

**ASTERIX Part 4  
Category 048  
Appendix A  
Coding rules for  
"Reserved Expansion  
Field"**



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# DOCUMENT IDENTIFICATION SHEET

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Coding rules for "Reserved Expansion Field"

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### Abstract

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The following table identifies all management authorities who have successively approved the present issue of this document.

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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 Monoradar Target Report from ASTERIX Cat 048.

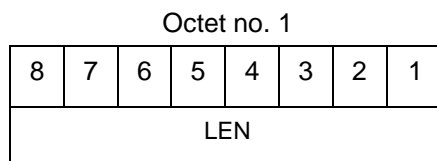
## 2. DESCRIPTION OF THE CONTENT OF RESERVED EXPANSION FIELD

### 2.1 Length Indicator

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

**Format :** One-octet fixed length Data Item

**Structure:**



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
MD5	M5N	M4E	0	0	0	0	0

bit 8 (MD5) = 0 Mode 5 Data/Reports, Extended Mode 1 Code and X Pulse are not present in the REF

= 1 Mode 5 Data/Reports and Extended Mode 1 Code and X Pulse are present in the REF

bit 7 (M5N) = 0 New Encoding for Mode 5 Data/Reports, Extended Mode 1 Code and X Pulse is not present in the REF

= 1 New Encoding for Mode 5 Data/Reports, Extended Mode 1 Code and X Pulse 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

### MD5

**Definition:** Mode 5 Data/Reports, Extended Mode 1 Code and X pulse

**Format:** Compound data item comprising one primary subfield of one octet, followed by up to 7 subfields

**Note:** In 2011 NATO has modified the format of the National Origin information available in subfield 2 of the Mode 5 data item in this Reserved Expansion Field. 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 was copied and the layout of subfield #2 adapted. The new layout is reflected in the 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.

## Structure of Primary Subfield of Compound Data Item:

Octet no. 1							
8	7	6	5	4	3	2	1
SUM	PMN	POS	GA	EM1	TOS	XP	FX

bit-8, octet 1	(SUM)	Subfield #1: Mode 5 Summary =0 Absence of Subfield #1 =1 Presence of Subfield #1
bit-7, octet 1	(PMN)	Subfield #2: Mode 5 PIN/ National Origin/Mission Code =0 Absence of Subfield #2 =1 Presence of Subfield #2
bit-6, octet 1	(POS)	Subfield #3: Mode 5 Reported Position =0 Absence of Subfield #3 =1 Presence of Subfield #3
bit-5, octet 1	(GA)	Subfield #4: Mode 5 GNSS-derived Altitude =0 Absence of Subfield #4 =1 Presence of Subfield #4
bit-4, octet 1	(EM1)	Subfield #5: Extended Mode 1 Code in Octal Representation =0 Absence of Subfield #5 =1 Presence of Subfield #5
bit-3, octet 1	(TOS)	Subfield #6: Time Offset for POS and GA. =0 Absence of Subfield #6 =1 Presence of Subfield #6
bit-2, octet 1	(XP)	Subfield #7: X Pulse Presence =0 Absence of Subfield #7 =1 Presence of Subfield #7
bit-1, octet 1	(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 = 1 Authenticated Mode 5 ID reply
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 = 1 Mode 1 code from Mode 5 reply.
bit-4	(M2)	= 0 Mode 2 code not present or not from Mode 5 reply = 1 Mode 2 code from Mode 5 reply.
bit-3	(M3)	= 0 Mode 3 code not present or not from Mode 5 reply = 1 Mode 3 code from Mode 5 reply.
bit-2	(MC)	= 0 Mode C altitude not present or not from Mode 5 reply = 1 Mode C altitude from Mode 5 reply
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 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 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/ Mission Code**

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	NAT (LSB)				0	0	MIS (LSB)						

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

bits-30/17 (PIN) PIN Code

bits-16/14 (spare) spare bits set to 0

bits-13/9 (NAT) National Origin

bits-8/7 (spare) spare bits set to 0

bits-6/1 (MIS) Mission 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  $-90^{\circ} \leq \text{latitude} \leq 90^{\circ}$ . Sign convention: North is positive.  
LSB =  $180/2^{23}$  degrees =  $2.145767 \cdot 10^{-05}$  degrees

Longitude in WGS 84 is expressed as a 24-bit two's complement number.  
Range  $-180^{\circ} \leq \text{longitude} < 180^{\circ}$ . Sign convention: East is positive.  
LSB =  $180/2^{23}$  degrees =  $2.145767 \cdot 10^{-05}$  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	0	X5	XC	X3	X2	X1

bits-8/6      spare bits set to zero

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)

**Encoding Rule:**

The Reserved Expansion Field is optional. When used to transmit MD5, 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.

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.

## 2.4

### M5N

**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 one primary subfield of one octet, followed by up to 7 subfields

**Note:** In 2011 NATO has modified the format of the National Origin information available in subfield 2 of the Mode 5 data item in this Reserved Expansion Field. 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 was copied and the layout of subfield #2 adapted. The new layout is reflected in the 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.

## Structure of Primary Subfield of Compound Data Item:

Octet no. 1							
8	7	6	5	4	3	2	1
SUM	PMN	POS	GA	EM1	TOS	XP	FX

bit-8, octet 1	(SUM)	Subfield #1: Mode 5 Summary =0 Absence of Subfield #1 =1 Presence of Subfield #1
bit-7, octet 1	(PMN)	Subfield #2: Mode 5 PIN/ National Origin =0 Absence of Subfield #2 =1 Presence of Subfield #2
bit-6, octet 1	(POS)	Subfield #3: Mode 5 Reported Position =0 Absence of Subfield #3 =1 Presence of Subfield #3
bit-5, octet 1	(GA)	Subfield #4: Mode 5 GNSS-derived Altitude =0 Absence of Subfield #4 =1 Presence of Subfield #4
bit-4, octet 1	(EM1)	Subfield #5: Extended Mode 1 Code in Octal Representation =0 Absence of Subfield #5 =1 Presence of Subfield #5
bit-3, octet 1	(TOS)	Subfield #6: Time Offset for POS and GA. =0 Absence of Subfield #6 =1 Presence of Subfield #6
bit-2, octet 1	(XP)	Subfield #7: X Pulse Presence =0 Absence of Subfield #7 =1 Presence of Subfield #7
bit-1, octet 1	(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 = 1 Authenticated Mode 5 ID reply
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 = 1 Mode 1 code from Mode 5 reply.
bit-4	(M2)	= 0 Mode 2 code not present or not from Mode 5 reply = 1 Mode 2 code from Mode 5 reply.
bit-3	(M3)	= 0 Mode 3 code not present or not from Mode 5 reply = 1 Mode 3 code from Mode 5 reply.
bit-2	(MC)	= 0 Mode C altitude not present or not from Mode 5 reply = 1 Mode C altitude from Mode 5 reply
bit-1	Spare bit set to 0	

**Notes:**

4. 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).
5. If an authenticated Mode 5 reply is received with the Emergency bit set, then the Military Emergency bit (ME) in Data Item I048/020, Target Report Descriptor, shall be set.
6. If an authenticated Mode 5 reply 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  $-90^{\circ} \leq \text{latitude} \leq 90^{\circ}$ . Sign convention: North is positive.  
LSB =  $180/2^{23}$  degrees =  $2.145767 \cdot 10^{-05}$  degrees

Longitude in WGS 84 is expressed as a 24-bit two's complement number.  
Range  $-180^{\circ} \leq \text{longitude} < 180^{\circ}$ . Sign convention: East is positive.  
LSB =  $180/2^{23}$  degrees =  $2.145767 \cdot 10^{-05}$  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	0	X5	XC	X3	X2	X1

bits-8/6      spare bits set to zero

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)

**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.

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.

## 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.

IFF interrogators not capable of using the extended Mode 4 encoding shall instead use data item I048/020, 1<sup>st</sup> extension.