Appendix C
Mode-S Specific Services (MSSS)

DRAFT

Version 1.0

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C. Mode-S Specific Services (MSSS)

C.1 Introduction

C.1.1 Purpose

This Appendix sets forth minimum operational performance standards for the Mode S Specific Services (MSSS). The MSSS provides a standard communication interface and service through which avionics application processors may exchange data with ground based application processors via the Mode S transponder. Compliance with these standards is required to assure that the Mode S Specific Services characteristics will perform its intended functions satisfactorily under normal operating conditions. Incorporated within these standards are system characteristics that will facilitate the design and implementation of the Mode S Specific Services.

C.1.2 Scope

This Appendix defines the functional requirements for the Mode S Specific Services, and describes the architecture within which the Mode S Specific Services entity will operate. It does not define data link applications that will be supported by Mode S and other data links.

C.1.3 Mode-S Application Entity (AE) / Transponder Interface Management

The Mode S Application Entity (AE) controls the interface to the Mode S Transponder based on information received from the Higher-Layer Entity (HLE) via the Specific Services Entity (SSE) interface, and based on the internal processing requirements of the AE. Additionally, the Mode S AE receives information via the AE/Transponder interface, which must be processed and transferred to the HLE.

The Mode S AE must also establish and maintain the local relationship between the Mode S Aircraft AE and the various Mode S Ground AEs with which it communicates.

Note: *In the framework of these Mode S Specific Services referenced herein, the Mode S AE supports the functionality required to support implementation of these capabilities. A Mode S ADLP would provide the Mode S AE functionality required, but in the context of this Appendix, it does not necessitate the need for full Mode S ADLP capabilities.*

C.2 Design Requirements

C.2.1 Basic Operations

The Mode S Specific Services shall offer the following types of services to the user.

a. Mode S Protocol service: The Mode S Protocol (MSP) service transfers limited data between air and ground application peers, using extremely low overhead. The MSP service does not use diagnostic, flow control, or interrupt procedures as defined within ISO 8208. Such mechanisms should be defined within the application entities.

b. Broadcast Protocol service (Comm-A, Comm-B): The Mode S subnetwork is capable of supporting information delivery to all interrogators participating in data link operations for that aircraft through the use of the Broadcast Comm-B protocol. It is also able to receive messages directed to all transponders through the use of the Broadcast Comm-A protocol.

c. Ground Initiated Comm-B service: The Mode S subnetwork allows for the access of prestored data within the Mode S transponder (256 register set) from ground application entities.

C.2.2 Mode-S Specific Services Entity (SSE) Interface Requirements

C.2.2.1 General

The AE shall support the accessing of Mode S Specific Services through the provision of one or more separate AE interfaces.

Note: *Mode S Specific Services consist of the broadcast Comm-A and Comm-B, Ground Initiated Comm-B (GICB) and MSP.*

C.2.2.2 Functional Capability

The AE shall support the accessing of Mode S Specific Services through the provision of one or more separate AE interfaces.

Message and control coding via the MSSS interface shall support all of the capabilities specified in §B.2.2.6.

Note: *Mode S Specific Services consist of the broadcast Comm-A and Comm-B, Ground Initiated Comm-B (GICB) and MSP.*

C.2.2.3 Mode-S Specific Services Architecture

The Mode S Specific Services architecture, as shown in Figure C-2-1, providces for the top level architecture, which is inclusive of the Mode S Specific Services Entity (SSE), the SSE interface to a higher layer application process, frame processing function, Mode S transponder (aircraft component), and Mode S interrogator (ground component). Between air and ground, the peer interface entities are identified as being, SSE Data, Frames, and Mode S link protocol (RF).

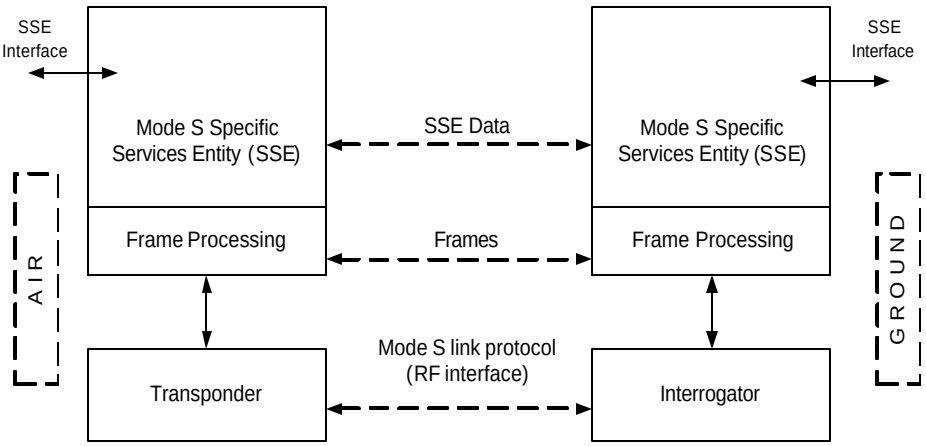


Figure C-2-1: Mode-S Specific Services Architecture

C.2.2.4 Transponder to Application Entity (AE) Interface

The AE shall accept an indication of protocol type from the transponder in connection with data transferred from the transponder to the AE. This shall include the following types of protocols:

a. Surveillance interrogation,

b. Comm-A interrogation,

c. Comm-A broadcast interrogation,

d. Uplink ELM.

The AE shall also accept the II code of the interrogator used to transmit the surveillance, Comm-A or uplink ELM.

Note: *Transponders will not output all call and Traffic Alert and Collision Avoidance System (TCAS) information on this interface. Use of SI code limited to Comm-A and Comm-A broadcast interrogations.*

The AE shall accept control information from the transponder indicating the status of downlink transfers. This shall include:

a. Comm-B closeout,

b. Comm-B broadcast time out,

c. Downlink ELM closeout.

The AE shall have access to current information defining the communication capability of the Mode S transponder with which it is operating. This information shall be used to generate the Data Link Capability Report.

C.2.2.5 Application Entity (AE) to Transponder Interface

The AE shall provide an indication of protocol type to the transponder in connection with data transferred from the AE to the transponder. This shall include the following types of protocols:

a. Ground initiated Comm-B,

b. Air initiated Comm-B,

c. Multisite directed Comm-B,

d. Comm-B broadcast,

e. Downlink ELM,

f. Multisite directed downlink ELM.

The AE shall also provide:

1. The II code for transfer of a multisite directed Comm-B or multisite directed downlink ELM, and

2. The Comm-B Data Selector (BDS) code for a ground initiated Comm-B.

Note: *Use of SI code limited to Ground-initiated Comm-B and Comm-B Broadcast.*

C.2.2.6 Mode-S Specific Services Processing

Mode S Specific Services shall be processed by an entity in the application termed the Mode S Specific Services entity.

C.2.2.6.1 Processing

Notes:

1. *There are three Mode S Specific Services protocol types; broadcast, GICB and MSP.*

2. *Control data can consist of information permitting message length, BDS code used to access the data format for a particular register, and aircraft 24 bit address.*

C.2.2.6.1.1 Downlink Processing

Note: *This section describes the processing of control and message data received from the Mode S Specific Services interface.*

C.2.2.6.1.1.1 General

The AE shall be capable of receiving control and message data from the Mode S Specific Services interface(s) and sending delivery notices to this interface. The control data shall be processed to determine the protocol type and the length of the message data. When a message or control data provided at this interface are erroneous (i.e., incomplete, invalid or inconsistent) the AE shall discard the message and deliver an error report at the interface.

Note: *The diagnostic content and the error reporting mechanism are a local issue.*

C.2.2.6.1.1.2 Broadcast Processing

The control and message data shall be used to format the Comm-B broadcast message as specified in §C.2.2.6.4 and transfer it to the transponder.

C.2.2.6.1.1.3 Ground-Initiated Comm-B (GICB) Processing

The GICB service consists of defined data available on board the aircraft being put into one of the 255 transponder registers (each with a length of 56 bits) in the Mode S transponder at specified intervals by a serving process, e.g. airborne collision avoidance system (ACAS), aircraft data link processor (ADLP), or an application entity (AE). A Mode S ground interrogator or an ACAS unit can extract the information from any of these transponder registers at any time and pass it for onward transmission to ground based or aircraft applications.

The assignment of Registers shall be as specified in Appendix B.

C.2.2.6.1.1.4 MSP Processing

The MSP message length, channel number (M/CH, §C.2.2.6.2.1) and optionally the interrogator II code shall be determined from the control data. The MSP message content shall be extracted from the received message data. If the message length is 26 bytes or less, the SSE shall format an air initiated Comm-B message for transfer to the transponder using the Short Form MSP Packet (see §C.2.2.6.2.1). If the message length is 27 to 159 bytes and the transponder has adequate downlink ELM capability, the SSE shall format an ELM message for transfer using the Short Form MSP Packet. If the message length is 27 to 159 bytes and the transponder has a limited downlink ELM capability, the SSE shall format multiple Long Form MSP Packets (see §C.2.2.6.2.2) using ELM messages as required utilizing the L bit and the M/SN Fields for association of the packets. If the message length is 27 to 159 bytes and the transponder does not have downlink ELM capability, the SSE shall format multiple long form MSP packets using air initiated Comm-B messages, as required utilizing the L bit and M/SN fields for association of the packets. Different frame types shall never be used in the delivery of an MSP message. Messages longer than 159 bytes shall be discarded. The assignment of downlink MSP channel numbers shall be as specified in Table C-2-2.

For an MSP, a request to send a packet shall cause the packet to be multisite-directed to the interrogator II code as specified in control data. If no II code is specified, the packet shall be down linked using the air-initiated protocol. A message delivery notice for this packet shall be provided to the Mode S specific interface when the corresponding closeout(s) have been received from the transponder. If a closeout has not been received from the transponder in Tz seconds, as specified in Table C-2-2, the MSP packet shall be discarded. This shall include the cancellation in the transponder of any frames associated with this packet. A delivery failure notice for this message shall be provided to the Mode S Specific Services interface.

Table C-2-2: MSP Channel Number Assignments

Uplink Channel Number	**Assignment**
0	Not Valid
1	Specific Services Management
2	Traffic Information Service
3	Ground-to-Air Alert
4	Ground Derived Position
5	TCAS Sensitivity Level Control
6	Ground-to-Air Service Request
7	Air-to-Ground Service Response
8 – 63	Unassigned
Downlink Channel Number	**Assignment**
0	Not Valid
1	Specific Services Management
2	Unassigned
3	Data Flash
4	Position Request
5	Unassigned
6	Ground-to-Air Service Response
7	Air-to-Ground Service Request
8 – 63	Unassigned

Table C-2-3: Broadcast Identifier Number Assignments

Uplink Broadcast Identifier	**Assignment**
00_{16}	Not Valid
01_{16}	Differential GPS Correwction
30_{16}	Not Valid
31_{16}	TCAS/ACAS (RA Broadcast)
32_{16}	TCAS/ACAS (ACAS Broadcast)
Others	Unassigned
Downlink Broadcast Identifier	**Assignment**
00_{16}	Not Valid
02_{16}	Traffic Information Service
10_{16}	Data Link Capability Report
20_{16}	Aircraft Identification
30_{16}	TCAS/ACAS (RA Broadcast)
FE_{16}	Update Request
FF_{16}	Search Request
Others	Unassigned

C.2.2.6.1.2 Uplink Processing

Note: *This section describes the processing of Mode S Specific Services messages received from the transponder.*

C.2.2.6.1.2.1 General

The AE shall be capable of receiving Mode S Specific Services messages from the transponder via Frame Processing. The AE shall be capable of delivering the messages and the associated control data at the specific services interface. When the resources allocated at the interface are insufficient to accommodate the output data, the AE shall discard the message and deliver an error report at this interface.

C.2.2.6.1.2.2 Broadcast Processing

If the received message is a broadcast Comm-A, as indicated by control data received over the transponder/AE interface, the broadcast ID and user data (see §C.2.2.6.4) shall be forwarded to the Mode S Specific Services interface, along with the control data that identifies this as a broadcast message. The assignment of uplink broadcast identifier numbers shall be as specified in Table C-2-3.

C.2.2.6.1.2.3 MSP Processing

If the received message is an MSP, as indicated by the packet format header (see §C.2.2.6.2), the User Data Field of the received MSP packet shall be forwarded to the Mode S Specific Services interface together with control data that identifies this as an MSP message. L bit processing (see §C.2.2.6.3) shall be performed as required. The assignment of uplink MSP channel numbers shall be as specified in Table C-2-3.

C.2.2.6.2 MSP Packet Formats

C.2.2.6.2.1 Short Form MSP Packet

The format for this packet shall be as follows:

DP:1	MP:1	M/CH:6	FILL 1:0 or 6	UD:v

Data Packet: Type (DP) This field shall be set to ZERO (0).

MSP Packet Type (MP): This field shall be set to ZERO (0) to indicate that this is a Short Form MSP Packet.

MSP Channel Number (M/CH): The field shall be set to the channel number derived from the SSE control data (Table C-2-5).

Fill Field. (FILL1: 0 or 6): The Fill length shall be 6 bits for a downlink SLM Frame. Otherwise the Fill length shall be ZERO (0).

User Data (UD): The User Data Field shall contain message data received from the Mode S Specific Services interface.

C.2.2.6.2.2 Long Form MSP Packet

The format for this packet shall be as follows:

DP:1	MP:1	SP:2	L:1	M/SN:3	FILL 2:0 or 2	M/CH:6	UD:v

Data Packet Type (DP): This field shall be set to ZERO (0).

MSP Packet Type (MP): This field shall be set to ONE (1) to indicate that this is not a Short Form MSP Packet.

Supervisory Packet (SP): This field shall be set to ZERO (0).

L Field (L): A value of one shall indicate that the packet is part of an L bit sequence with more packets in the sequence to follow. A value of ZERO (0) shall indicate that the sequence ends with this packet.

MSP Sequence Number Field (M/SN): This field shall be used to detect duplication in the delivery of L bit sequences. The first packet in an L bit sequence shall be assigned a sequence number of ZERO (0). Subsequent packets shall be numbered sequentially. A packet received with the same sequence number as the previously received packet shall be discarded.

MSP Channel Number (M/CH): The field shall be set to the channel number derived from the SSE control data (Table C-2-5).

User Data (UD): The User Data Field shall contain message data received from the Mode S Specific Services interface.

C.2.2.6.3 L-Bit Processing

L bit processing shall be performed only on the Long Form MSP Packet.

Upon receipt of a long form MSP Packet the AE shall construct the User Data Field by:

a. Verifying that the packet order is correct using the M/SN Field (see §C.2.2.6.2.2).

b. Assuming that the User Data Field in the MSP Packet is the largest number of integral bytes that is contained within the frame.

c. Associating each User Data Field in an MSP Packet received with a previous User Data Field in an MSP Packet that has an L bit value of ONE (1).

d. Truncating the assembled User Data Field to 151 bytes if necessary.

Note: *Truncation of the user data field is a condition that cannot be reported.*

e. If an error is detected in the processing of an MSP packet, the packet shall be discarded.

In the processing of an L bit sequence, the AE shall discard any MSP packets that have duplicate M/SN values. The AE shall discard the entire L bit sequence if a long form MSP Packet is determined to be missing by use of the M/SN Field.

The packets associated with any L bit sequence whose reassembly is not completed in Tm seconds (Table C-2-4) shall be discarded.

C.2.2.6.4 Broadcast Format

The first byte of the broadcast MA field shall contain the broadcast identifier as specified in Table C-2-1.

C.2.2.7 Frame Processing

C.2.2.7.1 Uplink Frames

C.2.2.7.1.1 Uplink SLM Frames

An uplink SLM frame shall be composed of up to 4 selectively addressed Comm-A segments.

Note: *Each Comm-A segment (MA Field) received by the AE is accompanied by the first 32 bits of the interrogation that delivered the segment. Within these 32 bits is the 16 bit Special Designator (SD) Field.*

C.2.2.7.1.1.1 SD Field

When the Designator Identification (DI) Field (bits 14-16) has a code value of 1 or 7, the Special Designator (SD) Field (bits 17-32) of each Comm-A interrogation shall be used to obtain the Interrogator Identifier Subfield (IIS, bits 17-20) and the Linked Comm-A Subfield (LAS, bits 30-32). The action to be taken shall depend on the value of LAS. The contents of LAS and IIS shall be retained and shall be associated with the Comm-A message segment for use in assembling the frame as indicated below. All fields other than the LAS Field shall be as defined in §2.2.19.2.1.1.

SD FIELD

For DI=1

					→	TMS
IIS	**MBS**	**MES**	**LOS**	**RSS**	**SPARE**	**LAS**
17 → 20	21 → 22	23 → 25	26	27 → 28	29	30 → 32

For DI=7

					→	TMS
IIS	**RRS**	**SPARE**	**LOS**	**SPARE**	**SPARE**	**LAS**
17 → 20	21 → 24	25	26	27 → 28	29	30 → 32

Figure C-2-2: The SD Field Structure

C.2.2.7.1.1.2 LAS Coding

The three bit LAS subfield shall be coded as specified in Table C-2-4.

Table C-2-4: LAS Subfield Coding

LAS (decimal)	**Meaning**
0	Single segment
1	Linked, 1st segment
2	Linked, 2nd but not final segment
3	Linked, 3rd but not final segment
4	Linked, 4th and final segment
5	Linked, 2nd and final segment
6	Linked, 3rd and final segment
7	Unassigned

C.2.2.7.1.1.3 Single Segment SLM Frame

If LAS=0, the data in the MA Field shall be considered a complete frame and shall be made available for further processing.

C.2.2.7.1.1.4 Multiple Segment SLM Frame

The AE shall accept and assemble linked 56 bit Comm-A segments associated with all 16 possible Interrogator Identifier (II) codes. Correct linking of Comm-A segments shall be achieved by requiring that all Comm-A segments have the same value of IIS. If LAS=1 through 6 the frame shall consist of two to four Comm-A segments as specified in the following:

Note 1: *The number of linked Comm-A's is limited to four because longer linked Comm-A transmissions would result in inefficient utilization of the Mode S link, as well as slow frame delivery. Longer frames can be transferred more efficiently using the ELM protocol.*

Initial Segment: If LAS = 1, the MA Field shall be assembled as the initial segment of an SLM frame. In this case, the initial segment shall be stored until all segments of the frame have been received or the frame is canceled.

Intermediate Segment: If LAS = 2 or 3, the MA Field shall be assembled in numerical order as an intermediate segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

Final Segment: If LAS = 4, 5 or 6, the MA Field shall be assembled as the final segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

Note 2: *A two segment linked Comm-A will consist of an initial segment (LAS=1) and a final segment (LAS=5).*

Frame Completion: The frame shall be considered complete and shall be made available for further processing as soon as all segments of the frame have been received.

Frame Cancellation: An incomplete SLM frame shall be canceled if one or more of the following conditions apply:

a. A new initial segment (LAS=1) is received with the same value of IIS. In this case, the new initial segment shall be retained as the initial segment of a new SLM frame.

b. The sequence of received LAS codes (after the elimination of duplicates) is not contained in the following list:

    1. LAS = 0
    2. LAS = 1,5
    3. LAS = 1,2,6
    4. LAS = 1,6,2
    5. LAS = 1,2,3,4
    6. LAS = 1,3,2,4
    7. LAS = 1,2,4,3
    8. LAS = 1,3,4,2
    9. LAS = 1,4,2,3
    10. LAS = 1,4,3,2

c. Tc (seconds) have elapsed since the last Comm-A segment with the same value of US was received. See Table C-2-6.

Segment Cancellation

A received segment for an SLM frame shall be discarded if it is an intermediate or final segment and no initial segment has been received with the same value of IIS.

Segment Duplication

If a received segment duplicates a currently received segment number with the same value of IIS, the new segment shall replace the currently received segment.

Note 3: *The action of the Mode S link protocols may result in the duplicate delivery of Comm-A segments.*

C.2.2.7.1.2 Uplink ELM Frame

An uplink ELM frame shall consist of from 20 to 160 bytes and shall be transferred from the interrogator to the transponder using the protocol defined in §2.2.20. The first 4 bits of each uplink ELM segment (MC Field) shall contain the Interrogator Identifier (II) code of the Mode S interrogator transmitting the ELM. The AE shall check the II code of each segment of a completed uplink ELM. If all of the segments contain the same II code, the II code in each segment shall be deleted and the remaining message bits retained as user data for further processing. If all of the segments do not contain the same II code, the entire uplink ELM shall be discarded.

Note: *An uplink ELM frame consists of 2 to 16 associated Comm C segments, each of which contains the 4 bit II code. Therefore, the capacity for packet transfer is 19 to 152 bytes per uplink ELM frame.*

C.2.2.7.2 Downlink Frames

Note: *Data is transferred from an AE to a "Ground Application Entity" using downlink frames.*

C.2.2.7.2.1 Downlink SLM Frame

A downlink SLM frame shall be composed of up to 4 Comm-B segments. The MB Field of the first Comm-B segment of the frame shall contain a 2 bit Linked Comm-B Subfield (LBS, bit 1 and 2 of the MB Field). This subfield shall be used to control linking of up to 4 Comm-B segments.

Note: *The LBS uses the first two bit positions in the first segment of a multi or single segment downlink SLM frame. Hence, 54 bits are available for Mode S packet data in the first segment of a downlink SLM frame. The remaining segments of the downlink SLM frame, if any, have 56 bits available.*

C.2.2.7.2.1.1 LBS Coding

Linking shall be indicated by the coding of the LBS subfield of the MB Field of the initial Comm-B segment of the SLM frame.

The coding of LBS shall be as specified in Table C-2-5.

Table C-2-5: LBS Subfield Coding

LBS (decimal)	**Meaning**
0	Single segment
1	Initial segment of a two-segment SLM frame
2	Initial segment of a three-segment SLM frame
3	Initial segment of a four-segment SLM frame

C.2.2.7.2.1.2 Linking Protocol

In the Comm-B protocol, the initial segment shall be transmitted using the air initiated or multisite directed protocols. The LBS Field of the initial segment shall indicate to the ground the number of additional segments to be transferred (if any). Before the transfer of the initial segment to the transponder, the remaining segments of the SLM frame (if any) shall be transferred to the transponder for transmission to the interrogator using the ground initiated Comm-B protocol. These segments shall be accompanied by control codes that cause the segments to be inserted in ground initiated Comm-B Registers 02_{16}, 03_{16} or 04_{16}, associated respectively with the second, third, or fourth segment of the frame.

Closeout of the air initiated segment that initiated the protocol shall not be performed until all segments have been successfully transferred.

Notes:

1. *The linking procedure including the use of the ground initiated Comm-B protocol is performed by the AE.*

2. *When the Mode S interrogator detects a non-zero LBS code in an air initiated or multisite directed Comm-B segment, it can proceed immediately with the ground initiated Comm-B protocol and request the remaining segments of the SLM frame. When it has received all of the segments, it closes out the air initiated or multisite directed segment that began the linked Comm-B protocol.*

3. *This linking protocol, as well as the linked Comm-A protocol, is transparent to the transponder.*

C.2.2.7.2.1.3 Directing SLM Frames

If the SLM frame is to be multisite directed, the AE shall determine the II code of the Mode S interrogator or cluster of interrogators that shall receive the SLM frame.

C.2.2.7.2.2 Downlink ELM Frame

Downlink ELM frames shall be used to deliver messages greater than 128 bytes and shall be formed using the protocol defined in §2.2.20.2.

Note: *A downlink ELM consists of 1 to 16 associated Comm D segments.*

C.2.2.7.2.2.1 Directing ELM Frames

If the ELM frame is to be multi-site directed, the AE shall determine the II code of the Mode S interrogator or cluster of interrogators that shall receive the ELM frame.

C.2.2.7.2.3 Delivery Status

AE Frame Processing shall accept an indication from the transponder that a specified downlink frame that was previously transferred to the transponder has been closed out as specified in [**DO-181C**].

C.2.2.7.2.4 Interrogator Identifier

AE Frame Processing shall accept from the transponder, along with the data in each uplink SLM or ELM, the Interrogator Identifier (II) code of the interrogator that transmitted the frame. AE Frame Processing shall transfer to the transponder the II code of the interrogator or cluster of interrogators that shall receive a multi-site directed frame.

C.2.2.7.2.5 Frame Cancellation

AE Frame Processing shall be capable of canceling downlink frames previously transferred to the transponder for transmission but for which a closeout has not been indicated. If more than one frame is stored within the transponder, the cancellation procedure shall be capable of canceling the stored frames selectively.

C.2.2.8 System Timers

The values for timers referenced in this specification shall conform to the values given in Table C-2-6.

Table C-2-6: AE Mode-S Subnetwork Timers

Timer Name	Timer Label	Nominal Value	Reference
L-Bit Delivery	Tm	120 seconds	§C.2.2.6.3
Interrogator Link	Tz	30 seconds	§C.2.2.6.1.1.4
Link Frame Cancellation	Tc	60 seconds	§C.2.2.7.1.1.4

Tolerance for all timers shall be ±1 percent.
Resolution for all timers shall be 1 second.

C.3 Mode-S Specific Services Test Procedures

The test procedures set forth below constitute a satisfactory method of determining required Mode S Specific Services performance. Although specific test procedures are cited, it is recognized that other methods may be preferred. Such alternate methods may be used if the manufacturer can show that they provide at least equivalent information. Therefore, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

C.3.1 General Characteristics

The test configuration (Figure C-3-1) provides a means of validating the information content of any message received from the Aircraft Application Entity (AAE), as well as the Ground Application Entity (GAE), which is processed and managed by both the Aircraft – Specific Services Entity (A-SSE), and the Ground – Specific Services Entity (G-SSE).

The test configuration should be capable of generating or accepting messages in the form of MSPs, Broadcast and GICB. The test configuration should be able to format and populate the data content for MSSS type messages.

The test configuration should be capable of generating the entire content of a Long and Short Mode S uplink message, and accept the entire content of a Long and Short downlink message according to the following:

(1) Long Mode S messages are 112 bits, encoded per §2.2.14 and §2.2.19. Short Mode S messages are 56 bits, also coded according to §2.2.14 and §2.2.19. When required, the coding of these messages is contained in the appropriate test procedure of this Appendix.

(2) For uplink Extended Length Messages (ELM)s, the test configuration should be able to convey a control field called Interrogator Identification Subfield (IIS) to the A-SSE independently of the messages described in (1) above.

(3) The test configuration should be able to convey delivery status of Mode S downlink messages to the A-SSE independently of the messages described in (1) above.

(4) The test configuration should be able to accept from the A-SSE a Mode S frame cancellation message independently of the messages described in (1) above.

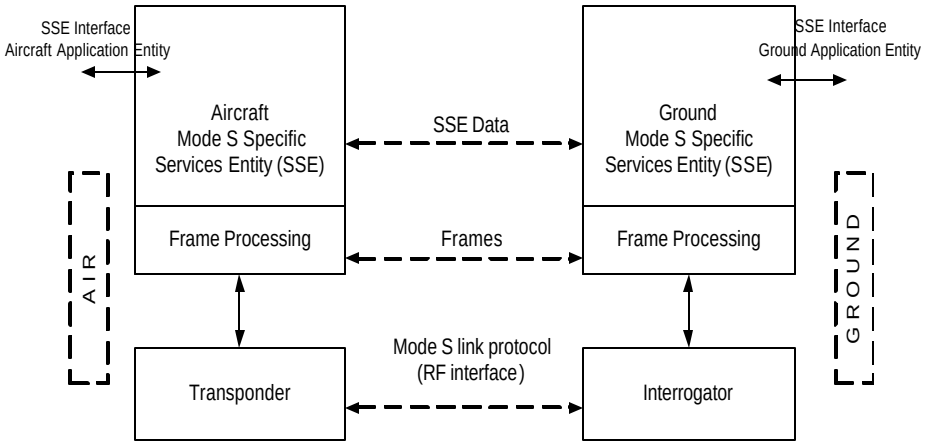


Figure C-3-1: Mode-S Specific Services Test Configuration

C.3.2 Detailed Test Procedures

C.3.2.1 Downlink Processing

C.3.2.1.1 Broadcast Processing

(§C.2.2.6.1.1.1 – General)
(§C.2.2.6.1.1.2 – Broadcast Processing)
(§C.2.2.6.4 – Broadcast Format)

Objective: This test is designed to validate the downlink broadcasting function of the MSSS, which includes broadcast processing and formatting of the broadcast messages.

Step 1 Generate two 56 bit downlink broadcast messages. The 56-bit message data field will consist of an alternating one zero pattern and alternating zero one pattern for alternate packets. Send the two broadcast messages to the A-SSE.

Step 2 At the G-SSE, verify that the transponder has generated two broadcast Comm-B segments whose MB Fields are equal to the message data fields of the broadcast messages. Verify format and content of the broadcast message.

Step 3 Generate a downlink broadcast message from the A-SSE with the data field length greater than 56 bits.

Step 4 Verify that an error message to the A-SSE is generated, and that no request for a Comm-B downlink appears at the RF interface.

C.3.2.1.2 MSP Processing

(§C.2.2.6.1.1.4 – MSP Processing)
(§C.2.2.6.2.1 – Short Form MSP Packet)
(§C.2.2.6.2.2 – Long Form MSP Packet)
(§C.2.2.7.2.3 – Delivery Status)

Objective: This test is designed to validate the downlink MSP processing function of the MSSS, which includes MSP processing, delivery status and formatting of the short form and long form MSP packets. The tests cover both SLM and ELM capabilities of the Mode S Transponder.

SLM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 From the AAE, generate the following MSP packets:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	5 bytes	1 segment	48 – 41
b.	4	12 bytes	2 segments	52 – 49
c.	4	19 bytes	3 segments	56 – 53
d.	4	26 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61
f.		165 bytes		61

Step 3 For groups "a" through "d," extract all Comm-B segments, and follow each with a closeout, as necessary. Verify that the control codes are DP=0, MP=0 (indicating the Short form MSP) and M/CH field corresponds to the selected MSP packet group (M/CH=48 to 41 for group a., M/CH = 52 to 49 for group b., etc.). Verify that the status of each downlink is sent to the A-SSE.

Note: *The packet from group "e" is oversize and cannot be transmitted in entirety. This portion of the test requires the A-SSE to use Long Form MSP packets with L bit assembly.*

Step 4 Verify that the first Comm-B message contains 26 bytes of user data identical to the first 26 bytes of the UD Field in the original MSP message, and the L bit is set. Verify that the second Comm-B message contains one segment with the MB Field identical to the last three bytes of user data in the original MSP message, and the L bit is not set.

Step 5 Send the data from group f to the A-SSE. Verify that no request for Comm-B downlink appears at the A-SSE RF interface.

ELM Capable

Step 1 Repeat the group e test described in the previous paragraph with the condition that the oversize packets are to be sent in total using downlink ELM containing Short MSP packets.

C.3.2.2 Uplink Processing

C.3.2.2.1 Broadcast Processing

(§C.2.2.6.1.2.1 – General)
(§C.2.2.6.1.2.2 – Broadcast Processing)
(§C.2.2.6.4 – Broadcast Format)
(§C.2.2.7.2.4 – Interrogator Identifier)

Objective: This test is designed to validate the uplink broadcasting function of the MSSS, which includes broadcast processing, interrogator identifier, and formatting of the broadcast messages.

Step 1 Send twelve uplink Comm-A Broadcast messages divided into two groups of six interrogations. The first group will be uplinked with a UF Field = 20 and the second group with UF = 21. Within each group of six interrogations, the 56 bit MA fields will contain a combination of the following bit patterns: all ones, all zeros, alternating ones and zeros and alternating zeros and ones. For each frame, set DI = 1 or 7, IIS = 15, and SD (except IIS) = 0, and provide an indication that the frame is an unlinked Comm-A (LAS = 0).

Step 2 Verify that the data delivered to the A-SSE interface contains the 56 bits of data in the MA field, the 32 bits Mode S frame header information, the II code, the broadcast ID and an indication that the frames are Comm-A broadcast frames."

C.3.2.2.2 MSP Processing

(§C.2.2.6.1.2.3 – MSP Processing)
(§C.2.2.6.2.1 – Short Form MSP Packet)
(§C.2.2.6.2.2 – Long Form MSP Packet)

Objective: This test is designed to validate the uplink MSP processing function of the MSSS, which includes MSP processing and formatting of the short form and long form MSP packets. The tests cover both SLM and ELM capabilities of the Mode S Transponder. The test uplinks several packets on different Mode S MSP channel numbers. The A-SSE is required to reformat Short and Long MSP packets into message and control data for the AE Separate Interface.

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 Send the following MSP messages to the AAE from the G-SSE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	6 bytes	1 segment	48 – 41
b.	4	13 bytes	2 segments	52 – 49
c.	4	20 bytes	3 segments	56 – 53
d.	4	27 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61

Step 3 Verify that the A-SSE forwards the contents of the UD fields, as well as a means for identifying the packets as MSP data, to the AAE interface.

Step 4 In case e), send to the A-SSE 2 Mode S linked Comm-A frames containing 2 linked Mode S Long Form MSP Packet on the selected MSP channel number. The first packet will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 3 bytes of user data. Make sure the A-SSE forwards the contents of the UD Field in its entirety and correct order to the AAE.

Step 5 If ELM capability is available, repeat Step e) but this time send a Mode S Short Form MSP packet to the A-SSE containing 29 bytes of data in the UD Field. Verify that the A-SSE forwards the contents of the UD Field as a means for identifying the packet as MSP data, to the AAE.

C.3.2.3 Frame Tests

C.3.2.3.1 Uplink SLM Frames

(§C.2.2.7.1.1 – Uplink SLM Frame)
(§C.2.2.7.1.1.1 – SD Field)
(§C.2.2.7.1.1.2 – LAS Coding)
(§C.2.2.7.1.1.3 – Single Segment SLM Frame)
(§C.2.2.7.1.1.4 – Multiple Segment SLM Frame)
(§C.2.2.7.2.5 – Frame Cancellation)

Objective: This test is designed to validate the uplink frame function of the MSSS, which includes processing of the SLM frame, SD field, LAS coding, the frame cancellation function, and the management of single segment and multiple segment SLM frames.

Single Segment SLM Frame

Step 1 From the G-SSE interface, generate 4 unlinked Comm-A frames containing Mode S Short Form MSP Packets having uniquely identifiable data in each of the 6 byte UD fields.

Step 2 Send this data to the A-SSE using MSP Channel Number 48 for the first frame, 47 for the second frames, etc., and use II = 6 for all frames.

Step 3 Verify that the A-SSE accepts control and message data from the transponder interface indicating 4 unlinked Comm-A segments with IIS = 6 and LAS = 0 in each case. Also, verify also that the A-SSE forwards the content of the UD Field to the A-SSE interface as well as a means for identifying the packets as MSP data, to the A-SSE interface.

Note: *If this test is to be performed in conjunction with Mode S transponder validation, the message field must be duplicated exactly in the Mode S RF interrogation, and uplink formats 20 and 21 must both be used.*

SD Field
LAS Coding
Frame Cancellation
Multiple Segment SLM Frame

This test requires the transmission of linked Comm-A segments over MSP channels.

In order for the A-SSE to reformat the frames, it is necessary to have segment number one contain the Short Form MSP Packet header.

Linked Comm-A messages can be canceled either whole or in part if the segments are not correctly received as determined by the LAS Field.

Step 1 Generate the following table of uplink frame data. Uniquely identify the data in the MA fields of each segment by using recognizable sequences of bit and/or byte patterns. All segments should be delivered by the same sensor II code, that is sensor 1, except frames 13 and 15 which should be delivered by sensor number 2.

Step 2 Send the following sequence of frames to the A-SSE:

LAS CODING

Frame	1	2	3	4	5	6	Notes
1.	1	0	0	0	1	0	Initial and Final Segments
2.	0	1	1	1	0	0	Two intermediate and one final segment; no initial segment
3.	1	1	0	0	0	1	Initial intermediate and final segments
4.	1	1	1	0	0	0	Initial and intermediate segments; no final segment
5.	1	0	0	0	0	1	Initial, third/final segments, no second segment
6.	1	1	1	0	0	0	Initial and intermediates; no final segment
7.	0	0	0	0	0	0	Delay Tc Plus one second
8.	0	0	0	1	0	0	Final segment for frame 6
9.	1	1	1	0	0	0	Initial and intermediate segments
10.	0	0	1	1	0	0	Duplicate and final segment for frame 9
11.	1	1	1	1	0	0	All 4 segments complete
12.	1	0	0	0	0	0	Initial segment IIS=1
13.	1	0	0	0	0	0	Initial segment IIS=2
14.	0	0	0	0	1	0	Final segment IIS=1
15.	0	0	0	0	1	0	Final segment IIS=2
16.	1	0	0	0	0	1	First and final segment
17.	0	1	0	0	0	0	Second segment

Step 3 Send each frame at 10 second intervals, except frame 7. After sending frame 6, wait at least Tc plus one second before sending frame 8. Thereafter, continue with 10 second intervals.

Step 4 Verify that frames 1, 3, 11, 12/14, 13/15, and 16/17 are sent to the A-SSE interface. Verify the 0.25 second reformatting time requirement and the data content for completeness and proper order.

Step 5 Frames 9 and 10 should comprise a complete linked Comm-A. However, segment 3 is duplicated in frame 10 and should be discarded. Verify that frames 9 and 10 are sent to the A-SSE interface. Verify from the length and content that the duplicate segment has been discarded.

Step 6 Frames 2, 4, 5, 6 and 8 should all be discarded; no message data should result. Each of these frames meets one of the conditions of §C.2.2.7.1.1.4 for uplink frame cancellation.

Link Frame Cancellation Timer Tc

Step 1 Generate two Short Form MSP packets with a 27 byte UD Field to fit into a four segment linked Comm-A message. The content of the UD Field will be a 1 in the first byte, 2 in the second byte, etc. Set II = 1 for all segments.

Step 2 Send only the first three Comm-A segments of the first frame to the A-SSE. Impose a delay of Tc minus two seconds, then send the final segment.

Step 3 Verify that the A-SSE forwards to the AAE interface a MSP message with a 27 byte UD Field in correct order and content.

Step 4 Repeat the process just described and transmit the first three Comm-A segments of the second frame. However, this time impose a delay of Tc plus two seconds between the transmission of the third and the final Comm-A segments. Verify that there is no output to the AAE.

C.3.2.3.2 Uplink ELM Frames

(§C.2.2.7.1.2 – Uplink ELM Frame)

Objective: This test is designed to validate the uplink frame function of the MSSS, and is intended to demonstrate that the A-SSE can receive segments of an ELM. ELM protocol is strictly a transponder issue; the A-SSE has no part in the message handling until the transponder sends a complete ELM.

The data content of each of the segments of the ELM will be identical to the transponder MC Fields after the receipt of an ELM. The bit pattern contained in the MC Field should permit each segment's data to be uniquely identified. Note that the first four bits of each uplink ELM MC Field contains the II code of the sensor. Therefore, there are 76 bits of User Data in each uplink ELM segment. All segments should be delivered by the same sensor 1, code.

Step 1 Send the following table of ELM frames (UF = 24) containing the Short Form of MSP packets, to the A-SSE at the transponder interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	1	18 bytes	2 segments	2
b.	1	27 bytes	3 segments	3
c.	1	37 bytes	4 segments	4
d.	1	46 bytes	5 segments	5
e.	1	56 bytes	6 segments	6
f.	1	65 bytes	7 segments	7
g.	1	75 bytes	8 segments	8
h.	1	84 bytes	9 segments	9
i.	1	94 bytes	10 segments	10
j.	1	103 bytes	11 segments	11
k.	1	113 bytes	12 segments	12
l.	1	122 bytes	13 segments	13
m.	1	132 bytes	14 segments	14
n.	1	141 bytes	15 segments	15
o.	1	151 bytes	16 segments	16

Step 2 Verify also that the A-SSE forwards the contents of the UD fields of the MSP packets and a means for identifying the packet as MSP data, to the AAE interface.

Negative Uplink ELM Frame Test

The A-SSE must discard the entire uplink ELM if all of the segments do not contain the same II code.

Step 1 Repeat the previous test with data from group "a" of the test but send the last segment with an II code different from the II code contained in the first segment.

Step 2 Verify that no output is generated to the A-SSE.

C.3.2.3.3 Downlink SLM Frames

(§C.2.2.7.2.1 – Downlink SLM Frame)
(§C.2.2.7.2.1.1 – LBS Coding)
(§C.2.2.7.2.1.2 – Linking Protocol)
(§C.2.2.7.2.1.3 – Directing SLM Frames)
(§C.2.2.7.2.3 – Delivery Status)

Objective: This test is designed to validate the downlink frame function of the MSSS, which includes processing of the SLM frame, LBS coding, linking protocol, directing and

delivery status of SLM frames. This test requires the transmission single and linked Comm-B segments over MSP channels.

SLM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field. Set II=1 for all packets in this section.

Step 2 Send the following MSP messages to the A-SSE from the AAE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	5 bytes	1 segment	48 – 41
b.	4	12 bytes	2 segments	52 – 49
c.	4	19 bytes	3 segments	56 – 53
d.	4	26 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61

Step 3 Extract each Comm-B segments from the A-SSE and send Comm-D close-outs, as necessary. Verify the A-SSE sends an indication of the downlink delivery status to the AAE. Verify the correct association of LBS value with the number of segments delivered and that the M/CH field decrements correctly.

Note: *Since the transponder is not downlink ELM capable, the packets from group "e" will be sent via Comm-B segments with MSP L bit procedures.*

Step 4 Verify that the first Comm-B message from group e consists of 4 segments and contains 26 bytes of data in the MB Field(s) and that the second Comm-B message contains one segment with three bytes of data in the MB Field.

C.3.2.3.4 Downlink ELM Frame

(§C.2.2.7.2.2 – Downlink ELM Frame)
(§C.2.2.7.2.2.1 – Directing ELM Frame)

Objective: This test is designed to validate the downlink frame function of the MSSS, which includes processing of the ELM frames. This test requires the transmission of ELM segments over MSP channels.

ELM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 Send the following MSP messages to the A-SSE from the AAE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	1	9 bytes	1 segment	1
b.	1	19 bytes	2 segments	2
c.	1	29 bytes	3 segments	3
d.	1	39 bytes	4 segments	4
e.	1	49 bytes	5 segments	5
f.	1	59 bytes	6 segments	6
g.	1	69 bytes	7 segments	7
h.	1	79 bytes	8 segments	8
i.	1	89 bytes	9 segments	9
j.	1	99 bytes	10 segments	10
k.	1	109 bytes	11 segments	11
l.	1	119 bytes	12 segments	12
m.	1	129 bytes	13 segments	13
n.	1	139 bytes	14 segments	14
o.	1	149 bytes	15 segments	15
p.	1	159 bytes	16 segments	16

Step 3 Extract the Comm-D segments from the A-SSE and send Comm-D close-outs, as necessary. Verify the A-SSE sends an indication of the downlink delivery status to the AAE interface. At the GAE interface, verify the correct association of the ND value with the number of segments delivered and that the M/CH field increments correctly for each packet.

C.3.2.4 MSP Operations

(§C.2.2.6.1.1.4, §C.2.2.6.1.2.3 – MSP Processing)
(§C.2.2.6.3 – L-bit Processing)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the MSP operations by using L-bit linking, MSP processing and System Timers in associated with these operations.

Step 1 Send 4 bytes of CONTROL MESSAGE data from the AAE interface on channel 1. Verify at the G-SSE interface that the A-SSE has sent a Mode S short form MSP packet on channel 1.

Step 2 Send 42 bytes of CONTROL MESSAGE DATA from the AAE interface on channel 1. At the G-SSE, verify that two Mode S MSP packets (long form) are received from the A-SSE on channel 1. The first frame will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 16 bytes of user data.

Step 3 Send a Mode S frame containing a Mode S MSP (short form) Packet to the A-SSE on channel 2. Fill the UD Field with five bytes of the bit pattern 01010101. At the A-SSE interface, verify the reception of a CONTROL MESSAGE DATA on channel 2.

Step 4 Generate 42 bytes of Control Message Data from the G-SSE interface on MSP channel 1 in a total of 2 MSP packets (Long Form). The first MSP packet will have L-bit set to 1 and contain 26 bytes of User Data. The second MSP packet will have L-bit set to 0 and contain 16 bytes of User Data. At the A-SSE interface, verify that an MSP packet (Long Form) is received from the A-SSE on channel 1.

C.3.2.5 L-Bit Linking

(§C.2.2.6.3 – L-bit Processing)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the L-bit linking function of the MSSS for long form MSP channels, and the use of the Tm timer for L-bit linking.

The Long Form MSP Packet test procedures are designed to test the A-SSE's ability to link Mode S Long Form MSP Packets when the packet size is greater than 28 bytes and the transponder has no downlink ELM capability.

Step 1 Use a selected MSP number, fill the Used Data Field with 32 bytes of the bit pattern 01010101. At the G-SSE interface, verify that two mode S long form MSP packets are received on the selected MSP channel from the A-SSE. The first frame will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 6 bytes of user data.

Step 2 Send two Mode S Comm-A frames containing a linked Mode S Long Form MSP Packet to the A-SSE on a MSP channel number. Fill the UD Field with 26 bytes and 6 bytes respectively with the bit pattern 10101010. At the A-SSE interface, verify that a Mode S long form MSP packet is received from the AAE. Verify the UD Field for content and order.

L-bit Delivery Timer (Tm)

Step 1 From the GAE, create 2 long form MSP packets for delivery to the AAE. The first packet will have 26 bytes of user control data and L-bit set to ONE (1). The seconds packet will have 16 bytes of user control data and L-bit set to ZERO (0) for a complete sequence.

Step 2 After sending the first packet, send the second packet within the Tm time period. At the AAE interface, verify the receipt of this constructed packet containing 42 bytes of user control data in correct order and content.

Step 3 Repeat the process to generate the long form MSP packets again to the A-SSE, except this time, send the second packet after Tm time period. This allows the A-SSE to discard the complete sequence since the expiration of the Tm timer for L-bit sequencing.

Verify that there's no related output for this transaction at the AAE interface.

C.3.2.6 Link Frame Cancellation Timer (Tc)

(§C.2.2.7.2.5 – Frame Cancellation)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the Tc frame cancellation timer of the frame processing function.

Step 1 From the GAE, generate two Short Form MSP packets with a 27 byte UD Field to fit into a four segment linked Comm-A message. The content of the UD Field will be a 1 in the first byte, 2 in the second byte, etc. Set II = 1 for all segments.

Step 2 Send only the first three Comm-A segments of the first frame to the A-SSE. Impose a delay of Tc minus two seconds, then send the final segment.

Step 3 Verify that the A-SSE receives an MSP message with a 27 byte UD Field in correct order and content.

Step 4 Repeat the process just described and transmit the first three Comm-A segments of the second frame. However, this time impose a delay of Tc plus two seconds between the transmission of the third and the final Comm-A segments. Verify that there is no output to the AAE.

C.3.2.7 Interrogator Link Timer (Tz)

(§C.2.2.6.1.1.4 – MSP Processing)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the Tz interrogator link timer of the MSSS.

Step 1 From the GAE, generate a short form MSP packet for delivery to the AAE (data content can be any).

Step 2 For this downlink, do not allow for a closeout from the G-SSE. This will force the Tz timer in the A-SSE to start its countdown for the non-closeout action.

Step 3 After 30 seconds elapse, verify that there's no output in the form of the MSP packet at the GAE, since the packet would have been discarded by the A-SSE due to the Tz timeout.

C.4 Dataflash Application

C.4.1 Introduction

Eurocontrol has defined a Table of parameters available from aircraft systems that will be downlinked via Mode S to ATC ground systems. This information is intended to provide the ATC systems with more information to improve knowledge, amongst other things, on the aircraft's current status and its short term intent. The parameters are called Downlink Aircraft Parameters (DAPs). They can be acquired via the Mode S system by the use of either one of two Mode S protocols as follows:

Ground initiated Comm B (GICB) which requires regular interrogation of the aircraft to extract the parameter.

Dataflash is a contract-based service specified by ICAO in the Manual on Mode S Specific Services (ICAO Doc 9871, Appendix A). It relies on the aircraft system, announcing in its Mode S replies to surveillance interrogations, that a parameter in a contracted transponder register has changed according to rules agreed in the contract. It therefore does not require regular interrogations to check the status of the parameter.

C.4.2 The Choice of Protocol

Data that needs to be updated every few scans of the ground radar will normally be extracted by the ground system using the GICB protocol. To use this protocol to acquire data which does not necessarily change very often, results in a lot of interrogations and replies which provide the same information as the previous transaction, therefore causing unnecessary interference on the radio frequency channel.

Dataflash is a much more radio frequency channel efficient protocol that can be used to extract information that may not change very often, and Eurocontrol states using Mode S will therefore need to use this protocol.

C.4.3 EUROCAE Documentation

The Mode S transponder functions and protocols are fully covered by Eurocae ED-73C MOPS, and the Mode S Aircraft Data Link Processor (ADLP) functions and protocols by the ED-82A MOPS. The latter, however does not include MOPS for the Dataflash function because Dataflash is a Mode S Specific Services Application, and as such is not covered by the Mode S Subnetwork standards or MOPS.

A characteristic for a Mark 4 transponder has now been published in ED-86, requiring the Dataflash function to be part of the Mark 4 transponder. To locate Dataflash elsewhere would require a lot of data already residing in the transponder to be shipped out to the Dataflash function for monitoring and back in again when action is required. This would result in an unnecessary aircraft wiring and data-bus load. In order to permit full certification of such a transponder, Dataflash MOPS are required.

If the Dataflash application is implemented in an ADLP and a failure of the ADLP occurs, the only possible recovery mechanism is a power up restart to ensure that the ADLP is in the initialization state. Failure of the ADLP shall not impair the surveillance function of the transponder.

In the case of a single ADLP connected to two transponders, it shall be possible to switch over to the standby transponder without affecting the ADLP states.

C.4.4 Dataflash Requirements

All the requirements of Uplink MSP channel 6 when the Service Request header is set to 1 and those of Downlink MSP channel 3 shall be met as specified in ICAO Annex 10 Volume III Part 1 Digital Data Communications Systems.

The detailed requirements are stated in §C.4.6.

C.4.5 Document Precedence

If there is any conflict between this Appendix and ICAO Annex 10, the latter takes precedence.

C.4.6 Uplink MSP Channel 6 (Ground-to-Air Request)

C.4.6.1 Purpose

To provide a means of requesting access to services supported by the aircraft. When implemented, bit 6 of the register accessed by Register $1D_{16}$ shall be set to ONE (1).

C.4.6.2 Format

The request shall be transferred in an uplink MSP packet with the channel number set to 6 and, in the case of a long form MSP packet, with SP set to ZERO (0). The first byte of the user data field contains a service request (SR) header. The contents and format of the service request are specified by the application.

C.4.6.3 SR Header Assignments

The decimal value of SR shall be interpreted as follows:

0	Unassigned
1	Dataflash
2	Local System Management
3 to 255	Unassigned

C.4.6.4 Dataflash Request Format

The purpose of Dataflash service is described in §C.4.7.1. The format of the user data field is shown in Table C-4-1. The user data field of the requesting MSP packet shall contain the decimal value of "ONE" in the first byte (SR header), followed by one or more requests for Dataflash services. Each request shall contain a two byte Dataflash request header (DH), followed by a one byte field to define the minimum time interval permitted between reports (MT field), a four bit field to determine the event criterion (EC field), a four bit field to determine stable time (ST field), and if indicated in EC, a Change Quanta field (CQ) and a Change Threshold (CT) field. The 4 bit ST field shall indicate the decimal value in seconds, how long the changed data has been stable before a message shall be initiated. ALL ZEROs in the Dataflash header (DH) shall indicate that there are no more Dataflash requests in the packet. When an MSP packet is completely filled with Dataflash requests, or when there is not sufficient room in the packet for another Dataflash request header, it shall be assumed that the Dataflash request sequence is complete.

A single Dataflash contract relates to a single contract number for a single register for a particular II code. This meets the requirement that multiple Dataflash services, with different DH values for each II code, can be established simultaneously with the same aircraft. These may be modified or discontinued independently of each other. All aircraft equipment and installations shall support 16 Dataflash contracts. All aircraft Dataflash equipment and installations originally certified after 1 January 2001 shall support 64 Dataflash contracts.

Note: *When a request has been accepted by the aircraft system a data flash response will be triggered immediately regardless of thresholds or event criteria. If no response is received in 30 seconds then a check should be made that the aircraft is still available on roll call, and if so a new request should be generated. In order to avoid repeated Dataflash requests that produce no response, the number of such requests (N) should be limited (N=3).*

When a new contract request is received for a contract already in existence, the old contract shall be discontinued and replaced immediately by the latest one.

C.4.6.5 Dataflash Header (DH) 16 Bits

The 16 bit DH field is divided into three subfields separated by 3 currently unassigned bits 14 through 16 (see Table C-4-1).

C.4.6.5.1 Contract Number Subfield (CNS) 4-Bits.

(Bits 9 to 12 of the Uplink MSP 6 User Data Field)

This subfield shall be interpreted as a contract number permitting 16 different contracts to be associated with the register specified by the BDS1 and BDS2 codes of this contract request.

Contract numbers available are 0 to 15.

C.4.6.5.2 Request Data Subfield (RDS) 1-Bit.

(Bit 13 of the Uplink MSP 6 User Data Field)

This subfield shall indicate whether or not the contents of the register being monitored by the requested contract must be sent in the MSP Packets on Downlink channel 3 that are sent each time the criterion for the contract is met.

The subfield shall be interpreted as follows:

RDS = 0 Send only bits 1 to 40 of the user data field on Downlink MSP 3 when the contract criterion is met.

RDS = 1 Send bits 1 to 96 of the user data field on Downlink MSP 3 when the contract criterion is met.

Note: *RDS only indicates the length of the user data field in Downlink MSP3 when responding with a value zero in the CI field (see §C.4.7.4.3.1).*

C.4.6.5.3 BDS1 and BDS2 Codes of the Register for Which the Contract is Required. 8 Bits.

(Bits 17 to 24 of the Uplink MSP 6 User Data Field)

BDS1 and BDS2 codes are specified in Annex 10 Volume IV.

C.4.6.6 Minimum Time (MT) 8 Bits

The decimal value of the 8 bit MT field represents the minimum time in seconds that shall elapse after a report has been event triggered and sent to the transponder, before a new report can be initiated. The report sent to the transponder shall always be the most current data available.

C.4.6.7 Event Initiation

Event initiation shall be controlled by the two following fields.

C.4.6.7.1 Event Criterion Field (EC) 4 Bits

These are the four bits following the MT field. If multiple events occur within a single register being monitored by a Dataflash contract, (e.g., if more than one parameter shows a significant change) only one message shall be triggered.

The decimal value of the EC field shall be interpreted as follows:

0 = No report required, discontinue service for the contract specified in the DH field.

1 = Report any change.

2 = 56 bit change field (CQ) follows ST. Only report changes to bits indicated by a "ONE" in CQ.

3 = 56 bit field CQ follows ST. For each parameter report all status changes and all changes of the parameter greater than the quantum value indicated in the same units and resolution of the field in CQ corresponding to that parameter. A zero in the field in CQ corresponding to the parameter indicates that no reports are required.

4 = 112 bits CQ plus CT follow ST. The first 56 bits are as for the EC value 3 above. The second 56 bits are the CT field indicating a threshold value in the field corresponding to the parameter. Report all changes above the threshold where the value in CQ gives the change quantum.

5 = 112 bits of CQ and CT follow ST. Same as for the EC value 4 above except: report all changes below the threshold.

6 = 112 bits of CQ and CT follow ST. Same as for ECS values 4 and 5 above except report only when the threshold is crossed (in either direction).

7 to 14 = Not currently assigned.

15 = Cancel all contracts for the II code in this request.

C.4.6.7.2 Stable Time Field (ST) 4 Bits

These are the four bits following the EC field. The decimal value of ST shall indicate in seconds, how long the changed data have been stable to within the change quanta specified in CQ field, before a message shall be initiated. A value of ZERO (0) in this subfield shall indicate that there is no minimum stable time and any change immediately initiates a message. The significance of the ST will differ slightly depending upon which EC mode is being used. In particular, for EC modes 4 & 5, regarding stability whilst above/below a threshold, if a parameter value remains above/below the defined threshold for greater than the ST time then a Dataflash shall be generated even if the value does not remain stable to within one quantum. Subsequent quantum changes which are stable for greater than the ST time shall generate further Dataflash messages until the value falls below / rises above the threshold.

C.4.6.8 Change Fields – Change Quanta (CQ) and Change Threshold (CT)

These fields shall be present when indicated in EC. For a GICB service (i.e., for DH from 1 to 255 inclusive), CQ shall be contained in bits 41 to 96 of the MSP 6 User Data Field. CT when required shall be contained in bits 97 to 152 of the MSP 6 User Data Field. The quantum value in the CQ field shall be in the same units and resolution as those specified for the register being monitored and it specifies the amount by which the parameter shall change, from its value at the initialization of the contract, and thereafter from the value last reported by a Dataflash response on downlink channel MSP 3.

Table C-4-1: Request for Dataflash Register monitoring Service Mode S SLM Frame Containing (Uplink MSP Channel 6)

MSP (6) USER DATA FIELD Bits 1 to 40			MSP (6) USER DATA FIELD Bits 41 to 96 (if required)		MSP (6) USER DATA FIELD Bits 97 to 152 (if required)	
	DP = 0 (1 BIT)	UPLINK MSP HEADER (1 BYTE)	41		97	
	MP = 0 (1 BIT)		42		98	
	M/CH = 6 (6 BITS)		43		99	
			44		100	
			45		101	
			46		102	
			47		103	
			48		104	
1	SERVICE REQUEST (SR)		49		105	
2			50		106	
3			51		107	
4			52		108	
5			53		109	
6			54		110	
7			55		111	
8			56		112	
9	CONTRACT NUMBER SUBFIELD (CNS)	DATAFLASH HEADER (DH)	57		113	
10			58		114	
11			59		115	
12			60	CHANGE QUANTA FIELD (CQ)	116	CHANGE THRESHOLD FIELD (CT)
13	REQUEST DATA (RDS)		61		117	
14	NOT ASSIGNED		62		118	
15			63		119	
16			64		120	
17	BDS1 CODE		65		121	
18			66		122	
19			67		123	
20			68		124	
21	BDS2 CODE		69		125	
22			70		126	
23			71		127	
24			72		128	
25	MINIMUM TIME (MT) INTERVAL		73		129	
26			74		130	
27			75		131	
28			76		132	
29			77		133	
30			78		134	
31			79		135	
32	LSB = 1 second		80		136	
33	EVENT CRITERION (EC)		81		137	
34			82		138	
35			83		139	
36			84		140	
37	STABLE TIME (ST)		85		141	
38			86		142	
39			87		143	
40	LSB = 1 second		88		144	
			89		145	
			90		146	
			91		147	
			92		148	
			93		149	

The last byte of the final MA field shall always be unassigned

Note: *See Annex 10 Volume III §5.2.7.3 for specification of MSP Packets.*

94		150	
95		151	
96		152	

C.4.7 Downlink MSL Channel 3. Dataflash Service

C.4.7.1 Purpose

Dataflash is a service which announces the availability of information from air-to-ground on an event triggered basis. This is an efficient means of downlinking information which changes occasionally and unpredictably. When implemented, bit 31 of the Register accessed by Register $1D_{16}$ shall be set to ONE (1).

C.4.7.2 Service Initiation and Termination

The Dataflash service shall be initiated or discontinued by a service request. It is received on uplink MSP channel 6 with a decimal value of ONE in the service request (SR) header which is contained in the first byte of the user data field. This indicates that the rest of the user data field contains Dataflash request. On the receipt of such a request a Dataflash message from the register concerned with the request, shall immediately be made available and announced to the ground regardless of the setting of the RDS field in the contract request and of any event criteria.

The response shall be as follows:

1. When the requested register is being serviced, the contract shall be established and an MSP Packet as in Table C-4-2 shall be announced to the ground on MSP channel 3. The CI field shall be set to a value of 1. The message shall be used by the ground system to confirm that the service has been initiated.

2. If the requested register is not being serviced the contract shall not be established. This shall be indicated by announcing the MSP Packet on Downlink MSP channel 3 to the ground as shown in Table C-4-2, and with a value of 2 in the CI field.

3. If the maximum number of contracts that can be supported are already established then the new contract shall be refused. This shall be indicated by announcing to the ground an MSP Packet on Downlink channel 3, as shown in Table C-4-2, and with a value of 3 in the CI field.

4. In the case of a request from the ground to terminate the service for a particular register the termination of the service shall be confirmed by announcing to the ground, an MSP Packet on Downlink channel 3, as shown in Table C-4-2, and with a value of 4 in the CI field.

5. In the case of a request from the ground to terminate the service for all contracts to a particular II code. The termination of the service shall be confirmed by

announcing to the ground, an MSP Packet on Downlink channel 3, as shown in Table C-4-2, and with a value of 5 in the CI field.

6. When the register service fails for an established contract, the contract shall be terminated by the airborne application. This shall be indicated by announcing an MSP Packet on Downlink channel 3, to the ground, as shown in Table C-4-2, and with a value of 7 in the CI field. Register service shall be deemed to have failed when any of the parameters specified to be monitored in the negotiation of the contract is not being updated at the specified minimum rate.

7. When a contract is refused due an invalid value of the EC field in the contract request this shall be indicated by announcing an MSP Packet on Downlink channel 3 to the ground as shown in Table C-4-2, and with a value of 15 in the CI field.

8. If any message is not extracted from the transponder by a ground interrogator within 30 seconds the aircraft subnetwork cancels the message and generates a delivery failure notice (i.e., the Tz timer expires) which is delivered to the aircraft MSP service provider. When a delivery failure notice is received the service shall be automatically terminated by the Dataflash function with no indication to the ground system.

Note: *This is to prevent the transponder message queues being blocked when the ground interrogator stops supplying the message extraction service, either due to a fault or loss of cover. It is the responsibility of the ground application to monitor the Dataflash service taking this into account.*

9. When the transponder has not been selectively interrogated by a Mode S interrogator with a particular II code for 60 seconds (this is determined by monitoring the IIS subfield in all accepted Mode S interrogations), all Dataflash contracts related to that II code shall be cancelled with no indication to the ground system.

C.4.7.3 Service Provision

On the reception of a Dataflash request the requested parameters shall be monitored and transferred to the ground using the Mode S air initiated protocols directed to the II code that was contained in the requesting interrogation. In order to prevent the flooding of the transponder with Dataflash messages, an upper limit of ten messages in a six seconds period shall be imposed. When the limit of ten messages within a six seconds period is reached, further messages shall be queued until they can be sent. Messages queued in this way shall respond with a CI field value of 6.

If after initiating a Dataflash message to the ground, the change criterion is met again prior to the message being entered into the transponder for announcement, the message is considered stale and shall be replaced by the most up to date information.

C.4.7.4 Downlink Message Structure

The information shall be transferred in a downlink MSP packet with the channel number M/CH = 3. The format is shown in Table C-4-2.

The first two bytes of the User Data (UD) field shall contain a Dataflash header (DH), which are identical to the DH field that was contained in the request for the service.

C.4.7.4.1 Bits 17 to 31 of UD form the II code Contract Report Field in which each bit shall indicate that at least one contract is active with the II code which the bit represents when it is set to a ONE, otherwise there are no active contracts with that II code.

C.4.7.4.2 Bits 32 to 36 of UD are not assigned.

C.4.7.4.3 Bits 37 to 40 of UD form the Contract Information (CI) field which shall be interpreted as follows:

CI Field Value	Meaning
0	Response to existing contract
1	New contract established
2	New contract not accepted due to no register data service
3	New contract not accepted due to maximum number of contracts already being serviced.
4	Contract terminated for the DH in this response due to a request from the ground.
5	All contracts terminated for the II code that delivered the MSP Packet having an EC value of 15 that requested this response. Response has been queued due to the limit of ten Dataflash messages in a six seconds period. Contract terminated due to failure of the register data service.
8 to 14	Unassigned
15	New contract not accepted due to invalid number in EC field of requesting uplink MSP Packet.

C.4.7.4.3.1 When the CI field is equal to ZERO the response shall be as requested by the RDS field in the Dataflash header of the contract (see §C.4.6.5.2). When the CI field is not equal to ZERO the response shall only contain bits 1 to 40 of the user data field on downlink MSP 3 (see Table C-4-2).

C.4.7.5 Data Extraction by Mode-S Ground Stations

The Dataflash transaction shall be announced as a downlink frame in replies to interrogations UF 4, 5, 20, or 21. The transaction announced shall be either a single segment Comm B frame, or a two segment Comm B frame, as requested by the contract

negotiation. The Air Directed Comm B first segment shall contain the MSP header, Dataflash header, and control information for that particular contract. In the case of a contract for a single segment response, if the data is required, it is acquired by the ground station extracting the register in question directly.

Table C-4-2: Dataflash for Register Monitoring Service (Mode-S Frame for Downlink MSP Channel 3)

MSP (3) USER DATA FIELD Bits 1 to 40			MSP (3) USER DATA FIELD Bits 41 to 96		
	LINKED COMM B SUBFIELD (LBS) (2 BITS)		41 42		
	DP = 1 (1 BIT)	MSP HEADER	43		
	MP = 0 (1 BIT)		44		
	M/CH = 3 (6 BITS)		45 46 47 48		*Note: See Annex 10 Volume III §5.2.7.3 for specification of MSP Packets*
	FILL 1 = 0 (6 BITS)		49 50 51 52 53 54 55 56		
1 2 3 4	CONTRACT NUMBER SUBFIELD (CNS)	DATAFLASH HEADER (DH)	57 58 59 60		
5	REQUEST DATA SUBFIELD (RDS)		61		
6 7 8	NOT ASSIGNED		62 63 64	REGISTER	
9 10 11 12	BDS1 CODE		65 66 67 68	MESSAGE CONTENT	
13 14 15 16	BDS2 CODE		69 70 71 72		
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	II=1 II=2 II=3 II=4 II=5 II=6 II=7 II CODE II=8 CONTRACT II=9 REPORT (CR) II=10 II=11 II=12 II=13 II=14 II=15		73 74 75 76 77 78 79 80 81 82 83 84 85 86 87		
32 33 34 35 36	NOT ASSIGNED		88 89 90 91 92		
37			93		

38	CONTRACT	94	
39	INFORMATION (CI)	95	
40		96	

C.4.7.6 Data flash Requirement/Test Cross Reference Table

Table C-4-3 lists all requirements and gives the test section Procedures which test each requirement.

Table C-4-3: Dataflash Requirements/Test Cross-Reference

Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
§C.4.6	Uplink MSP channel 6		headline
§C.4.6.1	Purpose	§C.4.8.2.1	Procedure 1 Step 1
§C.4.6.2	Format		uplink requirement
§C.4.6.3	SR header assignments	§C.4.8.2.2	Procedure 2 Step 2
§C.4.6.4	Dataflash request format	§C.4.8.2.2	Procedure 2 Step 2
§C.4.6.5	Dataflash header (DH) 16 bits		introduction
§C.4.6.5.1	Contract number Subfield (CNS)	§C.4.8.2.4	Procedure 4 Step 1
§C.4.6.5.2	Request Data Subfield (RDS)	§C.4.8.2.2	Procedure 2 Step 2
§C.4.6.5.3	BDS 1 and BDS2 codes of the register for which the contract is required.	§C.4.8.2.2	Procedure 2 Step 2
§C.4.6.6	Minimum time (MT)	§C.4.8.2.5	Procedure 5 Steps 1, 2
§C.4.6.7	Event Initiation		introduction
§C.4.6.7.1	Event Criterion field (EC) -a. EC = 0	§C.4.8.2.3	Procedure 3 Step 1
	-b. EC = 1	§C.4.8.2.2	Procedure 2 Step 1
	-c. EC = 2	§C.4.8.2.6	Procedure 6 Step 1
	-d. EC = 3	§C.4.8.2.6	Procedure 6 Step 2 Procedure 6 Step 3
	-e. EC = 4	§C.4.8.2.6	Procedure 6 Step 4
	-f. EC = 5	§C.4.8.2.6	Procedure 6 Step 5
	-g. EC = 6	§C.4.8.2.6	Procedure 6 Step 6
	-h. EC = 7-14	§C.4.8.2.6	Procedure 6 Step 9
	-i. EC = 15	§C.4.8.2.6	Procedure 6 Step 7
§C.4.6.7.2	Stable time (ST) field	§C.4.8.2.7	Procedure 7 Step 1
§C.4.6.8	Change fields - -a. Change Quanta (CQ)	§C.4.8.2.6	Procedure 6 Step 2 (LSB) Procedure 6 Step 3 (MSB)
	-b. Change Threshold (CT)	§C.4.8.2.6	Procedure 6 Step 4
Table C-4-1	MSP packet User Data (MSP 6)		implicitly tested
§C.4.7	Downlink MSP Channel 3 Dataflash Service		headline
§C.4.7.1	Purpose		introduction
§C.4.7.2	Service initiation and termination		implicitly tested
	1. Initiation action (contract established)	§C.4.8.2.2	Procedure 2 Step 2
	2. Initiation action (register not serviced)	§C.4.8.2.2	Procedure 2 Step 1
	3. Initiation action (maximum number of contracts)	§C.4.8.2.2	Procedure 2 Step 2
	4. Initiation action (contract terminated)	§C.4.8.2.3	Procedure 3 Step 1
	5. Initiation action (all contracts terminated)	§C.4.8.2.6	Procedure 6 Step 7

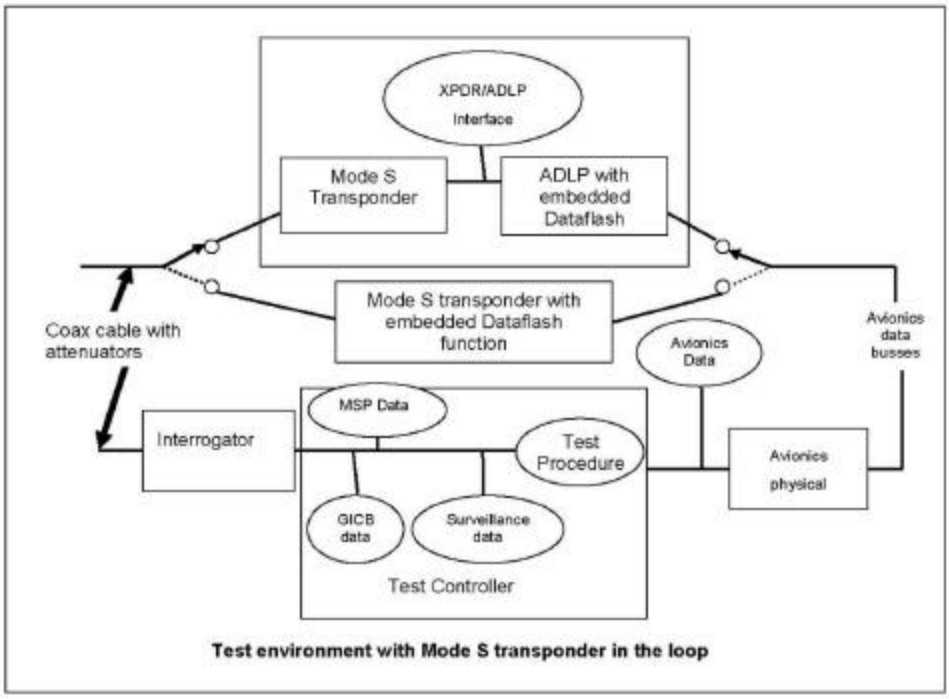
Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
	6. Initiation action (contract establishment failed)	§C.4.8.2.3	Procedure 3 Step 2
	7. Initiation action (EC field error)	§C.4.8.2.6	Procedure 6 Step 8
	8. Delivery failure notice	§C.4.8.2.3	Procedure 3 Step 3
	9. Non-interrogation timeout	§C.4.8.2.3	Procedure 3 Step 4
§C.4.7.3	Service provision	§C.4.8.2.8	Procedure 8 Step 3
§C.4.7.4	Downlink message structure		implicitly tested
§C.4.7.4.1	Contract report field.	§C.4.8.2.2	Procedure 2 Steps 1,2,3
§C.4.7.4.2	Unassigned bits		implicitly tested
§C.4.7.4.3	Contract information field -a. CI = 0	§C.4.8.2.5	Procedure 5 Step 2
	-b. CI = 1	§C.4.8.2.2	Procedure 2 Step 2
	-c. CI = 2	§C.4.8.2.2	Procedure 2 Step 1
	-d. CI = 3	§C.4.8.2.2	Procedure 2 Step 2
	-e. CI = 4	§C.4.8.2.2	Procedure 3 Step 1
	-f. CI = 5	§C.4.8.2.6	Procedure 6 Step 7
	-g. CI = 6	§C.4.8.2.8	Procedure 8 Step 3
	-h. CI = 7	§C.4.8.2.3	Procedure 3 Step 2
	-i. CI = 8-14		implicitly tested
	-j. CI = 15	§C.4.8.2.6	Procedure 6 Step 9
§C.4.7.4.3.1	Response type	§C.4.8.2.2	Procedure 2 Step 2
§C.4.7.5	Data Extraction by Mode S Ground stations		Implicitly tested
Table C-4-2	Dataflash for Register Monitoring service		implicitly tested

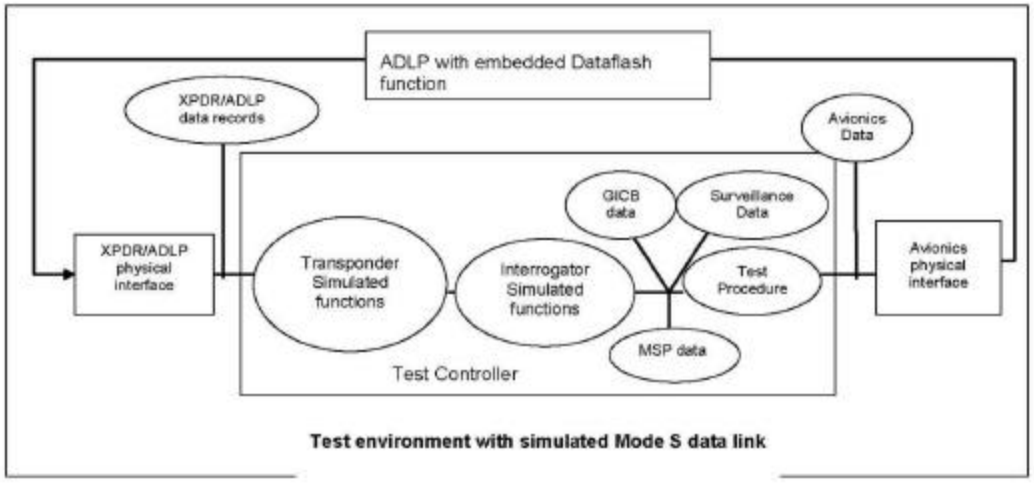
C.4.8 Test Procedures for Dataflash Application

C.4.8.1 Test Equipment

a. A Mode S transponder and a means to input and record test data into the Mode S transponder registers from simulated aircraft data buses at the required rates. (This may be done via an ADLP if the transponder does not have the Dataflash application inside it).
b. A means to interrogate the Mode S transponder at a regular rate between 6 and 10 seconds with surveillance interrogations and decode the replies.
c. A means to send data to the transponder, extract air initiated messages announced by the transponder, and extract the data from the transponder registers of the transponder, by means of interrogations with the appropriate control codes set.
d. A means to set up, record, and monitor Dataflash contracts by interrogating the Mode S transponder. Also a means of extracting and recording the data from the transponder when announced in the reply to a background surveillance interrogation.

The test equipment and its configuration will be dependent on where the Dataflash function resides. There are several possibilities, two examples of which are, either in an ADLP separate from a transponder, or in a combined ADLP transponder unit such as a Mark 4 transponder. The manufacturer shall declare the monitoring points to be used and offer a test equipment configuration to meet the requirements of the tests. Two possible test equipment configurations are shown in Figure C-4-1.





<u>Figure C-4-1:</u> Two Possible Test Equipment Options for Testing the Dataflash Application

C.4.8.2 Test Procedures

C.4.8.2.1 Procedure #1: Initialization and Checking for Dataflash Support

(Reference: §C.4.6.1)

This test procedure shall be carried out at the start of each test sequence to verify that the airborne Mode S system is functioning correctly and can support uplink MSP channel 6, downlink MSP channel 3, and the appropriate transponder registers.

Step 1 – MSPs installed and require service

a. Switch on the Mode S system under test and the test equipment and set the test interrogation II code to a non-zero value.

b. Start a regular pattern (one interrogation every 6 to 10 seconds) of Mode S Surveillance interrogations as shown in Table C-4-4.

Table C-4-4: Surveillance Interrogation

UF = 4 or 5	PC = 0	RR = 0	DI = 7	SD						AP
				IIS	RRS = 0		LOS = 0		TMS = 0	

c. Check that the specified replies are received and decoded correctly.

d. Extract the data from a transponder register using an interrogation as in Table C-4-4, but setting the RR field to 17 and the RRS subfield to ZERO (0). (This is a request for the Data Link Capability Report.)

e. Verify in the MB field of the reply that bit 25 is set to ONE (1). (This indicates that MSP services are supported.)

f. Extract the data from a transponder register using an interrogation as in Table C-4-4, but setting the RR field to 17 and the RRS subfield to 13. (This is a request for one of the Mode S Specific Services MSP capability report registers.)

g. Check in the MB field of the reply that bit 6 is set to ONE (1) indicating that MSP Uplink Channel 6 is installed and requires service, and that bit 31 is set to ONE (1) indicating that Downlink Channel 3 is installed and requires service.

Step 2 – Transponder Register data sources installed

a. Extract the data from a transponder register using an interrogation as in Table C-4-4, but setting the RR field to 17 and the RRS subfield to 8. (This is a request for one of the Mode S Specific Services MSP capability report registers.)

b. Check in the MB field of the reply and record the bits that are set to a ONE indicating that a transponder register service is indicated as installed.

c. Repeat Step 2 four times incrementing the RRS subfield by 1 each time to give RRS values 9, 10, 11, and 12.

Step 3 – Transponder Register data loading

a. Load known data into all transponder registers, indicated as installed from Step 2 above, in the transponder that contain other than static data (i.e., GICB capability report register etc.) at the minimum rate specified in ICAO Document 9688.

b. Extract the data from each register and verify that the data is correct.

c. Cease loading data into the transponder registers.

d. After a delay of at least twice the required update rate extract the data from each register and verify that the data is ALL ZEROs.

C.4.8.2.2 Procedure #2: Requesting the setup of Dataflash Contracts

(Reference: §C.4.6.3, §C.4.6.4, §C.4.6.5.2, §C.4.6.5.3, §C.4.6.7.1, §C.4.7.2.(1), §C.4.7.2.(2), §C.4.7.2.(3), §C.4.7.4.1, §C.4.7.4.3 & §C.4.7.4.3.1)

This test procedure is to check that the Dataflash application will not set up a contract for a transponder register that is not being serviced and that a contract can be set up when the transponder register is being serviced. It also checks that the maximum number of contracts for which the system is declared to be capable of handling can be set up. It also tests the function of CR field, the RDS field, and CI field values 1, 2, and 3.

Step 1 – Dataflash contract request for transponder registers not being loaded with data

a. Ensure that no data is being loaded into the installed transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-4-5, on uplink MSP channel 6 with the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

Table C-4-5: MSP Packet on MSP Channel 6

SR =1	DH					MT = 0	EC = 1	ST = 0
	CNS = 0	RDS = 1	Spare	BDS1	BDS2			

Note: *Mode S Frames are specified and tested in EUROCAE document ED-82.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in "b" above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-6 and it contains a DH equal to the value in the request interrogation and a value of 2 in the CI field. (This indicates that the contract was not accepted). Also verify that the CR field contains ALL ZEROs. (This indicates that there are no Dataflash contracts in existence.)

Note: *Since RDS = 1 in the contract request this test also verifies that the message register content is not sent when the register is not being loaded with data.*

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 requesting a contract for all transponder registers indicated as installed in the results of Procedure 1 Step 2.

Step 2 – Contract establishment for transponder registers being loaded with data

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Send a Mode S uplink frame to the transponder as specified in Table C-4-5 but with RDS=0, containing an MSP packet on uplink MSP channel 6.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7 and that it contains a DH equal to the value in the request interrogation. Verify that the CI field is set to ONE (1) when the contract is accepted, and that CI = 3 and the MSP packet is as shown in Table C-4-7, when the maximum number of contracts is exceeded. (This indicates that the contents of the transponder register are made available when the contract is established even though RDS=0). Also verify that in the CR field, the bit relating to the II code in the requesting interrogation is set to a ONE (1) for all II codes for which contracts have been accepted. (This indicates the contracts that have been accepted and are active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in the transponder register so that the criterion for a Dataflash message to be triggered is met.

g. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the data changed.

h. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-6. Verify that it contains a DH equal to the value in the request interrogation in Step 2 "b". Verify that the CI field is set to ZERO (0). (This indicates that after the contract has been established the transponder register data is not made available because RDS=0 in the contract request.)

Table C-4-6: MSP Packet on Downlink MSP Channel 3

DH (16 bits)	CR (15 bits)	Not Assigned (5 bits)	CI (4 bits)

i. Repeat Step 2 "b" to "c" but setting RDS=1 in Step 2 "b".

j. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to ONE (1) when the contract is accepted and CI = 3 when the maximum number of contracts is exceeded. Also verify that in the CR field, the bit relating to the II code in the requesting interrogation is set to a ONE (1) for all II codes for which contracts have been accepted. (This indicates the contracts that have been accepted and are active.) Verify that the register message content is that which was loaded into the register specified in the contract request.

Table C-4-7: MSP Packet on Downlink MSP Channel 3

DH (16 bits)	CR (15 bits)	Not Assigned (5 bits)	CI (4 bits)	Register message content (56 bits)

k. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

l. Change the data in the transponder register so that the criterion for a Dataflash message to be triggered is met.

m. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 second after the data changed.

n. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7. Verify that it contains a DH equal to the

value in the request interrogation in Step 2 "b". Verify that the CI field is set to ZERO (0). (This indicates that after the contract has been established the transponder register data is made available because RDS=1 in the contract request.)

o. Repeat Procedure 2 Step 2 "a" to "e", using a different non-zero II code each time requesting contracts up to a value equal to the maximum number of contracts that the system is declared to be capable of handling plus one. Use other transponder registers indicated as "installed" in the results of Procedure 1 Step 2 if the maximum number of contracts is more than 16.

p. Record the maximum number of contracts accepted, and verify that the number is at least 16, and that it is the maximum number declared by the manufacturer for the unit under test.

q. Use the techniques in §C.4.8.2.3 Procedure 3 to terminate all the contracts.

Step 3 – Multiple contract requests contained in a single MSP Packet on MSP channel 6

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Depending on the transponder Level, send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-4-8 or Table C-4-9 with RDS=1 in the Dataflash Header(DH), on uplink MSP channel 6 with different BDS codes of transponder registers being loaded in a above for each contract request.

Table C-4-8: MSP Packet Containing Multiple Contract Requests for a Level 2 Transponder

	Contract 1				Contract 2						END
SR=1	DH	MT	EC=1	ST	DH	MT	EC=4	ST	CQ Quanta	CT Threshold	DH=0

This will result in an Uplink 4 Segment Linked Comm A frame.

Table C-4-9: MSP Packet Containing Multiple Contract Requests for Level 3 and above Transponders

	Contract 1				Contract 2					Contract 3						END	Fill data
SR=1	DH	MT	EC=1	ST	DH	MT	EC=2	ST	CQ Quanta	DH	MT	EC=4	ST	CQ Quanta	CT Threshold	DH=0	All ZEROs

This will result in an Uplink ELM frame

c. Verify that downlink transactions directed to the II code that was used in the requesting transaction in "b" above, are announced by the transponder in replies to surveillance interrogations sent to the transponder, the first one, no later than 0.1 seconds after the uplink frame in "b" above was sent and one for each subsequent contract request as soon as the previous transaction has been closed out.

d. Extract each downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and that it contains DH equal to the value in the contract request interrogation, and verify that the CI field is set to ONE (1) and the relevant bit of the CR field is set to ONE (1) indicating the same II code as was set in the interrogation requesting transaction in "b" above. (This indicates that the contract was accepted and is active.)

e. Verify that all the requested contracts have been accepted.

f. Closeout each downlink transaction by means of a surveillance interrogation to the transponder.

g. Use the techniques in §C.4.8.2.3 Procedure 3 to terminate all the contracts.

Step 4 – Tests of wrong values in the Service Request (SR) header in MSP packet on uplink MSP channel 6

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as in Table C-4-5, on uplink MSP channel 6, but with the SR field set to ZERO (0).

c. Verify that no downlink transaction is announced by the transponder in the reply to a surveillance interrogation as in Table C-4-4, sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent. (No downlink response indicates that the contract was not accepted.)

d. Repeat Step 1 requesting the same contract using all other SR values. i.e., 2 to 255 inclusive and verify that no Dataflash downlink transactions are announced by the transponder.

C.4.8.2.3 Procedure #3: Termination of Dataflash Contracts

(Reference: §C.4.6.7.1, §C.4.7.2.(4), §C.4.7.2.(6), §C.4.7.2.(8), §C.4.7.2.(9), & §C.4.7.4.3)

This Procedure tests the different methods of terminating Dataflash contracts and can be performed in conjunction with Procedure 2 of §C.4.8.2.2 in order to minimize the total number of tests required.

Step 1 – Dataflash contract termination by the interrogator using the EC Field

a. Establish the maximum number of contracts as in Procedure 2 §C.4.8.2.2.

b. For an established contract send a Mode S uplink Frame containing an MSP packet as in Table C-4-5, on uplink MSP channel 6, but with the EC Field set to ZERO (0). (This should cause the contract to be cancelled.)

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after each uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet as shown in Table C-4-7, on Downlink MSP channel 3 and it contains a DH field corresponding to the contract to be cancelled and that the CI field is set to a value of 4. (This indicates that the contract has been cancelled.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 for all the established contracts.

Step 2 – Dataflash contract termination by transponder register losing its source data

a. Establish the maximum number of contracts as in Procedure 2 Step 2 sections "a" to "e" in §C.4.8.2.2.

b. For an established contract discontinue the loading of the relevant transponder register. (This should cause the contract to be cancelled.)

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation shown in Table C-4-4, sent to the transponder no later than 0.1 seconds after each uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH field corresponding to the contract for the transponder register which is no longer serviced and that the CI field is set to a value of 7. (This indicates that the contract has been cancelled.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 for all the established contracts.

Step 3 – Dataflash contract termination by the airborne application due to link failure

a. Establish a contract as in Procedure 2 Step 2 sections "a" to "e," in §C.4.8.2.2.

b. Change and record the data pattern being loaded into the relevant transponder register.

c. Verify that a downlink transaction is announced by the transponder, directed to the II code that was used in the requesting transaction, in the reply to a surveillance interrogation shown in Table C-4-4, sent to the transponder no later than 0.1 seconds after the data change in "b" above.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH field equal to that in the request interrogation, and verify that the CI field is set to ZERO. (This indicates that the contract has detected the change in data and is functioning correctly.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change and record the data pattern being loaded into the relevant transponder register.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation no later than 1 second after the data change in "f" above.

h. Wait 35 seconds.

i. Verify that a downlink transaction is no longer announced in replies to surveillance interrogations. (This indicates that the airborne system has declared a link failure and should have terminated the contract).

j. Change the data pattern being loaded into the relevant transponder register and record the new pattern.

Verify that NO downlink transaction is announced by the transponder in the reply to surveillance interrogations after the data change in "j" above. (This means that the contract has been cancelled by the airborne system.)

Step 4 – Dataflash contract termination due to loss of service from an interrogator with the same II code as the one that initiated the contract

a. Establish a contract as in Procedure 2 Step 2 sections "a" to "e," in §C.4.8.2.2.

b. Change and record the data pattern being loaded into the relevant transponder register.

c. Verify that a downlink transaction is announced by the transponder, directed to the II code that was used in the requesting transaction, in the reply to a surveillance interrogation shown in Table C-4-4, sent to the transponder no later than 0.1 seconds after the data change in "b" above.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH field equal to that in the request interrogation, and verify that the CI field is set to ZERO. (This indicates that the contract has detected the change in data and is functioning correctly.)

e. Change the II code of all interrogations to the transponder, record the new II code, and repeat "a" to "d" above. Verify in the CR field of the response in "d" above, that contracts are indicated for both the original and the new II codes.

f. Wait 60 seconds from the time of the last interrogation with the original II code and repeat "b" to "d" above. Verify in the response to "d" above that the CR field indicates no contracts for the original II code. (This confirms that the contracts to the original II code have been cancelled.)

g. Repeat the whole of Step 4 "a" to "f" to test all II codes as the original II code.

C.4.8.2.4 Procedure #4: Dataflash Header (DH) Field Tests

(Reference: §C.4.6.5.1)

This Procedure tests for the correct interpretation of the Contract Number Subfield (CNS) in the DH field. The BDS code subfield interpretation is tested in §C.4.8.2.2 Procedure #2 Step 2.

Step 1 – Establishing multiple contracts with a single transponder register

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 "a" to "e" using the same BDS1 and BDS2 codes in the interrogations in "c" above, and setting each of the other values in the CNS subfield in turn in "b" above.

g. Repeat Step 1 "a" to "f" for at least three different transponder registers.

Note: *If in "f" or "g" above the maximum number of contracts that the transponder can handle is reached, the contracts must be terminated by the method used in Procedure 3 Step 1 in §C.4.8.2.3 above, and this test continued to test all CNS values.*

h. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.5 Procedure #5: Minimum Time (MT) Field Tests

(Reference: §C.4.6.6 & §C.4.7.4.3)

This Procedure tests for the correct interpretation of the Minimum Time (MT) field contained in the MSP packet of uplink MSP channel 6.

Step 1 – Data changing at longer intervals than the value in the MT field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-5.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the transponder register data being loaded into the transponder register which was indicated in the contract initiated in "a" to "d" above.

g. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance

interrogation sent to the transponder no later than 0.1 seconds after the transponder register data was changed in the transponder register.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1).

i. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "f." Verify that it contains the new changed data that was loaded into that transponder register. (This indicates that the changed data is immediately available as requested in the MT field.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. Repeat Step 1 "f" to "j" at least 10 times and verify that all the data changes are reported.

l. Repeat Step 1 "f" to "k" for values of 10, 50, 100, 150, and 255 seconds set into the MT field of the MSP packet in "b" above, and the transponder register data changes of "f" above, at rates of 11, 51, 101, 151, and 256 seconds respectively.

m. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 2 – Data changing at shorter intervals than the value in the MT field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-5.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the contract by sending a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-5, but with the MT field set to ONE (1) second.

g. Change data being loaded into the transponder register at time intervals approximately equal to a quarter of the time indicated in the MT field of the requesting contract.

h. Verify that a downlink transaction is NOT announced by the transponder in the reply to a surveillance interrogation sent to the transponder at any time earlier than the value in MT field.

i. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than the value in the MT field plus 0.1 seconds after the previous data extraction.

j. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to ZERO (0). (This indicates a response to an existing contract.)

k. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 2 "f" above. Verify that it contains the latest data that was loaded into that transponder register before expiry of the time value in the MT field. (This indicates that the MT field is being interpreted correctly.)

l. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

m. Repeat Step 1 "f" to "l" with MT values of 10, 50, 100, 150, 200, and 255 seconds being set into the MSP packet on MSP uplink channel 6 of "f" above.

n. Terminate the contract by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.6 Procedure #6: Event Criterion (EC) Field Tests

(Reference: §C.4.6.7.1, §C.4.6.8, §C.4.7.2.(5), §C.4.7.2.(7), & §C.7.4.3)

This Procedure tests the 4 bit Event Criterion Field (EC. Tests for the EC values of ZERO (0) and ONE (1) are covered in the previous Procedures. CI field values 0, 1, 3, and 5, and CR field bit tests are included in this Procedure.

Step 1 – Tests with EC Field = 2

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-10 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above, and the bits in the Change Quanta (CQ) field set to alternating Zeros and Ones, starting with a ZERO (0).

Table C-4-10: MSP Packet on MSP Channel 6 with EC=2

SR=1	DH					MT=0	EC=2	ST=0	CQ Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

Note: *When EC=2 the Change Quanta (CQ) field is interpreted as 56 individual bits. When a bit is set to ZERO, the corresponding bit in the transponder register is not monitored and when it is set to a ONE a report is sent whenever the corresponding bit in the transponder register changes.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each bit in the transponder register in turn, change that bit and perform "g," "h," "i," "j," and "k" below.

g. When the corresponding bit in the CQ Quanta is set to a ONE verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "f" above was sent.

h. When the corresponding bit in the CQ Quanta is set to a ZERO (0) verify that NO downlink transaction is announced by the transponder in the reply to a surveillance interrogation.

i. Extract all announced downlink transactions, and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-4-7, and they contain a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO.

j. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

k. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

l. Repeat the whole of Step 1 for all of the transponder registers capable of being serviced.

m. For at least three of the transponder registers set the bits in the CQ Quanta to alternating Ones and Zeros, starting with a ONE (1) in the first bit and repeat Step 1.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 2 – LSB change tests with EC Field = 3

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-11 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Also set the sub divided fields in the Change Quanta field (CQ) as in (i) and (ii) below:

(i) When the sub divided field represents a numerical value set it to the least significant bit value.

(ii) When the sub field represents a character or status information set it to ALL ONEs.

Table C-4-11: MSP Packet on MSP Channel 6 with EC=3

SR=1	DH					MT= 0	EC=3	ST=0	CQ Quanta (56 bits) LSB=1 all other bits = 0
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

Note: *When EC=3 the Change Quanta field (CQ) is sub-divided into the same fields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported and ALL ONEs indicates that any change to that parameter shall be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the quantum of the minimum change in that parameter, taking any sign bit into account, which has to be reported. The units of the change parameter are the same as the least significant bit of the parameter being monitored. Status and switch bits are treated as separate fields for change field monitoring.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance

interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, change the parameter by an amount equal to its least significant bit.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in f. above was sent.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

i. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 2 "b" above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. Repeat "f" to "j," this time changing each parameter in turn by an amount equal to its most significant bit.

l. Repeat the whole of Step 2 for all of the transponder registers capable of being serviced.

m. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 3 – MSB change tests with EC Field = 3

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-11 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Also set the sub divided fields in the Change Quanta field (CQ) as in (i) and (ii) below:

(i) When the sub divided field represents a numerical value set it to the least significant bit value.

(ii) When the sub field represents a character or status information set it to ALL ONEs.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, change the parameter by an amount equal to its most significant bit.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the parameter change in "f" above was sent.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

i. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 3 "b" above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. For each parameter in the transponder register in turn, change the parameter by an amount equal to less than its most significant bit.

l. Verify that NO downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder after the parameter change in "i" above was sent. (This indicates that the contract is functioning correctly.)

m. Repeat the whole of Step 3 for all of the transponder registers capable of being serviced.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 4 – Tests with EC Field = 4 (Only report changes above a threshold value)

a. Ensure that data having a value of the least significant bit is being loaded, into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-12 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Set the sub fields in the Change Quanta (CQ) field to a value equal to a maximum of one quarter of the MSB, or to the LSB, in each case where the field represents a numerical value. Set the CQ field to ALL ONEs where the field represents a character or status information etc. Also set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-4-12: MSP Packet on MSP Channel 6 with EC=4

SR=1	DH					MT= 0	EC=4	STS=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=4 the Change Threshold (CT) field is sub-divided into the same subfields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only parameter changes that cross the threshold criterion are reported. The Change Quanta (CQ) field is similarly divided into subfields which indicate that a change will not be reported for that subfield until the parameter has changed by at least the CQ value since the contract was agreed in the case of a first report, or since the last report generated by this contract.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, increment the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified for it in the CQ Quanta until the threshold has been crossed by at least four increments, or has reached its maximum value, and perform the actions of "g," "h," "i," and "j" below.

Note: *The reason for crossing the threshold by four increments if possible is to verify that all changes greater that CQ that are above the threshold crossing are reported.*

g. Extract any announced downlink transaction and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-4-7, and they contain a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

h. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 4 "b" above. Verify that it contains the data that was loaded into that transponder register and that the data is equal to or has exceeded the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that a correct downlink transaction was only received for each parameter increment that gave a value higher than the threshold.

k. Repeat the whole of Step 4 for all of the transponder registers capable of being serviced.

l. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 5 – Tests with EC Field = 5 (Only report changes below a threshold value)

a. Ensure that data having the maximum value is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-13, with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above, and the subfields in the Change Quanta (CQ) field set to the least significant bit value in each case where the subfield represents a numerical value, and to ALL ONEs where the field represents a character or status information etc. Set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-4-13: MSP Packet on MSP Channel 6 with EC=5

SR=1	DH					MT=0	EC=5	STS=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=5 the Change Threshold field (CT) is divided into the same subfields as the transponder register with which the contract is being made. For each of these subfields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only changes in the parameter that are equal to or greater than the CQ Quanta value and are lower than the threshold are reported.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, decrement the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified in the Dataflash contact request in Step 5 "b" above for it in the CQ Quanta until the threshold has been crossed by at least four decrements, or has reached its minimum value, and perform the actions of "g," "h," "i," and "j" below.

g. Extract any announced downlink transactions and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-4-7, and they contain a DH equal to the value in the request interrogation.

h. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 5 "b" above. Verify that it contains the data that was loaded into that transponder register and that the data is equal to or has gone below the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that a correct downlink transaction was only received for each parameter increment that gave a value lower than the threshold.

k. Repeat the whole of Step 5 for all of the transponder registers capable of being serviced.

l. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 6 – Tests with EC Field = 6 (Only report changes when the threshold is crossed)

a. Ensure that data having a value of at least 4 Quanta below the threshold or the minimum for the parameter, is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-14, with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above, and the sub divided fields in the Change Quanta (CQ) field set to the least significant bit value in each case where the field represents a numerical value, and to ALL ONEs where the field represents a character or status information etc. Set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-4-14: MSP Packet on MSP Channel 6 with EC=6

SR=1	DH					MT=0	EC=6	ST=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=6 the Change Threshold field (CT) is sub-divided into the same fields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only changes in the parameter that are equal to or greater than the CQ Quanta value and cross the threshold in either direction are reported.*

c. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, increment the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified in the Dataflash contract request in Step 6 "b" above (in the CQ Quanta) until a downlink transaction is announced in the reply to a surveillance interrogation then perform tests "g," "h," "i," and "j" below.

g. Extract any announced downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

h. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above. Verify that it contains the data that was loaded into that transponder register and that the data has crossed the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that only one downlink transaction was announced and extracted and that it contained the data value for the first increment after the threshold was crossed. (This indicates that the threshold is functioning correctly.)

k. Ensure that data having a value of at least 4 Quanta above the threshold, or the maximum value for the parameter, is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

l. Repeat the whole of Step 6 but decrementing the parameter value in "f" above.

m. Repeat the whole of Step 6 for all of the transponder registers capable of being serviced.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 7 – Single II CodeTests with EC Field = 15 (Cancel all contracts for the II Code in this request regardless of other information in the DH Field)

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame using II code = 1 to the transponder, containing an MSP packet on uplink MSP channel 6 as in Table C-4-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to a value of ONE (1), and the bit in the CR field corresponding to the II code used in "b" above is set to a ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 7 "a" to "e" using different BDS1 and BDS2 codes corresponding to registers that are being loaded with data in the interrogations in "b" above until the maximum number of contracts that can be handled by the system under test have been established. If the maximum number of contracts that can be handled exceeds the number of transponder registers being loaded then repeat "a" to "e" above, setting different values in the CNS subfield in the uplink frames in "b" above until the maximum number of contracts is reached.

g. Send a Mode S uplink frame using II code set as in "b" above, to the transponder, containing an MSP packet on uplink MSP channel 6 as in Table C-4-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register with the EC field set to a value of 15.

h. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "g" above was sent.

i. Extract the downlink transaction and close it out by means of a surveillance interrogation sent to the transponder. Verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 5. (This indicates that all contracts for the II code set in the interrogation at "g" above have been cancelled).

j. Change the data being loaded into the transponder registers that have contracts established such that a Dataflash message would be triggered if a contract currently existed.

k. Verify that no downlink transactions are announced in the replies to surveillance interrogations in the following 30 seconds.

l. Repeat Step "a" to "i" For II codes 2 to 14 inclusive.

Step 8 – Multiple II CodeTests with EC Field = 15 (Cancel all contracts for the II Code in this request regardless of other information in the DH Field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame using II code = 1 to the transponder, containing an MSP packet on uplink MSP channel 6 as in Table C-4-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to a value of ONE (1) and the bit in the CR field corresponding to the II code used in "b" above is set to a value of ONE (1). (This indicates that the contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 8 "a" to "e" incrementing the II code in the interrogation in "b" above until the maximum number of contracts that can be handled by the system under test have been established. If the maximum number of contracts that can be handled exceeds the number of II codes repeat "a" to "e" above accessing different transponder registers by setting different values the BDS1 and BDS2 subfields in the uplink frames in "b" above until the maximum number of contracts is reached.

g. Send a Mode S uplink frame setting the II code to the same value as in "b" above, to the transponder, containing an MSP packet on uplink MSP channel 6 as shown in Table C-4-5, with the BDS1 and BDS2 codes set for a contract with a transponder register not contracted for that II code and with the EC field set to a value of 15.

h. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction in "g" above, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "g" above was sent.

i. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7 and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 5 and the bit in the CR field corresponding to the II code used in "b" above is set to a ZERO (0). (This indicates that all contracts for the II code set in the interrogation at "g" above have been cancelled).

j. Change the data being loaded into the transponder registers that have contracts established such that a Dataflash message would be triggered if a contract currently existed.

k. Verify that a separate downlink transaction is announced, directed to each II code other than the II code that was used in "b" above, is announced by the transponder in the replies to a surveillance interrogations sent to the transponder in the period after the uplink frame in "g" above was sent. Also verify that no transaction is announced directed to the II code used in "b" above.

l. Extract each downlink transaction and close it out by means of a surveillance interrogation sent to the transponder. Verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 01 and the bit in the CR field corresponding to the II code used in "b" above is set to a ONE (1). (This indicates that all contracts other than those for the II code set in the interrogation at "g" are still in existence and working normally).

m. Repeat Step 8 "a" to "l" using II codes 2 to 14 inclusive in "b" above.

Step 9 – Tests with EC Field set to unassigned values

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-15 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above and EC set to 7.

Table C-4-15: MSP Packet on MSP Channel 6

SR=1	DH					MT=0	EC	ST=0	CF Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of 15. (This indicates that the contract was NOT accepted. This is the correct result because the EC is not valid.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat the whole of Step 9 “a” to “e” incrementing the EC by ONE until EC=14.

C.4.8.2.7 Procedure #7: Stable Time (ST) Field tests

(Reference: §C.4.6.7.2)

This Procedure tests the correct functioning of the ST field.

Step 1 – Tests with ST Field

a. Ensure that fixed data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-4-16 with BDS1 and BDS2 codes to set up a contract with the register being loaded in “a” and ST set to ONE (1).

Table C-4-16: MSP Packet on MSP Channel 6 with EC=2

SR=1	DH					MT=0	EC=2	ST	CQ Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Use an interrogation as in Table C-4-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 “b” above, and with EC = 2. Verify that it contains the data that was loaded into that transponder register for the parameter under test.

f. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

g. Change and record the data being loaded into any parameter of the transponder register by an amount that exceeds the Quanta value specified in the contract, at intervals equal to one quarter of the value in ST.

h. Verify that NO downlink transaction is announced by the transponder in the reply to surveillance interrogations whilst the data is changing as in “g” above.

i. Stop changing the data being loaded into the transponder register and record the register data.

j. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder not earlier than a time equal to ST, and no later than time equal to the value of ST plus 0.1 seconds after the data was first changed.

k. Extract all announced downlink transactions and verify that they contain MSP Packets on Downlink MSP channel 3 as in Table C-4-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to ZERO (0).

l. Use an interrogation as in Table C-4-4, but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above. Verify that it contains the same data that was loaded into that transponder register at "i" above. (This indicates that ST is functioning correctly.)

m. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

n. Repeat the "f" to "l" above, for each parameter in the transponder register.

o. Repeat the "a" to "l" above setting values of ST = 2, 4, 8, 12, and 15 seconds in "b" above.

p. Repeat the whole of Step 1 using at least three different transponder registers.

q. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.8 Procedure #8: Maximum Message Rate

(Reference: §C.4.7.3, & §C.4.7.4.3)

This Procedure tests that no more than ten Dataflash messages are output in any six seconds period and that waiting messages are queued and announced to the ground with an indication of delay by setting CI = 6 in the response, as soon as the maximum message criterion allows.

Step 1 – Initializing contracts

a. Ensure that NO data is loaded into any of the transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-4-5, on uplink MSP channel 6. With the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in "b" above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and it contains a DH equal to the value in the request interrogation and a value of 2 in the CI field. (This indicates that the new contract was not accepted.) Also verify that the CR field contains ALL ZEROs. (This indicates that there are no Dataflash contracts in existence.)

Note: *Since RDS=1 in the contract request this test also verifies that the message register content is not sent when CI is not equal to ZERO.*

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 requesting a contract for at least two transponder registers

Step 2 – Dataflash Message triggering rate up to six messages per second

a. Ensure that fixed data is being loaded into the installed registers and being updated at a rate faster than the minimum rate specified for each register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-4-5, on uplink MSP channel 6. With the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in "b" above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and it contains a DH equal to the value in the request interrogation and a value of ONE (1) in the CI field. (This indicates that the new contract was accepted.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in one or more of the registers in order to trigger ten Dataflash messages every six seconds.

g. Verify that downlink transactions, directed to the II code that was used in the requesting transaction, are announced by the transponder in the reply to a surveillance interrogations sent to the transponder 0.1 seconds after the each of the data changes in "e" above were received by the transponder.

h. Extract and closeout the downlink transactions and verify that they are MSP packets on Downlink MSP channel 3 as shown in Table C-4-7, and they contain a DH equal to the value in the request interrogation and a value of ZERO (0) in the CI field. (This indicates that they are responses to an existing contract.)

Note: *Closeout each downlink transaction by means of a surveillance interrogation to the transponder.*

Step 3 – Dataflash Message triggering rate greater than six messages per second

a. Ensure that fixed data is being loaded into the installed registers and being updated at a rate faster than the minimum rate specified for each register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-4-5, on uplink MSP channel 6 with the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in "b" above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-4-7, and it contains a DH equal to the value in the request interrogation and a value of ONE (1) in the CI field. (This indicates that the new contract was accepted.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in one or more of the registers in order to trigger more than ten Dataflash messages every six seconds for a period of at least twelve seconds.

g. Verify that downlink transactions, directed to the II code that was used in the requesting transaction are announced by the transponder in the replies to surveillance interrogations sent to the transponder starting 0.1 seconds after the first of the data changes in "f" above were received by the transponder.

h. Extract and closeout all the downlink transactions and verify that they are MSP packets on Downlink MSP channel 3 as shown in Table C-4-7. Verify that they contain a DH equal to the value in the request interrogation and do not exceed a rate of ten messages in any six seconds period. Verify that messages, which are not delayed due to the Dataflash message limit of ten within six seconds, contain a value of ZERO (0) in the CI field. (This indicates that they are normal responses to an existing contract.) Also verify that Dataflash messages which have been delayed by queuing in order to remain within the limit for Dataflash messages contain a value of 6 in the CI field. (This indicates that the responses to an existing contract which have been delayed due to Dataflash message limit queuing.)

Note: *Closeout each downlink transaction by means of a surveillance interrogation to the transponder.*

C.4.8.2.9 Procedure #9: Test of Mode S Subnetwork Version Number and Global Capability Reporting

Extract Register 10_{16}

Verify that:

- Bit 17 - 23 = 3 (for an Annex 10 Amendment 77 transponder), = 4 (for an Annex 10 Amendment 81 and Doc 9871 Edition 1 transponder), > 4 (for future Amendments of Annex 10 and future editions of Doc 9871)
- Bit 25 =1

Inject all data used to fill register 40_{16}, 50_{16} and 60_{16}

Reset the transponder (in order to take into account dynamic check at start-up)

Extract Register 17_{16}

Verify that:

- Bit 9 = 1
- Bit 16 = 1
- Bit 24 = 1

Extract Register $1D_{16}$

Verify that:

- Bit 6 = 0 and Bit 31 = 0 if no dataflash application supported
- Bit 6 = 1 and Bit 31 = 1 if dataflash application is supported

Extract Register 19_{16}

Verify that:

- Bit 49 = 1
- Bit 33 = 1
- Bit 17 = 1

Stop injection of all data with the aircraft data generator

Extract register 17_{16}

Verify that:

- Bit 9 = 0
- Bit 16 = 0
- Bit 24 = 0

Extract register 19_{16}

Verify that:

- Bit 49 = 1
- Bit 33 = 1
- Bit 17 = 1

C.4.9 Dataflash Installed System Performance

Installed performance shall be consistent with that specified in §C.4.8, which was verified through bench and environmental tests. However, certain performance parameters may be affected by the physical installation and can only be verified after installation. The installed performance specified below takes this into consideration.

C.4.9.1 Ground Test Procedures

a. Conformity Inspection

(1) Visually inspect the installed equipment or system to determine the use of acceptable workmanship and engineering practices.

(2) Verify that proper mechanical and electrical connections have been made and that the equipment or system has been located and installed in accordance with the manufacturer's recommendations.

b. Test Equipment Required

(1) A means to interrogate the Mode S transponder with surveillance interrogations and decode the resulting replies.

(2) A means to send data to the transponder registers, extract the air initiated messages announced by the transponder, and extract the data from the registers in the transponder accessed by means of the BDS1 and BDS2 codes in interrogations sent to the transponder.

(3) A means to set up, record and monitor Dataflash contracts by interrogating the Mode S transponder.

c. Test Procedure

(1) Input data either directly from aircraft data sources or stimulate the aircraft systems, such that all the declared transponder registers are being updated.

(2) Using the test equipment, extract the appropriate capability reports and verify that the aircraft Mode S system is functioning, and that it can support uplink MSP channel 6, Downlink MSP channel 3, and the appropriate transponder registers are being updated by the aircraft systems.

d. Interference Effects

With the equipment or system energized,

(1) individually operate each of the other electrically operated aircraft equipment and systems to determine that no significant interference effects are present:

(2) evaluate all reasonable combinations of control settings and operating modes.

C.4.10 Implementation Guidelines for Dataflash

C.4.10.1 Overview

Dataflash is a service which announces the availability of information from air-to-ground on an event-triggered basis. This is an efficient means of downlinking information which changes occasionally and unpredictably.

A contract is sent to the airborne application through the Mode S transponder and the ADLP using an uplink Mode S specific protocol (MSP) (MSP 6, SR = 1) as specified in Annex 10 Volume III, Appendix to Chapter 5. This uplink MSP packet contains information specifying the events which should be monitored regarding the changes of data in a transponder register. When the event occurs, this is announced to the ground installation using the AICB protocol.

The ground installation may then request the downlink information which takes the form of a downlink MSP packet on channel 3 constituted of one or two linked Comm-B segments. The second segment is a direct copy of the relevant transponder register specified in the contract.

The ground system with the embedded dataflash application should determine if an aircraft supports the dataflash protocol as follows:

- if bit 25 of transponder register 10_{16} is set to 1, the system will extract transponder register $1D_{16}$, then,
- if bit 6 and bit 31 of transponder register $1D_{16}$ are set to 1, then the aircraft supports the dataflash service.

C.4.10.2 Minimum number of contracts

The minimum number of contracts activated simultaneously that can be supported by the airborne installation should be at least 64. In the case of a software upgrade of existing installations, at least 16 dataflash contracts should be supported.

C.4.10.3 Contract request for a transponder register not serviced by the airborne installation

On the receipt of a dataflash service request, a downlink dataflash message should immediately be announced to the ground regardless of any event criteria. This message is used by the ground system to confirm that the service has been initiated. The message will only consist of one segment. In the case of a service request for an unavailable transponder register, the message sent to the ground should only contain bits 1 to 40 of the downlink message structure with a CI field value of 2. This value will indicate to the ground system that the service request cannot be honored because of the unavailability of the transponder register. The service will then be terminated by the airborne dataflash function, and the ground system should notify the user which has initiated the request that the service request cannot be honored by the airborne installation.

When a transponder register (which was previously supported) becomes unavailable and is currently monitored by a dataflash contract, a downlink dataflash message containing bits 1 to 40 will be sent with a CI field value of 7. This will indicate to the ground that the transponder register is not serviced anymore. The related contract is terminated by the airborne application, and the ground system should notify the user which has initiated the request that the service request has been terminated by the airborne installation. An alternative means for the ground system to detect that the transponder register is not serviced any longer is to analyze the resulting transponder register 10_{16} which will be broadcast by the transponder to indicate to the ground system that transponder register 17_{16} has changed. The Mode S sensor should then extract transponder register 17_{16} and send it to the ground application. The ground application should then analyze the content of this transponder register and should notice that the transponder register monitored by a dataflash contract is no longer supported by the airborne installation.

C.4.10.4 Service continuity in overlapping coverage with radars using the same II code

Depending on the system configuration the following guidance should be taken into account to ensure service continuity in overlapping coverage of radars working with the same II code.

C.4.10.4.1 Radar with the dataflash application embedded in the radar software

For this configuration it is necessary to manage the contract numbers which will be used by each station and to ensure that the same contract number for the same transponder register is not used by another sensor having overlapping coverage and working with the

same II code. The reason for this is that a sensor has no means of detecting if a contract it has initialized has been overwritten by another sensor using an identical dataflash header. Also one sensor could terminate a contract because an aircraft is leaving its coverage and no other sensor would know that this contract had been closed. For this reason, no dataflash contract termination should be attempted by either sensor in order to ensure a service continuity.

When two ground stations with overlapping coverage and having the same II code each set up dataflash contracts with the same transponder register for the same aircraft, it is essential to ensure that the contract number is checked by each ground station prior to the closeout of any AICB which is announcing a dataflash message.

C.4.10.4.2 Use of an ATC centre-based dataflash application

The ATC system hosting the dataflash application should manage the distribution of contract numbers for sensors operating with the same II code. This ATC system will also have the global view of the aircraft path within the ATC coverage to either initiate or close dataflash contracts when appropriate. This is the preferred configuration since a central management of the contract numbers is possible which also allows a clean termination of the contracts.

C.4.10.5 Ground management of multiple contracts for the same transponder register

The ground system managing the dataflash application must ensure that when it receives a request from ground applications for several contracts to monitor different parameters, or different threshold criteria, related to the same transponder register for a particular aircraft/II code pair, it assigns a unique contract number for each contract sent to the aircraft.

C.4.10.6 Service termination

There are three ways to terminate a dataflash service (one from the ground initiative, two from the airborne installation):

1. The ground can send an MSP with the ECS field set to 0 which means that the service is to be discontinued by the airborne installation.

2. The airborne installation will terminate the service with no indication to the ground system if any message is not extracted from the transponder by a ground interrogator within 30 seconds following the event specified in the dataflash contract (TZ timer).

3. When the transponder has not been selectively interrogated by a Mode S interrogator with a particular II code for 60 seconds (this is determined by monitoring the IIS subfield in all accepted Mode S interrogations), all dataflash contracts related to that II code will be cancelled with no indication to the ground system.

The termination from the ground initiative is the preferable way to terminate the service since both the ground and the airborne systems terminate the service thanks to a mutually understood data link exchange. This termination should nevertheless not be allowed in certain configurations especially with adjacent sensors (with the dataflash application embedded in the sensor software) working with the same II code as explained in §C.2.1. If the termination of the contract by a ground system is to be exercised, it should also be noticed that the ground system should anticipate the exit of the aircraft from its coverage to send the close-out message.

C.4.10.7 Dataflash request containing multiple contracts

It is possible to merge several contracts into one single dataflash request. If multiple events occur which are related to several contracts of the initial dataflash request, one downlink message for each individual event should be triggered containing the associated transponder register. Each of these downlink messages should use the air initiated protocol.

C.4.10.8 Transponder register data contained in the downlink message

The transponder register data received by the ground system following the extraction of a downlink dataflash message consisting of two segments are the transponder register data at the time of the event. The transponder register data may be up to 1 aerial scan old since the event may occur just after the illumination of the aircraft. Should the end-user need more up-to-date data, the user should use the event announcement to trigger extraction via GICB protocol to get the latest transponder register data.