINC Characteristics 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 Section 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 Part 1 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, ARINC Characteristics 724 or 724B as defined in Section 3, should be used.

1.5 Referenced Documents

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

ARINC Specification 429: *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 Specification 622: *ATS Data Link Applications over ACARS Air-Ground Network*

ARINC Specification 623: *Character-Oriented Air Traffic Service (ATS) Applications*

ARINC Characteristic 702A: *Advanced Flight Management Computer Systems*

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

ARINC Characteristic 724: *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 744A: *Full-Format Printer with Graphics Capability*

ARINC Characteristic 757: ***Cockpit Voice Recorder (CVR)***

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 Sections 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 section 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 Part 1 (through Supplement 11).

COMMENTARY

Provisions for character-based file transfer were supported by ARINC Specification 429 Part 1 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, Character Protocol General Characteristics and Section 3.4, Character File Transfer Communications Protocol, of this specification define the character-oriented ARINC 429 protocols. Section 3.6, Translation of Uplink Message Text to ARINC 429 Character File Transfer Format, 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, Downlinks, describes the converse, preparing an ARINC 429 character-oriented file transfer input into a form compatible with an ACARS downlink. See Sections 3.5, ACARS Character Protocol Message Routing, and 3.7, Routing Messages Received From End Systems, for routing and Section 3.9, Documentary Data Function, 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 Characteristic 724 may be upgraded with new avionics (including an ARINC 724B MU). Sometimes portions of the wiring are modified per ARINC Characteristic 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 configured to take advantage of this facility within the MU to avoid additional wiring.

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.

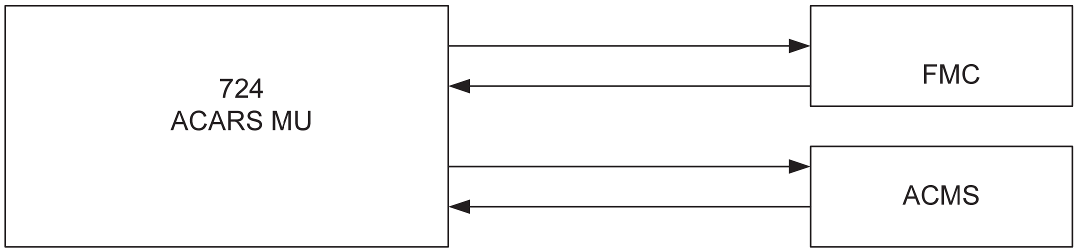

Figure 3.2.1-1 – Example of ARINC 724 Architecture

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.

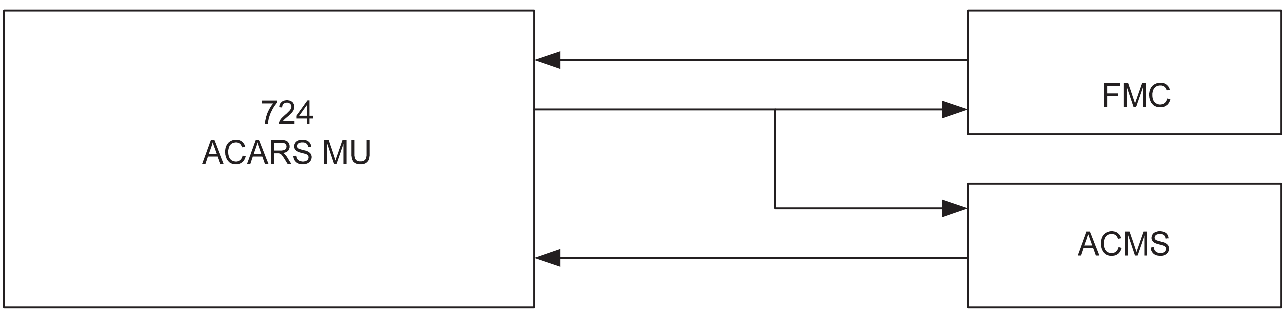

Figure 3.2.2-1 – Example of ARINC 724B Architecture

3.2.3 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 **ARINC Specification 429-11:** *Digital Information Transfer System (DITS)*. The protocol documented in this specification describes older existing systems and is not recommended for new systems. Refer to Commentary in Section 3.1.

3.3.1 Coding

Messages should be coded per the ISO #5 Alphabet 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.

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 #5 Alphabet 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 #5 Alphabet 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 may 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 an End of Block (ETB) or End of Text (ETX) word. The total text handling capability will thus be 226 characters including all headers and a ETB/ETX character.

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 should 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 Very High Frequency (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.

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 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, ARINC 429 Label 357 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 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 are 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 the interaction possibilities described in the following subsections are provided in Attachment 10.

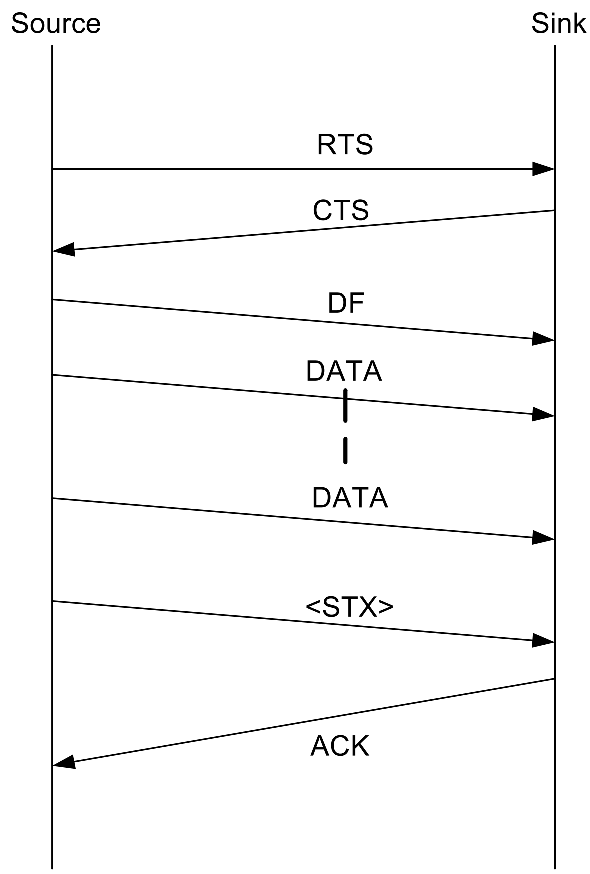

Figure 3.4-1 – Typical Character Protocol Block Transfer

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.

A sink will ignore any file transfer words received that are not preceded by a valid Request to Send (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.

3.4.2.1 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.

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 Minimum Shift Keying (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 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.

3.4.8 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:

1. Transmit a NAK word and discard the block
2. Discard the word containing the parity error or not include it in the word count

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

1. Compare the number of words actually received with the word count transmitted in the DF word
2. Generate either an ACK or NAK response, if a NAK has not already 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.

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:

- Unit separator is not the value 1F (Hex)
- Origin code not valid for originator
- Destination code not valid
- The Block Sequence Character is less than 40 (Hex)

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. 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

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

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

Name	**T3, ACK/NAK Response Timer**
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 ACARS Character Protocol 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 ACARS 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.

Table 3.5.1-1 – ACARS 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, ACARS Character Protocol

When the ACARS MU receives uplinks which should be delivered to an end system using the **ACARS** Character-oriented 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.

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

Sub-label	Destination Code	End System
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

Notes:

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.
2. This value will be the Destination code for current Master Satellite Data Unit (SDU) (Q or R).
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.
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 Sign/Status Matrix (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.
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 1 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.

3.5.2.2.2 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 Radio Frequency (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.

3.6.1.2 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.

3.7.1 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:

- Use the VHF link if available
- If the VHF link is not available, then use the satcom link if it is available
- 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, Ground Acknowledgement.

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.

3.8.1.1.1 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.

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

Data Follows word	Control/Accountability Header	Optional Header	206 Data 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:

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

There may be other solutions also. It is determined by 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.

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.

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 section 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, Section 4.5.8 of ARINC Characteristic 724, and Section 4.5.2.2 of ARINC Characteristic 724B. Information regarding the physical characteristics of the printer can be found in Section 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 an 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

4.2.1.1 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 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 Start of Text (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 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 Block Check Sequence (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 Start of Header (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.

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.

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:

- Print the partial message received thus far
- 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 Link Data Units (LDU) (see Section 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 section 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 Open System Interconnection (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:** *Digital Information Transfer System (DITS), Part 1, Functional Description, Electrical Interfaces, Label Assignments and Word Formats.* 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 the low-speed rate 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.

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 Link Data Units (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 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 Characteristic 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.

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
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 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.

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 0, 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, Central Fault Display Interface Unit (CFDIU)/CMC, Digital Flight Data

Acquisition Unit (DFDAU)/Aircraft Condition Monitoring System (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 #5 Alphabet 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 #5 Alphabet characters identified in ARINC Specification 618 are transmitted across the air-ground data link. The ISO #5 character sets are reproduced in 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 #5 Alphabet 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 may 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 sub-label, 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.

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 sub-label 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 sub-label 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 sub-label.

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 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 0, 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 LDUs 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 End of Transmission (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 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.

5.5.1.4.1.4 Destination Code

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 0, 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 0, 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.

5.5.1.4.1.8 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 Sub-label fields to the beginning of the Text field of each ACARS block.

The Sub-label field is a four character field composed of the pound sign <#>, the two character Sub-label, and the character B. The Sub-label code indicates the origin of the message. Appendix C of ARINC Specification 620 contains the sub-labels assigned to the various end systems. The MD Sub-label 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.

5.5.1.5 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 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.

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.

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 section is intended to accommodate data transfer between the ACARS CMU and the Cockpit Voice Recorder (CVR). The CMU-CVR interface is used to stream data to the CVR for recording as described in ARINC Characteristic 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 datalink 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 Specification 429, as well as the ability to default to version 3, if no Aloha (ALO) word is received from the CMU.

6.2 Physical Medium

The physical interface is described in **ARINC Specification 429:** *Digital Information Transfer System (DITS) Part 1 – Functional Description, Electrical Interfaces, 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 Specification 429 Part 1, to send data to the recorder. Some devices will use high-speed, as defined in ARINC Specification 429 Part 1, 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 Specification 429 Part 1.

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 (BOP) defined in ARINC Specification 429 Part 3. The recorder uses a modified procedure for protocol determination from the protocol described in ARINC Specification 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 Aloha (ALO)/Aloha Response (ALR).

If an LRU wants to use Williamsburg Version 1, then the LRU should initiate an ALO/ALR message 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.

ARINC Specification 429 Part 3 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 Specification 429:** *Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques*, Section 3, Bit-Oriented Media Access Control (MAC) Protocol.

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 Specification 429, Part 3, Attachment 10, Variables of Bit-Oriented Protocol, Table 10-3b, Bit-Oriented Protocol Options Version 3, for a Williamsburg Version 3 implementation) is shown in Table 6.4.1-1, Bit-Oriented Protocol Options Version 3.

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

ARINC 429 Option	Value
O_1	Half duplex
O_2	Note 1
O_3-O_7	N/A per ARINC 429
O_8	No
O_9-O_{10}	N/A per ARINC 429
O_{11}	No verification
O_{12}	No
O_{13}	Command frames only
O_{14}	No pausing
O_{15}	N/A (Note 2)

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 Part 3, Section 3.4.9, Frame Check Sequence.

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:** *Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques*, Section 2.5, Bit-Oriented Communications Protocol.

The Option profile (see ARINC Specification 429, Part 3, Attachment 10, Variables of Bit-Oriented Protocol, Table 10-3a, Bit-Oriented Protocol Options for Version 1) for a Williamsburg Version 1 implementation is shown in Table 6.4.2-1, Williamsburg for Version 1 Options.

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

Table 6.4.2-1 – Williamsburg Version 1 Options

Option	Description	Default
O_1	Half or Full Duplex	Half
O_2	High or Low-Speed Bus	High
O_3	Automatic CTS When Ready	Yes
O_4	Accept Automatic CTS	Yes
O_5	System Priority to Resolve-Conflict	CMU
O_6	Reserved	--
O_7	Reserved	--
O_8	Use of SOLO Word	Yes
O_9	Reserved	--
O_{10}	Destination Code Required	Yes
O_{11}	Bit-Protocol Verification (ALO/ALR Protocol Determination)	Yes
O_{12}	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 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 (Williamsburg Protocol). 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.

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.

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 defines extended GFI 03. Section 6.5.4 would be added to define extended GFI 04, 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_h in the GFI field location indicates that an Extended GFI (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 (Proposed by Airbus)

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

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.

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.

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 0, then the source/destination field identifies the message source. If the input/output field has a value of 1, 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 0 indicates that the frame is a single frame message or is the last frame of a multi-frame message. A value of 1 indicates that there is at least one more frame in the remainder of the message. This bit is always 0 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 0.

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

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/End of Frame (EOF) word.

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

6.5.2 Extended GFI 02 Hex (Proposed by 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.

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 Extended GFI 03 Hex (Proposed by Universal Avionics Systems Corporation)

The Extended Header format uses the Williamsburg Version 3 (V3) protocol. All records are transmitted using a 3-part payload structure surrounded by the standard Williamsburg Start Of Frame (SOF) and EOF protocol words. The first payload element is the Extended GFI Header, the second element is the File/Message Identifier, and the third element of the structure is the Event Record data.

The format of the header for extended GFI of 03h is shown in Table 6.5.3-1.

Table 6.5.3-1 – General Format of Data Records Transmitted to CVR

Element	Details
SOF	Standard Williamsburg V3 Start of Frame. This data is not expected to be recorded by the CVR.
Extended GFI Header	Extended GFI Header. This data is intended to be recorded by the CVR as the start of the record.
File/Message Identifier	Provides a unique message identifier that can be used to track a file/message thread over time.
Event Record	This contains, among other things, the actual file/message data (or graphic file information) transferred between LRUs and is the last part of data intended to be recorded by the CVR.
EOF	Standard Williamsburg V3 End of Frame. This data is not expected to be recorded by the CVR.

6.5.3.1 Extended GFI 03h Header Format

The Extended GFI Header immediately follows the Williamsburg SOF. The Extended GFI Header is composed of five data elements totaling eight bytes of data. The Extended GFI Header is included in every frame transmitted to the CVR. The term frame pertains to the Williamsburg V3 data transfer protocol.

The format of the header for extended GFI of 03h is shown in Table 6.5.3.1-1.

Table 6.5.3.1-1 – Format of Extended GFI Header

Start of Data (Byte)	Size (Bytes)	Element
1	1	EGFI
2	1	EGFI Version Number
3	1	Frame Sequence Number
4	1	Final Frame Indicator
5	4	Time of Event

6.5.3.1.1 Extended GFI

The Extended GFI (EGFI) uniquely identifies the structure from other documented formats. This format uses an EGFI of 03h.

6.5.3.1.2 Version Number

The Version Number identifies the specific version of the data element definitions. The Version Number is expected to be incremented each time the data definitions are modified from a previously documented definition. This format uses an EGFI Version Number of 01h.

6.5.3.1.3 Frame Sequence Number

The Frame Sequence Number provides a means to determine if a Williamsburg frame is missing or otherwise corrupted in the recorder memory. The Frame Sequence Number is incremented from 0 to 255 for each Williamsburg frame transmitted to the recorder. The Frame Sequence Number of the first frame of data transmitted to the recorder since initialization is set to 0. Within a single power cycle, the Frame Sequence Number value rolls over from 255 to 1.

6.5.3.1.4 Final Frame Indication

The Final Frame Indication provides information as to whether the current Williamsburg frame is the end of a record or if additional, succeeding frames are required to reconstruct the complete record.

The Final Frame Indication codes are shown in Table 6.5.3.1.4-1.

Table 6.5.3.1.4-1 – Final Frame Indication Codes

Frame Code (ASCII)	Description
A	Additional frame(s) required
F	Final frame of record

6.5.3.1.5 Time of Event

The Time of Event identifies the date/time of the event being recorded. If multiple Williamsburg frames are required to transmit the entire record, the Time of Event remains the same as all frames pertain to a single event.

The Time of Event within the Extended GFI Header is set to the date/time at of the time of the event that triggered the transmission of a record to the recorder. The Time of Event is defined as the number of seconds that have elapsed since midnight on 1 January 2001 as shown in Table 6.5.3.1.5-1. Byte 5 is the most significant byte; byte 8 is the least significant byte.

Table 6.5.3.1.5-1 – Format of Time of Event/Time of Initiation

Byte Order of Time of Event within Extended GFI Header				Resulting Date/Time of Event
5 (MSB) (hex)	6 (hex)	7 (hex)	8 (LSB) (hex)	
00	00	00	01	1 Jan 2001 at 00:00:01
00	00	0E	10	1 Jan 2001 at 01:00:00
00	01	5F	90	2 Jan 2001 at 01:00:00
01	E2	85	00	2 Jan 2002 at 00:00:00

COMMENTARY

The Time Stamp defined within Section 6.5.1.1.3 initiates from 1 January 2000. The Time of Event field initiated from 1 January 2001.

6.5.3.2 File/Message Identifier

The File/Message Identifier immediately follows the Extended GFI Header. The File/Message Identifier is composed of two data elements totaling five bytes of data. The File/Message Identifier is included in every frame transmitted to the recorder.

The format of the File/Message Identifier is shown in Table 6.5.3.2-1.

Table 6.5.3.2-1 – Format of File/Message Identifier

Octet No.	Octet Content
1-4	Time of Initiation
5	Event Index Number

The File/Message Identifier acts as a unique identifier that can be used to associate records to create a history timeline for a file/message. For example, for an uplink, the File/Message Identifier is initially assigned within the record that corresponds to the receipt of the uplink from the media device. The same File/Message Identifier is used within the record that corresponds to the display of the uplink on a display device. This allows the two independent events to be easily associated.

6.5.3.2.1 Time of Initiation

The Time of Initiation is formatted as described in Section 6.5.3.1.5. Unlike the Time of Event contained within the Extended GFI Header, which lists the date/time of the specific event that triggered the transmission of the record, the Time of Initiation is used in conjunction with the Event Index Number to provide a unique identifier for a message or file.

Byte 1 is the most significant byte; byte 4 is the least significant byte.

6.5.3.2.2 Event Index Number

When multiple recording event triggers occur within the same second, the Event Index Number ensures a unique record designation when used in conjunction with the Time of Initiation.

The Event Index Number is sequentially incremented, from 0 to 255 each time an initiating event occurs, such as a new uplink is received, or a downlink is queued. The Event Index Number of the first event trigger since initialization is set to 0.

For all other records, the File/Message Identifier is set to the same value as the record of the initiating event.

COMMENTARY

The determination of initiating events is a local matter for the equipment manufacturer of the device(s) creating records.

6.5.3.3 Event Record

The Event Record immediately follows the File/Message Identifier. The Event Record is composed of five data elements. The Extended GFI Header is included in every frame transmitted to the CVR.

The format of the Event Record is shown in Table 6.5.3.3-1

Table 6.5.3.3-1 – Format of Event Record

Octet No.	Octet Content
1	File/Message Type
2	File/Message Status
3	Device Code
4-7	Additional Details
8-Variable	File/Message Contents

6.5.3.3.1 File/Message Type

The File/Message Type provides a general indication of the specific contents and definitions within the record. The File/Message Type code is based on the specific event that triggered the transmission of the record to the recorder.

The data contained within the one-byte File/Message Type field is a local matter for the equipment manufacturer of the device(s) creating records. See example records in Appendix D.

6.5.3.3.2 File/Message Status

The File/Message Status provides a high-level indication of the state of a file or message over time. The File/Message Status codes are relevant to the type of file/message indicated by the File/Message Type code.

The data contained within the one-byte File/Message Status field is a local matter for the equipment manufacturer of the device(s) creating records. See example records in Appendix D.

6.5.3.3.3 Device Code

The Device Code identifies the peripheral device from which the message has been received or to which the message has been transmitted. The Device code is based on the specific event that triggered the transmission of the record.

The definition of device codes is a local matter for the equipment manufacturer of the device(s) creating records. See example records in Appendix D.

6.5.3.3.4 Additional Details

The Additional Details field provides 4 bytes intended to provide high-level message information which may be of specific interest. For example, when the CMU receives a file from the FMS, the file could either be a downlink or an on-board file transfer (such as a message to be printed).

The data contained within the four-byte Additional Details field is a local matter for the equipment manufacturer of the device(s) creating records. See example records in Appendix D.

6.5.3.3.5 File/Message Contents

The File/Message Contents contains the file/message contents formatted as transmitted or received by the device. The specific contents to be recorded are of variable length.

See example records in Appendix D.

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

Hex value → 04 1 ← Note
Character → EOT

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

Notes:

1. Refer to ARINC Characteristic 597 for special uses of these characters.
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 → Row ↓	0	1	2	3	4	5	6	7
0	0	0	0		00 NUL	10 DLE	20 SP	30 0	40 @	50 P	60 ’	70 p
0	0	0	1	1	01 SOH	11 DC1	21 !	31 1	41 A	51 Q	61 a	71 q
0	0	1	0	2	02 STX	12 DC2	22 "	32 2	42 B	52 R	62 b	72 r
0	0	1	1	3	03 ETX	13 DC3	23 #	33 3	43 C	53 S	63 c	73 s
0	1	0	0	4	04 EOT	14 DC4	24 $	34 4	44 D	54 T	64 d	74 t
0	1	0	0	4	05 ENQ	15 NAK	25 %	35 5	45 E	55 U	65 e	75 u
0	1	1	0	6	06 ACK	16 SYN	26 &	36 6	46 F	56 V	66 f	76 v
0	1	1	1	7	07 BEL	17 ETB	27 ’	37 7	47 G	57 W	67 g	77 w
1	0	0	0	8	08 BS	18 CAN	28 (	38 8	48 H	58 X	68 h	78 x
1	0	0	1	9	09 HT	19 EM	29)	39 9	49 I	59 Y	69 i	79 y
1	0	1	0	10	0A LF	1A SUB	2A *	3A :	4A J	5A Z	6A j	7A z
1	0	1	1	11	0B VT	1B ESC	2B +	3B ;	4B K	5B [	6B k	7B {
1	1	0	0	12	0C FF	1C FS	2C ,	3C <	4C L	5C \	6C l	7C ¦
1	1	0	1	13	0D CR	1D GS	2D -	3D =	4D M	5D]	6D m	7D }
1	1	1	0	14	0E SO	1E RS	2E 1 .	3E >	4E N	5E ^	6E n	7E ~
1	1	1	1	15	0F SI	1F US	2F /	3F ?	4F O	5F _	6F o	7F DEL

Hex value → 04 1 ← Note
Character → EOT

(shaded) Characters not recommended in “Free Text” portion Uplink or Downlink messages

Notes:

1. Refer to ARINC Characteristic 597 for special uses of these characters.
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 Block
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 LOGIC

Table 2-1 – Master FMC Selection Logic

FMC1 Status	FMC2 Status	Discrete Status	Master FMC
inactive status word	inactive status word	Open	FMC1
inactive status word	inactive status word	Ground	FMC2
bit 17 = 1	inactive status word	don't care	FMC1
bit 17 = 0	inactive status word	don't care	default to FMC1 abnormal condition
inactive status word	bit 17 = 1	don't care	FMC2
inactive status word	bit 17 = 0	don't care	default to FMC2 abnormal 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 FMC1 abnormal condition
bit 17 = 0	bit 17 = 0	don't care	default to FMC1 abnormal 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

<table>
<tr><th>32</th><th>31</th><th>30</th><th>2 2 2 2 2 2 2 2 2 2 2 1 1
9 8 7 6 5 4 3 2 1 0 9 8</th><th>17</th><th>1 1 1 1 1 1 1 0
6 5 4 3 2 1 0 9</th><th>8 7 6 5 4 3 2 1</th></tr>
<tr><td>P</td><td colspan="2">SSM</td><td>STATUS DATA</td><td>MASTER/
SLAVE</td><td>SOURCE SAL</td><td>LABEL</td></tr>
</table>

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

Notes:

1. SSM Coding

<table>
<tr><th colspan="2">BIT</th><th rowspan="2">STATUS</th><th rowspan="2">COMMENT</th></tr>
<tr><th>31</th><th>30</th></tr>
<tr><td>0</td><td>0</td><td>Normal Operation</td><td>Necessary for Master/Slave determination in Bit 17</td></tr>
<tr><td>0</td><td>1</td><td>No Computed Data</td><td></td></tr>
<tr><td>1</td><td>0</td><td>Functional Test</td><td></td></tr>
<tr><td>1</td><td>1</td><td>Failure</td><td></td></tr>
</table>

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	
Dialogue Service Interface (DSI)	9	5
FMC, Left Side (1)	A	
FMC, Right Side (2)	B	
Control/Display Unit	C	
DFDAU	D	
Cabin Packet Function	E	
CFDIU	F	
Ground Station	G	
HF Link	H	3
EICAS/ECAM/EFIS	I	
ATSU (for ATS Messages)	J	
Keyboard/Display	K	
TCAS/Traffic Computer	**L**	
ACARS Management Unit (MU or CMU 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	2
Satellite Data Unit, Right Side (SDU 2)	R	2
Satellite Link	S	2, 4
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
Iridium Satellite Link	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
		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
		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> ------------------------------ P 0 0 0 0 0 1 0	Optional Header Flag = 1 ------------------------------ 0 0 0 0 0 0 0 1	Block Word Count = 13 ------------------------------ 0 0 0 0 1 1 0 1	System Address Label (357) ------------------------------ 1 1 1 1 0 1 1 1
Purpose/Nature VHF Downlink = W ------------------------------ P 1 0 1 0 1 1 1	Origin Code Left FMC = A ------------------------------ X 1 0 0 0 0 0 1	<US> ------------------------------ X 0 0 1 1 1 1 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
Downlink Message Sequence Code = F ------------------------------ P 1 0 0 0 1 1 0	Block Sequence Character = 40 Hex ------------------------------ X 1 0 0 0 0 0 0	Destination VHF Link = V ------------------------------ X 1 0 1 0 1 1 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
ONE 1 ------------------------------ P 0 1 1 0 0 0 1	ZERO 0 ------------------------------ X 0 1 1 0 0 0 0	ZERO 0 ------------------------------ X 0 1 1 0 0 0 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
Flight Number 0 ------------------------------ P 0 1 1 0 0 0 0	Flight Number A ------------------------------ X 1 0 0 0 0 0 1	Flight Number A ------------------------------ X 1 0 0 0 0 0 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
Flight Number 5 ------------------------------ P 0 1 1 0 1 0 1	Flight Number 6 ------------------------------ X 0 1 1 0 1 1 0	Flight Number 4 ------------------------------ X 0 1 1 0 1 0 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
Sub-label Character #2 1 ------------------------------ P 0 1 1 0 0 0 1	Sub-label Character #1 M ------------------------------ X 1 0 0 1 1 0 1	Poundsign # ------------------------------ X 0 1 0 0 0 1 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
PLAN P ------------------------------ P 1 0 1 0 0 0 0	FLIGHT F ------------------------------ X 1 0 0 0 1 1 0	MESSAGE TYPE A ------------------------------ X 1 0 0 0 0 0 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
COMPANY C ------------------------------ P 1 0 0 0 0 1 1	SEPARATOR / ------------------------------ X 0 1 0 1 1 1 1	REQUEST R ------------------------------ X 1 0 1 0 0 1 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
L ------------------------------ P 1 0 0 1 1 0 0	K ------------------------------ X 1 0 0 1 0 1 1	ROUTE R ------------------------------ X 1 0 1 0 0 1 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
K ------------------------------ P 1 0 0 1 0 1 1	X ------------------------------ X 1 0 1 1 0 0 0	A ------------------------------ X 1 0 0 0 0 0 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
X ------------------------------ P 1 0 1 1 0 0 0	H ------------------------------ X 1 0 0 1 0 0 0	P ------------------------------ X 1 0 1 0 0 0 0	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1
<ETX> ------------------------------ P 0 0 0 0 0 1 1	0 ------------------------------ X 0 1 1 0 0 0 0	1 ------------------------------ X 0 1 1 0 0 0 1	System Address 357 ------------------------------ 1 1 1 1 0 1 1 1

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

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

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 6
CHARACTER FILE TRANSFER MESSAGE FORMATS

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.

<STX> ------------------------------ P 0 0 0 0 0 1 0	Value = 1 ------------------------------ 0 0 0 0 0 0 0 1	Block Word Count = 5 ------------------------------ 0 0 0 0 0101	System Address Label (300) ------------------------------ 0 0 0 0 0 0 1 1
Purpose/Nature Ground ACK = K ------------------------------ P 1 0 1 0 1 1 0	Origin Code VHF Link = V ------------------------------ X 1 0 1 0 1 1 0	<US> ------------------------------ X 0 0 1 1 1 1 1	System Address 300 ------------------------------ 0 0 0 0 0 0 1 1
Message Sequence Code - Char 1= M ------------------------------ P 1 0 0 1 1 0 1	Block Sequence Character = 40 Hex ------------------------------ X 1 0 0 0 0 0 0	Destination Code Left FMC = A ------------------------------ X 1 0 0 0 0 0 1	System Address 300 ------------------------------ 0 0 0 0 0 0 1 1
Message Sequence Code - Char 4 = A ------------------------------ P 1 0 0 0 0 0 1	Message Sequence Code - Char 3 = 1 ------------------------------ X 0 1 1 0 0 0 1	Message Sequence Code - Char 2 = 0 ------------------------------ X 0 1 1 0 0 0 0	System Address 300 ------------------------------ 0 0 0 0 0 0 1 1
<NUL> ------------------------------ P 0 0 0 0 0 0 0	<NUL> ------------------------------ X 0 0 0 0 0 0 0	<ETX> ------------------------------ X 0 0 0 0 0 1 1	System Address 300 ------------------------------ 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
3	P	000	Reserved: Zero Filled		Reserved: Zero Filled		Dest. Code		Header
	P		Char #3 L S Nibble	Character #2		Character #1			
	P		XXXXXXXX		Character #4		Char #3 M S Nibble		
			•••			•••			Binary
			•••		Message	•••			Data
			•••			•••			Words
			•••			•••			
			•••			•••			
			•••			•••			
			•••			•••			
			•••		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.

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	Priority	Life Time	Media Select		Dest. Code		
	P	000	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 7-2 – 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 originiator (see Attachment 3). The File Sequence number will reflect the FSN of the Williamsburg file as it was received by the ACARS MU.

ATTACHMENT 8
FORMAT OF WILLIAMSBURG SERVICE MESSAGES

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 429W Version 1

Notes:

1. The Link layer CRC will be be computed over the shaded area 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 Intetgrators – 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		↓	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

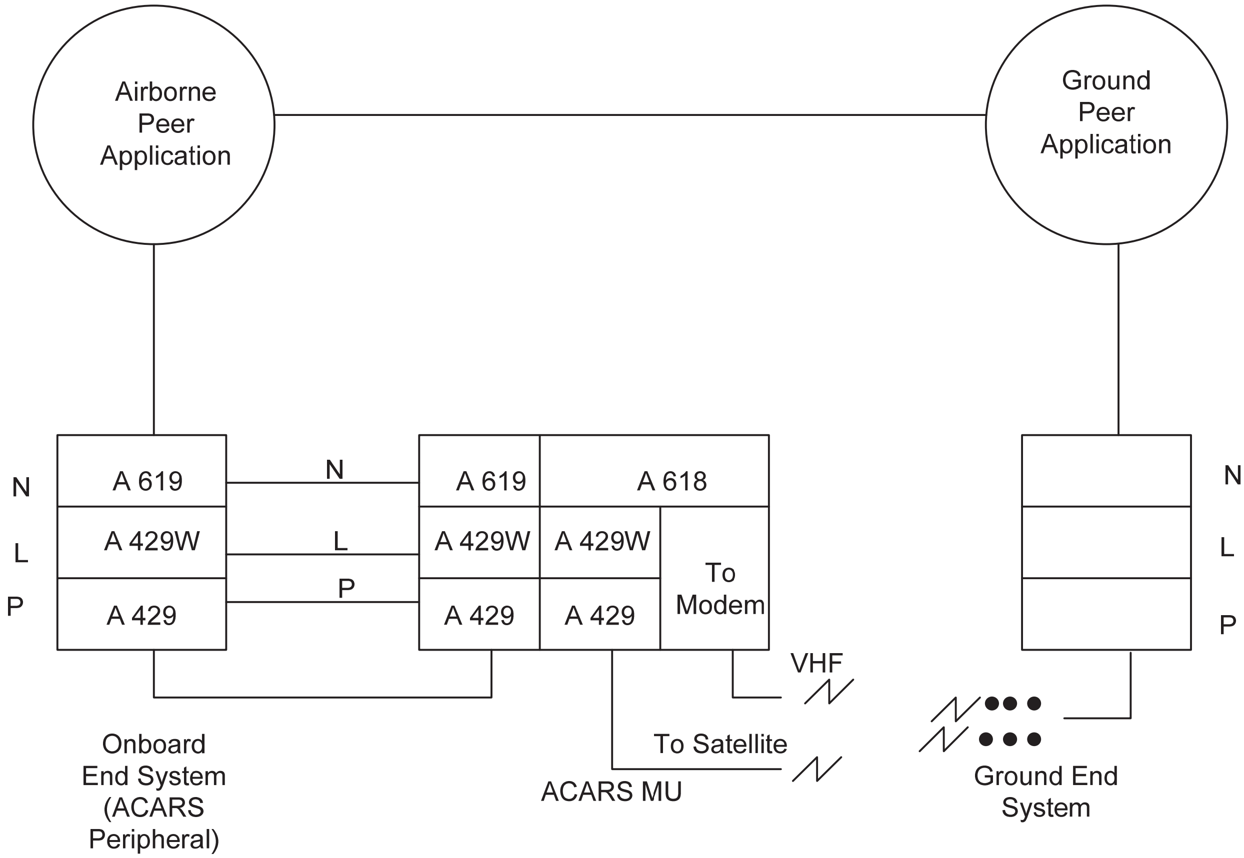

Figure 9-1 – Interaction of End Systems through an ACARS MU

ATTACHMENT 10 CHARACTER FILE TRANSFER PROTOCOL TIMING

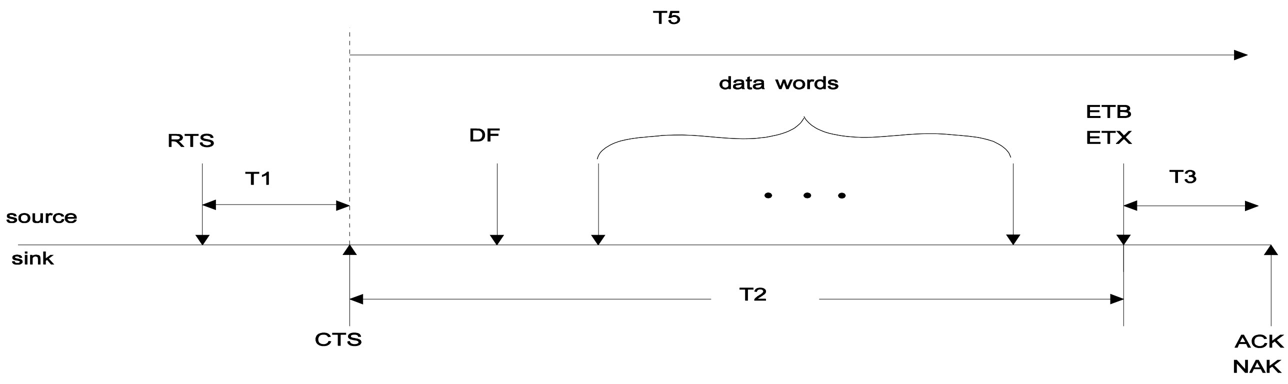

Figure 10-1 – Typical Block Transfer Timing

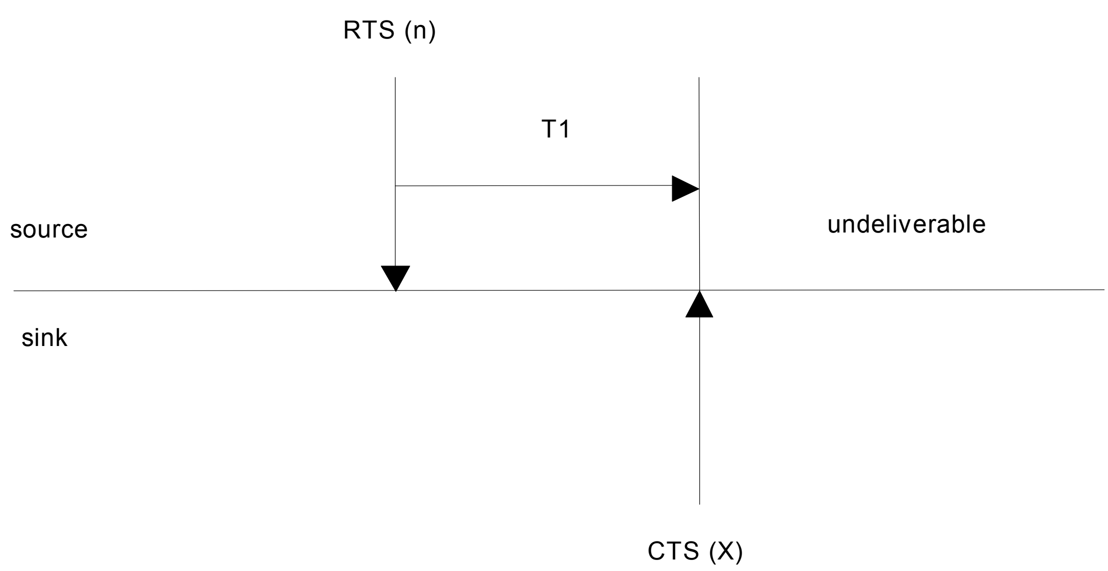

Figure 10-2 – CTS Response

ATTACHMENT 10
CHARACTER FILE TRANSFER PROTOCOL TIMING

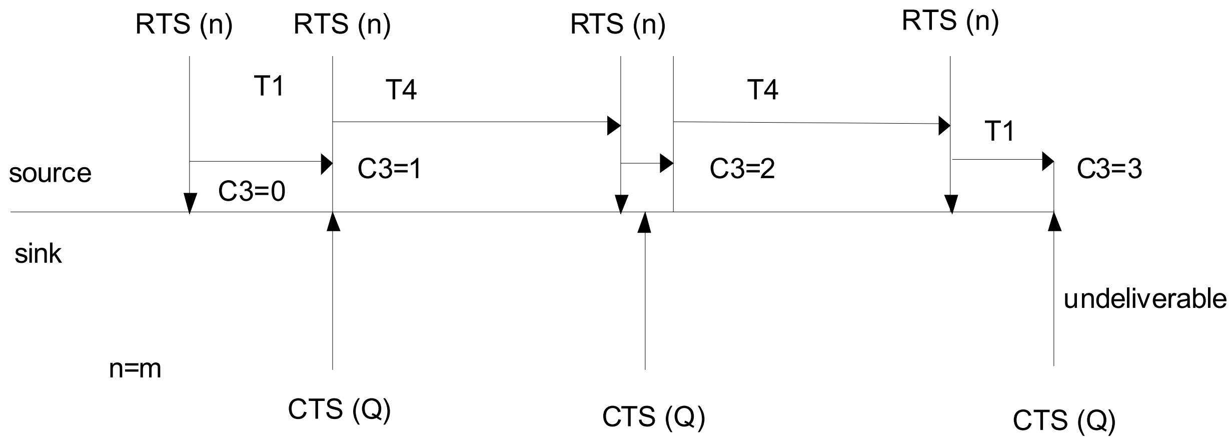

Figure 10-3 – Busy (Q) Response

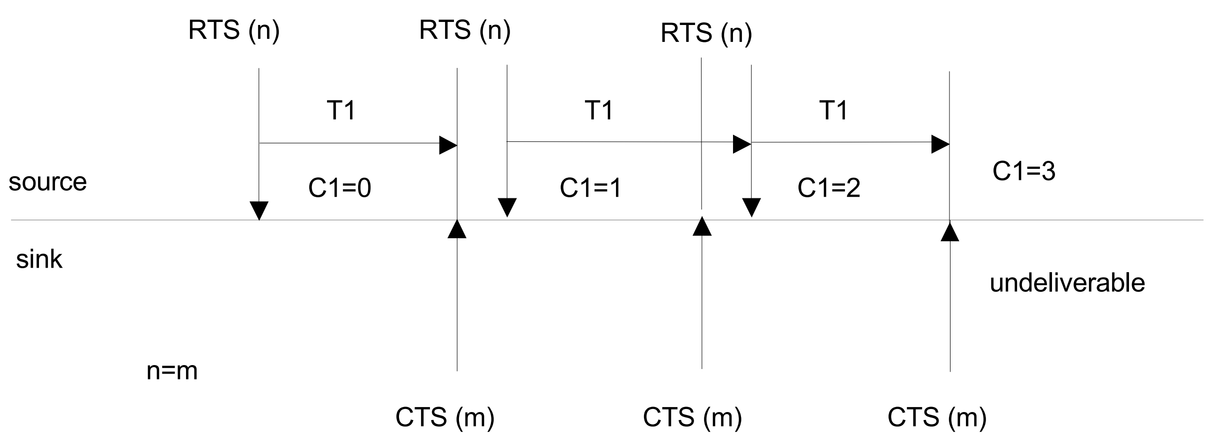

Figure 10-4 – CTS Not Matching and No Busy (Q) Response

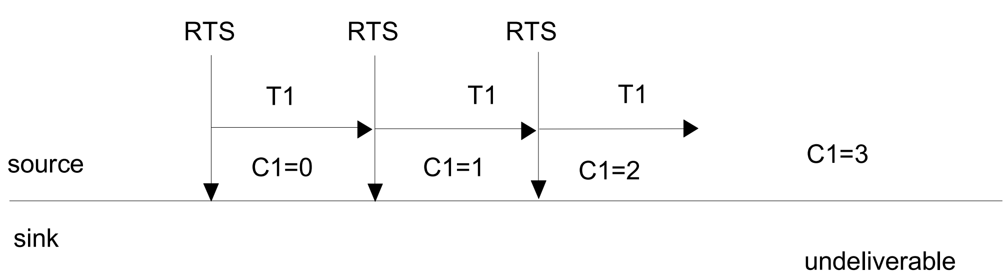

Figure 10-5 – No Response

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 (See Table 11-C)				LIFETIME (See Table 11-B)							MEDIA SELECT (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 does 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 AND MEDIA SELECTION

Table 11-1C – Priority Indexing

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

TRANSMIT PRIORITY	OCTET 5 CODING 8	7	6	5	DESCRIPTION	NOTES
1	0	0	0	1	Emergency Situation, Hijack Message (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 Flight Plan Requests Take-Off Data Weight and Balance Requests Flight Data Requests Position Reports Free Text	
6	0	1	1	0	Aeronautical Information Service Message	
7	0	1	1	1	Flight Regularity Message Airline Flight Information Aircraft Movement (OOOI/Delay/ETA) LRU Failure Report Exceedance/Problem Report	
8	1	0	0	0	Aeronautical Administrative Crew-Entered Report Free-Text Downlink BITE History 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 Cabin Supply Request Payroll Report	
13	1	1	0	1		
14	1	1	1	0	Low Priority Administrative Passenger Services	
15	1	1	1	1	(Lowest)	
User 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 AUXILLARY TERMINAL (OAT)

12.1 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.

12.2 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.

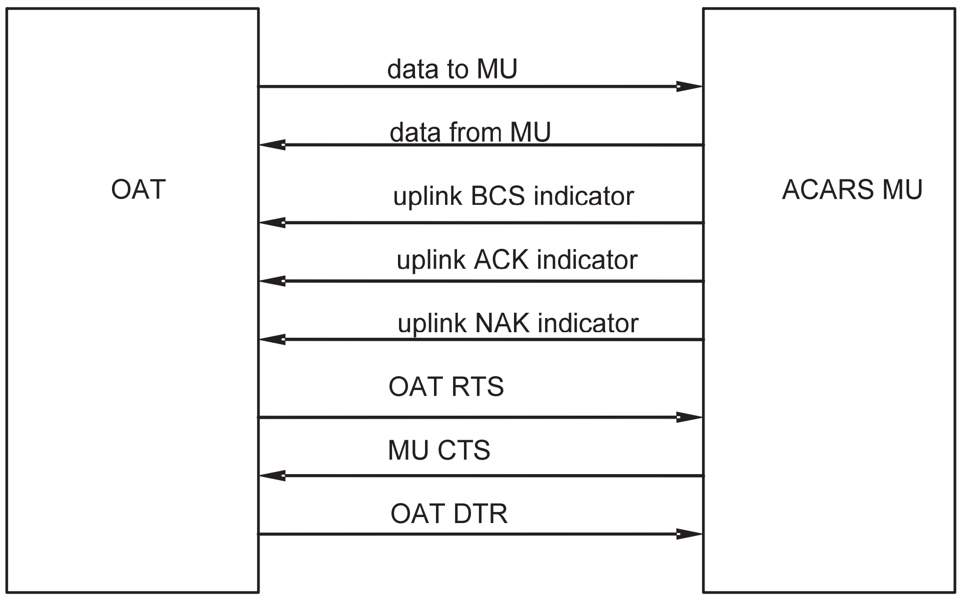

Figure 12.2-1 – OAT/ACARS Interface

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.

12.2.1 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 AUXILLARY TERMINAL (OAT)

12.2.1.1 A – Direction of Data Flow

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

12.2.1.2 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=<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.

12.2.1.3 A – Information Identifier

Does not apply.

12.2.1.4 A – Language Identifier

Does not apply.

12.2.1.5 A – Sign Status Matrix

Does not apply.

12.2.1.6 A – Data Standards

Does not apply.

12.2.1.7 C – Transmission Interconnect

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

12.2.1.8 B – Modulation

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

12.2.1.9 C – Voltage levels

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

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

12.2.1.10 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.

12.2.1.11 C – Digital Language

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

12.2.1.12 B – Transmission Order

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

12.2.1.13 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).

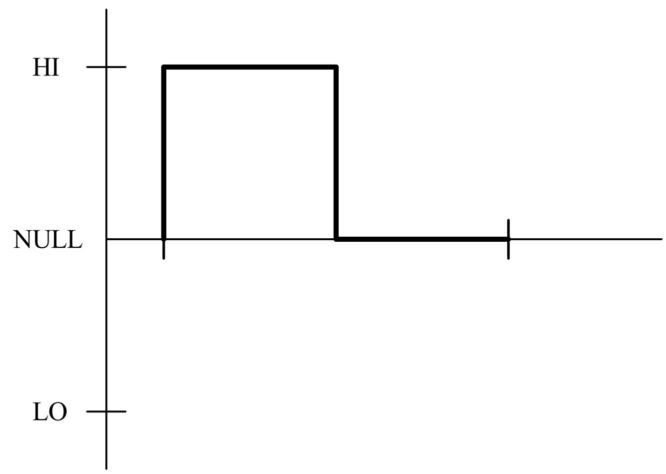

Figure 12.2.1.13-1 – Waveform for a bit with value one (1)

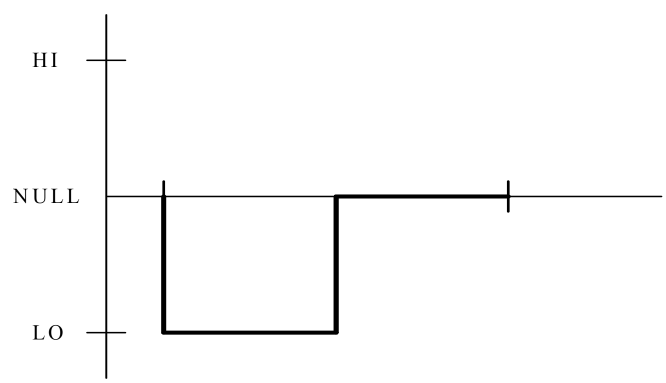

Figure 12.2.1.13-2 – Waveform for a bit with Value Zero (0)

12.2.1.14 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.

12.2.1.15 X – Bit Rate

The bit rate is 2400 bits per second.

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

12.2.1.16 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.

12.2.1.17 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 I in order to provide a clock signal for the OAT to synchronize with.

12.2.1.18 X – Timing Tolerances

The bit length is 416.7 microseconds ± 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.

12.2.2 OAT Interface Signal Definitions

12.2.2.1 ACARS Data to OAT

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

12.2.2.2 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).

12.2.2.3 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.

12.2.2.4 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.

12.2.2.5 Uplink NAK Indicator Discrete Output

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

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

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.

12.2.2.6 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.

12.2.2.7 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.

12.2.2.8 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.

12.3 OAT Link Layer Protocol

See Section 12.4 for the File format.

12.3.1 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.

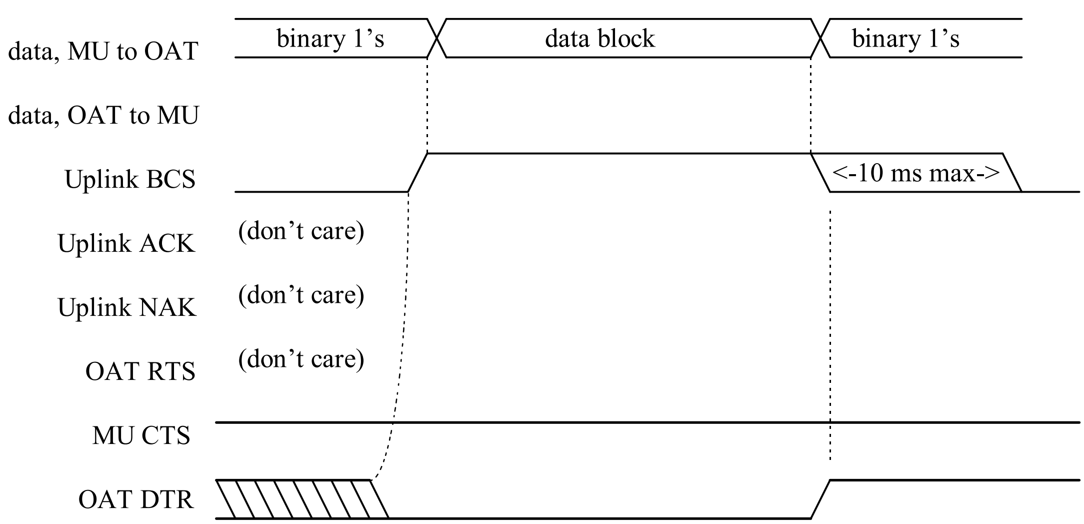

Figure 12.3.1-1 – Normal MU to OAT Timing

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

If the DTR signal is ground, then the MU will respond to an uplink to the OAT with an 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.

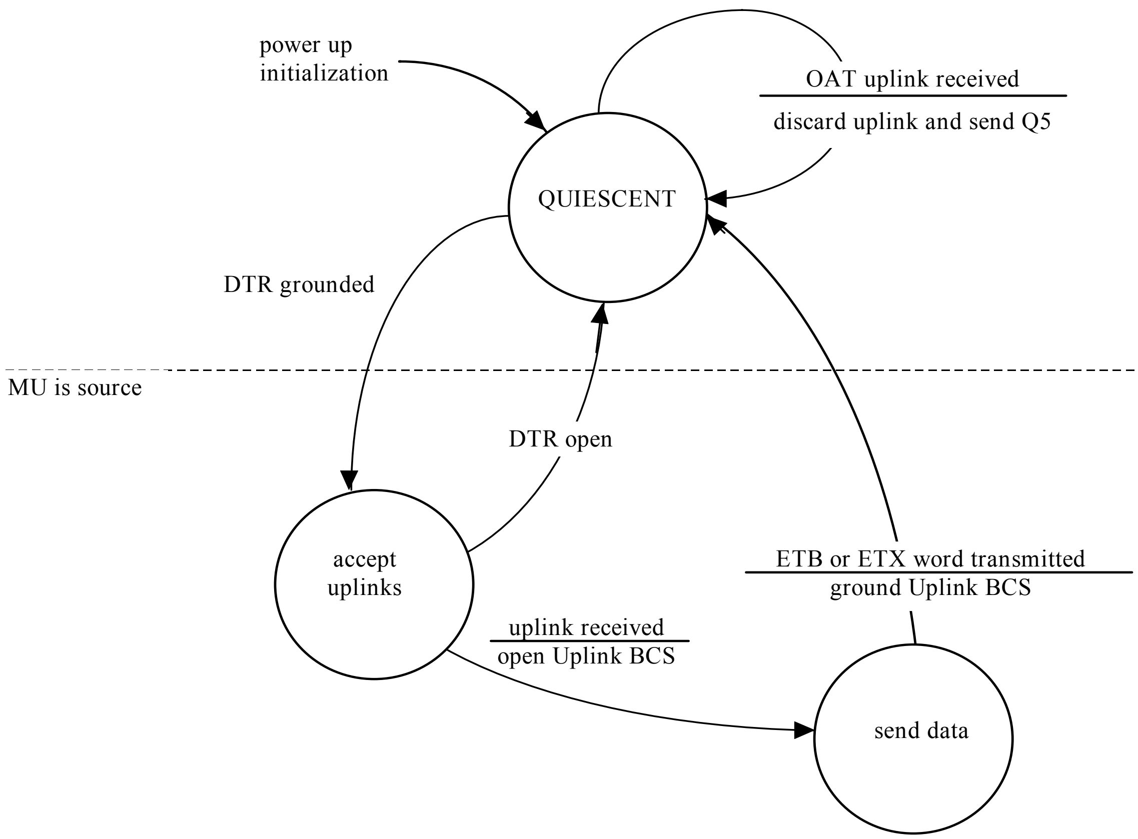

Figure 12.3.1-2 – OAT Protocol State Diagram for ACARS Transmit

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

12.3.2 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.

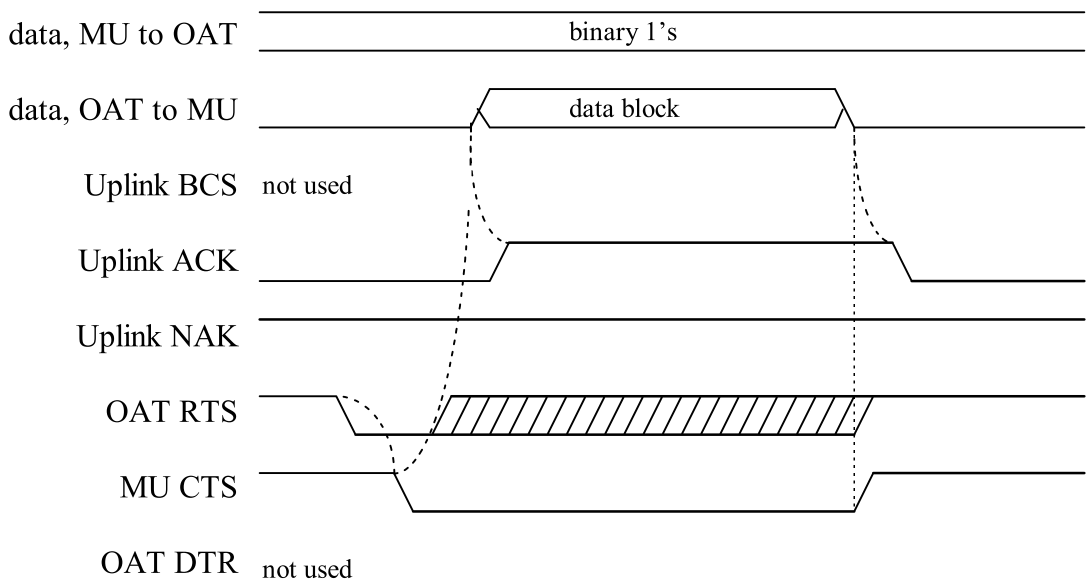

Figure 12.3.2-1 – OAT to MU Timing for an Error Free Block and Previous Block was Error Free

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.

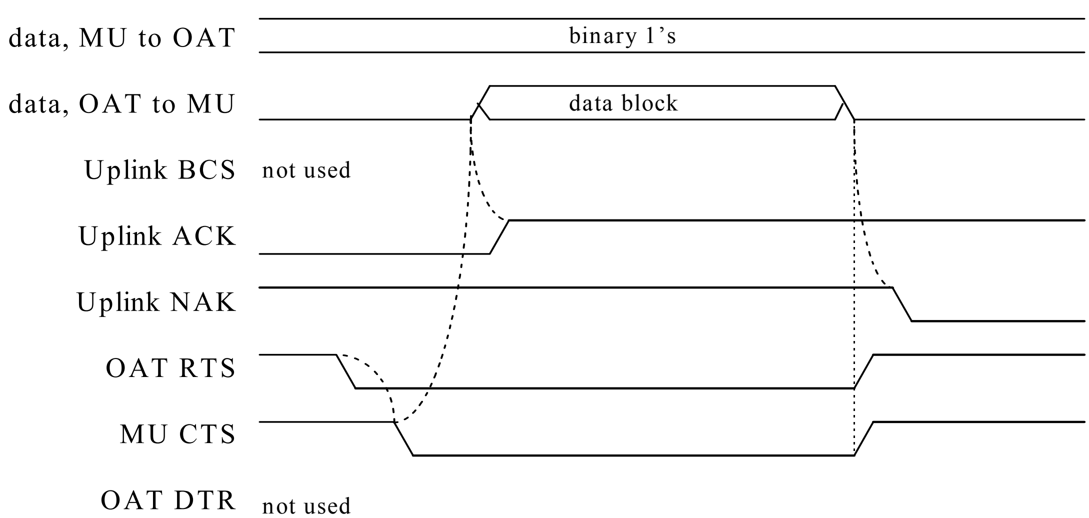

Figure 12.3.2-2 – OAT to MU Timing for a Block Containing an Error and Previous Block was Error Free

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

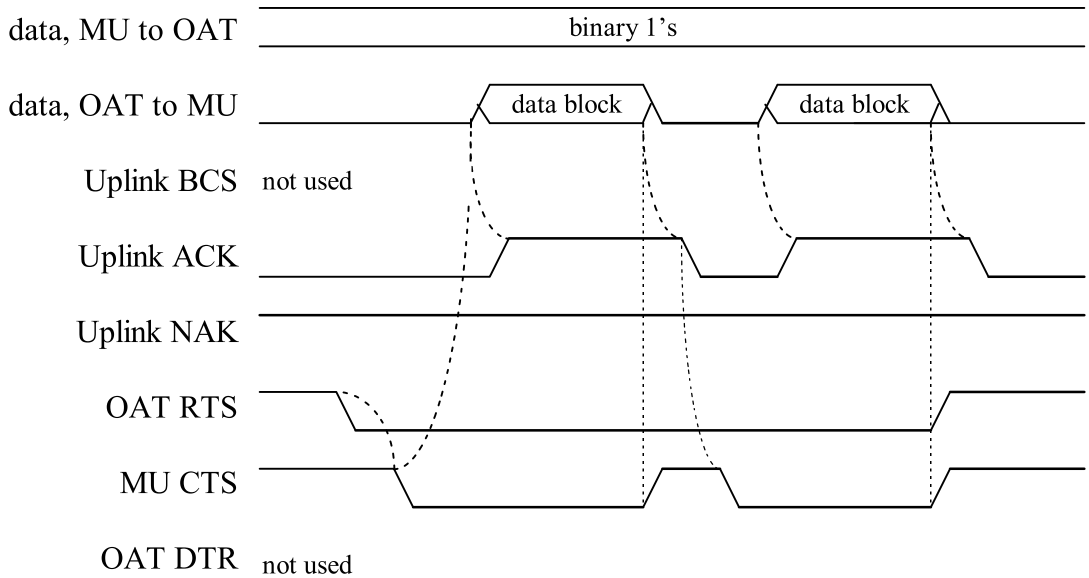

Figure 12.3.2-3 – OAT to MU Timing for a 2 Block Message and Previous Block was Error Free

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).

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

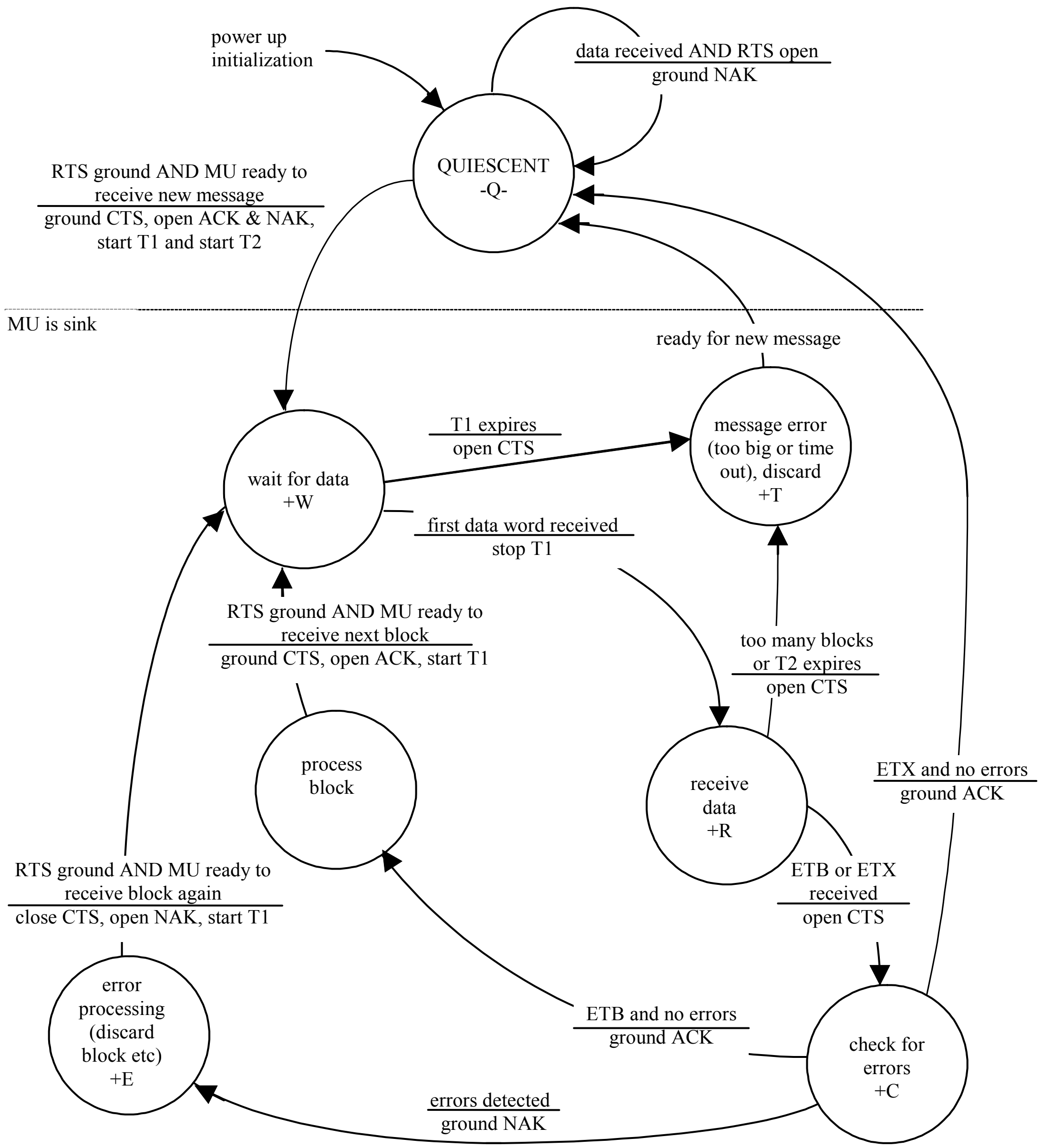

Figure 12.3.2-4 – OAT to MU Link Layer Protocol State Diagram

ATTACHMENT 12
OPTIONAL AUXILLARY TERMINAL (OAT)

12.3.3 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

12.4 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.

12.4.1 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 Built In Test Equipment (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.

12.4.2 Destination VHF

12.4.2.1 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

12.4.3 Destination SDU (GFI 1110)

12.4.3.1 SDU File Format

The MU will format the downlink message as specified in **Attachment 12, Section 12.4.2.1** plus the additional processing specified in this section.

The MU adds the VHF HEADER (see **Table 12.4.3.1-1**) 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 AUXILLARY 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.

12.4.4.2 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

Character	Description	Example
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
ADS	Automatic Dependent Surveillance
AFN	ATS Facility Notification
ALO	Aloha
ALR	Aloha Response
ATS	Air Traffic Services
ATSU	ATS Unit
BCS	Block Check Sequence
BITE	Built In Test Equipment
BOP	bit-oriented protocol
CFDIU	Central Fault Display Indicator Unit
CMC	Central Maintenance Computer
CMU	Communications Management Unit
CPDLC	Controller – Pilot Data Link Communications
CRC	Cyclic Redundancy Check
CTS	Clear To Send
CVR	Cockpit Voice Recorder
DF	Data Follows
DFDAU	Digital Flight Data Acquisition Unit
DGSS/IS	Data Link Ground System Standard and Interface Specification
DITS	Digital Transfer Information System
DMU	Digital Management Unit
DSI	Dialogue Service Interface
DTR	Data Terminal Ready
EGFI	Extended GFI
ELC	Engine Life Computer
EOF	End of Frame
EOT	End of Transmission
ES	End System
ETB	End of Block
ETX	End of Text
FDU	Frame Data Unit
FIS	Flight Information Service
FMC	Flight Management Computer
GFI	General Format Identifier
GPBOP	General Purpose Bit-Oriented Protocol
HF	High Frequency

APPENDIX A
LIST OF ACRONYMS

HFDR	HF Data Radio
I/O	Input/Output
ISO	International Organization for Standardization
LDU	Link Data Units
LRU	Line Replacement Unit
LSB	Least Significant Bit
MAC	Media Access Control
MCDU	Multi-Purpose control and Display Unit
MFD	Multi-Function Display
MICP	Multi-Input Cockpit Printer
MSB	Most Significant Bit
MSK	Minimum Shift Keying
MSN	Message Sequence Number
MU	Management Unit
NAK	Data Received Not OK
NCTS	Not Clear to Send
OAT	Optional Auxiliary Terminal
OSI	Open System Interconnection
RF	Radio Frequency
RTS	Request to Send
SAL	System Address Label
SATCOM	Satellite Communications
SDU	Satellite Data Unit
SOF	Start of Frame
SOH	Start of Header
SOT	Start of Text
SSM	Sign/Status Matrix
STX	Start of Text
VDR	VHF Data Radio
VHF	Very High Frequency

APPENDIX B
DATA LINK RECORDING

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.

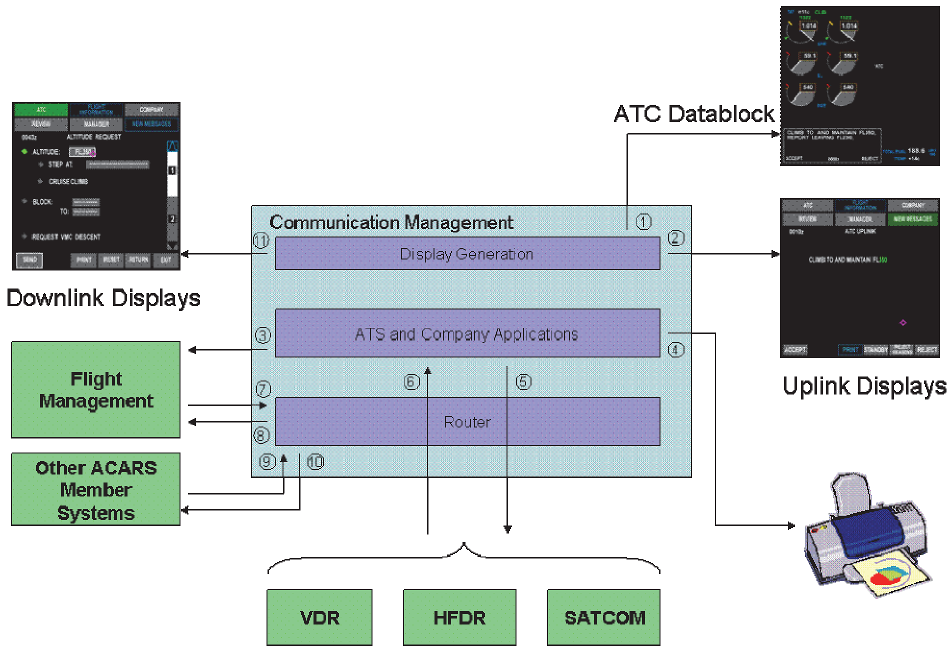

Figure B1-1 – Data Link Recording Points

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 Air Traffic Services (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:

- Future Air Navigation System (FANS) ATS messages (including AFN, ADS, and Controller-Pilot Data Link Communications (CPDLC))
- ATN ATS messages (including Context Management, ADS, CPDLC and Flight Information Services (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 determined by 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. 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.

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.

APPENDIX B
DATA LINK RECORDING

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: 01h Uplink message to be routed to an end system or a downlink message from an end system to be routed to the ground 02h Message from end system directed to recorder 03h AOC message processed by CMU/CMF 04h FANS ATS Facility Notification (AFN) message 05h FANS Automatic Dependent Surveillance (ADS) message 06h FANS CPDLC message 07h ATN Context Management message 08h ATN ADS message 09h ATN CPDLC message 0Ah ARINC 623 message 0Bh ATN FIS message 0Ch System-generated message 0Dh Message loaded to FMC 0Eh Technical acknowledgement of downlink message 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: 01h The source/destination is not a display device 02h Message presented on Multi-Function Display (MFD) 03h Message presented on Datablock 04h Message presented on both MFD and datablock 05h Message presented on Multi-Purpose Control and Display Unit (MCDU) 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.

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) may not.

APPENDIX B
DATA LINK RECORDING

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
Extended GFI Header	Extended GFI	02h	
	I/O and multi-frame bits	0000 0001	Uplink, single frame
	Source/Destination	“C”	Directed to MFD
	Date/Time Stamp	01E2 850Ah	1 Jan 2001 at 00:00:10
	Sequence Number	F6h	Set by CMU
Implementation-Specific Header	Version Number	01h	Version 1
	Message Type	06h	FANS CPDLC
	Display Type	03h	Presented on ATC datablock
Recorded Message	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

C-1 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.

C-1.1 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

C-1.2 Detailed Data Structure

C-1.2.1 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

C-1.2.1.1 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).

C-1.2.1.2 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

C-1.2.1.3 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

C-1.2.1.4 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.

C-1.2.1.5 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.

C-1.2.2 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

C-1.2.2.1 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

C-1.2.2.2 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

C-1.2.2.3 Ground Center Designator

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

C-1.2.2.4 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

C-1.2.2.5 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).

C-1.2.2.6 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

C-1.2.2.7 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.

C-1.2.2.8 Information Field

The information field is specific for each ATC application.

APPENDIX C
AIRBUS DATA LINK RECORDING EXAMPLE

C-2 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	XXXXXXX	Message contents as defined in the flight recorder documentation

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

APPENDIX D DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

D-1 Extended GFI 03 EXAMPLE

The CMU recorder protocol for Extended GFI 03 defined within Section 6.5.3 defines several fields that are reserved for use by the equipment manufacturer. Individual event triggers and recorded information may vary by manufacturer while adhering to the protocol format. The following example describes several event triggers and resulting datalink records.

D-1.1 Recording Event Triggers

Figure D1.1-1 illustrates example uplink and downlink message threads. Recording event triggers are identified by the numeric values.

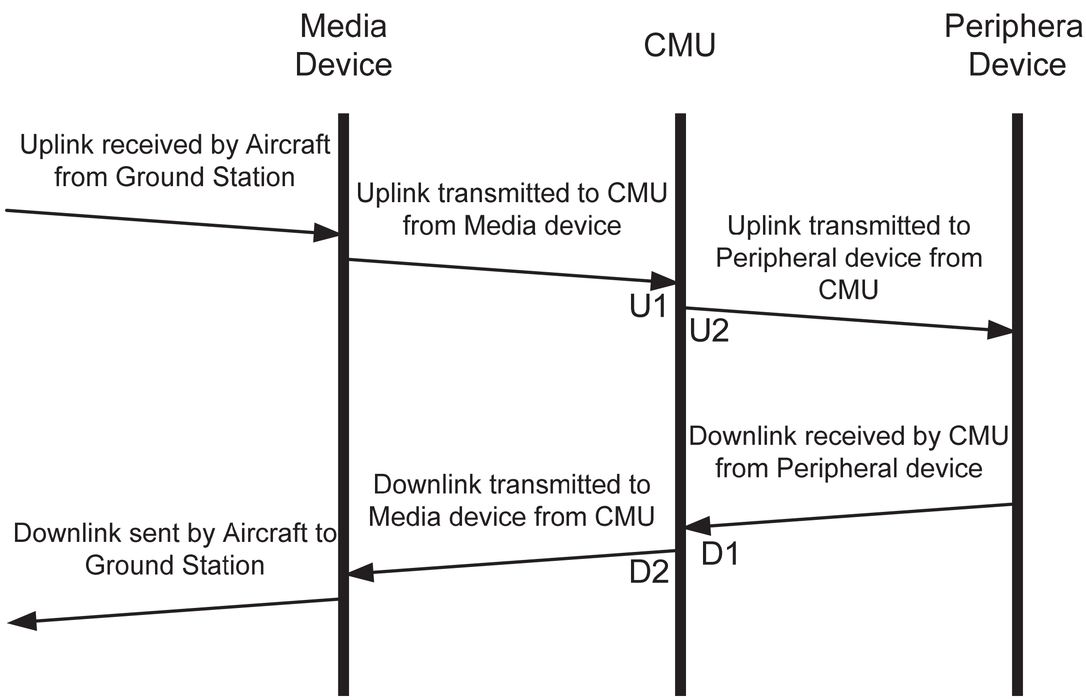

Figure D1.1-1 Example Message Threads

Event U1 represents an uplink message being received by the CMU from the media device (e.g., VHF Data Radio or SDU). Event U2 represents an uplink message being transferred by the CMU to a peripheral device (e.g., FMS or Display Unit). Event D1 represents a downlink message being received by the CMU from a peripheral device (e.g., FMS). Event D2 represents a downlink message being transmitted by the CMU to a media device (e.g., VHF Data Radio or SDU). Additional recording event triggers may be defined by the equipment manufacturer.

Table D1.1-1 provides example records for the message threads illustrated in Figure D1.1-1. Note the relationship between the Time of Event within the Extended GFI Header (Section 6.5.3.1.5) and the Time of Initiation within the File/Message Identifier (Section 6.5.3.2.1) for each event. Also note the relationship between the File/Message Identifier fields for the uplink and downlink message threads.

APPENDIX D
DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

Table D1.1-1 Example Record Elements for Message Threads

Record Element		Data Value			
		Record U1	Record U2	Record D1	Record D2
EGFI Header	EGFI	03	03	03	03
	EGFI Version	01	01	01	01
	Frame Sequence	126	127	128	129
	Final Frame ID	F (Final)	F (Final)	F (Final)	F (Final)
	Time of Event	1 Jan 2001 at 00:00:01	1 Jan 2001 at 00:00:32	1 Jan 2001 at 00:10:25	1 Jan 2001 at 00:10:29
File/Message Identifier	Time of Initiation	1 Jan 2001 at 00:00:01	1 Jan 2001 at 00:00:01	1 Jan 2001 at 00:10:25	1 Jan 2001 at 00:10:25
	Event Index Number	195	195	196	196
Event Record	File/Message Type	U (Uplink)	U (Uplink)	D (Downlink)	D (Downlink)
	File/Message Status	U (New Uplink Received)	F (Uplink Forwarded to Peripheral)	Q (Queued Downlink)	S (Sent Downlink)
	Device Code	S (SDU)	A (FMC#1)	C (CDU#1)	V (VDR)
	Additional Details	H1	H1	BA	BA
	File/Message Contents	<uplink contents>	<forwarded data>	<downlink contents>	<downlink contents>

D-1.2 Detailed Field Definitions

D-1.2.1 File/Message Type

The defined File/Message Type codes are shown in Table D1.2.1-1.

Table D1.2.1-1 – File/Message Type Codes

Type Code (ASCII)	Type of File or Message
U	Uplink Message
D	Downlink Message
X	FMS Peripheral to Peripheral Transfer File (per ARINC Specification 619)

D-1.2.2 File/Message Status

The defined File/Message Status codes are shown in Table D1.2.2-1. The file/message status pertains to the file/message type as indicated within the table.

Table D1.2.2-1 – File/Message Status Codes

Applies to File/Message Type	Status Code (ASCII)	General File/Message Status	Description
Uplink	F	Uplink Forwarded to Peripheral	An uplink that has been forwarded to a peripheral (including printer).
Uplink	U	New Uplink Message	A new uplink that has been received.
Uplink	V	Viewed Uplink Message	An uplink that has been displayed to crew (via display device or printed).
Downlink	Q	Queued Downlink	A downlink that has been queued.
Downlink	S	Sent Downlink	A downlink that has been successfully sent.

APPENDIX D
DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

Applies to File/Message Type	Status Code (ASCII)	General File/Message Status	Description
Downlink	X	Downlink not Sent	A downlink that was deleted from the queue prior to transitioning to the sent state or a downlink that was transmitted but failed to transition to the sent state.
File Transfer	P	File Received	An ARINC 619 Peripheral to Peripheral Transfer file was received.
File Transfer	F	File Forwarded to Peripheral	An ARINC 619 Peripheral to Peripheral Transfer file was forwarded to a device.

D-1.2.3 Device Code

The defined Device Codes are shown in Table D1.2.3-1-1. The device codes are based on the Origin/Destination Codes listed in Attachment 3 but have been modified to provide a greater level of detail regarding attached peripherals.

Table D1.2.3-1 – File/Message Device Codes

ORIGIN or DESTINATION	CHAR CODE	NOTE
CDU/MCDU #2	0	1
CDU/MCDU #3	1	1
RCDU #1	2	1
RCDU #2	3	1
RCDU #3	4	1
MFD #1	5	1
MFD #2	6	1
MFD #3	7	1
890R #1	8	
890R #2	9	1
FMC #1	A	
FMC #2	B	
CDU/MCDU #1	C	1
DFDAU/AIDS	D	
CPDF	E	
CFDIU/CMC	F	
Ground station	G	
HF link/HFDR	H	
EICAS/ECAM/EFIS	I	
ADSU	J	
Keyboard/display	K	
TCAS/Traffic Computer	L	
ACARS CMU	M	
FMC #3	N	
Optional Auxiliary Terminal	O	
Printer	P	
SDU #1	Q	
SDU #2	R	
Satcom link/SDU	S	
HFDR #1	T	

APPENDIX D
DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

ORIGIN or DESTINATION	CHAR CODE	NOTE
HFDR #2	U	
VHF Link / VDR	V	
TAWS	W	
CVR	X	
EFB #1	Y	
EFB #2	Z	
(Not assigned)	a-s	
Telephony link	t	1
(Not assigned)	u-z	

Note:

1. Device definition specifically added/modified for datalink recording.

D-1.2.4 Additional Details

For records pertaining to an uplink or a downlink, the defined Additional Details field is formatted as shown in Table D1.2.4-1.

Table D1.2.4-1 – Format of Additional Details: Uplink/Downlink

Start of Data (Byte)	Size (Bytes)	Element
1	2	ACARS Message Label (ASCII)
3	1	Message Priority
4	1	ATN Application (ATN only)

The Message Label is used for ACARS (including FANS) messages. ATN Application is used to identify the ATN application (not used for FANS).

No additional data is recorded for FMS ARINC 619 Peripheral to Peripheral transfers. If a record pertains to an FMS ARINC 619 Peripheral to Peripheral Transfer file addressed to the printer or recorder, all bytes of the Additional Details are set to all zeros (0).

D-1.2.5 File/Message Contents

The specific File/Message Contents recorded by equipment is based on the event that triggered the creation of the data link record.

D-1.2.5.1 Uplink Received by the CMU

When the CMU receives an uplink containing data intended for text-based display (as opposed to a graphic file), the File/Message Contents field is populated with the supplementary address (if defined in the message) and the message application text. Only messages sent from ATS facilities are defined to contain a supplementary address.

When an uplink containing a file, such as weather graphics, is received, the File/Message Contents field is populated with the file name and title of the file (if available) in ASCII text format.

D-1.2.5.2 Uplink Displayed by the CMU

When a text-based uplink is printed or displayed, the File/Message Contents field is populated with the ASCII text printed or displayed to the crew.

APPENDIX D
DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

When the file in an uplink is accessed (such as displaying weather graphics), the File/Message Contents field is populated with the file name and title of the file (if available) in ASCII text format.

D-1.2.5.3 Uplink Forwarded to Peripheral by the CMU

When an uplink is forwarded to a peripheral device, the File/Message Contents field is populated with the entire concatenated ARINC 619 file excluding the Control/Accountability Header.

D-1.2.5.4 Downlink Queued by the CMU

When a downlink is queued due to direct crew action or by the CMU itself, the File/Message Contents field is populated with the supplementary address (if defined in the message) and the message application text.

When a downlink is queued due to the receipt of an ARINC 619 file from a peripheral device that is addressed to the ground, the File/Message Contents field is populated with the entire concatenated ARINC 619 file excluding the Control/Accountability Header.

D-1.2.5.5 Downlink State Transitioned by the CMU

When a downlink is transitioned to a final state (such as sent), the File/Message Contents field is populated with the supplementary address (if defined in the message) and the message application text.

D-1.2.5.6 ARINC 619 Transfer File Received by the CMU

When the CMU receives an ARINC 619 Peripheral to Peripheral Transfer file addressed to a destination device other than the CMU, the File/Message Contents field is populated with the entire concatenated ARINC 619 file excluding the Control/Accountability Header.

D-1.2.5.7 ARINC 619 Transfer File Forwarded by the CMU

When the CMU transmits an ARINC 619 Peripheral to Peripheral Transfer file to destination device, the File/Message Contents field is populated with the entire concatenated ARINC 619 file excluding the Control/Accountability Header.

COMMENTARY

Peripheral to Peripheral files addressed to the CVR are recorded upon receipt of the file.

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 22, 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.

5.5.1.16 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 fron "Not assigned" to "EFB 1".

In Table 3-1 for Character code Z, the Origin/Destination assignment changed fron "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 25, 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.

SAE INDUSTRY TECHNOLOGIES CONSORTIA (SAE-ITC)
16701 Melford Blvd., Suite 120
Bowie, Maryland 20715 USA

SUPPLEMENT 4
TO
ARINC SPECIFICATION 619

ACARS PROTOCOLS FOR AVIONIC END SYSTEMS

Published: August 15, 2014

Prepared by the AEEC

Adopted by the AEEC Executive Committee: April 15, 2014

PURPOSE OF THIS DOCUMENT

This supplement defines and provides Datalink Recording Format examples for Extended General Format Identifier (GFI) 03 Hex. Origin/Destination code is added for the TCAS Computer (In Trail Procedure).

B. ORGANIZATION OF THIS SUPPLEMENT

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.

1.2 Organization of this Document

Information on Section 6, which defines the data transfer protocol between the ACARS Management Unit (MU) or the Communication Management Unit (CMU) and the Cockpit Voice Recorder (CVR), is added.

1.3 LRU Interface Definitions

This section is expanded.

Reference to MU is replaced with reference to CMU/MU.

Clarifications are added to the FMC and ACMS ACARS messages. Information is added that describes the exchange of data with the CVR interface is specified in ARINC Characteristic 757.

1.5 Referenced Documents

Reference to **ARINC Characteristic 757:** *Cockpit Voice Recorder (CVR)* is added.

3.5 ACARS Character Protocol Message Routing

The section title is changed from “429 Part 3 Character Message Routing” to “ACARS Character Protocol Message Routing.”

3.5.1 ACARS Character Protocol Message Format

The section title is changed from “429 Part 3 Character Protocol Message Format” to “ACARS Character Protocol Message Format.”

Table 3.5.1-1 – ACARS Character Control/Accountability Header: Reference to “ARINC 429 Part3” is changed to “ACARS.”

3.5.2 Uplink to End System, ACARS Character Protocol

The section title is changed from “Uplink to End Systems, 429 Part 3 Character Protocol.”

Reference to “Character-oriented ARINC 429 protocol” is replaced with “ACARS Character-oriented protocol.”

6.5.3 Extended GFI 03 Hex (proposed by Universal Avionics Systems Corporation)

The content of this section and subordinate sections was added.

6.5.4 Reserved for Extended GFI 04 Hex

Placeholder section title was added.

ATTACHMENT 3 – ORIGIN/DESTINATION CODE

An entry for the TCAS/Traffic Computer is added to the Origin/Destination Codes table.

ATTACHMENT 12 – OPTONAL AUXILLARY TERMINAL (OAT)

12.4.3.1 – SDU File Format

Reference to Section 6.6.1.2.1 is changed to Section 12.4.2.1 and reference to Figure 6.6.1.3.1-1 is changed to Table 12.4.3.1-1.

APPENDIX D –DATALINK RECORDING EXAMPLE FOR EXTENDED GFI 03

This section is added.

ARINC Standard – Errata Report

1. Document Title

(Insert the number, supplement level, date of publication, and title of the document with the error)

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 standards@sae-itc.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 Project Initiation/Modification (APIM)

1.0 Name of Proposed Project **APIM #: ___________**

(Insert name of proposed project.)

1.1 Name of Originator and/or Organization

(Insert name of individual and/or the organization that initiated the APIM)

2.0 Subcommittee Assignment and Project Support

2.1 Suggested AEEC Group and Chairman

(Identify an existing or new AEEC group.)

2.2 Support for the activity (as verified)

Airlines: (Identify each company by name.)
Airframe Manufacturers:
Suppliers:
Others:

2.3 Commitment for Drafting and Meeting Participation (as verified)

Airlines:
Airframe Manufacturers:
Suppliers:
Others:

2.4 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.)

3.2 Planned usage of the envisioned specification

Note: New airplane programs must be confirmed by manufacturer prior to completing this section.

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 ☐ no ☐

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 software 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 benefits unique to the equipment supplier's point of view.)

5.0 Documents to be Produced and Date of Expected Result

Identify Project Papers expected to be completed per the table in the following section.

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 (Total)	Expected Start Date	Expected Completion Date
Document a	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
Document b	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*

Please note the number of meetings, the number of meeting days, and the frequency of web conferences to be supported by the IA Staff.

6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

6.1 Expiration Date for the APIM

April/October 20XX

Completed forms should be submitted to the AEEC Executive Secretary.