EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

ASTERIX Part 21 Category 007 Appendix A Coding rules for "Reserved Expansion Field"

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EUROPEAN AIR TRAFFIC MANAGEMENT

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0.2	March 2010	Definition and Note to TA item updated	2.3
1.0	April 2010	Changed to “Released Issue”	All
1.1	April 2011	Document Id corrected Signature Page updated	Front Page iii
1.2	June 2011	Data item M5N added Data item M4E added	2.4 2.5
1.3	July 2012	Signature Page updated X-Pulse definition updated Subfield #8 (FOM) added to M5N	iii 2.3 2.4 2.4

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Scope

This document describes the way to encode information in the Reserved Expansion Field of ASTERIX Cat 007 (Directed Interrogations).

2. DESCRIPTION OF THE CONTENT OF RESERVED EXPANSION FIELD

2.1 Length Indicator

Definition : This field indicates the total length in octets of the Reserved Expansion Field (including the REF length indicator itself)

Format : One-octet fixed length Data Item

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
LEN							

bits 8-1	(LEN)	Length of REF in octets, including the Length Indicator itself.

Encoding Rule :

This item shall be present in every REF

2.2 Items indicator

Definition : This field indicates what are the items encoded in the REF
Format : One-octet fixed length Data Item
Structure:

Octet no. 1

8	7	6	5	4	3	2	1
TA	M5N	M4E	0	0	0	0	0

bit 8 (TA)
= 0 Target Altitude is not present in the REF
= 1 Target Altitude is present in the REF

bit 7 (M5N)
= 0 Mode 5 New is not present in the REF
= 1 Mode 5 New is present in the REF

bit 6 (M4E)
= 0 Extended Encoding for Mode 4 is not present in the REF
= 1 Extended Encoding for Mode 4 is present in the REF

bits 5/1 Spare bits set to 0

Encoding Rule :
This item shall be present in every REF

2.3 TA Target Altitude

Definition: Potential height of a target to be interrogated. The height shall use mean sea level as the zero reference level.

Format: Four-octet fixed length Data Item.

Structure:

	Octet no. 1								Octet no. 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
0	0	TA_{max}													LSB

	Octet no. 3								Octet no. 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	TA_{min}													LSB

bits-32/31	(spare)	Spare bits, set to 0
bits-30/17	(TA_{max})	Maximum value of potential target altitude
bit 17	(LSB)	=25ft
bits-16/15	(spare)	Spare bits, set to 0
bits-14/1	(TA_{min})	Minimum value of potential target altitude
bit 1	(LSB)	=25ft

NOTE: Negative Values are expressed in two's complement
$TA_{min} \leq TA_{max}$

Encoding Rule :

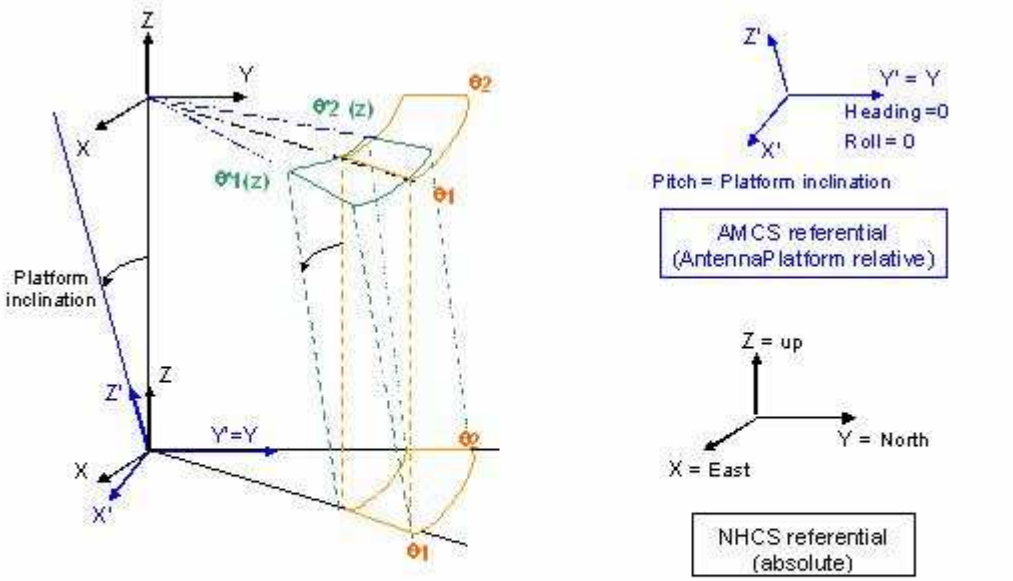
This Item is optional.

Application :

When operating a sensor on a moving platform (such as a ship) it is subjected to movements around the three special axes (heading, roll, pitch).

As shown in the diagram hereafter, the start and end value for the interrogation window differs depending on the movement of the sensor. In order to compensate for these variations, it is required to indicate to the sensor the altitude of the target in order to calculate the potential differences in the start and end angle of the interrogation window.

This REF implements the capability to indicate to the sensor the potential height band in which the target to be interrogated can be expected.



2.4 M5N Mode 5 New

Definition: Mode 5 Data/Reports, Extended Mode 1 Code and X pulse following the updated NATO format for the National Origin code

Format: Compound data item comprising of a primary subfield of of up to two octets, followed by the indicated subfields.

Note: In 2011 NATO has modified the format of the National Origin information available in subfield 2 of the Mode 5 data item (I007/085). The information for National Origin and Mission Code were combined into a 11-bit long field. In order to maintain backwards compatibility and to ease the use of the new layout, the original Mode 5 data item (I007/085) was copied into this Reserved Expansion Field and the layout of subfield #2 adapted.

The new layout is reflected in this data item M5N and shall be used by equipment prepared for the new National Origin system.

Equipment certified to the previous encoding shall continue to use the data item MD5 corresponding to the 5-bit National Origin / 6-bit Mission Code as described in data item I007/085 of the main ASTERIX category 007 specification.

Structure of Primary Subfield of Compound Data Item*:*

Octet no. 1

16	15	14	13	12	11	10	9
SUM	PMN	POS	GA	EM1	TOS	XP	FX

Octet no. 2

8	7	6	5	4	3	2	1
FOM	0	0	0	0	0	0	FX

bit-16, octet 1 (SUM) Subfield #1: Mode 5 Summary
=0 Absence of Subfield #1
=1 Presence of Subfield #1

bit-15, octet 1 (PMN) Subfield #2: Mode 5 PIN/ National Origin
=0 Absence of Subfield #2
=1 Presence of Subfield #2

bit-14, octet 1 (POS) Subfield #3: Mode 5 Reported Position
=0 Absence of Subfield #3
=1 Presence of Subfield #3

bit-13, octet 1 (GA) Subfield #4: Mode 5 GNSS-derived Altitude
=0 Absence of Subfield #4
=1 Presence of Subfield #4

bit-12, octet 1 (EM1) Subfield #5: Extended Mode 1 Code in Octal Representation
=0 Absence of Subfield #5
=1 Presence of Subfield #5

bit-11, octet 1 (TOS) Subfield #6: Time Offset for POS and GA.
=0 Absence of Subfield #6
=1 Presence of Subfield #6

bit-10, octet 1 (XP) Subfield #7: X Pulse Presence
=0 Absence of Subfield #7
=1 Presence of Subfield #7

bit-9, octet 1	(FX)	= 0 End of Primary Subfield = 1 Extension of Primary Subfield into next octet
bit-8, octet 2	(FOM)	Subfield #8: Figure of Merit =0 Absence of Subfield #8 =1 Presence of Subfield #8
bits-7/2, octet 2	(spare)	Spare bits, set to 0
bit-1, octet 2	(FX)	= 0 End of Primary Subfield = 1 Extension of Primary Subfield into next octet

Structure of Subfield #1*:*
Mode 5 Summary:

Octet no. 1

8	7	6	5	4	3	2	1
M5	ID	DA	M1	M2	M3	MC	0

bit-8 (M5) = 0 No Mode 5 interrogation
= 1 Mode 5 interrogation

bit-7 (ID) = 0 No authenticated Mode 5 ID reply/report
= 1 Authenticated Mode 5 ID reply/report

bit-6 (DA) = 0 No authenticated Mode 5 Data reply or Report
= 1 Authenticated Mode 5 Data reply or Report (i.e any valid Mode 5 reply type other than ID)

bit-5 (M1) = 0 Mode 1 code not present or not from Mode 5 reply/report
= 1 Mode 1 code from Mode 5 reply/report.

bit-4 (M2) = 0 Mode 2 code not present or not from Mode 5 reply/report
= 1 Mode 2 code from Mode 5 reply/report.

bit-3 (M3) = 0 Mode 3 code not present or not from Mode 5 reply/report
= 1 Mode 3 code from Mode 5 reply/report.

bit-2 (MC) = 0 Mode C altitude not present or not from Mode 5 reply/report
= 1 Mode C altitude from Mode 5 reply/report

bit-1 Spare bit set to 0

Notes:

1. The flags M2, M3, MC refer to the contents of data items I048/050, I048/070 and I048/090 respectively. The flag M1 refers to the contents of data item I048/055, Mode 1 Code in Octal Representation, and to the contents of the Subfield #5 (Extended Mode 1 Code in Octal Representation).
2. If an authenticated Mode 5 reply/report is received with the Emergency bit set, then the Military Emergency bit (ME) in Data Item I048/020, Target Report Descriptor, shall be set.
3. If an authenticated Mode 5 reply/report is received with the Identification of Position bit set, then the Special Position Identification bit (SPI) in Data Item I048/020, Target Report Descriptor, shall be set.

Structure of Subfield #2*:*
Mode 5 PIN /National Origin

Octet no. 1 Octet no. 2

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
0	0	PIN													(LSB)

Octet no. 3 Octet no. 4

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	NO										

bits-32/31 (spare) spare bits set to 0

bits-30/17 (PIN) PIN Code

bits-16/12 (spare) spare bits set to 0

bits-11/1 (NO) National Origin Code

Structure of Subfield #3*:*
Mode 5 Reported Position

Octet no. 1 Octet no. 2

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Latitude in WGS 84															

Octet no. 3 Octet no. 4

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
							(LSB)	Longitude in WGS 84							

Octet no. 5 Octet no. 6

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
															(LSB)

bits-48/25 (LAT) Latitude in WGS 84

bits-24/1 (LON) Longitude in WGS 84

Notes : Latitude in WGS 84 is expressed as a 24-bit two's complement number. Range -90° ≤ latitude ≤ 90°. Sign convention: North is positive.

LSB = $180/2^{23}$ degrees = $2.145767*10^{-05}$ degrees

Longitude in WGS 84 is expressed as a 24-bit two's complement number. Range -180° ≤ longitude < 180°. Sign convention: East is positi ve.

LSB = $180/2^{23}$ degrees = $2.145767*10^{-05}$ degrees

The resolution implied by the LSB is better than the resolution with which Mode 5 position reports are transmitted from aircraft transponders using currently defined formats.

Structure of Subfield #4*:*
Mode 5 GNSS-derived Altitude

Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	RES	GA													(LSB)

bit-16 (spare) spare bit set to 0

bit-15 (RES) Resolution with which the GNSS-derived Altitude (GA) is reported.
=0 GA reported in 100 ft increments,
=1 GA reported in 25 ft increments.

bits-14/1 (GA) GNSS-derived Altitude of target, expressed as height above WGS 84 ellipsoid. GA is coded as a 14-bit two's complement binary number with an LSB of 25 ft. irrespective of the setting of RES. The minimum value of GA that can be reported is -1000 ft.

Structure of Subfield #5:
Extended Mode 1 Code in Octal Representation

				Octet 1							Octet 2				
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	Extended Mode 1 Code											
				A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

bit 16/13 Spare bits set to 0

bits-12/1 (EM1) Extended Mode 1 Code in octal representation

Note: If Subfield #1 is present, the M1 bit in Subfield #1 indicates whether the Extended Mode 1 Code is from a Mode 5 reply or a Mode 1 reply. If Subfield #1 is not present, the Extended Mode 1 Code is from a Mode 1 reply.

Structure of Subfield #6 of Compound Data Item:
Time Offset for POS and GA

Octet no. 1

8	7	6	5	4	3	2	1
TOS							(LSB)

bits-8/1 (TOS) Time Offset coded as a twos complement number with an LSB of 1/128 s. The time at which the Mode 5 Reported Position (Subfield #3) and Mode 5 GNSS-derived Altitude (Subfield #4) are valid is given by Time of Day (I048/140) plus Time Offset.

Note:

TOS shall be assumed to be zero if Subfield #6 is not present.

Structure of Subfield #7 of Compound Data Item:
X Pulse Presence

Octet no. 1

8	7	6	5	4	3	2	1
0	0	XP	X5	XC	X3	X2	X1

bits-8/7 spare bits set to zero

bit-6 (XP) X-pulse from Mode 5 PIN reply/report
= 0 X-Pulse not present.
= 1 X-pulse present.

bit-5 (X5) X-pulse from Mode 5 Data reply or Report.
= 0 X-pulse set to zero or no authenticated Data reply or Report received.
= 1 X-pulse set to one (present).

bit-4 (XC) X-pulse from Mode C reply
= 0 X-pulse set to zero or no Mode C reply
= 1 X-pulse set to one (present)

bit-3 (X3) X-pulse from Mode 3/A reply
= 0 X-pulse set to zero or no Mode 3/A reply
= 1 X-pulse set to one (present)

bit-2 (X2) X-pulse from Mode 2 reply
= 0 X-pulse set to zero or no Mode 2 reply
= 1 X-pulse set to one (present)

bit-1 (X1) X-pulse from Mode 1 reply
= 0 X-pulse set to zero or no Mode 1 reply
= 1 X-pulse set to one (present)

NOTE to Subfield #7 (X Pulse Presence)**:**

Within Mode 5 replies/reports, the X-Pulse can be set for the following cases:

1. In a combined Mode 1 and Mode 2 reply/report: in this case the X5 bit and the X2 bit shall be set;
2. In a combined Mode 3 and Mode C reply/report: in this case the X5 bit and the X3 bit shall be set;
3. In a Mode 5 PIN data reply/report: in this case the X5 bit and the XP bit shall be set.

The X1 bit and the XC bit are meaningless as in Mode 1 and Mode C replies/reports the X Pulse is not defined. They are kept for compatibility reasons.

Structure of Subfield #8 of Compound Data Item:
Figure of Merit

Octet no. 1

8	7	6	5	4	3	2	1
0	0	0	FOM				

bits-8/6	(spare)	spare bits set to zero
bits-5/1	(FOM)	Figure of Merit Position Accuracy as extracted and provided by a Mode 5 transponder

Encoding Rule:

The Reserved Expansion Field is optional. When used to transmit M5N, it shall be sent when at least one of the following conditions is satisfied:

1. The target represented by the Monoradar Target Report has been interrogated in Mode 5.
2. A non-zero Extended Mode 1 Code is received.
3. An X-pulse is present in a Mode 5 reply/report.

If condition 1 is satisfied, then Subfield #1 (Mode 5 Summary) shall be present.
If condition 2 is satisfied then Subfield #5 (Extended Mode 1 Code in Octal Representation) shall be present.
If condition 3 is satisfied, then Subfield #7 (X Pulse Presence) shall be present.

2.5 M4E

Definition: Extended encoding of the Mode 4 interrogation result

Format: Variable length Data Item comprising a first part of one-octet, followed by one-octet extents as necessary.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
0	0	0	0	0	FOE/FRI		FX

Bits 8/4	(spare)	spare bits, set to 0
Bits 3/2	(FOE/FRI)	Indication Foe/Friend (Mode4) = 00 No Mode 4 identification = 01 possibly friendly target = 10 probably friendly target = 11 friendly target
Bit-1	(FX)	= 0 End of Data Item = 1 Extension into first extent

Encoding Rule :

This item is optional and shall be used if the IFF interrogator is capable to encode the extended Mode 4 interpretation.