ModeS-WP01-04

RTCA Special Committee 209

Working Group #1

Mode S Transponder Development/Maintenance

Meeting #1

RTCA, Washington DC
3 – 5 April 2007

Proposed Appendix C to DO-181D for the "Dataflash Application" in response to SC-209 Action Item 6-2

Gary Furr
Engility Corporation
(the company previously known as L-3/Titan)

SUMMARY

This Working Paper presents a proposed Appendix C for DO-181D as information taken out of the current draft of ED-101 as it was presented in working paper WG49N9-15, which is directly related to the Dataflash Application, as was agreed to during the Joint Plenary Session of RTCA SC-209 and Eurocae WG-49 in Melbourne Florida, the week of 29 January 2007.

Draft version 0.1 of the Proposed Appendix C for DO-181D:

During the Joint Plenary Session of RTCA SC-209 and Eurocae WG-49 personnel in Melbourne Florida, during the week of 29 January 2007, it was agreed that SC-209 would extract the information related to the "Dataflash Application" from the current draft version of ED-101, as it was last presented in Working Paper WG49N9-15.

During a review of WG49N9-15, the following sections were identified as relevant regarding the Dataflash Application:

§2.7 – Recovery from Failure
§3.2 – Dataflash Application and Requirements
§5.2 – Dataflash Application Test Procedures
§6.4.2 – Dataflash Application Ground Test Procedures

The above sections were extracted and copied into the attached proposed draft version 0.1 of Appendix C, with the exception that the content of §2.7 was moved into §C.3 until a further review could take place during Meeting #1 of SC-209 Working Group #1.

All references to sections in ED-101 were converted into the appropriate references in this proposed Appendix C, and all of those references in the attached document have been hyperlinked for ease of review, plus for the purpose of double checking the correctness of the original reference link.

The attached text was copied directly from WG49N9-15 and reformatted. There were some typographical errors that were discovered in the content of WG49N9-15 and those have been corrected in the attached draft.

Members of RTCA SC-209 Working Group #1 and Eurocae WG-49 are invited to review the attached proposed Appendix C for completeness and correctness. If any fundamental errors are discovered, they must be reported also against the current draft of ED-101, and dealt with by WG-49 as appropriate. Any such errors that may be reported before or discussed during Meeting #1 of SC-209 Working Group #1 will be tracked and corrected in this proposed Appendix C and reported back to WG-49 for their consideration.

Appendix C

Dataflash Application

This page intentionally left blank.

C. Dataflash Application

C.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 9688). 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.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.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

©2007, RTCA, Inc.

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 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.6.

C.5 Document Precedence

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

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

C.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 BDS Code 1,D shall be set to 1.

C.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.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

©2007, RTCA, Inc.

C.6.4 Dataflash Request Format

The purpose of Dataflash service is described in §C.7.1. The format of the user data field is shown in Table C-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.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-1).

C.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.

©2007, RTCA, Inc.

C.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.7.4.3.1).*

C.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.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.6.7 Event Initiation

Event initiation shall be controlled by the two following fields.

C.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.

©2007, RTCA, Inc.

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.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.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.

©2007, RTCA, Inc.

Table C-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

	DP = 0 (1 BIT)	UPLINK MSP HEADER (1 BYTE)
	MP = 0 (1 BIT)	
	M/CH = 6 (6 BITS)	
1	SERVICE REQUEST (SR)	
2		
3		
4		
5		
6		
7		
8		
9	CONTRACT NUMBER SUBFIELD (CNS)	DATAFLASH HEADER (DH)
10		
11		
12		
13	REQUEST DATA (RDS)	
14	NOT ASSIGNED	
15		
16		
17	BDS1 CODE	
18		
19		
20		
21	BDS2 CODE	
22		
23		
24		
25	MINIMUM TIME (MT) INTERVAL	
26		
27		
28		
29		
30		
31		
32	LSB = 1 second	
33	EVENT CRITERION (EC)	
34		
35		
36		
37	STABLE TIME (ST)	
38		
39		
40	LSB = 1 second	

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.*

MSP (6) USER DATA FIELD
Bits 41 to 96 (if required)

41	CHANGE QUANTA FIELD (CQ)
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	
58	
59	
60	
61	
62	
63	
64	
65	
66	
67	
68	
69	
70	
71	
72	
73	
74	
75	
76	
77	
78	
79	
80	
81	
82	
83	
84	
85	
86	
87	
88	
89	
90	
91	
92	
93	
94	
95	
96	

MSP (6) USER DATA FIELD
Bits 97 to 152 (if required)

97	CHANGE THRESHOLD FIELD (CT)
98	
99	
100	
101	
102	
103	
104	
105	
106	
107	
108	
109	
110	
111	
112	
113	
114	
115	
116	
117	
118	
119	
120	
121	
122	
123	
124	
125	
126	
127	
128	
129	
130	
131	
132	
133	
134	
135	
136	
137	
138	
139	
140	
141	
142	
143	
144	
145	
146	
147	
148	
149	
150	
151	
152	

©2007, RTCA, Inc.

C.7 Downlink MSL Channel 3. Dataflash Service

C.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 BDS Code 1,D shall be set to 1.

C.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:

C.7.2.1 When the requested register is being serviced, the contract shall be established and an MSP Packet as in Table C-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.

C.7.2.2 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-2, and with a value of 2 in the CI field.

C.7.2.3 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-2, and with a value of 3 in the CI field.

C.7.2.4 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-2, and with a value of 4 in the CI field.

C.7.2.5 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-2, and with a value of 5 in the CI field.

C.7.2.6 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-2, and with a value of 7 in the CI field. Register service shall be deemed to have failed when any of the parameters

©2007, RTCA, Inc.

specified to be monitored in the negotiation of the contract is not being updated at the specified minimum rate.

C.7.2.7 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-2, and with a value of 15 in the CI field.

C.7.2.8 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.*

C.7.2.9 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.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.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-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.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.

©2007, RTCA, Inc.

C.7.4.2 Bits 32 to 36 of UD are not assigned.

C.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.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.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-2).

C.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.

©2007, RTCA, Inc.

Table C-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	
			49	
			50	
	FILL 1 = 0 (6 BITS)		51	
			52	
			53	
			54	
			55	
			56	
1	CONTRACT	DATAFLASH HEADER (DH)	57	
2	NUMBER		58	
3	SUBFIELD		59	
4	(CNS)		60	
5	REQUEST DATA SUBFIELD (RDS)		61	
6	NOT		62	
7	ASSIGNED		63	
8			64	REGISTER
9			65	MESSAGE
10	BDS1		66	CONTENT
11	CODE		67	
12			68	
13			69	
14	BDS2		70	
15	CODE		71	
16			72	
17	II=1		73	
18	II=2		74	
19	II=3		75	
20	II=4		76	
21	II=5		77	
22	II=6		78	
23	II=7 II CODE		79	
24	II=8 CONTRACT		80	
25	II=9 REPORT (CR)		81	
26	II=10		82	
27	II=11		83	
28	II=12		84	
29	II=13		85	
30	II=14		86	
31	II=15		87	
32			88	
33			89	
34	NOT ASSIGNED		90	
35			91	
36			92	
37			93	
38	CONTRACT		94	
39	INFORMATION (CI)		95	
40			96	

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

©2007, RTCA, Inc.

C.7.6 Data flash Requirement/Test Cross Reference Table

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

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

Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
§C.6	Uplink MSP channel 6		headline
§C.6.1	Purpose	§C.8.2.1	Procedure 1 Step 1
§C.6.2	Format		uplink requirement
§C.6.3	SR header assignments	§C.8.2.2	Procedure 2 Step 2
§C.6.4	Dataflash request format	§C.8.2.2	Procedure 2 Step 2
§C.6.5	Dataflash header (DH) 16 bits		introduction
§C.6.5.1	Contract number Subfield (CNS)	§C.8.2.4	Procedure 4 Step 1
§C.6.5.2	Request Data Subfield (RDS)	§C.8.2.2	Procedure 2 Step 2
§C.6.5.3	BDS 1 and BDS2 codes of the register for which the contract is required.	§C.8.2.2	Procedure 2 Step 2
§C.6.6	Minimum time (MT)	§C.8.2.5	Procedure 5 Steps 1, 2
§C.6.7	Event Initiation		introduction
§C.6.7.1	Event Criterion field (EC) -a. EC = 0	§C.8.2.3	Procedure 3 Step 1
	-b. EC = 1	§C.8.2.2	Procedure 2 Step 1
	-c. EC = 2	§C.8.2.6	Procedure 6 Step 1
	-d. EC = 3	§C.8.2.6	Procedure 6 Step 2 Procedure 6 Step 3
	-e. EC = 4	§C.8.2.6	Procedure 6 Step 4
	-f. EC = 5	§C.8.2.6	Procedure 6 Step 5
	-g. EC = 6	§C.8.2.6	Procedure 6 Step 6
	-h. EC = 7-14	§C.8.2.6	Procedure 6 Step 9
	-i. EC = 15	§C.8.2.6	Procedure 6 Step 7
§C.6.7.2	Stable time (ST) field	§C.8.2.7	Procedure 7 Step 1
§C.6.8	Change fields - -a. Change Quanta (CQ)	§C.8.2.6	Procedure 6 Step 2 (LSB) Procedure 6 Step 3 (MSB)
	-b. Change Threshold (CT)	§C.8.2.6	Procedure 6 Step 4
Table C-1	MSP packet User Data (MSP 6)		implicitly tested
§C.7	Downlink MSP Channel 3 Dataflash Service		headline
§C.7.1	Purpose		introduction
§C.7.2	Service initiation and termination		implicitly tested
§C.7.2.1	Initiation action (contract established)	§C.8.2.2	Procedure 2 Step 2
§C.7.2.2	Initiation action (register not serviced)	§C.8.2.2	Procedure 2 Step 1
§C.7.2.3	Initiation action (maximum number of contracts)	§C.8.2.2	Procedure 2 Step 2
§C.7.2.4	Initiation action (contract terminated)	§C.8.2.3	Procedure 3 Step 1
§C.7.2.5	Initiation action (all contracts terminated)	§C.8.2.6	Procedure 6 Step 7
§C.7.2.6	Initiation action (contract establishment failed)	§C.8.2.3	Procedure 3 Step 2
§C.7.2.7	Initiation action (EC field error)	§C.8.2.6	Procedure 6 Step 8
§C.7.2.8	Delivery failure notice	§C.8.2.3	Procedure 3 Step 3
§C.7.2.9	Non-interrogation timeout	§C.8.2.3	Procedure 3 Step 4
§C.7.3	Service provision	§C.8.2.8	Procedure 8 Step 3

©2007, RTCA, Inc.

Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
§C.7.4	Downlink message structure		implicitly tested
§C.7.4.1	Contract report field.	§C.8.2.2	Procedure 2 Steps 1,2,3
§C.7.4.2	Unassigned bits		implicitly tested
§C.7.4.3	Contract information field -a. CI = 0	§C.8.2.5	Procedure 5 Step 2
	-b. CI = 1	§C.8.2.2	Procedure 2 Step 2
	-c. CI = 2	§C.8.2.2	Procedure 2 Step 1
	-d. CI = 3	§C.8.2.2	Procedure 2 Step 2
	-e. CI = 4	§C.8.2.2	Procedure 3 Step 1
	-f. CI = 5	§C.8.2.6	Procedure 6 Step 7
	-g. CI = 6	§C.8.2.8	Procedure 8 Step 3
	-h. CI = 7	§C.8.2.3	Procedure 3 Step 2
	-i. CI = 8-14		implicitly tested
	-j. CI = 15	§C.8.2.6	Procedure 6 Step 9
§C.7.4.3.1	Response type	§C.8.2.2	Procedure 2 Step 2
§C.7.5	Data Extraction by Mode S Ground stations		Implicitly tested
Table C-2	Dataflash for Register Monitoring service		implicitly tested

C.8 Test Procedures for Dataflash Application

C.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).

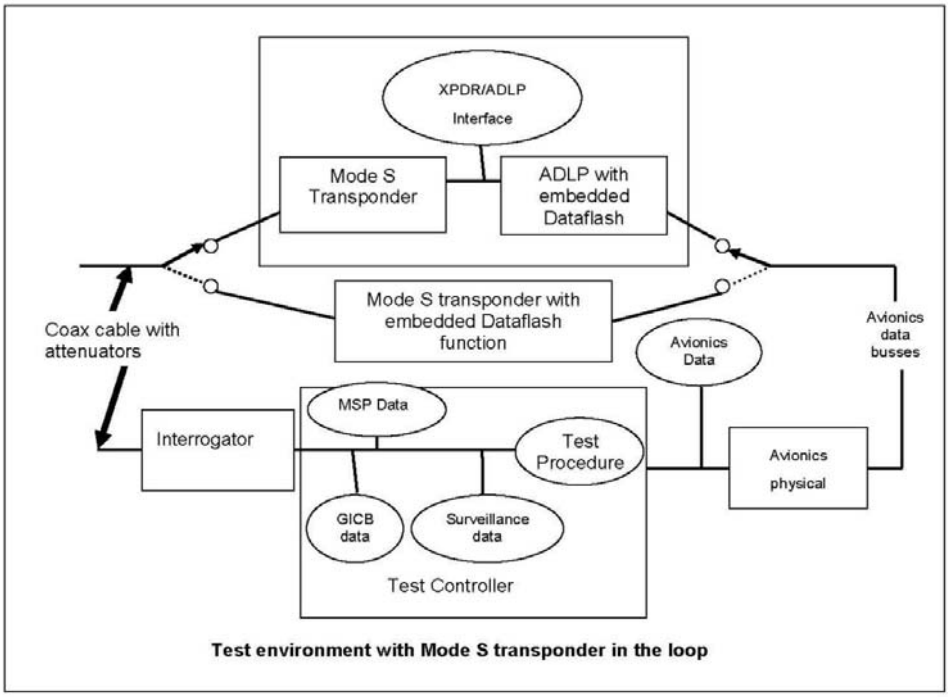
b. A means to interrogate the Mode S transponder at a regular rate between 6 and 10 seconds with surveillance interrogations and decode the replies.

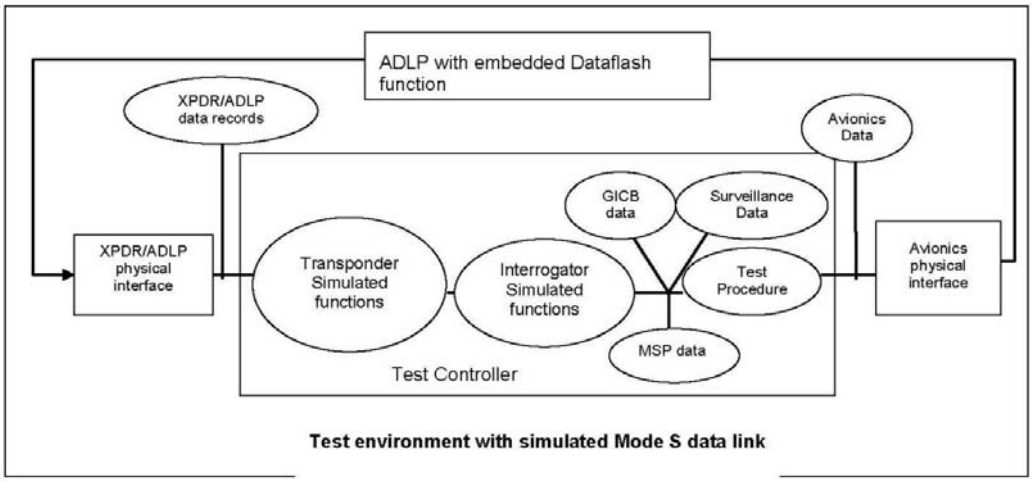
c. A means to send data to the transponder, extract air initiated messages announced by the transponder, and extract the data from the transponder registers of the transponder, by means of interrogations with the appropriate control codes set.

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-1.

©2007, RTCA, Inc.





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

©2007, RTCA, Inc.

C.8.2 Test Procedures

C.8.2.1 Procedure #1: Initialization and Checking for Dataflash Support

(Reference: §C.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.

Table C-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, 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, 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, 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.

©2007, RTCA, Inc.

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.8.2.2 Procedure #2: Requesting the setup of Dataflash Contracts

(Reference: §C.6.3, §C.6.4, §C.6.5.2, §C.6.5.3, §C.6.7.1, §C.7.2.1, §C.7.2.2, §C.7.2.3, §C.7.4.1, §C.7.4.3 & §C.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-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-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.

©2007, RTCA, Inc.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-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-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-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-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-6. Verify that it contains a DH equal to the

©2007, RTCA, Inc.

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-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-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-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-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.

©2007, RTCA, Inc.

q. Use the techniques in §C.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-8 or Table C-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-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-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-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.8.2.3 Procedure 3 to terminate all the contracts.

©2007, RTCA, Inc.

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-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, 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.8.2.3 Procedure #3: Termination of Dataflash Contracts

(Reference: §C.6.7.1, §C.7.2.4, §C.7.2.6, §C.7.2.8, §C.7.2.9, & §C.7.4.3)

This Procedure tests the different methods of terminating Dataflash contracts and can be performed in conjunction with Procedure 2 of §C.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.8.2.2.

b. For an established contract send a Mode S uplink Frame containing an MSP packet as in Table C-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-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.

©2007, RTCA, Inc.

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.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, 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-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.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, 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-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.

©2007, RTCA, Inc.

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.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, 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-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.8.2.4 Procedure #4: Dataflash Header (DH) Field Tests

(Reference: §C.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.8.2.2 Procedure #2 Step 2.

©2007, RTCA, Inc.

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-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-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.8.2.3 above, and this test continued to test all CNS values.*

h. Terminate all contracts by the method used in §C.8.2.3 Procedure 3 Step 1.

C.8.2.5 Procedure #5: Minimum Time (MT) Field Tests

(Reference: §C.6.6 & §C.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-5.

©2007, RTCA, Inc.

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-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-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 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.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-5.

©2007, RTCA, Inc.

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-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-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-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 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.8.2.3 Procedure 3 Step 1.

©2007, RTCA, Inc.

C.8.2.6 Procedure #6: Event Criterion (EC) Field Tests

(Reference: §C.6.7.1, §C.6.8, §C.7.2.5, §C.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-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-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-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.

©2007, RTCA, Inc.

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-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 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.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-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-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*

©2007, RTCA, Inc.

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-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-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 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.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.

©2007, RTCA, Inc.

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

©2007, RTCA, Inc.

n. Terminate all contracts by the method used in §C.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-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-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-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

©2007, RTCA, Inc.

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-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 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.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-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-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					

©2007, RTCA, Inc.

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-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-7, and they contain a DH equal to the value in the request interrogation.

h. Use an interrogation as in Table C-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.8.2.3 Procedure 3 Step 1.

©2007, RTCA, Inc.

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-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-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-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-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).

©2007, RTCA, Inc.

h. Use an interrogation as in Table C-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.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-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-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.

©2007, RTCA, Inc.

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-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-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-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-7, and it contains a DH equal to the value in the request

©2007, RTCA, Inc.

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-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-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-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.

©2007, RTCA, Inc.

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-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-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-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.8.2.7 Procedure #7: Stable Time (ST) Field tests

(Reference: §C.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-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-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				

©2007, RTCA, Inc.

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-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 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-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, 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.

©2007, RTCA, Inc.

q. Terminate all contracts by the method used in §C.8.2.3 Procedure 3 Step 1.

C.8.2.8 Procedure #8: Maximum Message Rate

(Reference: §C.7.3, & §C.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-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-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-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.

©2007, RTCA, Inc.

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-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-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-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-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.

©2007, RTCA, Inc.

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-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.9 Dataflash Installed System Performance

Installed performance shall be consistent with that specified in §C.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.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

©2007, RTCA, Inc.

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.

©2007, RTCA, Inc.