Interface Control Document

for the

Multimode Digital Radio (MDR)

ARINC

2551 Riva Road
Annapolis, MD
21401-7435

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1 SCOPE

1.1 Identification

This document contains a detailed description of the communication interfaces for the Multimode Digital Radio (MDR) for Voice, Analog ACARS, Digital ACARS via Ethernet, and VDL Mode 2 via Ethernet operations. The MDR also supports the legacy VDL Mode 2 via HDLC over RS-422 serial operation as described in ARINC document No. 17940, *Interface Control Document for the VDL Digital Radio (VDR)*.

In AM Voice operation, the MDR configuration and monitoring interface is a 10/100Base-T Ethernet physical connection, carrying TCP/IP data packets, using primitive commands to set radio operating parameters and monitor status. The MDR has audio input and output connections, a PTT control line, and SSV voltage output. Transmit keying can be accomplished via an external PTT signal or tone keying. In this mode, the MDR will be used for voice communications on the aviation bands.

In Analog ACARS mode, the MDR will be connected to an original IAGS ACARS ground station that outputs uplink messages as an MSK-modulated analog signal. In this mode, the MDR will not provide squelch, sound-enhancing filters, or other features that might distort ACARS message signals.

In Digital ACARS operation, the MDR control interface is a 10/100Base-T Ethernet physical connection, carrying TCP/IP data packets, using primitive commands to set radio operating parameters and monitor status, and convey uplink and downlink messages. The MDR performs MSK modulation and p-persistent CSMA channel access management. In this mode, the MDR will be connected to a ground station supporting Ethernet communications to ACARS air/ground radios.

In Digital VDL Mode 2 operation, the MDR provides two control interfaces, a 10/100Base-T Ethernet physical connection and HDLC over an RS-422 physical connection, using primitive commands to set radio operating parameters and monitor status, and convey uplink and downlink messages. The MDR performs D8PSK modulation and p-persistent CSMA channel access management. In this mode, the MDR will be connected to a ground station supporting Ethernet communications to VDL Mode 2 air/ground radios, or to a legacy ground station supporting HDLC over RS-422 serial communications to VDR or MDR radios.

1.2 Acronyms

The following abbreviations, acronyms, and mnemonics are used in this document.

Item	*Meaning*
A/G	Air/Ground
ACARS	Aircraft Communications, Addressing, and Reporting System
ACK	Acknowledgment
AGC	Automatic Gain Control
ARINC	Aeronautical Radio, Incorporated
ARP	Address Resolution Protocol
AVLC	Aviation VHF Link Control
BCS	Block Check Sequence
BER	Bit Error Rate
BIT	Built-In Test
CD	Carrier Detect
CLK	Clock
CMC	Central Maintenance Computer
CMU	Communications Management Unit
COTS	Commercial Off-The-Shelf
CRC	Cyclic Redundancy Check
CSMA	Channel Sense Multiple Access
CSF	Command/Status Frame
CTS	Clear to Send
CU	Channel Utilization
D8PSK	Differential Eight Phase Shift Keying
dB	Decibel

dBm	Decibels above (or below) 1 milliwatt
DCD	Data Carrier Detect
DCE	Data Control Equipment
DFS	Digital Frequency Select
DL	Downlink
DLE	Data Link Entity
DLS	Data Link Service
DTE	Data Terminal Equipment
EEPROM	Electrically Erasable Read Only Memory
EIA	Electronics Industry Association
FCS	Frame Check Sequence
FEC	Forward Error Correction
IAGS	Integrated ARINC Ground Station
IBIT	Interruptive Built-In Test
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ICMP	Internet Control Message Protocol
IEC	International Engineering Consortium
IEEE	Institute of Electrical and Electronics Engineers
IND	Indication
IP	Internet Protocol
ISO	International Standards Organization
kHz	kilohertz
LAN	Local Area Network
LLC	Logical Link Layer

LME	Link Management Entity
LSB	Least Significant Byte
MAC	Media Access Control
MDR	Multimode Digital Radio
MHz	Megahertz
MSB	Most Significant Byte
MSK	Minimum Shift Keying
NRZ	Non Return to Zero
NVRAM	Non-Volatile RAM
OSI	Open System Interconnection
PICS	Protocol Implementation Conformance Statement
PID	Process ID
PTT	Push To Talk
REQ	Request
RF	Radio Frequency
RFC	Request for Comment
RSSI	Received Signal Strength Indicator
RTS	Request To Send
Rx	Receive
SARPs	Standards and Recommended Practices
SAS	Station Address Set
SNR	Signal-to-Noise Ratio
SOH	Start of Header
SQP	Signal Quality Parameter
TBD	To Be Determined
TCP	Transmission Control Protocol

TIA	Telecommunications Industry Association
TSP	Transmitted Signal Power
Tx	Transmit
UL	Uplink
VDL	VHF Digital Link
VDLM2	VHF Digital Link Mode 2
VHF	Very High Frequency
VME	VHF Management Entity
VSWR	Voltage Standing Wave Ratio

2 APPLICABLE DOCUMENTS

2.1 ARINC Documents

[1] *Requirements Specification, Multimode Digital Radio (MDR), ARINC document 54877, May 2005.*

[2] *Interface Control Document for the VDL Mode 2 Digital Radio (VDR), ARINC document 17940.*

2.2 Non-ARINC Documents

[3] *Dynamic Host Configuration Protocol*, Internet Engineering Task Force RFC 2131, March 1997

[4] *High Speed 25-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment, Including Alternate 26-Position Connector*,
EIA/TIA-530-A, June 1992

[5] *IEEE Standard for Information Technology - Telecommunication & Information Exchange Between Systems - LAN/MAN - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*, ANSI/IEEE Standard 802.3, 2002 Edition

[6] *IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 2: Logical Link Control*, ANSI/IEEE Std 802.2, 1998 Edition

[7] *Internet Control Message Protocol,* Internet Engineering Task Force RFC 792, September 1981

[8] *Internet Protocol,* Internet Engineering Task Force RFC 791, September 1981

[9] *Transmission Control Protocol,* Internet Engineering Task Force RFC 793, September 1981

[10] *VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) ICAO Aeronautical Telecommunications Annex 10,* Volume III, Part I, Chapter 6, July 1995, including:

- Amendment 71 (July 1996)
- Amendment 72 (July 1997)
- Amendment 73 (July 1998)
- Amendment 74 (July 1999)
- Amendment 75 (July 2000)
- Amendment 76 (July 2001)
- Amendment 77 (July 2002)
- Amendment 78 (July 2003)
- Amendment 79 (July 2004)

3 OVERVIEW

3.1 Functional Partitioning

3.1.1 VDL Mode 2 Operation

ARINC 750-1 defines a method for the airborne Communications Management Unit (CMU) and the data radio to work as a paired entity to perform the functions necessary to operate in the A/G VDL Subnetwork. Ground stations build on this baseline and implement the ground station control computer-to-data radio interface in the ground station in an equivalent manner. Figure 3-1 is a representation of the functional partitioning to be implemented in the IAGS for digital data link modes.

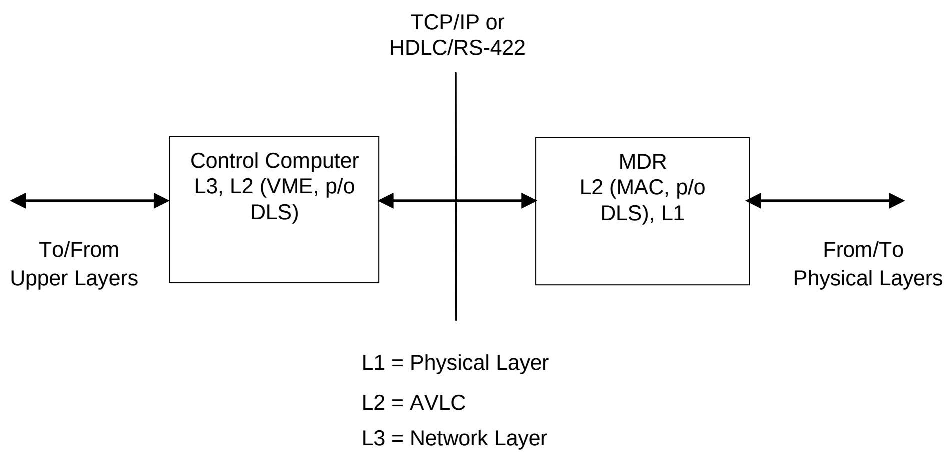


Figure 3-1 Ground Station Control Computer - MDR Functional Partitioning

The MDR shall be responsible for all aspects of the physical layer required to access the RF communication channel as defined in the VDL SARPs.

The ground station control computer is responsible for all aspects of establishing, maintaining, and managing connections between the airborne and ground stations as defined in the VDL SARPs.

The functionality associated with the DLS sublayer is divided between the ground station control computer and MDR.

The ground station control computer is responsible for frame sequencing and management of the AVLC link. It maintains accountability for delivery of the message traffic, perform flow control, operate the AVLC link layer timers, and generate command/response frames, as necessary.

For frames to be transmitted, the ground station control computer performs initial assembly of the AVLC frame (data or control) and passes it to the MDR via the TCP/IP connection defined in

Section 4.1 of this document, or to the MDR via the HDLC/RS-422 connection defined in ARINC document 17940, *Interface Control Document for the VDL Mode 2 Digital Radio (VDR)*. The MDR shall complete construction of the AVLC frame and concatenate it with other AVLC frames into a RF Transmission Packet.

The operation is performed in reverse order for RF packets received by the MDR with two additional steps: the MDR performs address filtering and calculate received signal quality.

Chapter 7 of this document provides more insight into this function partitioning and into the ground station control computer-to-data radio communication mechanism. Section 3.3 describes the various information packets used to move messages between the ground station control computer and data radio.

3.1.2 ACARS Operation

The MDR shall be responsible for all aspects of the physical layer required to access the RF communication channel. The radio shall modulate uplink blocks and demodulate downlink blocks using MSK modulation as defined in *Air/Ground Character-Oriented Protocol Specification*, ARINC Specification 618. The radio shall use a p-persistent Carrier Sense Multiple Access (CSMA) algorithm to control transmission access to the RF channel.

The ground station control computer maintains accountability for delivery of ACARS blocks, inter-block flow control, calculates prekey and message assurance fields, and formats the uplink block ready for transmission.

3.1.3 AM Voice Operation

The MDR shall modulate the audio input signal and demodulate received AM signals, and generate an SSV voltage output. Control of transmission is via the PTT control line, or by tone keying.

3.1.4 Analog ACARS Operation

The MDR shall modulate the audio input signal and demodulate received AM signals, and generate an SSV voltage. Control shall be via an Ethernet connection or manual, front-panel interface.

3.2 VDL Mode 2 OSI Model

The VDL system is based upon the OSI Reference Model and has been designed in a modular fashion that separates the functions of the physical, link, and lower sub-layers of the network layers. The aviation VHF Link Control (AVLC) layer conforms to HDLC as specified by ISO 3309, 4335, 7809, and 8885. Given that HDLC is designed to support stationary network terminals where bandwidth is not scarce, AVLC has been created as a variant of HDLC to optimize performance where the network terminals are in a mobile environment with limited bandwidth available. The VDL sub-network layer protocol used across the VHF A/G sub-network conforms to ISO 8208.

The ground station control computer and ground station radio operate together to provide the first two layers of connectivity in the A/G sub-network architecture model as defined below:

- A/G Physical Layer
- A/G Link Layer (AVLC)
  - Media Access Control (MAC) sublayer
  - Data Link Service (DLS) sublayer
  - VHF Management Entity (VME) sublayer

The airborne and ground stations shall access the physical media operating in a simplex mode. The physical layer provides the services to activate, maintain, and deactivate connections for bit transmissions in the data link layers. The following service elements are the responsibility of the physical layer:

- Transmitter and receiver frequency control (per VME request)
- Reception of data
- Transmission of data
- Notification services (Operational monitoring)

The link layer is responsible for transferring information from one network entity to another over the RF channel, including the operation of error detection and correction mechanisms. Data at the link layer is transmitted as a bit stream in a series of frames exchanged between the airborne and ground stations. The link layer provides the following sublayer functions:

- The Media Access Control (MAC) sublayer acquires the communication channel. It performs the following functions:
  - Multiple access via a p-persistent CSMA algorithm
  - RF channel sensing
  - RF channel congestion detection
  - Transmission authorization

- The DLS sublayer provides connection-oriented, point-to-point links using Data Link Entities (DLEs) or connectionless broadcast links, over the MAC sublayer. DLS contains the state machine that implements the AVLC protocol. It performs the following functions:
  - Frame sequencing
  - Error detection
  - Station and broadcast address identification
  - Data transfer in frames

- The VME sublayer establishes and maintains DLEs between airborne and ground stations using Link Management Entities (LMEs). It performs the following functions:
  - RF frequency management
  - Link establishment
  - Link maintenance
  - Link change notification

3.3 Data Packet Formats

3.3.1 VDL Mode 2 Operation

3.3.1.1 Ground station control computer AVLC frame

AVLC Dest. Addr	*AVLC Src. Addr*	*AVLC Cntrl*	*Information*
32 Bits	32 Bits	8 Bits	M Bits

3.3.1.2 Ground station control computer - data radio frames

3.3.1.2.1 Ground station control computer – MDR TCP/IP frame

Ground station control computer – MDR TCP/IP frame structure:

IP Header											
Version	*Header Length*	*Type of Service*	*Total Length (bytes)*	*Ident*	*Bit Flags*	*Fragment Offset*	*Time to Live*	*Protocol*	*Header Checksum*	*Source IP Address*	*Destination IP Address*
4 Bits	4 Bits	8 Bits	16 Bits	16 Bits	3 Bits	13 Bits	8 Bits	8 Bits	16 Bits	32 Bits	32 Bits

TCP Header									
Source Port	*Destination Port*	*Sequence Number*	*Ack Number*	*Header Length*	*Reserved Field*	*Control Flags*	*Window Size*	*TCP Checksum*	*Urgent Pointer*
16 Bits	16 Bits	32 Bits	32 Bits	4 Bits	6 Bits	6 Bits	16 Bits	16 Bits	16 Bits

PID Header			*PID Data*
PID	*Message Length MSB*	*Message Length LSB*	
8 Bits	8 Bits	8 Bits	8 * N Bits
MDR Control Primitive			

Note: this example is valid when the amount of the PID data is small enough to fit within one IP block. If there is more PID data, the Ethernet protocol provides for splitting into multiple IP blocks.

3.3.1.3 MDR AVLC Frame

AVLC frame bit-stuffed with CRC:

AVLC Flag	*AVLC Destination Address*	*AVLC Source Address*	*Control*	*Information*	*AVLC CRC*	*AVLC Flag*
8 Bits	32 Bits	32 Bits	8 Bits	N Bits	16 Bits	8 Bits
0x7E	[Var]	[Var]	[Var]	[Var]	[Var]	0x7E

3.3.1.4 RF Transmission Packet

Before interleaving, FEC, and scrambling is performed on datagram section:

Tx Power	Sync	Reserved	Tx Length	Header FEC	AVLC Flag	AVLC Frame 1	AVLC Flag	•••	AVLC Frame N	AVLC Flag
4 Symbols	16 Symbols	1 Symbol	17 Bits	5 Bits	8 Bits	M Bits	8 Bits		M Bits	8 Bits
[Var]	[Var]	[Var]	[Var]	[Var]	0x7E	[Var]	0x7E		[Var]	0x7E

3.3.2 ACARS Operation

3.3.2.1 Ground station control computer ACARS packet

VHF Preamble					ACARS Block					
Prekey Character 1	•••	Prekey Character M	Bit Sync Characters	Character Sync Characters	Start of Header	Mode	Address	Tech ACK	Label	Block ID
8 Bits		8 Bits	2 Bytes	2 Bytes	1 Byte	1 Byte	7 Bytes	1 Byte	2 Bytes	1 Byte
0xFF		0xFF	0x2B2A	0x1616	0x01	[Var]	[Var]	[Var]	[Var]	[Var]

ACARS Block (con't)			BCS Field	
Start of Text	Text Field	EOT or EOB	Block Check Sequence	BCS Suffix
1 Byte	M Bytes	1 Byte	2 Bytes	1 Byte
0x02	220 Bytes Maximum	[Var]	[Var]	0x7F

Note: The individual bytes within the ACARS message are to be transmitted between the ground station control computer and the MDR most significant bit (MSB) first and are modulated on the air least significant bit (LSB) first.

3.3.2.2 Ground station control computer – MDR TCP/IP frame

Ground station control computer – MDR TCP/IP frame structure:

IP Header											
Version	*Header Length*	*Type of Service*	*Total Length (bytes)*	*Ident*	*Bit Flags*	*Fragment Offset*	*Time to Live*	*Protocol*	*Header Checksum*	*Source IP Address*	*Destination IP Address*
4 Bits	4 Bits	8 Bits	16 Bits	16 Bits	3 Bits	13 Bits	8 Bits	8 Bits	16 Bits	32 Bits	32 Bits

TCP Header									
Source Port	*Destination Port*	*Sequence Number*	*Ack Number*	*Header Length*	*Reserved Field*	*Control Flags*	*Window Size*	*TCP Checksum*	*Urgent Pointer*
16 Bits	16 Bits	32 Bits	32 Bits	4 Bits	6 Bits	6 Bits	16 Bits	16 Bits	16 Bits

Primitive Header			*Primitive Data*
PID	*Message Length MSB*	*Message Length LSB*	
8 Bits	8 Bits	8 Bits	8 Bits * (24 + M Bytes)
MDR Control Primitive			

3.3.2.3 ACARS packet ready for RF transmission

VHF Preamble					ACARS Block					
Prekey Character 1	•••	Prekey Character M	Bit Sync Characters	Character Sync Characters	Start of Header	Mode	Address	Tech ACK	Label	Block ID
8 Bits		8 Bits	2 Bytes	2 Bytes	1 Byte	1 Byte	7 Bytes	1 Byte	2 Bytes	1 Byte
0xFF		0xFF	0x2B2A	0x1616	0x01	[Var]	[Var]	[Var]	[Var]	[Var]

ACARS Block (con't)			BCS Field	
Start of Text	Text Field	EOB Or EOT	Block Check Sequence	BCS Suffix
1 Byte	M Bytes	1 Byte	2 Bytes	1 Byte
0x02	220 Bytes Maximum	[Var]	[Var]	0x7F

4 COMPUTER-RADIO INTERFACE

4.1 MDR Interface

This section describes the interface from the ground station control computer to the Multimode Digital Radio (MDR).

4.1.1 Physical Interfaces

4.1.1.1 Ethernet Port

Information transfer between the ground station control computer and MDR shall occur over a 10/100BaseT twisted pair Ethernet connection compliant with the electrical requirements defined in IEEE specifications 802.3 (10BaseT) and 802.3u (100BaseT). The MDR port shall auto sense network speed and automatically configure for 10BaseT (10 Mbps) or 100BaseT (100 Mbps) operation without the need for manual configuration.

The MDR shall provide a visual indication of the following states of the Ethernet port:

- No valid network connection
- Valid network connection
- Traffic flowing

The MDR Ethernet port connector shall an industry-standard RJ-45 connector, pin-out shall conform to IEEE Specification 802.3.

4.1.1.2 Analog Connections

The MDR shall provide the following connections for in analog operation:

- Voice Input 600Ω impedance, minus 6 dBm
- Voice Output 600Ω impedance, minus 6 dBm
- SSV Output 15kΩ impedance
- PTT Input grounded = talk
- Signal Ground

The SSV Output correlation is shown in Table 4-1.

The MDR shall provide an HDLC over RS-422 serial interface as defined in *Interface Control Document for the VDL Mode 2 Digital Radio (VDR)*, ARINC document 17940.

Connections shall be via a DB-25 connector, with pin-out as specified in ARINC document 17940.

Table 4-1 SSV Output Voltage Levels

RF Input (dBm)	***SSV (Vdc)***
-108	5.00
-107	4.94
-106	4.87
-105	4.82
-103	4.75
-102	4.70
-101	4.64
-100	4.59
-98	4.53
-97	4.48
-94	4.42
-93	4.35
-92	4.31
-89	4.24
-87	4.18
-86	4.14
-84	4.08
-81	4.02
-79	3.96
-76	3.89
-74	3.84
-72	3.79
-69	3.72
-66	3.66
-63	3.61
-61	3.56
-58	3.50
-55	3.44
-51	3.36
-49	3.31
-46	3.25
-43	3.19
-41	3.15
-38	3.07
-35	3.01
-33	2.96
-31	2.91
-29	2.87
-26	2.81
-23	2.74
-21	2.68
-19	2.64
-16	2.56
-14	2.51
-12	2.46
-10	2.40
-8	2.34
-6	2.29
-5	2.25
-2	2.18
1	2.09
3	2.04
4	2.00
6	1.95
10	1.88

Note: The calibration point is 4.35 V (-93 dBm RF Input) – values at the extremes may deviate.

4.1.2 Transfer Protocols

4.1.2.1 Datalink Layer Protocol

The Logic Link Control sublayer shall conform to Type 1 (connectionless) operation defined in *IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 2: Logical Link Control*, ANSI/IEEE Std 802.2, 1998 Edition.

4.1.2.2 Network Layer Protocols

The MDR shall implement Internet Protocol (IP) as defined in RFC 791 for all network communications.

The MDR shall implement Internet Control Message Protocol (ICMP) as defined in RFC 792.

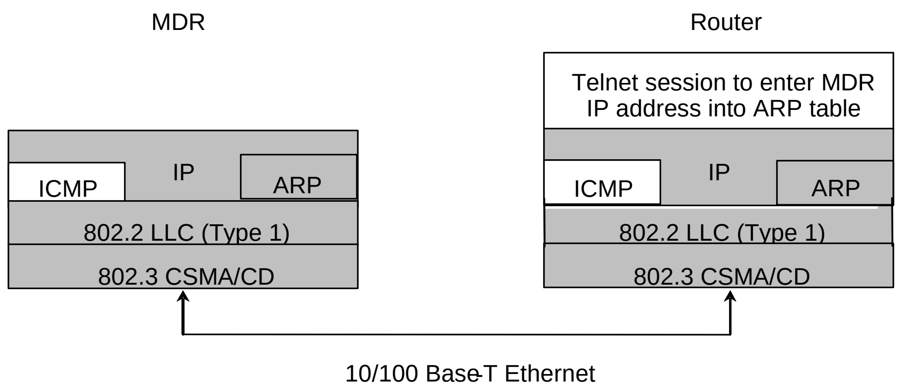


Figure 4-1, MDR ICMP Interface

4.1.2.2.1 IP Address Collision Avoidance Process

The MDR shall implement the following process to ensure the IP address it uses is not already in use on the LAN (see Figure 4-2). This process determines what values the MDR will use for its IP parameters (IP address, subnet mask, default gateway) and TCP parameters (control application TCP port number and TCP keepalive values).

On power up the MDR shall test its configured IP address for a collision. If the configured IP address is not already in use the MDR will use its configured values IP and TCP parameters. If the MDR determines the configured IP address is already in use the MDR then tests the default IP address for a collision.

If the default IP address is not already in use the MDR will use default values for IP and TCP parameters. If the default IP address is already in use the MDR shall enable DHCP.

The MDR shall continue the DHCP process until an IP address is obtained. The MDR shall use IP parameters obtained via DHCP and the default values for its TCP parameters.

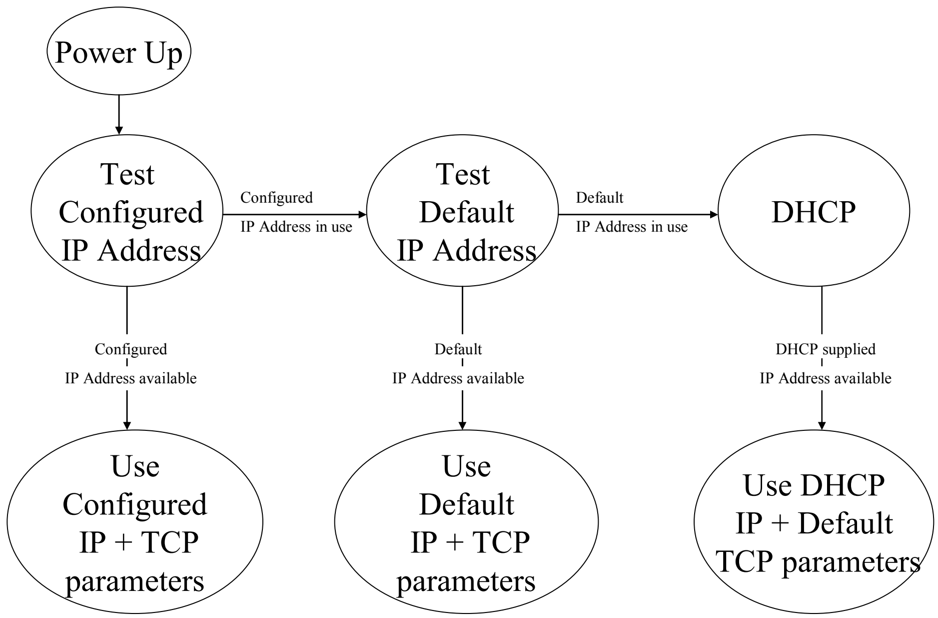


Figure 4-2. IP Address Collision Avoidance

4.1.2.3 Transport Layer Protocols

The MDR shall implement Transmission Control Protocol (TCP) as defined in RFC 793. The MDR shall allow only 1 TCP connection to be open at any given time. The MDR shall disable the Nagel algorithm in the TCP/IP stack. The MDR shall implement the TCP keepalive algorithm with parameters configured in the IP_CONFIG_REQ primitive. The TCP keepalive parameters include an Idle Time, Interval, and Probe Count defined below.

- Idle Time - If the connection has been idle for this time TCP will send a special segment forcing the other end to respond.
- Interval - The probes sent out by TCP upon expiration of the Keepalive idle timer are separated by this fixed time interval.
- Probe Count - Upon expiration of the Keepalive idle timer TCP will send a number of probes separated by a fixed interval. If the other end fails to respond the TCP connection will be terminated.

4.1.2.4 Application Layer Protocols

The MDR shall be a Dynamic Host Configuration Protocol (DHCP) client as defined in RFC 1451. The default state of DHCP shall be OFF.

The MDR shall implement the data communication and control primitives listed in Appendix A of this document.

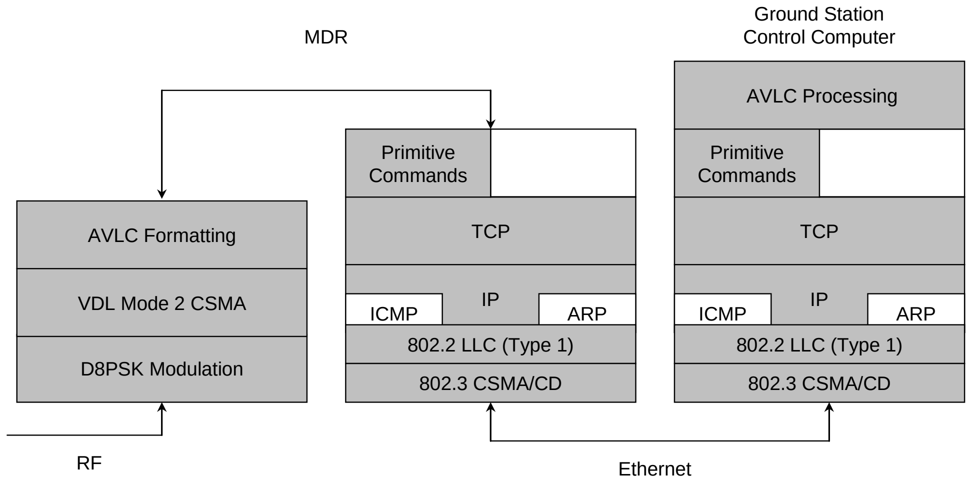


Figure 4-3. VDL Mode 2 Communication

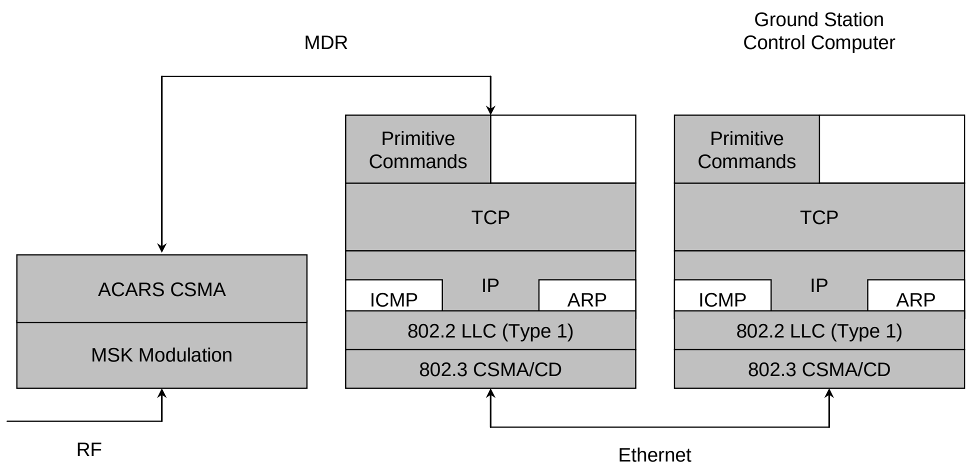


Figure 4-4. ACARS Communication

5 A/G SUBNETWORK PHYSICAL LAYER

5.1 MDR VDL Mode 2 Operation

The Multimode Digital Radio (MDR) shall handle all protocol and error correcting associated with the RF communications link and a portion of the DLS sublayer of AVLC as partitioned in Section 3.2.

5.1.1 Transmission

The MDR format outgoing Mode 2 messages in compliance with the VDL SARPs to include the following actions:

- For each AVLC frame to be transmitted:
  - Bit stuffing
  - Flag field insertion
  - CRC generation

- For each RF transmission packet:
  - Concatenation of multiple AVLC frames
  - Compute FEC
  - Interleave
  - Create transmission Header
    - Training sequence
    - Ramp-up symbols
    - Unique word/reserved symbols
    - Transmission length
    - Header FEC
  - Bit-scrambling
  - Bit phase encoding
  - Modulation and transmission
  - Verification (loopback)

5.1.2 Reception

The MDR process incoming Mode 2 messages in compliance with the VDL SARPs to include the following actions:

- For each RF transmission packet detected:
  - Demodulate
  - Phase decoding
  - Bit descrambling
  - Detect unique word
  - Remove training sequence
  - Verify Header FEC
  - Verify transmission length
  - De-interleave
  - Correct RF Packet per FEC
  - De-concatenation of multiple AVLC frames
  - Create an SQP indicator if the CRC is valid

- For each AVLC frame received:
  - Bit un-stuffing
  - Flag field removal
  - Verify CRC
  - Address filtering

5.2 MDR ACARS Operation

5.2.1 Transmission

The MDR formats outgoing ACARS blocks in compliance with ARINC Specification 618, *Air/Ground Character-Oriented Protocol Specification* including the following actions:

- For each ACARS uplink block received from ground station control computer:
  - Perform p-persistent CSMA channel access management
  - Modulate and transmit ACARS block
  - Verify transmission via character comparison of uplink block to block heard by MDR receiver (loopback)
  - Send transmit confirmation to ground station control computer

5.2.2 Reception

The MDR processes incoming ACARS messages formatted in compliance with Arinc Specification 618, *Air/Ground Character-Oriented Protocol Specification,* performing the following actions:

- Demodulate downlink
- Discard received uplink blocks after verifying CRC for uplink loopback validation
- For each ACARS downlink block received, build downlink block primitive containing:
  - Block SSV
  - Prekey duration
  - Received block of characters, less prekey
- Send downlink block primitive to ground station control computer

5.3 AM Voice Operation

5.3.1 Transmission

- If PTT keying is enabled, the MDR AM modulates and transmits analog input signal whenever the PTT line is grounded.
- If tone keying is enabled, the MDR continuously monitors in the input line for the configured keying tone, filters out the tone, and AM modulates and transmits the base signal.

5.3.2 Reception

- Receive and demodulate AM signals
- Output signals as audio in the output line
- Monitor the received signal level and generate the SSV voltage

5.4 Analog ACARS Operation

5.4.1 Transmission

- The MDR modulates and transmits analog input signal whenever the PTT line is grounded.

5.4.2 Reception

- Receive and demodulate AM signals
- Output signals as audio in the output line
- Monitor the received signal level and generate the SSV voltage

6 VDL MODE 2 AVLC LINK LAYER

6.1 MAC Sublayer/CSMA

The MAC sublayer shall be implemented per Section 3.2 of the VDL SARPs. The MDR has sole responsibility for this function.

6.2 Data Link Services

Data link service shall be implemented per Section 3.3 of the VDL SARPs. The DLS functionality is distributed between the ground station control computer and MDR as stated below. Additional information about the distribution of this function is contained in Section 3.2 and Chapter 5 of this document.

- Ground station control computer:
  - Data transfer in frames
  - Frame sequencing

- MDR:
  - Error detection
  - Address identification

6.3 VME Services

VME services shall be implemented per Section 3.4 of the VDL SARPs. The ground station control computer has sole responsibility for this function.

7 GROUND STATION CONTROL COMPUTER - RADIO OPERATION

7.1 Radio to Ground Station Control Computer Command Interface

The Radio Command layer treats all command primitives as broadcast datagrams. Many of the commands require acknowledgment. These commands are generated by a need from an upper level functionality. It is up to the upper level functional unit to handle any problems with command response sequences. Unit Data primitives will not be tracked across the Radio Command layer. They are broadcast to the other side of the TCP/IP link and assumed successful.

The TCP/IP and Ethernet layers are covered in the section on the physical interface between the ground station control computer and MDR of this document. The MDR Command layer is addressed through the description of the command layer primitives and the operational scenarios. The peer communications of the radio command layer in the ground station control computer and the MDR will be the focus of the operational scenarios.

Data integrity is handled at the TCP layer. The radio command layer will not provide for any error recovery or retransmission of commands. If an error is discovered at the radio command layer, an Error Indication will be generated. These Error Indications will contain error codes (reference Appendix A of this document) to differentiate different types of software errors.

VDL Mode 2 AVLC frames sent to the MDR in the Unit Data command primitive will be assumed to have been transmitted over the RF after they have passed through the TCP layer. It will be up to the AVLC protocol (in the ground station control computer) to handle any retransmission of frames that are necessary.

The MDR shall acknowledge transmission of ACARS blocks sent to the MDR in the ACARS_UPLINK_REQ primitive by returning the ACARS_UPLINK_ACK primitive.

7.2 Power Up

If the MDR has operational software installed, and an IP address configured, upon power up, the MDR shall test RAM, perform a checksum verification on loaded software fill(s), load the last active mode’s software and configuration parameters, and enter the TCP LISTEN state. Upon a reset/power-up condition, the MDR always sets the transmitter OFF for VDLM2 and Digital ACARS modes, so there is no chance of the MDR jabbering until configured by the ground station control computer. The ground station control computer initiates the TCP connection by sending the MDR a SYN segment, the MDR replies with a corresponding SYN segment/acknowledgement, and the control computer replies with an acknowledgement. At this point the TCP connection is established. The allowable time window to establish a TCP/IP connection with the MDR is within 10 seconds of completion of computer boot-up once the TCP handshake process initiates. TCP connection time will be tested on an isolated network containing only the ground station control computer and a single MDR.

The MDR initiates application layer communication by sending a RESET_IND primitive within 10 seconds of establishing a TCP/IP connection.

Figures 7-1 and 7-2 shows the power-up sequence for an MDR reset/power-up situation.

Figures 7-3 and 7-4 shows the power-up sequence for a reboot of the ground station control computer.

Figure 7-5 shows the initial power-up sequence when DHCP is enabled.

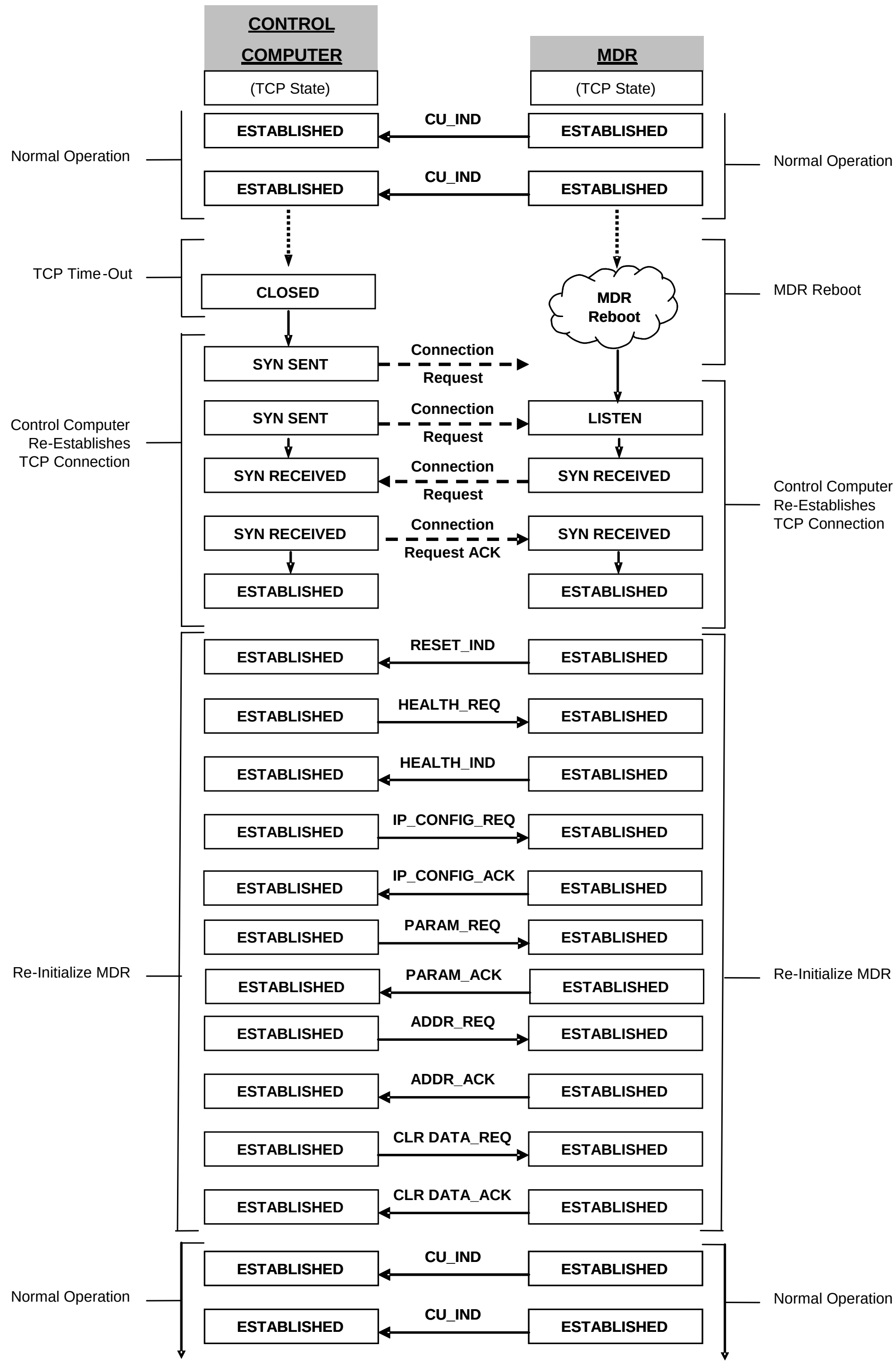


Figure 7-1 Power-Up Sequence for MDR Reset (VDL Mode 2)

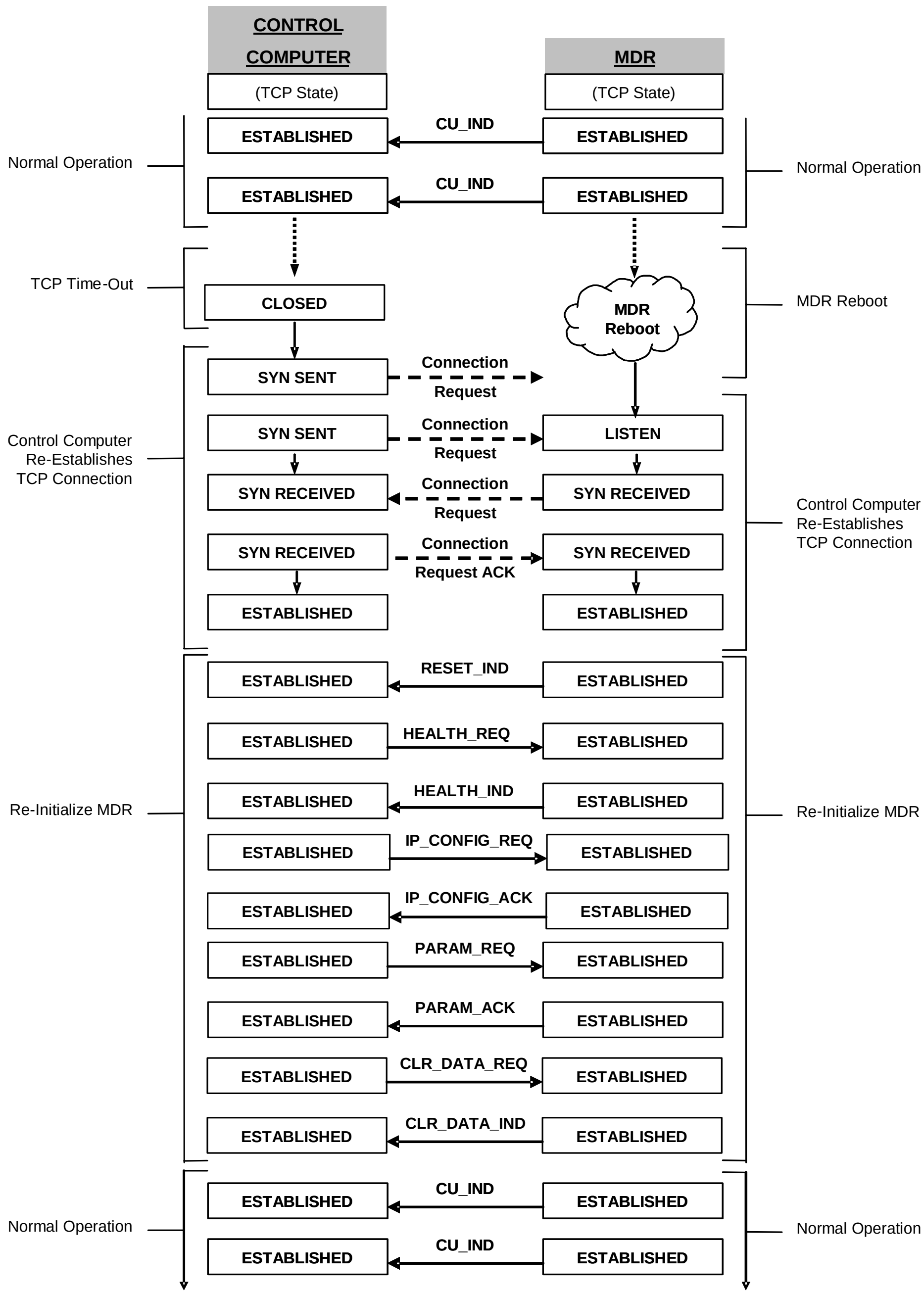


Figure 7-2 Power-Up Sequence for MDR Reset (ACARS)

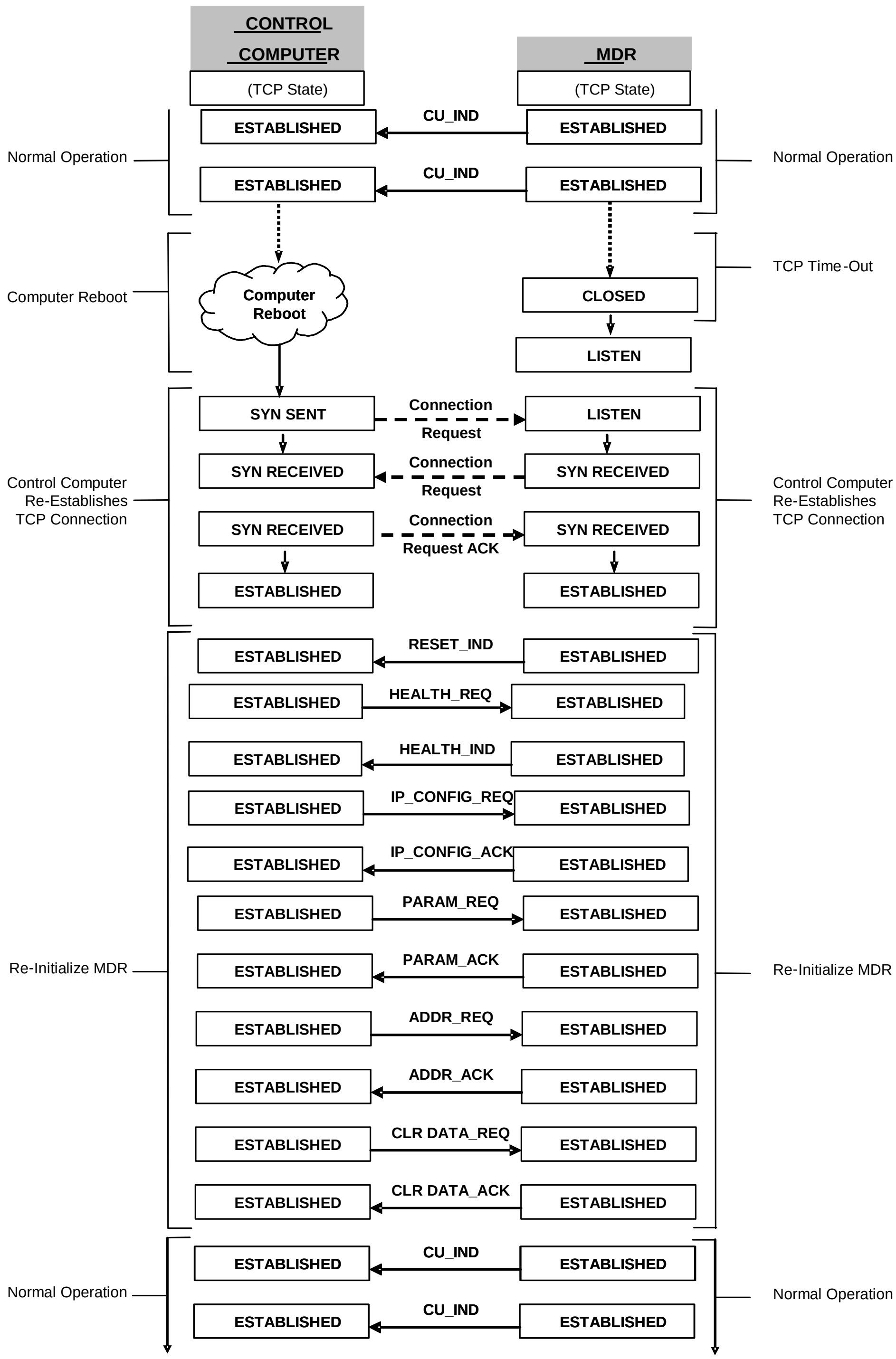


Figure 7-3 Power-Up Sequence for Control Computer Reboot (VDL Mode 2)

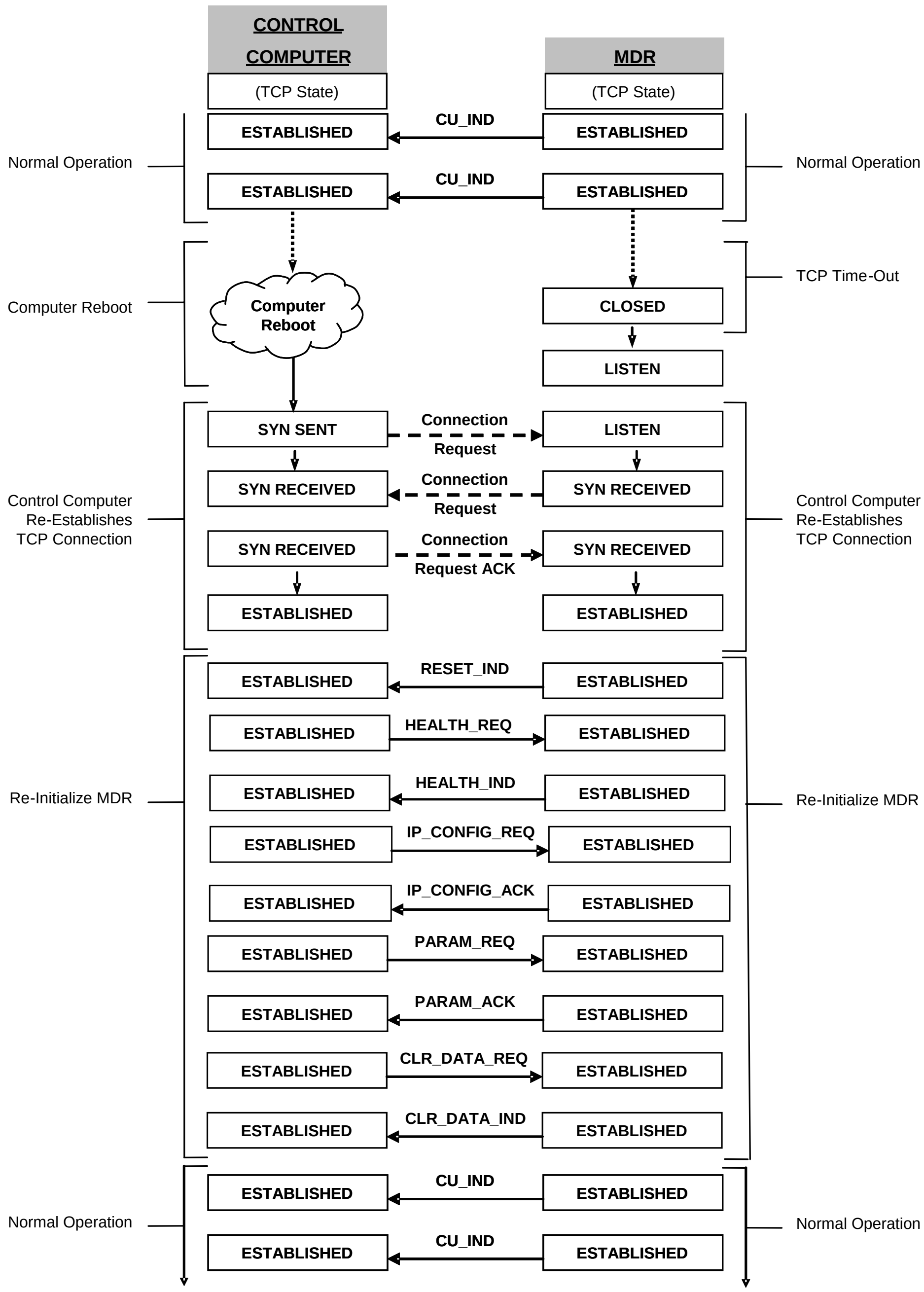


Figure 7-4 Power-Up Sequence for Control Computer Reboot (ACARS)

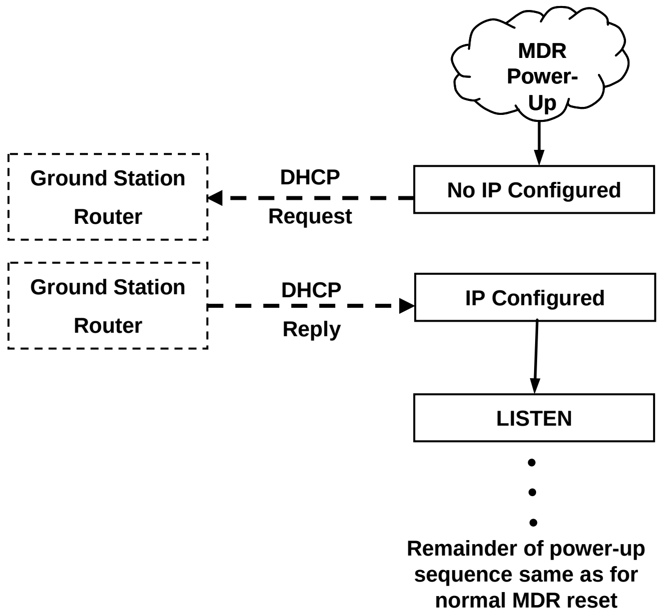


Figure 7-5   MDR Power-Up with DHCP Enabled

7.3 Operational Scenarios

7.3.1 VDL Mode 2 Operation

7.3.1.1 Uplinks

The ground station control computer is responsible for keeping track of the number of bits sent to the MDR for transmission. The MDR shall be capable of handling 131,071 bits of data.

The data will be sent to the radio in packets. Each packet will be the size of one AVLC frame. The AVLC frame size is variable with a maximum size of 16,504 bits. The ground station control computer will maximize the size of each transmission by sending as many AVLC frames to the MDR as can fit in 131K bits of space.

The data from the ground station control computer to the MDR will be sent in a Unit Data Command primitive. This command does not require, nor does it have, any associated response/acknowledgment from the MDR. It will be up to the ground station control computer to send the correct number of Unit Data commands to the radio.

The ground station control computer will send up to, but no more than, 131K bits of data in AVLC frames size packets. If the ground station control computer does not have 131K of data to send, it may elect to command the radio to transmit the smaller amount of data. (This detail is more important on the air side than the ground side.) The ground station control computer will not send the MDR more than 131K bits of data. Because the units of data passed to the radio are complete AVLC frames, the total amount of data sent to the MDR may be less than 131K bit if the next AVLC frame to be sent would cause an overflow of 131K bits.

After all the Unit Data has been sent to the MDR, the ground station control computer will generate a Transmit Data Command primitive to the radio. This command is an indication to the radio that no more data will be sent from the ground station control computer for transmission. On receipt of the Transmit Data Command from the ground station control computer, the MDR shall acknowledge with a Transmit Data Ack. The radio shall then proceed to format the data received from the ground station control computer for transmission. At this point, the data is passed from the input buffer to the next stage of processing and cannot then be cleared.

The ground station control computer will wait for an indication from the MDR that it is ready to receive more data for a new transmission. This indication will be a Buffer Empty Indication from the radio. This primitive will not indicate status of the current transmission. This primitive ONLY indicates that the radio can receive another 131K bits to create another transmission. The Buffer Empty indication does not indicate that the transmission has started or has completed.

After the ground station control computer receives a BUFFER_EMPTY_IND from the radio, it will repeat the process for sending data to the MDR for transmission. The ground station control computer can clear the buffer at any time by issuing a CLR_DATA_REQ primitive. The radio will respond with a CLR_DATA_ACK and a BUFFER_EMPTY_IND.

Errors with the command packet (Unit Data command) will be indicated by an Error Indication primitive sent from the radio. The MDR shall discard the data packet in error and continue processing.

A TM2 timer expiration will result in the MDR issuing a TM2_FAIL_IND primitive to the ground station control computer and discarding the message.

If the transmitter is turned off (see Section 7.3.5), it will continue to accept data from the ground station control computer, but after a Transmit Data Command, will simply discard the data.

See Figures 7-6 and 7-7 for VDL uplink sequence diagrams.

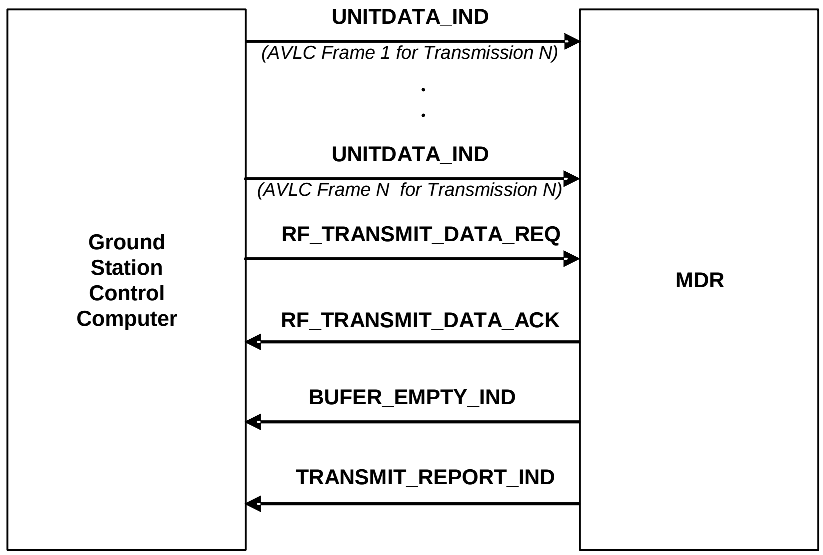


Figure 7-6 VDLPrimitive Exchange for a Single VDL Uplink

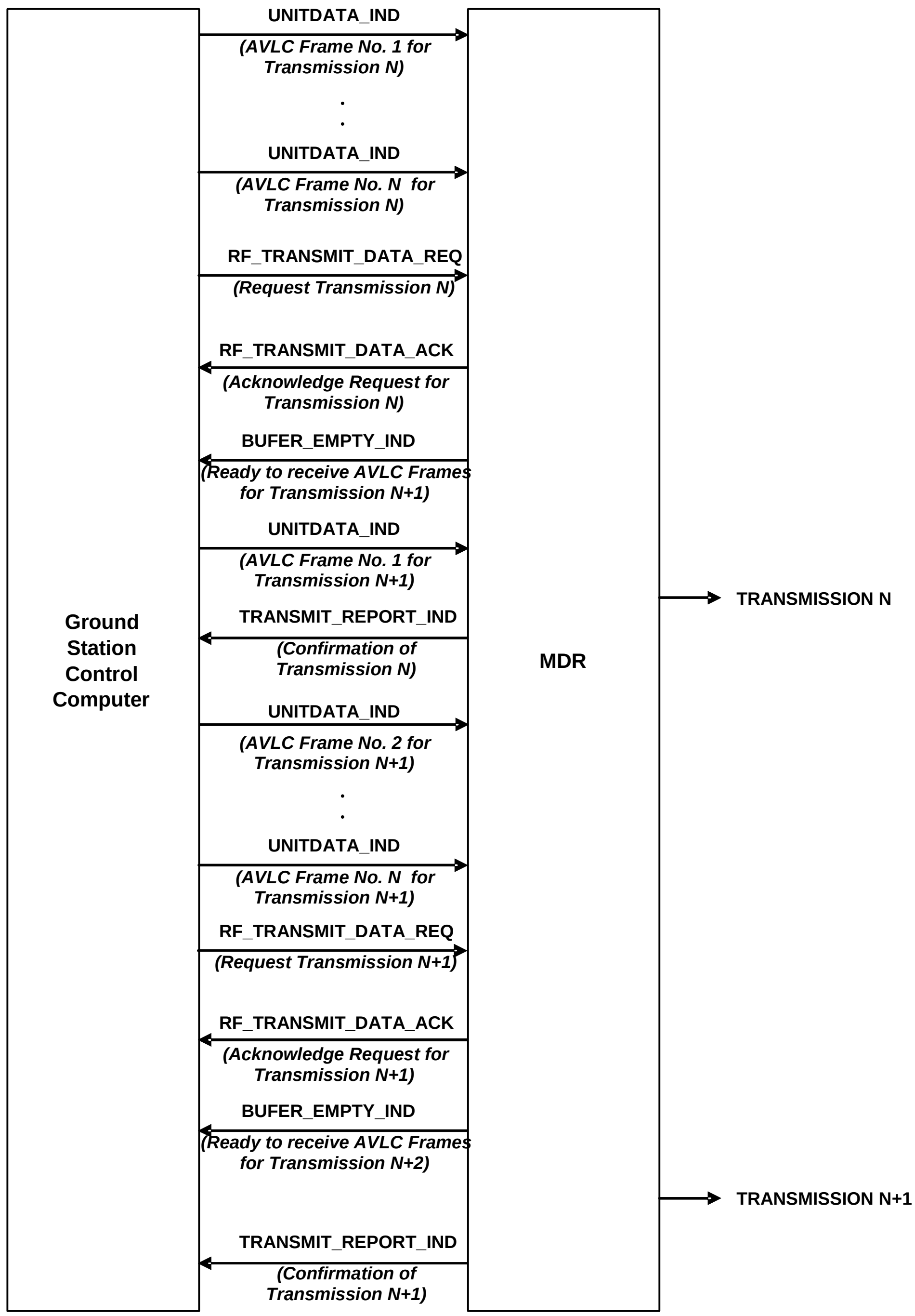


Figure 7-7 Primitive Exchange for 2 Consecutive VDL Transmissions

7.3.1.2 Downlinks

Downlink transmissions will be received by the MDR. Each downlink will consist of one or more AVLC frames. The radio will generate one and only one SQP indication if at least one AVLC frame passes the CRC (independent of Address Screening).

Only the AVLC frames that meet the Address Screening criteria (reference Section 7.3.3 of this document) will be passed along to the ground station control computer. Any frames that do not meet the Address Screening criteria will be discarded. A single SQP_IND will be sent to the ground station control computer if no frames in the received transmission meet the Address Screening criteria.

Each received AVLC frame is individually forwarded to the ground station control computer via the Unit Data command primitive. The ground station control computer does not acknowledge this command. The radio is notified of problems in forwarding of Unit Data via the Error Indication primitive.

The single SQP_IND for each received transmission will be forwarded by the MDR to the ground station control computer, immediately following the last UNITDATA_IND that forwards data for that received transmission.

If a received AVLC frame fails to pass the CRC, the MDR shall not pass that frame to the ground station control computer. If all AVLC frames in the reception fail the CRC, then all frames will be discarded and the radio shall not pass an SQP indication for that downlink to the ground station control computer.

See Figure 7-8 for a VDL downlink sequence diagram.

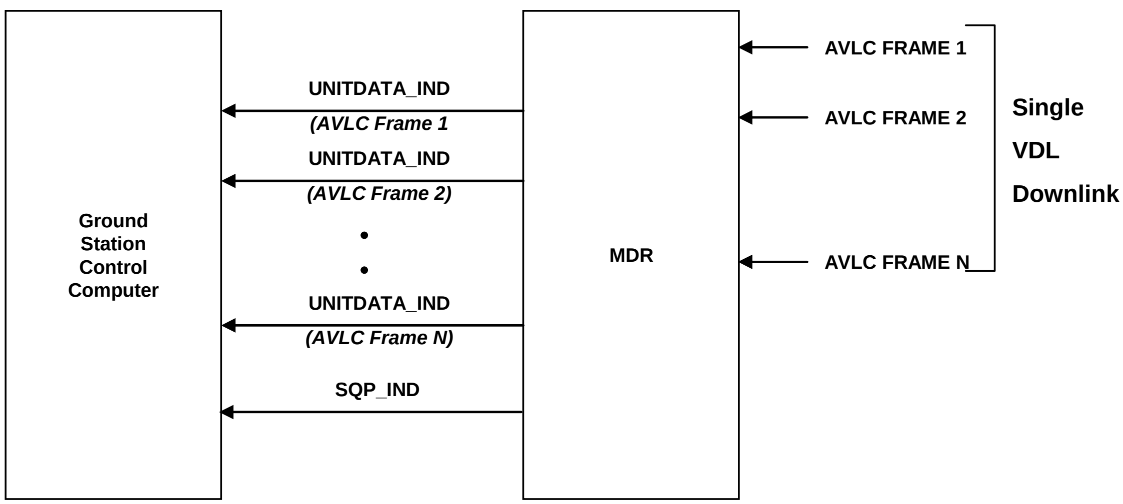


Figure 7-8 Primitive Exchange for a Multi-Frame VDL Downlink Reception

7.3.1.3 Address Screening

7.3.1.3.1 Address Filtering

A received frame should contain source and destination address fields (see Section 3.3 of this document). The MDR is capable of receiving both downlinks and uplinks. It is desirable that only those messages (downlinks) destined for this particular ground station control computer (Ground Station) be allowed to be passed to it from the radio.

This function is called Address Filtering. Its operation can be controlled by an octet in the PARAM_REQ primitive.

Primary operation of Address Filtering is accomplished by examining the destination address field of the Station Address portion of the AVLC frame and comparing it to an established set of acceptable addresses. The acceptable set is programmed into the MDR through use of the Station Address Set (SAS) passed to the radio in the ADDR_REQ primitive.

For certain conditions, it may be desirable to allow the MDR to send to the ground station control computer any uplinks it receives. This secondary operation of Address Filtering is accomplished by examining the source address field of the Station Address portion of the AVLC frame and comparing it to an established set of acceptable addresses that have been programmed into the radio through use of the SAS, as described above. The secondary Address Filtering operation is not a normal operational mode for the ground station; it is used for testing of the ground station or the VDLM2 system.

Before a receive frame can be sent to the ground station control computer, its address field should meet one of the following criteria for the Address Filter State established by PARAM_REQ:

Address Filtering State OOh

All messages heard by the radio shall be passed to the ground station control computer, regardless of Type field or Source or Destination Station Address.

Address Filtering State O1h

All messages heard by the radio shall be passed to the ground station control computer, if the Type field of the Destination Station Address indicates that the frame was destined for a ground station.

Address Filtering State O2h

All messages heard by the radio shall be passed to the ground station control computer, if the Station Address field of the Destination Station Address matches one of the addresses in the SAS and the Type field of the Destination Station Address field indicates that the frame was destined for a ground station.

Address Filtering State O3h

All messages heard by the radio shall be passed to the ground station control computer if:

- The Station Address field of the Destination Station Address matches one of the addresses in the SAS and the Type field of the Destination Station Address field indicates that the frame was destined for a ground station.

or

- The Station Address field of the Source Station Address matches one of the addresses in the SAS, regardless of Type field in the Source Station Address.

7.3.1.3.2 Loopback

For test purposes, it is desirable for the ground station to be able to receive its own transmissions, i.e., to hear itself. This function is called Loopback and can be enabled or disabled by an octet in the PARAM_REQ primitive.

Normally, loopback is disabled. Self-receptions are not presented to the Address Filtering Function or returned to the ground station control computer. When Loopback is enabled, the MDR shall present self-receptions to the Address Filtering function which will filter the received image in accordance with the state of the Address Filtering, as defined above.

7.3.1.4 Statistics

Statistics are related to RF and channel utilization. The ground station control computer will request the statistics or clear the statistics from the MDR with the Statistics Command primitive. The MDR shall respond with the Statistics Acknowledgment that will contain the current value of the statistics.

TCP/IP statistics will be collected only on the ground station control computer side of the ground station control computer/radio link. The MDR will not be queried for these statistics.

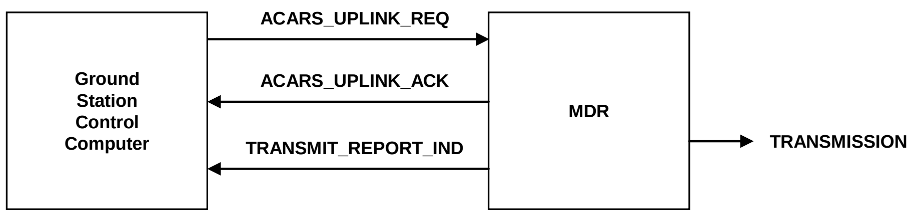
7.3.2 ACARS Operation

7.3.2.1 Uplinks

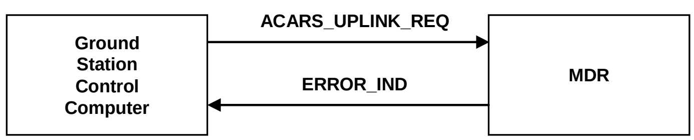
ACARS uplink blocks are received by the ground station control computer from the ACARS Central Processing System. The ground station control computer then assembles the block for transmission, including prepending prekey, bit sync, and character sync characters, as well as calculating and postpending the BCS sequence. The completed uplink block is sent to the MDR via the ACARS_UPLINK_REQ primitive.

The MDR then attempts to access the RF channel, and transmits the block when access is granted by the CSMA access control algorithm. The radio receives its own transmission as it is sent, and performs a character-by-character comparison to ensure the accuracy of the transmitted block. Once the block is transmitted, the MDR sends the ACARS_UPLINK_ACK primitive to the ground station control computer to communicate the final status of the uplink block (successfully transmitted, loopback failure, or unspecified error). Only after receiving this indication will the ground station control computer attempt to send another uplink block to the MDR.

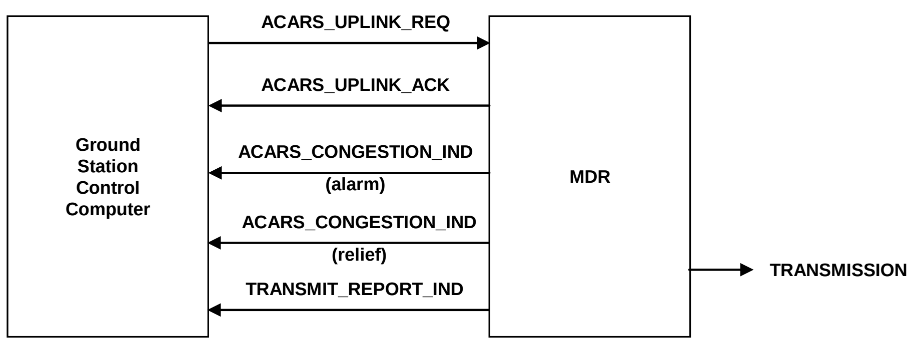
See Figure 7-9 for ACARS uplink sequence diagrams.



Primitive Exchange for a Normal ACARS Uplink



Primitive Exchange for an ACARS Uplink w/ bad request format



Primitive Exchange for an ACARS Uplink w/ congestion alarm

Figure 7-9 ACARS Uplink Data Exchange Sequences

7.3.2.2 Downlinks

When the MDR receives and decodes an ACARS downlink block, it sends the received block to the ground station control computer via the ACARS_DOWNLINK_IND primitive, including information on the received SSV, prekey duration, and any detected character errors (missing characters, parity error, length error, CRC error, etc.). The received block sent to the ground station control computer shall begin with the ACARS block SOH character and end with the BCS Suffix character.

See Figure 7-10 for ACARS downlink sequence diagrams.

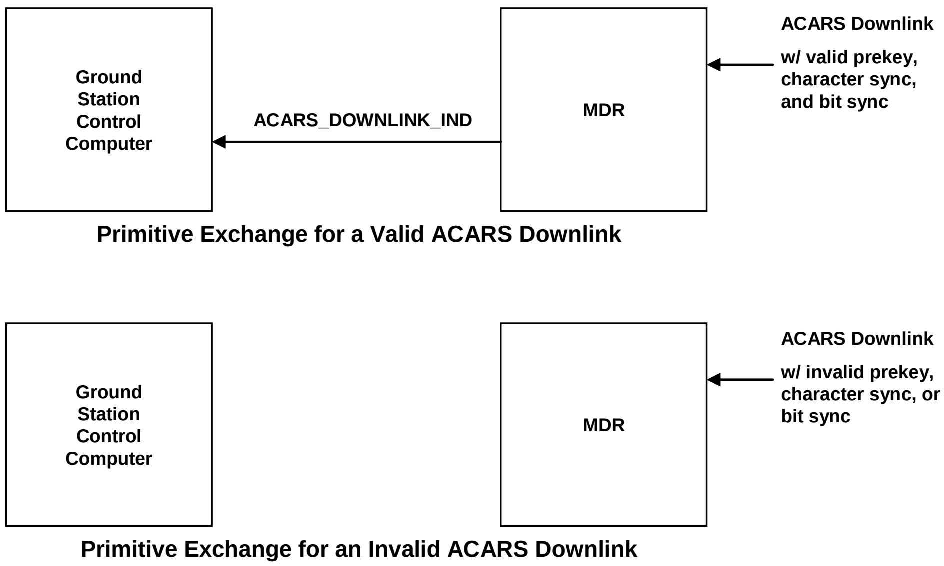


Figure 7-10 ACARS Downlink Data Exchange Sequences

7.3.2.3 Loopback

The MDR can hear it's own uplinks and uses the received uplink block to check for transmit errors. However, in normal operation, the radio does not send received uplinks to the ground station control computer. If loopback is enabled in ACARS mode, then the MDR shall send the received uplink block to the ground station control computer via the ACARS_DOWNLINK_IND primitive. The purpose of this capability is to facilitate remote troubleshooting.

7.3.2.4 RF Condition Reporting

The MDR reports the following RF conditions when operating in ACARS mode:

Once every 10 seconds, the MDR shall send the CU_IND primitive to the ground station control computer to report the percentage RF utilization. CU_IND shall be calculated as a percentage of time the RF is busy over the immediate past 10 seconds.

The MDR shall send the ACARS_CONGESTION_IND to the ground station control computer whenever a congested channel is detected based on the ACARS TM2 value. This parameter indicates the percentage of time that the channel is occupied either by this radio or by other stations.

The MDR shall send the STUCK_CARRIER_IND primitive to the ground station control computer whenever a stuck carrier is detected based on AGC level and ACARS TM3 value. When the stuck carrier condition clears, the MDR shall send the STUCK_CARRIER_IND (with Carrier Status = Alarm Relief) to the ground station control computer.

7.3.3 Transmit Disable

Transmitting of the MDR can be disabled by configuring the Tx Enable flag to Off via the PARAM_REQ primitive.

7.4 Error Handling

The ERROR_IND primitive is used to indicate problems with passing and processing of commands or data between the ground station control computer and the MDR. It is also used to report software errors in the radio to the ground station control computer. The primitive provides an error code as well as an octet for an error data field. If the error occurred as the result of processing a received primitive, due to bad data length for example, the error data field should contain the PID of the offending primitive (as currently defined). These indications can be sent in either direction.

Because there is no requirement for the radio to take action in response to an ERROR_IND from the ground station control computer, the ground station control computer is not required to generate an ERROR_IND when it detects an erroneous primitive from the radio or if it does not receive an appropriate or timely (within 10 seconds) response from the MDR.

Hardware faults in the radio give rise to an unsolicited HEALTH_IND indication. These include monitoring every transmission (RF loopback) to check for correct transmitter operation. Built-in test is ongoing and gives information based on normal operation. Heath status faults are divided into two categories: errors and warnings. Errors are serious conditions that prevent normal operation. Warnings are fault indications where operation can continue (and quite often cannot be associated uniquely with the MDR, such as high VSWR). Once an error is detected, the radio can be reset (RESET_REQ) to clear the indication. Warnings are cleared when the warning condition is found to have disappeared. Health status indications can be requested by the HEALTH_REQ command and are returned in a HEALTH_IND primitive. This primitive is also sent unsolicited if the health status changes.

The ground station control computer can reset the radio to its power-up state if the MDR is perceived to be in an unknown state. The Reset command from the ground station control computer will result in the MDR performing a warm boot on itself. After rebooting, the radio will issue a RESET_IND indication.

No explicit means is provided for the MDR for fatal error recovery because the nature of a fatal error may prevent the radio from recovering. In this event, the radio shall reset itself.

7.5 Software Download

The MDR can have new software installed to it from the Ethernet and HDLC connections. However, unlike the VDR, there is no BOOT mode and the operational code is responsible for programming the flash device.

Therefore, to install new software, there is no need to reset the radio into BOOT mode and this step can be left out with no adverse effect to the software download process. However, to keep inline with the existing procedures, if a RESET_REQ is sent, it is responded to by a RESET_IND. When in this pseudo BOOT mode, all outgoing messages from the radio are inhibited and all incoming non software-download related messages are ignored.

The ground station can then send a SW_DOWNLOAD_START_REQ message with the required fill number – any MDR mode can be uploaded to either fill area (set as fill area parameter 1 or 2). New Ethernet software can be uploaded by selecting 3 as the fill area parameter. If an invalid fill area is given, then an ERROR_IND will be returned.

A sequence diagram detailing software download is shown in figure 7-11.

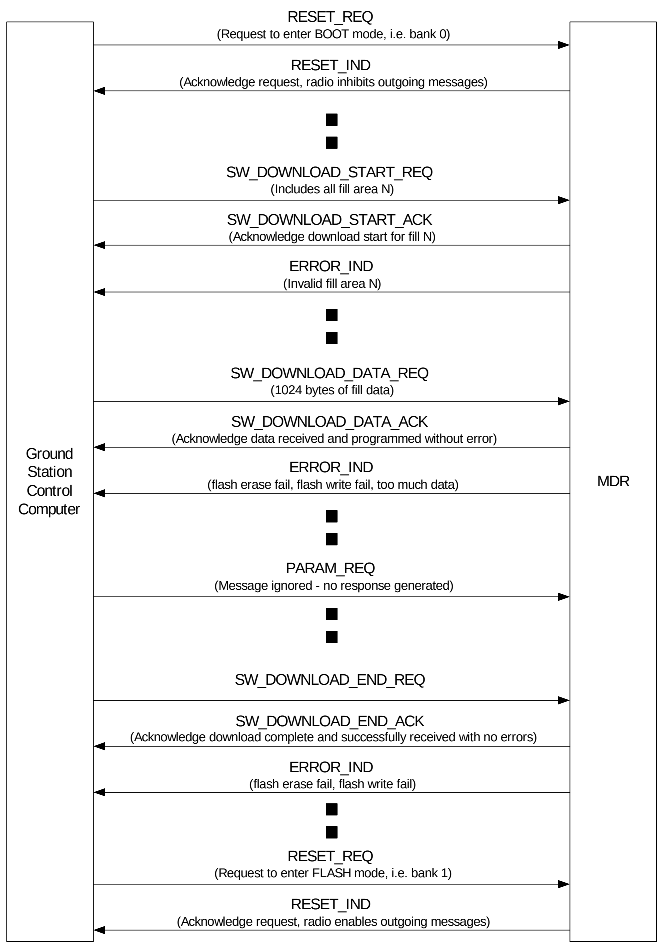


Figure 7-11 Software Download Sequence

7.6 Scratch Pad Space

The scratch area is a nonvolatile storage space of at least 20 characters inside the MDR that can be used to store inventory or engineering information. The primitives (SCRATCH_AREA_REQ and SCRATCH_AREA_ACK) allow the ground station control computer to either read the contents of the scratch area or write new information depending on a control byte.

The data that the ground station control computer stores in each character position must be an ISO-5 character in the range 20h to 7Eh (i.e., a printable character). When reading, the MDR returns the data exactly as stored. Any corruption that might have occurred in the nonvolatile storage are passed back to the ground station control computer verbatim. It is up to the ground station control computer to include checking information in the data stored if this is required.

7.7 Interruptive Built-In Test

MDR Interruptive Built-In Test (IBIT) will exercise the radio, including the transmitter and receiver. During IBIT, the normal functions of the MDR are not available. IBIT will confirm the operation and report health of the following functional areas:

- RF Drive
- Forward and Reflected Power
- Modulation Depth
- Power Amplifier (PA)
- Sensitivity
- TX and RX RF Filters
- IF Filters
- Audio path loss
- Base Band

IBIT is available only in Voice Mode. In order to initiate IBIT, the ground station control computer must ensure that the Voice Mode software fill is loaded into the MDR, change mode to Voice, and issue the IBIT_REQ primitive. Once the IBIT is complete, the MDR will respond with the IBIT_IND primitive showing test results.

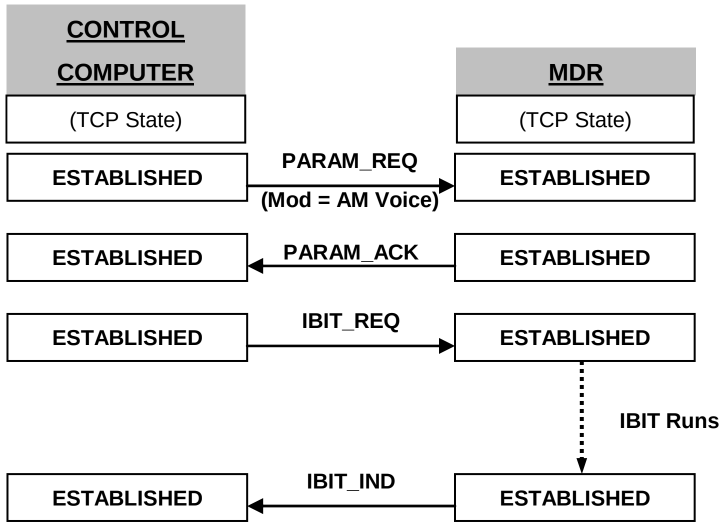


Figure 7-12 Data Exchange Sequence to run IBIT

Appendix A. RADIO CONTROL PRIMITIVES

A.1. Primitive Structure

The interface definition supports a simple structure for its primitives. Each primitive is uniquely identified by a parameter identifier,the first octet in the message. The format is as follows:

Octet	***Definition***
1	Primitive Identifier
2	Data Field Length MSB
3	Data Field Length LSB
4	Data Byte #1
5	Data Byte #2
.	.
.	.
N+3	Data Byte #N

In all octets, the bits are defined MSB to LSB (8-1). If a set of octets are to be grouped together to form a value, the most significant octet is sent first (i.e., the value is 24 bits or 3 octets long. Data Byte #1 = bits 24-17, Data Byte #2 = bits 16-9, Data Byte #3 = bits 8-1).

The primitives are used by the ground station control computer to set up and maintain the operation of the MDR operating in VDL Mode 2. The MDR uses primitives to report its configuration and to indicate error conditions. VDL Mode 2 AVLC frames (void of any flag, bit stuffing, or FCS information) are transferred across the interface through primitives, as are ACARS blocks.

Primitive ID	*Length (MSB)*	*Length (LSB)*	*Data*
1 Octet	1 Octet	1 Octet	N Octets

Table A-1 illustrates the primitives organized by REQ/ACK and IND. Table A-2 illustrates the primitives grouped by PID.

Table A-1 Primitives Grouped by REQ/ACK and IND

Primitive Name	***PID***
PARAM_REQ	0x20
PARAM_ACK	0x50
IP_CONFIG_REQ	0x44
IP_CONFIG_ACK	0x6C
ADDR_REQ	0x22
ADDR_ACK	0x52
RESET_REQ	0x24
RESET_IND	0x54
STATISTICS_REQ	0x27
STATISTICS_ACK	0x57
RF_XMIT_DATA_REQ	0x28
RF_XMIT_DATA_ACK	0x58
CLR_DATA_REQ	0x29
CLR_DATA_ACK	0x59
ACARS_UPLINK_REQ	0x36
ACARS_UPLINK_ACK	0x66
ERROR_IND	0x51
HEALTH_REQ	0x23
HEALTH_IND	0x53
IBIT_REQ	0x45
IBIT_IND	0x6D
SQP_IND	0x56
CU_IND	0x55
BUFFER_EMPTY_IND	0x60
TM2_FAIL_IND	0x61
UNITDATA_IND	0x21
SCRATCH_AREA_REQ	0x2A
SCRATCH_AREA_ACK	0x5A
ACARS_DOWNLINK_IND	0x67
BACKGROUND_NOISE_REQ	0x43
BACKGROUND_NOISE_IND	0x68
STUCK_CARRIER_IND	0x69
ACARS_CONGESTION_IND	0x6B
SW_DOWNLOAD_START_REQ	0x40
SW_DOWNLOAD_START_ACK	0x70
SW_DOWNLOAD_DATA_REQ	0x41
SW_DOWNLOAD_DATA_ACK	0x71
SW_DOWNLOAD_END_REQ	0x42
SW_DOWNLOAD_END_ACK	0x72
TRANSMIT_REPORT_IND	0x73
Reserved for vendor use	0xF0 – 0xFF

Table A-2 Primitives Grouped by PID

Primitive Name	***PID***
PARAM_REQ	0x20
UNITDATA_IND	0x21
ADDR_REQ	0x22
HEALTH_REQ	0x23
RESET_REQ	0x24
STATISTICS_REQ	0x27
RF_XMIT_DATA_REQ	0x28
CLR_DATA_REQ	0x29
SCRATCH_AREA_REQ	0x2A
ACARS_UPLINK_REQ	0x36
SW_DOWNLOAD_START_REQ	0x40
SW_DOWNLOAD_DATA_REQ	0x41
SW_DOWNLOAD_END_REQ	0x42
BACKGROUND_NOISE_REQ	0x43
IP_CONFIG_REQ	0x44
IBIT_REQ	0x45
PARAM_ACK	0x50
ERROR_IND	0x51
ADDR_ACK	0x52
HEALTH_IND	0x53
RESET_IND	0x54
CU_IND	0x55
SQP_IND	0x56
STATISTICS_ACK	0x57
RF_XMIT_DATA_ACK	0x58
CLR_DATA_ACK	0x59
SCRATCH_AREA_ACK	0x5A
BUFFER_EMPTY_IND	0x60
TM2_FAIL_IND	0x61
ACARS_UPLINK_ACK	0x66
ACARS_DOWNLINK_IND	0x67
BACKGROUND_NOISE_IND	0x68
STUCK_CARRIER_IND	0x69
ACARS_CONGESTION_IND	0x6B
IP_CONFIG_ACK	0x6C
IBIT_IND	0x6D
SW_DOWNLOAD_START_ACK	0x70
SW_DOWNLOAD_DATA_ACK	0x71
SW_DOWNLOAD_END_ACK	0x72
TRANSMIT_REPORT_IND	0x73
Reserved for vendor use	0xF0 – 0xFF

A.2. Primitive Types

The primitives that are transferred between MDR and ground station control computer are used for all command and data transfer. Primitives are of the following three generic types:

REQUEST:	The REQUEST primitive is used when a response is required. Primitives of this type have the form XXX_REQ.
ACKNOWLEDGED:	The ACKNOWLEDGED primitive is used in response to a previous REQUEST primitive. Primitives of this type have the form XXX_ACK.
INDICATION:	The INDICATION primitive is used to convey information that does not require a response.

Note that primitives are listed in order of PID.

The validity of the primitive in each mode of operation is shown as a series of check-boxes:

☐ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

A.2.1. PARAM_REQ [PID 0x20]

This primitive is sent by the ground station control computer to set all operating parameters of the MDR, including frequency and mode of operation (ACARS, VDL Mode 2, or AM Voice). Depending on its contents, the ground station control computer can request the state of all parameters or set the value of all parameters. For VDL Mode 2 operation, see Section 7.3.1.3 for a description of the interaction between Loopback and address filtering.

NOTE: A PARAM_REQ with a mode different from the current mode will cause the MDR to reset. The control computer will perform normal initialization procedures following the reset.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block, structured as one of the following depending on the value of the Control Octet and Modulation Format field:

For Request of all Parameters:

Octet	***Parameters***	***Value or Range***
1	PID	0x20
2	Data field length MSB	0x0001 *An ERROR_IND primitive is returned for a request with any other length*
3	Data field length LSB	
4	Control Octet	0x00 = requests state of all parameters

For VDL Mode 2:

Octet	Parameters	Value or Range
1	PID	0x20
2	Data field length MSB	0x0011
3	Data field length LSB	
4	Control Octet	0x01 = set all parameters
5	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 MHz is 131,775 kHz and is expressed as 31,775, or 0x7C1F Default = 136.975 MHz (0x906F)
6	Frequency LSB	
7	Modulation format	0x02 for VDL Mode 2
8	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
9	TM1 value	0.5 – 125.0 ms, 0.5 ms step size (0x01 – 0xFA) Default = 4.5 msec (0x09)
10	TM2 value	6 - 120 sec, 1 s step size (0x06 – 0x78) Default = 60 sec (0x3C)
11	M1 MSB	1 through 65535 (0x0001 – 0xFFFF) Default = 135 (0x0087)
12	M1 LSB	
13	ρ-Persistence value	ρ = 1/256 – 1, 1/256 step size, (0x00 – 0xFF) Default = 13/256 (0x0C)
14	Bit scramble vector value (MSB)	0000h-7FFFh Default = 0x4D4B
15	Bit scramble vector value (LSB)	
16	Transmitter power output level	3-25 watts, 1 watt step size (0x03 – 0x19) Default = 25 Watts (0x19)
17	Address filtering	0x00 – 0x03 as defined in section 7.3.1.3 (default = 0x02)
18	Tx enable ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
19	Loopback ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
20	Reed Solomon Decoding ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON

For ACARS:

Octet	Parameters	Value or Range
1	PID	0x20
2	Data field length MSB	0x0013
3	Data field length LSB	
4	Control Octet	0x01 = set all parameters
5	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 Mhz is 131,775 kHz and is expressed as 31,775, or 0x7C1F Default = 131.550 MHz (0x7B3E)
6	Frequency LSB	
7	Modulation format	0x01 for digital ACARS
8	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
9	TM1 value Back-off time after refusal of channel access by the p-persistent CSMA algorithm.	0.5 – 125.0 ms, 0.5 ms step size (0x01 – 0xFA) Default = 75.5 ms (0x97)
10	TM2 value Maximum time a block may remain in the transmit queue before generation of Channel Congestion Alarm.	1 - 120 sec, 1 s step size (0x01 – 0x78) Default = 60 sec (0x3C)
11	TM3 value Time the RF Channel must remain in the Busy or Busy-Idle Pending State before transitioning to the Stuck Carrier State.	1 - 120 sec, 1 s step size (0x01 – 0x78) Default = 20 sec (0x14)
12	ρ-Persistence value Probability that the CSMA algorithm grants access to an idle channel.	ρ = 1/256 – 1, 1/256 step size, (0x00 – 0xFF) Default = 50/256 (0x31)
13	ACARS signal power level Signal power level used for Stuck Carrier determination.	-110 to -40 dBm 1 dB step size (0x00 – 0x46) Default = -90 dBm (0x14)
14	Idle Time Time to transition RF Channel from Busy to Idle state after detection of no activity.	10 – 130 ms, 1 ms step size (0x0A – 0x82) Default = 13 ms (0x0D)
15	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19) Default = 25 Watts (0x19)
16	Tx enable ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
17	Loopback message forwarding ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
18	M1 Back-off Counter MSB Maximum number of times to back off	2 – 9999 (0x02 – 0x270F) Default = 10 (0x0A)

Octet	Parameters	Value or Range
	when trying to access an idle channel.	
19	M1 Back-off Counter LSB	
20	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F) Default = 90% (0x5A)
21	Min delay between TX MSB	50 – 500 ms (0x0032 – 0x01F4) Default = 100 ms (0x0064) Minimum time between the end of transmission and the beginning of a subsequent transmission
22	Min delay between TX LSB	

For AM Voice operation:

Octet	Parameters	Value or Range
1	PID	0x20
2	Data field length MSB	0x000E
3	Data field length LSB	
4	Control Octet	0x01 = set all parameters
5	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 MHz is 131,775 kHz and is expressed as 31,775, or 0x7C1F Default = 118.000 MHz (0x4650)
6	Frequency LSB	
7	Modulation format	0x05 for AM Voice
8	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
9	Keying control	0x00 Disable tone keying (Default) 0x01 2,175 Hz tone keying 0x02 2,300 Hz tone keying
10	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19) Default = 25 Watts (0x19)
11	Tx enable ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON
12	Audio input line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E) Default = -5 dBm (0x0F)
13	Audio output line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E) Default = -5 dBm (0x0F)
14	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F) Default = 90% (0x5A)
15	Carrier squelch level	-110 to -60 dBm, 1 dB step (0x00 – 0x32) Default = -110 dBm (0x00)
16	Base Frequency Offset	0x00 On Frequency (Default) 0x01 + 2 ½ kHz 0x02 – 2 ½ kHz

Octet	Parameters	Value or Range
		0x03 + 5 kHz 0x04 – 5 kHz 0x05 + 7 ½ kHz 0x06 – 7 ½ kHz
17	Channel Separation	0x00 25 kHz separation, on channel (Default) 0x01 8.33 kHz,separation, on channel 0x02 8.33 kHz separation, + 8.33 kHz 0x03 8,33 kHz separation, +16.66 kHz

For Analog ACARS operation:

Octet	Parameters	Value or Range
1	PID	0x20
2	Data field length MSB	0x000A
3	Data field length LSB	
4	Control Octet	0x01 = set all parameters
5	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 Mhz is 131,775 kHz and is expressed as 31,775, or 0x7C1F Default = 131.550 MHz (0x7B3E)
6	Frequency LSB	
7	Modulation format	0x00 for analog ACARS
8	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
9	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19) Default = 25 Watts (0x19)
10	Tx enable ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON
11	Audio input line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E) Default = -5 dBm (0x0F)
12	Audio output line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E) Default = -5 dBm (0x0F)
13	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F) Default = 90% (0x5A)

Normal Response

The MDR respond to this primitive with a PARAM_ACK primitive containing the active values of the MDR for all the above parameters in the current operating mode (ACARS, VDL Mode 2, AM Voice).

Error Response

In the event the MDR detect an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem. If the necessary software fill for the specified modulation format is not loaded onto the MDR, it will send an ERROR_IND primitive, and remain in the current operating mode. If any parameter is out of range the MDR will respond with an ERROR_IND and the entire PARAM_REQ will be rejected with no parameters accepted. If a transmission is in progress when the MDR processes the PARAM_REQ the MDR will respond with an ERROR_IND and reject the PARAM_REQ

A.2.2. UNITDATA_IND [PID 0x21]

This primitive is used by both the ground station control computer and MDR to send AVLC data to the other during the course of VDL Mode 2 operation. It contains one AVLC frame.

The total amount of data sent by the ground station control computer shall not exceed 131,071 bits, minus the bit stuffs and flags that are added on by the MDR.

The ground station control computer sends AVLC frames to the MDR in the UNITDATA_IND for transmission. The MDR sends the ground station control computer AVLC frames, received over the RF, in the UNITDATA_IND.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	***Parameters***	***Value or Range***
1	PID	0x21h
2	Data field length MSB	0x0001 – 0x07FF
3	Data field length LSB	
4	Data field byte #1	AVLC frame as defined in VDL SARPs, without flags, bit stuffs, or FCS
5	Data field byte #2	
.	.	
.	.	
.	.	
N+3	Data field byte #N	

Normal Response

No response is expected.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.3. ADDR_REQ [PID 0x22]

This primitive is sent by the ground station control computer to manage addresses used by the MDR for address screening during the course of VDL Mode 2 Operation. Depending on the contents, the ground station control computer can request a list of all addresses or set all addresses in the SAS. Any addresses set using this primitive should completely replace the existing contents of the SAS, thus if the ground station control computer wishes to delete all entries in the SAS, it can do so by sending a NULL table to the MDR (octet 5 = 0).

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of two formats, one to request the addresses and one to set the addresses:

For Request:

Octet	Parameter	Value or Range
1	Primitive ID	0x22
2	Data field length MSB	0x0001 *An ERROR_IND primitive is returned for a request with any other length*
3	Data field length LSB	
4	Control Octet	0x00 = request list of all addresses in DAS

For Set:

Octet	*Parameters*	*Value or Range*
1	PID	0x22
2	Data field length MSB	0x0005 – 0x0032, where 0x32 accounts for 16*3 + 2 octets.
3	Data field length LSB	
4	Control octet	0x01 = set the following addresses.
5	N, number of addresses	1 – 16 (0x01 – 0x10) The number of addresses contained in the file.
6	Address 1, bits 24-17	The 3 octets of the address compose the 24-bit ICAO administered address and map to bits 1-24 of the Station Address Field in the Source or Destination Address Fields of the AVLC Frame.
7	Address 1, bits 16-9	
8	Address 1, bits 8-1	
9	Address 2, bits 24-17	
10	Address 2, bits 16-9	
11	Address 2, bits 8-1	
.	.	
.	.	
5+3*N	Address N, bits 8-1	

Normal Response

The MDR shall respond with an ADDR_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.4. HEALTH_REQ [PID 0x23]

The ground station control computer issues this primitive to request the MDR to send its current health status data.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of a command word, formatted as follows:

Octet	***Parameters***	***Value or Range***
1	PID	0x23
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR responds with a HEALTH_IND primitive within one second.

Error response

In the event the MDR detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.5. RESET_REQ [PID 0x24]

The RESET_REQ primitive is sent by the ground station control computer to reset the MDR to its power-up initialized state. After resetting, the MDR conducts a full BIT and issues a RESET_IND as on normal power up.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x24
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Software bank	0x00 = reserved 0x01 = OPERATION mode

Normal Response

The MDR responds with a RESET_IND primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem. If the software bank is set to 0x00, it shall send an ERROR_IND response.

A.2.6. STATISTICS _REQ [PID 0x27]

The STATISTICS_REQ is a primitive sent from the ground station control computer to the MDR in the course of VDL Mode 2 operation requesting RF communication statistics. The MDR responds with a STATISTICS_ACK that contains the statistics information.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of a command word, formatted as follows:

Octet	Parameters	Value or Range
1	PID	0x27
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR shall respond with a STATISTICS_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem.
.

A.2.7. RF_XMIT_DATA_REQ [PID 0x28]

This primitive is sent by the ground station control computer to command the MDR to transmit its current buffer over the air during the course of VDL Mode 2 operation.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of a command word, formatted as follows:

Octet	***Parameters***	***Value or Range***
1	PID	0x28
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR shall respond with an RF_XMIT_DATA_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.8. CLR_DATA_REQ [PID 0x29]

This primitive is sent by the ground station control computer to command the MDR to clear its current transmit buffers and prepare to receive new data. This primitive is used after reboots of either the MDR or control computer, and in VDL Mode 2 operation allows the ground station control computer to put the MDR into a known state if a problem arises when transferring AVLC data for transmission.

In ACARS mode, this command is only used to restart the flow of CU_IND after MDR restart.

☑ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of a command word, formatted as follows:

Octet	*Parameters*	*Value or Range*
1	PID	0x29
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR shall respond with a CLR_DATA_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.9. SCRATCH_AREA_REQ [PID 0x2A]

This primitive is sent by the ground station control computer to access the scratch area in the MDR. The primitive allows the ground station control computer to either read the contents of the scratch area or write new information depending on a control byte. When reading, the MDR returns the data exactly as stored. It is up to the ground station control computer to include checking information in the data stored if this is required.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of two formats, one to read the scratch area and one to write the scratch area:

For Request:

Octet	Parameter	Value or Range
1	Primitive ID	0x2A
2	Data field length MSB	0x0001
3	Data field length LSB	*An ERROR_IND primitive is returned for a request with any other length*
4	Control Octet	0x00 = read scratch area

For Set:

Octet	***Parameters***	***Value or Range***
1	PID	0x2A
2	Data field length MSB	0x0015
3	Data field length LSB	
4	Control octet	0x01 = write scratch area. Followed by 20 octets with data to be written.
5	Char 1	0x20 – 0x7E
6	Char 2	0x20 – 0x7E
...		
...		
24	Char 20	0x20 – 0x7E

Normal Response

The MDR shall respond with a SCRATCH_AREA_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.10. ACARS_UPLINK_REQ [PID 0x36]

This primitive is used by the ground station control computer in the course of ACARS operation to send an ACARS uplink block to the MDR. The size of the data field shall not exceed 303 bytes (2,424 bits). Upon receipt of this primitive, the MDR shall immediately initiate CSMA channel access and transmit the message as soon as the media access algorithm permits.

Uplink blocks shall be assigned a sequential ID number (~~1~~0 – 255) for use by the MDR to report the final status of the uplink.

☑ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	*Parameter*	*Value or Range*
1	Primitive ID	0x36
2	Data field length MSB	Up to 0x0130
3	Data field length LSB	
4	Uplink ID Number	~~1~~0 – 255 (0x00 to 0xFF) Roll over to 0x00 after 0xFF
5	Block byte No. 1	
6	Block byte No. 2	
7	Block byte No. 3	
•	•	
•	•	
•	•	
n+9	Block byte No. n	

Normal Response

MDR sends the ACARS_UPLINK_ACK upon transmission of the uplink block.

Error Response

In the event the MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.11. SW_DOWNLOAD_START_REQ [PID 0x40]

This primitive is sent to the MDR to request the start of a software download.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x40
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Software to be updated	0x00 = Reserved 0x01 = First mode fill 0x02 = Second mode fill 0x03 = Ethernet

Normal Response

The MDR shall respond with a SW_DOWNLOAD_START_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.12. SW_DOWNLOAD_DATA_REQ [PID 0x41]

This primitive is sent to the MDR to transfer a block of software transmitted as several binary records and stored in flash. The robust TCP link ensures the error-free delivery of the records. The size of each record is 1024 octets except the last record which can be from 1 to 1024 octets.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x41
2	Data field length MSB	0x0001 – 0x0400
3	Data field length LSB	
4	Record data octet 1	0x00 – 0xFF
	• • •	
N + 3	Record data octet N	0x00 – 0xFF

Normal Response

The MDR shall respond with a SW_DOWNLOAD_DATA_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.13. SW_DOWNLOAD_END_REQ [PID 0x42]

This primitive is sent to the MDR after the last record has been transferred and acknowledged. It indicates the download is complete. The MDR will validate the whole of the downloaded software against the checksum it contained.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x42
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR shall respond with a SW_DOWNLOAD_END_ACK primitive.

Error Response

In the event the MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.14. BACKGROUND_NOISE_REQ [PID 0x43]

This primitive is used to request a report of background noise on the RF channel.

Upon receipt of the BACKGROUND_NOISE_REQ primitive, the MDR shall measure the average and peak received channel energy for the period of time specified in the Measurement Period. If the Message Exclusion boolean is set to 0x00, then all received traffic shall be included in the measurement, including valid messages for the current mode (ACARS or VDLM2). If the Message Exclusion boolean is set to 0x01, then receipt of a valid message for the current mode (ACARS or VDLM2) shall cause the MDR to reset the measurement period timer, clear the average and peak readings, and restart the measurement process. Once the measurement is complete, the MDR shall transmit the BACKGROUND_NOISE_IND primitive, reporting the measurement values. If, due to repeated restarts caused by valid message traffic, the measurement cannot be completed before the Measurement Timeout Period, the MDR shall transmit the BACKGROUND_NOISE_IND primitive, reporting the timeout condition.

☑ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x43
2	Data field length MSB	0x0003
3	Data field length LSB	
4	Measurement Period	0.25 – 60 seconds, step size of 0.25 seconds (0x01 – 0xF0)
5	Time-Out Period	1 – 255 seconds, step size of 1seconds (0x01 – 0xFF)
6	Message Exclusion	0x00 = include valid messages in measurement 0x01 = exclude valid messages from measurement

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return the ERROR_IND primitive.

A.2.15. IP_CONFIG _REQ [PID 0x44]

This primitive configures the MDR IP Address, Subnet Mask, Default Gateway, Control Application TCP Port number, and TCP Keepalive parameters. Depending on its contents, the ground station control computer can request the state of the IP parameters or set the value of IP parameters. Setting IP parameter values results in an MDR reset. The resulting IP_CONFIG_ACK is sent on the current connection and reflects the new values.

If the MDR detects IP_CONFIG_REQ supplied address is in use it will respond with an ERROR_IND and not change any parameters.

NOTE: The MDR shall use the following default IP configuration parameters:

- IP Address: 192.168.0.2
- Subnet Mask: 255.255.255.248
- Default Gateway IP: 192.168.0.1
- Control Application Port: 10555 (0x293B)
- DHCP: off

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of two formats, one to request the parameter states and one to set the parameters:

For Request:

Octet	Parameter	Value or Range
1	Primitive ID	0x44
2	Data field length MSB	0x0001 *An ERROR_IND primitive is returned for a request with any other length*
3	Data field length LSB	
4	Control Octet	0x00 = requests state of parameters

For Set:

Octet	Parameter	Value or Range
1	Primitive ID	0x44
2	Data field length MSB	0x0013
3	Data field length LSB	
4	Control Octet	0x01 = set parameters
5	DHCP Control	0x00 = DHCP Off (Default) 0x01 = DHCP On
6	MDR IP Address – 1st Byte **255**.255.255.255	0 – 255 (0x00 - 0xFF)
7	MDR IP Address – 2nd Byte 255.**255**.255.255	0 – 255 (0x00 - 0xFF)
8	MDR IP Address – 3rd Byte 255.255.**255**.255	0 – 255 (0x00 - 0xFF)
9	MDR IP Address – 4th Byte 255.255.255.**255**	0 – 255 (0x00 - 0xFF)
10	MDR Subnet Mask – 1st Byte **255**.255.255.255	0 – 255 (0x00 - 0xFF)
11	MDR Subnet Mask – 2nd Byte 255.**255**.255.255	0 – 255 (0x00 - 0xFF)
12	MDR Subnet Mask – 3rd Byte 255.255.**255**.255	0 – 255 (0x00 - 0xFF)
13	MDR Subnet Mask – 4th Byte 255.255.255.**255**	0 – 255 (0x00 - 0xFF)
14	Default Gateway IP – 1st Byte **255**.255.255.255	0 – 255 (0x00 - 0xFF)
15	Default Gateway IP – 2nd Byte 255.**255**.255.255	0 – 255 (0x00 - 0xFF)
16	Default Gateway IP – 3rd Byte 255.255.**255**.255	0 – 255 (0x00 - 0xFF)
17	Default Gateway IP – 4th Byte 255.255.255.**255**	0 – 255 (0x00 - 0xFF)
18	MDR Control Application TCP Port Number MSB	5001 – 65535 (0x1389 – 0xFFFF) *Note: MDR shall use port 10555 (0x293B) as the default TCP control application port.*
19	MDR Control Application TCP Port Number LSB	

Octet	Parameter	Value or Range
20	TCP Keepalive Idle Time	12 – 255 seconds, 1 second step (0x0C – 0xFF) Default = 12 seconds
21	TCP Keepalive Probe Count	1 – 255 (0x01 – 0xFF) Default = 8 probes
22	TCP Keepalive Interval	1 – 255 seconds, 1 second step (0x01 – 0xFF) Default = 8 seconds

Normal Response

If the Control Octet is set to 0x00, requesting the state of the IP parameters, the MDR responds with the IP_CONFIG_ACK primitive. If the Control Octet is set to 0x01, setting the IP parameters, the MDR shall repond with the IP_CONFIG_ACK primitive then reset after implementing the new IP settings.

Error Response

In the event the MDR detects an error in the primitive, it will return the ERROR_IND primitive.

A.2.16. IBIT_REQ [PID 0x45]

The ground station control computer issues this primitive to request the MDR to perform the interruptive BIT test. If the MDR is not in AM Voice Mode or Analog ACARS Mode, this command is ignored.

☐ ACARS Mode ☐ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of a command word, formatted as follows:

Octet	*Parameters*	*Value or Range*
1	PID	0x45
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

The MDR responds with a IBIT_IND primitive.

Error response

In the event the MDR detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.17. PARAM_ACK [PID 0x50]

This primitive is sent by the MDR as the result of a PARAM_REQ message, and as the result of any manual configuration changes input via the front panel or VFP. It returns information to the ground station control computer about the state of the radio operation and the contents of its Operation parameters.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block, structured as one of the following depending on the value of the Modulation Format field:

For VDL Mode 2:

Octet	*Parameters*	*Value or Range*
1	PID	0x50
2	Data field length MSB	0x0010
3	Data field length LSB	
4	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F)
5	Frequency LSB	Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 MHz is 131,775 kHz and is expressed as 31,775, or 0x7C1F
6	Modulation format	0x02 for VDL Mode 2
7	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
8	TM1 value	0.5 – 125.0 ms, 0.5 ms step size (0x01 – 0xFA)
9	TM2 value	6 - 120 sec, 1 s step size (0x06 – 0x78)
10	M1 MSB	1 through 65535 (0x0001 – 0xFFFF)
11	M1 LSB	
12	ρ-Persistence value	ρ = 1/256 – 1, 1/256 step size, (0x00 – 0xFF)
13	Bit scramble vector value (MSB)	00h-7Fh
14	Bit scramble vector value (LSB)	00h-FFh
15	Transmitter power output level	3-25 watts, 1 watt step size (0x03 – 0x19)
16	Address filtering	0x00 – 0x03 as defined in section 7.3.1.3 (default = 0x02)
17	Tx enable ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
18	Loopback ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
19	Reed Solomon Decoding ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON

For digital ACARS:

Octet	Parameters	Value or Range
1	PID	0x50
2	Data field length MSB	0x0010
3	Data field length LSB	
4	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 Mhz is 131,775 kHz and is expressed as 31,775, or 0x7C1F
5	Frequency LSB	
6	Modulation format	0x01 for digital ACARS
7	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
8	TM1 value Back-off time after refusal of channel access by the p-persistent CSMA algorithm.	0.5 – 125.0 ms, 0.5 ms step size (0x01 – 0xFA)
9	TM2 value Maximum time a block may remain in the transmit queue before generation of Channel Congestion Alarm.	1 - 120 sec, 1 s step size (0x01 – 0x78)
10	TM3 value Time the RF Channel must remain in the Busy or Busy-Idle Pending State before transitioning to the Stuck Carrier State.	1 - 120 sec, 1 s step size (0x01 – 0x78)
11	ρ-Persistence value Probability that the CSMA algorithm grants access to an idle channel.	ρ = 1/256 – 1, 1/256 step size, (0x00 – 0xFF)
12	ACARS signal power level Signal power level used for Stuck Carrier determination.	-110 to -40 dBm 1 dB step size (0x00 – 0x46)
13	Idle Time Time to transition RF Channel from Busy to Idle state after detection of no activity.	10 – 130 ms, 1 ms step size (0x0A – 0x82)
14	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19)
15	Tx enable ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
16	Loopback message forwarding ON/OFF	Boolean (default = OFF) 0x00 = OFF, 0x01 = ON
17	M1 Back-off Counter MSB Maximum number of times to back off when trying to access an idle channel.	2 – 9999 (0x02 – 0x270F)
18	M1 Back-off Counter LSB	
19	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F) Default = 90% (0x5A)

For AM Voice operation:

Octet	Parameters	Value or Range
1	PID	0x50
2	Data field length MSB	0x000D
3	Data field length LSB	
4	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 Mhz is 131,775 kHz and is expressed as 31,775, or 0x7C1F
5	Frequency LSB	
6	Modulation format	0x05 for AM Voice
7	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
8	Keying control	0x00 Disable tone keying 0x01 2,175 Hz tone keying 0x02 2,300 Hz tone keying
9	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19)
10	Tx enable ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON
11	Audio input line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E)
12	Audio output line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E)
13	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F)
14	Carrier squelch level	-110 to -60 dBm, 1 dB step (0x00 – 0x32)
15	Base Frequency Offset	0x00 On Frequency 0x01 + 2 ½ kHz 0x02 – 2 ½ kHz 0x03 + 5 kHz 0x04 – 5 kHz 0x05 + 7 ½ kHz 0x06 – 7 ½ kHz
16	Channel Separation	0x00 25 kHz separation, on channel 0x01 8.33 kHz,separation, on channel 0x02 8.33 kHz separation, + 8.33 kHz 0x03 8,33 kHz separation, +16.66 kHz

For Analog ACARS operation:

Octet	Parameters	Value or Range
1	PID	0x50
2	Data field length MSB	0x0009
3	Data field length LSB	
4	Frequency MSB	118.000-136.975 MHz. (0x4650 – 0x906F) Expressed as frequency in kHz above 100.000 MHz, rounded to the nearest whole kHz. Example: 131.775 Mhz is 131,775 kHz and is expressed as 31,775, or 0x7C1F
5	Frequency LSB	
6	Modulation format	0x00 for analog ACARS
7	RF pre-attenuator	Boolean (default = switched out) 0x00 = switched out, 0x01 = switched in
8	Transmitter power level	3-25 watts, 1 watt step size (0x03 – 0x19)
9	Tx enable ON/OFF	Boolean (default = ON) 0x00 = OFF, 0x01 = ON
10	Audio input line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E)
11	Audio output line level	-20 to +10 dBm, 1 dB step (0x00 – 0x1E)
12	Modulation level	5 – 95% relative to current input line level setting, 1% step size (0x05 – 0x5F)

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.18. ERROR_IND [PID 0x51]

This primitive is sent by the ground station control computer or the MDR to indicate error conditions in the processing of the primitives.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x51
2	Data field length MSB	0x0002
3	Data field length LSB	
4	Error code	See Table A-1
5	Error data	See Table A-1

☞ Note: There are 256 possible error conditions that could be reported by this primitive. The errors in table A-1 have been identified. The remaining are future/TBD.

Table A-1. Errors

Error Condition	Sender	Error Code	Error Data
Unspecified Error	ground station control computer, MDR	0x00	Offending PID
Unrecognized PID	ground station control computer, MDR	0x01	Offending PID
Bad Data	ground station control computer, MDR	0x02	Offending PID
Bad Length	ground station control computer, MDR	0x03	Offending PID
Buffer Overflow	ground station control computer, MDR	0x04	Offending PID
Software fill for selected mode is not loaded in MDR	MDR	0x05	Offending PID
Primitive rejected due to transmission in progress	MDR	0x06	Offending PID

Normal Response

None.

Error Response

In the event the ground station control computer or MDR detects an error in the primitive, it shall return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.19. ADDR_ACK [PID 0x52]

This primitive is sent by the MDR to indicate the contents of its Station Address Set (SAS) during the course of VDL Mode 2 Operation. It is sent as a response to an ADDR_REQ primitive.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	*Parameters*	*Value or Range*
1	PID	0x52
2	Data field length MSB	0x0001 – 0x0032
3	Data field length LSB	
4	N, number of addresses	0 – 16 (0x00 – 0x10) The number of addresses contained in the file.
5	Address 1, bits 24-17	The 3 octets of the address compose the 24-bit ICAO-administered address and map to bits 1-24 of the Station Address Field in the Source or Destination Address Fields of the AVLC Frame.
6	Address 1, bits 16-9	
7	Address 1, bits 8-1	
8	Address 2, bits 24-17	
9	Address 2, bits 16-9	
10	Address 2, bits 8-1	
11		
.	.	
.	.	
.	.	
N*3+4	Address N, bits 8-1	

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.20. HEALTH_IND [PID 0x53]

The following defines the different types of heath status data parameters that the MDR may send to the ground station control computer:

- Status Booleans
- SW Part Numbers

This primitive is sent by the MDR and contains all of the available health status information. It is sent in response to a HEALTH_REQ primitive or due to the occurrence of an Operation failure.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block. The message block should contain status Boolean and software part numbers formatted as follows:

Octet	Parameters	Value or Range
1	PID	0x53
2	Data field length MSB	0x0000 – 0x0285
3	Data field length LSB	
4	Error Booleans	0x00 – 0xFF
5	Warning Booleans	0x00 – 0xFF
6	Spare	0x00 – 0xFF (Vendor-Defined)
7	N, number of part numbers contained in the file	1 – 8 (0x01 – 0x08)
8	M, number of characters per part number	1 – 80 (0x01 – 0x50)
9	PN1, char 1	
10	PN1, char 2	
•	•	
•	•	
M+8	PN1, char M	
M+9	PN2, char 1	
M+10	PN2, char 2	
•	•	
•	•	
2M+8	PN2, char M	
•	•	
•	•	
NM+8	PNN, char M	

At a minimum, the HEALTH_IND shall report memory errors, amplifier control loop errors, synthesizer lock errors, over-temperature conditions, RF look-back errors, and high VSWR.

Octet 4 (Errors) Boolean Detail:

BIT	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Description	Non-Specified MDR Error	EEPROM Error	No Software Fills Loaded	PA Loop Error	Synth Lock Error	Over Temperature	RF Loopback Failure	Spare

Octet 5 (Warnings) Boolean Detail:

BIT	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Description	Non-Specified MDR Warning	High VSWR	Spare	Spare	Spare	High Temperature	Spare	Spare

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.21. RESET_IND [PID 0x54]

The RESET_IND message is sent by the MDR when the software starts up. It is therefore sent on power-up, if the MDR reboots for any reason, and as a result of a RESET_REQ.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x54
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Software bank	0x00 = Reserved 0x01 = OPERATION mode

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.22. CU_IND [PID 0x55]

This primitive is sent by the MDR to indicate CU, the Channel Utilization parameter. This primitive is used in the course of both ACARS and VDL Mode 2 operations. This parameter indicates the percentage of time that the channel is occupied either by this radio or by other stations. Channel utilization for ACARS operation is defined in the MDR Requirements Specification document as Channel Busy State. The non-averaged Channel Utilization for VDL Mode 2 operation is defined in the VDL SARPs.

A value of 100 (64h) indicates 100% utilization of the channel. This primitive should be sent to the ground station control computer from the MDR at a rate of every ten (10) seconds. The CU function is disabled after MDR initialization and is enabled by the first CLR_DATA_REQ primitive sent to the MDR.

☑ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	*Parameters*	*Value or Range*
1	PID	0x55
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Data field octet	0% - 100%, 1% steps (0x00 – 0x64)

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.23. SQP_IND [PID 0x56]

The SQP_IND primitive is a VDL Mode 2 quality-of-service report and is sent by the MDR once for any received transmission containing a frame whose FCS is good.

The SQP indication is used by the LME function, which resides in the ground station control computer. The SQP reporting function is disabled after MDR initialization and is enabled by the first ADDR_REQ primitive. One SQP report is sent for every transmission received from a station that contains at least one frame with a valid FCS. The SQP message contains the address of the transmitting station and the value corresponding to the signal quality of that transmission.

The SARPs suggests that BER, SNR, timing jitter, RSSI, and group delay may be evaluated to calculate SQP.

The MDR will evaluate quality according to its own choice of measures, recognizing that signal strength is not necessarily the best measure and that the result must represent the average over the transmission. The SQP shall range from a normalized scale from 0 to 15, where 0 to 3 is considered poor, 4 to 12 adequate, and 13 to 15 is excellent.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	*Parameters*	*Value or Range*
1	PID	0x56
2	Data field length MSB	0x000E
3	Data field length LSB	
4	SQP	0 – 15 (0x00 – 0x0F), quality of service indicator, where 0 = poorest quality, 15 = best quality
5	Source address bits 32-25	This octet of the address has the 5 most significant bits set to zero as padding, followed by the 3-bit ICAO source code.
6	Source address bits 24-17	These 3 octets of the address compose the 24-bit ICAO-administered address and map to bits 1-24 of the Station Address field in the Source or Destination Address Fields
7	Source address bits 16-9	
8	Source address bits 8-1	
9	RSSI (MSB)	Received Signal Strength Indicator in dBm, which is a signed number in 2's compliment, accurate to ± 2 dB for signal levels below -90 dBm ± 5 dB otherwise.
10	RSSI (LSB)	
11	Symbol count (MSB)	Total number of symbols received by the MDR or MDR during this reception
12	Symbol count (LSB)	
13	ReedSolErr	Total number of byte errors detected by Reed Solomon algorithm for last reception. If sufficient byte errors have occurred such that there is any uncorrectable blocks in the transmission, this octet will be set to 255d.
14	Flag count	Number of flags received by the MDR in the last reception
15	LowConfidence	Indicating a correlation with low confidence for last reception (value will be scaled between 0 and 100, where low =100). The MDR shall perform the correlation of low confidence in the last reception according to its own choice of measures, recognizing that the result must be scaled between 0 and 100.
16	BrokenMsg	Boolean, indicating a message was received by the MDR that ended unexpectedly
17	BAD CRC count	Number of frames received by MDR with bad CRCs in last reception

Normal Response

None.

Error Response

In the event the MDR detects an error in the primitive, it shall send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.24. STATISTICS_ACK [PID 0x57]

The STATISTICS_ACK is a primitive from the MDR to the ground station control computer in response to a STATISTICS_REQ. It contains RF communication statistics. If a counter overflows, it will not roll over, but limit at its maximum value (0xFFFF or 0xFFFFFFFF). The statistics will be cleared once they have been reported.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x57
2	Data field length MSB	0x000C
3	Data field length LSB	
4	Received Msg Count MSB	Total number of RF transmissions received, 0 – 65,535 (0x0000 – 0xFFFF)
5	Received Msg Count LSB	
6	Broken Msg Count MSB	Number of RF transmissions received by MDR that ended unexpectedly, 0 – 65,535 (0x0000 – 0xFFFF)
7	Broken Msg Count LSB	
8	Symbol Count MSB	Total number of symbols received, 0 – 4,294,967,295 (0x00000000 – 0xFFFFFFFF)
9	Symbol Count 2	
10	Symbol Count 1	
11	Symbol Count LSB	
12	Bad CRC Count MSB	Number of received AVLC frames with bad CRCs, 0 – 65,535 (0x0000 – 0xFFFF)
13	Bad CRC Count LSB	
14	FEC Count MSB	Number of RS blocks where FEC used to correct byte errors, 0 – 65,535 (0x0000 – 0xFFFF)
15	FEC Count LSB	

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.25. RF_XMIT_DATA_ACK [PID 0x58]

This primitive is sent by the MDR immediately after receiving an RF_XMIT_DATA_REQ primitive during the course of VDL Mode 2 operation. The MDR shall prepare the data in its buffers for transmission, and channel access is obtained, the radio shall transmit its data.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	*Parameters*	*Value or Range*
1	PID	0x58
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

None

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.26. CLR_DATA_ACK [PID 0x59]

This primitive is sent by the MDR in response to a CLR_DATA_REQ primitive. The MDR shall not send this primitive until the buffers have been cleared and the radio is ready to begin accepting data for a new transmission.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x59
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

None

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.27. SCRATCH_AREA_ACK [PID 0x5A]

This primitive is sent by the MDR to indicate the contents of its scratch area. It is sent as a response to a SCRATCH_AREA_REQ primitive.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x5A
2	Data field length MSB	0x0014
3	Data field length LSB	
4	Char 1	0x20 – 0x7E
5	Char 2	0x20 – 0x7E
...		
...		
23	Char 20	0x20 – 0x7E

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.28. BUFFER_EMPTY_IND [PID 0x60]

This primitive is sent by the MDR to inform the ground station control computer that its buffers are ready to accept UNITDATA_IND primitives from the ground station control computer. It will be sent automatically by the MDR as a result of an RF_XMIT_DATA_REQ or CLR_DATA_REQ primitive. It is not sent when the MDR is first initialized.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	***Parameters***	***Value or Range***
1	PID	0x60
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

None

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.29. TM2_FAIL_IND [PID 0x61]

This primitive is sent by the MDR during the course of VDL Mode 2 operation to inform the ground station control computer that TM2 has expired. The message pending for transmission shall be discarded.

☐ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

The primitive consists of one message block containing the following:

Octet	*Parameters*	*Value or Range*
1	PID	0x61
2	Data field length MSB	0x0000
3	Data field length LSB	

Normal Response

None

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.30. ACARS_UPLINK_ACK [PID 0x66]

This primitive is used by the MDR in the course of ACARS operation to inform the ground station control computer of the final status of the corresponding ACARS_UPLINK_REQ.

☑ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	***Parameter***	***Value or Range***
1	Primitive ID	0x66
2	Data field length MSB	0x0002
3	Data field length LSB	
4	Block ID Number	0 – 255 (0x00 – 0xFF)
5	Transmission Status Code	0x00 = Successful Transmission 0x01 = Loopback Failure 0x02 = Unspecified Block Error

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.31. ACARS_DOWNLINK_IND [PID 0x67]

This primitive is used by the MDR in the course of ACARS operation to send an ACARS downlink to the ground station control computer. The MDR shall only transmit downlinks with valid prekey, character sync, bit sync characters. The MDR shall not transmit ACARS uplinks heard on that channel, unless Loopback is enabled.

☑ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	*Parameter*	*Value or Range*
1	PID	0x67
2	Data field length MSB	Up to 287 bytes (up to 0x011F) Note: ACARS Preamble – 14 bytes Text - Up to 220 bytes Suffix/BCS – 4 bytes
3	Data field length LSB	
4	Downlink SSV MSB	Received Signal Strength Indicator in dBm, which is a signed number in 2's compliment, accurate to ± 2 dB for signal levels below -90 dBm ± 5 dB otherwise.
5	Downlink SSV LSB	
6	Downlink QA Report	0x04 = Missing SOH characters 0x03 = Byte Parity Error 0x02 = Block Too Long 0x01 = Bad CRC 0x00 = Valid Downlink
7	Received Prekey Duration	0 – 190 ms, 1 ms step size (0x00 – 0xBE)
8	Downlink byte No. 1	ACARS SOH Character
9	Downlink byte No. 2	
10	Downlink byte No. 3	
•	•	
•	•	
n-2	Downlink byte No. n-2	ACARS BCS Character
n-1	Downlink byte No. n-1	ACARS BCS Character
n	Downlink byte No. n	ACARS BCS Suffix Character

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.32. BACKGROUND_NOISE_IND [PID 0x68]

This primitive is used by the MDR in the course of ACARS and VDL Mode 2 operations to report background noise on the RF channel.

Upon receipt of the BACKGROUND_NOISE_REQ primitive, the MDR shall measure the average and peak received channel energy for the period of time specified in the Measurement Period. If the Message Exclusion boolean is set to 0x00, then all received traffic shall be included in the measurement, including valid messages for the current mode (ACARS or VDLM2). If the Message Exclusion boolean is set to 0x01, then receipt of a valid message for the current mode (ACARS or VDLM2) shall cause the MDR to reset the measurement period timer, clear the average and peak readings, and restart the measurement process. Once the measurement is complete, the MDR shall transmit the BACKGROUND_NOISE_IND primitive, reporting the measurement values. If, due to repeated restarts caused by valid message traffic, the measurement cannot be completed before the Measurement Timeout Period, the MDR shall transmit the BACKGROUND_NOISE_IND primitive, reporting the timeout condition by setting the measurement period octet to 0x00.

☑ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x68
2	Data field length MSB	0x0005
3	Data field length LSB	
4	Measurement Period	0.25 – 60 seconds, step size of 0.25 seconds (0x01 – 0xF0) set to 0x00 if a timeout occurs
5	Average Signal Strength MSB	Average Signal Strength in dBm, which is a signed number in 2's compliment, accurate to ± 2 dB.
6	Average Signal Strength LSB	
7	Peak Signal Strength MSB	Peak Signal Strength in dBm, which is a signed number in 2's compliment, accurate to ± 2 dB for signal levels below -90 dBm ± 5 dB otherwise .
8	Peak Signal Strength LSB	

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return the ERROR_IND primitive.

A.2.33. STUCK_CARRIER_IND [PID 0x69]

This primitive is used by the MDR to inform the ground station control computer of a stuck carrier condition where the received AGC level remains above a configurable value for a configurable time duration, based on the AGC_LEVEL and TM3 values passed to the radio in the PARAMETER_REQ primitive. Upon declaring a stuck carrier condition, the MDR shall characterize the nature of the signal as MSK modulated carrier or non-MSK modulated carrier.

☑ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	***Parameter***	***Value or Range***
1	Primitive ID	0x69
2	Data field length MSB	0x0002~~1~~
3	Data field length LSB	
4	Carrier Status	0x00 = Alarm Relief 0x01 = Stuck Carrier Alarm,
5	Carrier Quality	0x00 = MSK-modulated carrier 0x01 = non-MSK modulated carrier Note: Octet 5 is N/A when Carrier Status is 0x00

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.34. ACARS_CONGESTION_IND [PID 0x6B]

This primitive is used by the MDR to inform the ground station control computer of a Congested Channel, defined as conditions that prevents the CSMA algorithm from transmitting the current uplink block for longer than the TM2 value passed to the radio in the PARAM_REQ primitive. The time is started in the MDR when an uplink block is presented to the MAC layer; the MDR shall report congestion if the time exceeds the TM2 value before the uplink block is transmitted.

☑ ACARS Mode ☐ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	PID	0x6B
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Channel Status	0x00 = Alarm Relief 0x01 = Congestion Alarm

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.35. IP_CONFIG _ACK [PID 0x6C]

This primitive reports the current MDR IP Address, Subnet Mask, Default Gateway, Control Application TCP Port number, TCP Keepalive parameters, and MAC address. It is sent in response to the IP_CONFIG_REQ primitive.

NOTE: The MDR shall use the following default IP configuration parameters:

- IP Address: 192.168.0.2
- Subnet Mask: 255.255.255.248
- Default Gateway IP: 192.168.0.1
- Control Application Port: 10555 (0x293B)
- DHCP: off

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x6C
2	Data field length MSB	0x0018
3	Data field length LSB	
4	DHCP State	0x00 = DHCP Off 0x01 = DHCP On
5	MDR IP Address – 1st Byte **255**.255.255.255	0 – 255 (0x00 - 0xFF)
6	MDR IP Address – 2nd Byte 255.**255**.255.255	0 – 255 (0x00 - 0xFF)
7	MDR IP Address – 3rd Byte 255.255.**255**.255	0 – 255 (0x00 - 0xFF)
8	MDR IP Address – 4th Byte 255.255.255.**255**	0 – 255 (0x00 - 0xFF)
9	MDR Subnet Mask – 1st Byte **255**.255.255.255	0 – 255 (0x00 - 0xFF)
10	MDR Subnet Mask – 2nd Byte 255.**255**.255.255	0 – 255 (0x00 - 0xFF)

Octet	Parameter	Value or Range
11	MDR Subnet Mask – 3rd Byte 255.255.**<u>255</u>**.255	0 – 255 (0x00 - 0xFF)
12	MDR Subnet Mask – 4th Byte 255.255.255.**<u>255</u>**	0 – 255 (0x00 - 0xFF)
13	Default Gateway IP – 1st Byte **<u>255</u>**.255.255.255	0 – 255 (0x00 - 0xFF)
14	Default Gateway IP – 2nd Byte 255.**<u>255</u>**.255.255	0 – 255 (0x00 - 0xFF)
15	Default Gateway IP – 3rd Byte 255.255.**<u>255</u>**.255	0 – 255 (0x00 - 0xFF)
16	Default Gateway IP – 4th Byte 255.255.255.**<u>255</u>**	0 – 255 (0x00 - 0xFF)
17	MDR Control Application TCP Port Number MSB	5001 – 65535 (0x1389 – 0xFFFF) *Note: MDR shall use port 10555 (0x293B) as the default TCP control application port.*
18	MDR Control Application TCP Port Number LSB	
19	TCP Keepalive Idle Time	1 – 255 seconds, 1 second step (0x01 – 0xFF) Default = 8 seconds
20	TCP Keepalive Probe Count	1 – 255 (0x01 – 0xFF) Default = 8 probes
21	TCP Keepalive Interval	1 – 255 seconds, 1 second step (0x01 – 0xFF) Default = 8 seconds
22	MDR MAC address – 1st Byte **<u>FF</u>**-FF-FF-FF-FF-FF	0x00 – 0xFF
23	MDR MAC address – 2nd Byte FF-**<u>FF</u>**-FF-FF-FF-FF	0x00 – 0xFF
24	MDR MAC address – 3rd Byte FF-FF-**<u>FF</u>**-FF-FF-FF	0x00 – 0xFF
25	MDR MAC address – 4th Byte FF-FF-FF-**<u>FF</u>**-FF-FF	0x00 – 0xFF
26	MDR MAC address – 5th Byte FF-FF-FF-FF-**<u>FF</u>**-FF	0x00 – 0xFF
27	MDR MAC address – 6th Byte FF-FF-FF-FF-FF-**<u>FF</u>**	0x00 – 0xFF

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return the ERROR_IND primitive.

A.2.36. IBIT_IND [PID 0x6D]

This primitive is sent by the MDR to report the results of the interruptive BIT test.

☐ ACARS Mode ☐ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameters	Value or Range
1	PID	0x6D
2	Data field length MSB	0x0006
3	Data field length LSB	
4	Forward RF Power	0x00 – 0x20 (0 – 32 W ±1dB)
5	Reflected RF Power	0x00 – 0x20 (0 – 32 W ±1dB)
6	Modulation Depth	0x00 – 0x6E (0 – 110% ±10%)
7	Sensitivity	Sensitivity in dBm, which is a signed number in 2's compliment, accurate to ±3 dB.
8	IBIT Booleans	0x00 – 0xFF
9	IBIT Booleans	0x00 – 0xFF

The tables below detail the 2 octets containing IBIT Booleans. The test failed if the corresponding bit is set to 0 the test passed if it is 1.

Octet 8 IBIT Booleans Detail:

BIT	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Parameter	Spare	EEPROM	RF Drive	PA Loop	PA Output	Modulation Depth	Sensitivity	Spare

Octet 9 IBIT Booleans Detail:

BIT	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Parameter	Spare	TX RF Filters	RX RF Filters	IF Filters	Audio	Base band	Spare	Spare

The following list provides the test criteria for each parameter from the 2 octets of IBIT Booleans.

Parameter	*Test Criteria*
EEPROM	Failed if EEPROM checksum fails
RF Drive	Failed if RF drive power < +1 dBm
PA Loop	Failed if I and Q error signal vector sum magnitude is out of specification by > 3dB
PA Output	Failed if PA output power is > 6dB below or 3dB above set power
Modulation Depth	Failed if modulation depth > 20% from set value
Sensitivity	Failed if sensitivity is out of specification > 7dB for either channel spacing
TX RF Filters	Failed if < 3dB in RF drive with filters retuned by 10 MHz
RX RF Filters	Failed if detected filter output varies > ±5dB measured at 4 frequencies to exercising all filter control lines
IF Filters	Failed if sensitivity test fails on one but not both channel spacing
Audio	Failed if detected path loss > 12dB between audio in and audio out ports of the DSP when line gain set to 0dB
Base band	Failed if either I or Q at the PA control module is > 3dB below set level of I and Q

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.37. SW_DOWNLOAD_START_ACK [PID 0x70]

This primitive is sent from the MDR in response to the SW_DOWNLOAD_START_REQ primitive.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x70
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Status	0x00 = OK 0x01 = Not used 0x02 = Not used

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.38. SW_DOWNLOAD_DATA_ACK [PID 0x71]

This primitive is sent from the MDR in response to the SW_DOWNLOAD_DATA_REQ primitive.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x71
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Status	0x00 = OK 0x01 = Not used 0x02 = Write failed 0x03 = No preceding start 0x04 = Too much data 0x05 = Flash erase failed

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.39. SW_DOWNLOAD_END_ACK [PID 0x72]

This primitive is sent from the MDR in response to the SW_DOWNLOAD_END_REQ primitive.

☑ ACARS Mode ☑ VDL Mode ☑ AM Voice Mode ☑ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x72
2	Data field length MSB	0x0001
3	Data field length LSB	
4	Status	0x00 = OK 0x01 = Not used 0x02 = Checksum error; downloaded software cannot be used 0x03 = No preceding start 0x04 = Flash erase failed

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will send an ERROR_IND primitive containing an error code to specify the nature of the problem.

A.2.40. TRANSMIT_REPORT_IND [PID 0x73]

This primitive is sent by the MDR after transmission of an ACARS or VDL block, to report the transmission and to report the time spent in the MAC layer CSMA algorithm. For ACARS Mode the TRANSMIT_REPORT_IND immediately follows the ACARS_UPLINK_ACK for the same transmission.

☑ ACARS Mode ☑ VDL Mode ☐ AM Voice Mode ☐ Analog ACARS mode

Format

This primitive consists of one message block containing the following:

Octet	Parameter	Value or Range
1	Primitive ID	0x73
2	Data field length MSB	0x0007
3	Data field length LSB	
4	Mode	0x01 = ACARS 0x02 = VDL Mode 2
5	CSMA Decision Time MSB	0 – 65,535 msec, 1 msec step (0x0000 - 0xFFFF)
6	CSMA Decision Time LSB	
7	TM1 value	0.5 – 125.0 ms, 0.5 ms step size (0x01 – 0xFA)
8	TM2 value	1 - 120 sec, 1 s step size (0x01 – 0x78)
9	TM3 value	1 - 120 sec, 1 s step size (0x01 – 0x78) 0x00 if in VDL Mode.
10	ρ-Persistence value .	ρ = 1/256 – 1, 1/256 step size, (0x00 – 0xFF)

Normal Response

None.

Error Response

In the event the ground station control computer detects an error in the primitive, it will return the ERROR_IND primitive.