EUROCONTROL Specification for Surveillance Data Exchange ASTERIX

Part 21 Category 007
Directed Interrogation Messages
Appendix A: Reserved Expansion Field

Edition: 1.7
Edition date: 19 April 2022
Reference nr: EUROCONTROL-SPEC-0149-21A
ISBN: 978-2-87497-028-3

EUROCONTROL Specification for Surveillance Data Exchange
ASTERIX Part 21 Category 007
Directed Interrogation Messages
Appendix A: Reserved Expansion Field

DOCUMENT IDENTIFIER : EUROCONTROL-SPEC-0149-21A

Edition Number	**:**	**1.7**
Edition Date	**:**	**19/04/2022**
Status	**:**	**Released Issue**
Intended for	**:**	**General Public**
Category	**:**	**EUROCONTROL Specification**

DOCUMENT CHARACTERISTICS

TITLE		
EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 21 Appendix A Category 07: Directed Interrogations – REF		
	Publications Reference:	SPEC-0149-21A
	ISBN Number:	978-2-87497-028-3
Document Identifier	**Edition Number:**	1.7
EUROCONTROL-SPEC-0149-4A	**Edition Date:**	19/04/2022

Abstract

This document specifies the contents of the Reserved Expansion Field for ASTERIX Category 007 messages used for the transmission of Directed Interrogation Messages.

Keywords

Data Exchange	Messages	SAC	SIC
Data Category	Data Field	Data Block	Data Item
ASTERIX	UAP	REF	Directed Interrogations

Contact Person(s)	Tel	Unit
Alexander Engel	+32-2-729 3355	DECMA/PCS/SCS/STAN

STATUS, AUDIENCE AND ACCESSIBILITY					
Status		**Intended for**		**Accessible via**	
Working Draft	☐	General Public	☑	Intranet	☐
Draft	☐	EUROCONTROL	☐	Extranet	☐
Proposed Issue	☐	Restricted	☐	Internet (www.eurocontrol.int)	☑
Released Issue	☑				

DOCUMENT APPROVAL

This document has been approved by the ASTERIX Maintenance Group AMG.

For management approval of the complete set of ASTERIX documentation please refer to Part 1.

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.1	February 2010	Creation	All
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
1.4	November 2012	V, L and G bits added to M5N, SF#5 Mode 1 Code	2.4
1.5	October 2016	Validity flag added to “NAT” in Mode 5 NEW data	2.4
1.6	August 2017	Alignment with Category 048 Reserved Expansion Field Edition 1.9: Data Item “Radar Plot Characteristics” added Extended Range Report item added	 2.6 2.7
1.7	April 2022	Alignment with Category 048 Reserved Expansion Field Edition 1.10: Editorial correction in MD5 New Format – Subfield #2-NOV Note added to MD5 New Format – Subfield #5 Range of ERR corrected (includes 256 NM) – please **check Note 5 in 2.7.**	 2.4 2.4 2.7

Publications
EUROCONTROL Headquarters
96 Rue de la Fusée
B-1130 BRUSSELS

Tel: +32 (0)2 729 4715
Fax: +32 (0)2 729 5149
E-mail: publications@eurocontrol.int

TABLE OF CONTENTS

This page is intentionally left blank

EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Scope of this Document

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

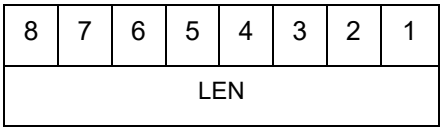
2.1 Length Indicator

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



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	RPC	ERR	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

bit 5 (RPC)
= 0 Radar Plot Characteristics is not present in the REF
= 1 Radar Plot Characteristics is present in the REF

bit 4 (ERR)
= 0 Extended Range Report is not present in the REF
= 1 Extended Range Report is present in the REF

bits 3/1 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 :

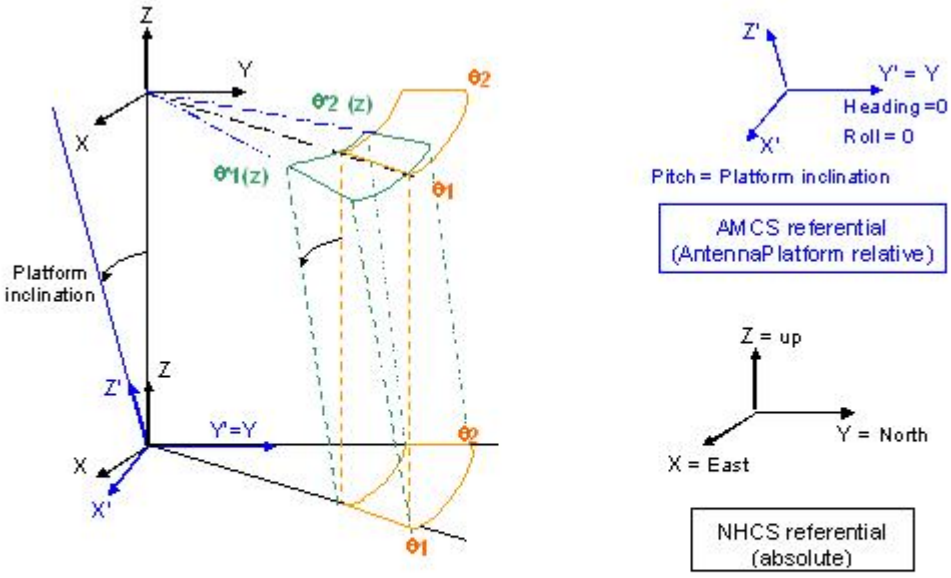
This Item is optional.

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 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 I007/050, I007/070 and I007/090 respectively. The flag M1 refers to the contents of data item I007/055, 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 I007/020, 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 I007/020, 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	NOV	NO										

bits-32/31	(spare)	spare bits set to 0
bits-30/17	(PIN)	PIN Code
bits-16/13	(spare)	spare bits set to 0
bit-12	(NOV)	Validity of NO =0: National Origin is valid =1: National Origin is invalid
bits-11/1	(NO)	National Origin Code

Note: Bit 12 (NOV) is set to 1 if the value for National Origin is not known or invalid. Under certain conditions PIN is available but NO is not available. NOV then indicates that the NO field was not actively populated.

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 positive.
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
V	G	L	0	Extended Mode 1 Code											
				A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

bit-16	(V)	= 0	Code not validated (see note 2)
		= 1	Code validated (see note 2)
bit-15	(G)	= 0	Default
		= 1	Garbled code
bit-14	(L)	= 0	Mode-3/A code derived from the reply of the transponder
		= 1	Mode-3/A code not extracted during the last scan
bit-13	(spare)	spare bit, set to “0”	
bits-12/1	(EM1)	Extended Mode 1 Code in octal representation	

Note 1: 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.

Note 2: For reasons of backwards compatibility the logic for the setting of the V-bit was inverted compared to other similar data items.

Note 3: The values of the bits for V, G, L, A4, A2, A1, B2 and B1 **shall** be identical to the values of the corresponding bits in data item I007/055.

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 (I007/140) 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

2.5 M4E – Extended Mode 4

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.

2.6 Radar Plot Characteristics

Definition: Extension to data item I007/130 for primary reports

Format: Compound Data Item comprising a first part of one-octet extensible, followed by the indicated subfields.

Structure of Primary Subfield of Compound Data Item*:*

Octet no. 1

8	7	6	5	4	3	2	1
SCO	SCR	RW	AR	0	0	0	FX

bit-8	(SCO)	Subfield #1: Score =0 Absence of Subfield #1 =1 Presence of Subfield #1
bit-7	(SCR)	Subfield #2: Signal/Clutter Ratio =0 Absence of Subfield #2 =1 Presence of Subfield #2
bit-6	(RW)	Subfield #3: Range Width =0 Absence of Subfield #3 =1 Presence of Subfield #3
bit-5	(AR)	Subfield #4: Ambiguous Range =0 Absence of Subfield #4 =1 Presence of Subfield #4
Bits-4/2	(spare)	Spare bits, set to 0
bit-1	(FX)	= 0 End of Primary Subfield = 1 Extension of Primary

Structure of Subfield #1 of Compound Data Item: Score

The score describes the number of raw responses used to create the plot.

Octet no. 1

8	7	6	5	4	3	2	1
SCO							

bits-8/1 (SCO) Score

Structure of Subfield #2: Signal / Clutter Ratio

The Signal / Clutter Ratio describes the difference in signal strength between the signal constituting the raw plot and the signal of the clutter.

Octet no. 1 Octet no. 2

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

bits-16/1 (SCR) Signal to Clutter Ratio
LSB = 0.1 db
0.1 db < SCR < 2550

Structure of Subfield #3: Range Width

The Range Width defines the difference in range between the closest proximity to the radar of the raw response and the point farthest away from the radar.

Octet no. 1 Octet no. 2

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

bits-16/1 (RW) Range Width
LSB = 1/256 NM
Max. value: 256 NM

Structure of Subfield #4: Ambiguous Range

The Ambiguous Range describes the Pulse Repetition Interval of the radar in range.

Octet no. 1 Octet no. 2

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

bits-16/1	(AR)	Ambiguous Range LSB = 1/256 NM Max. value: 256 NM

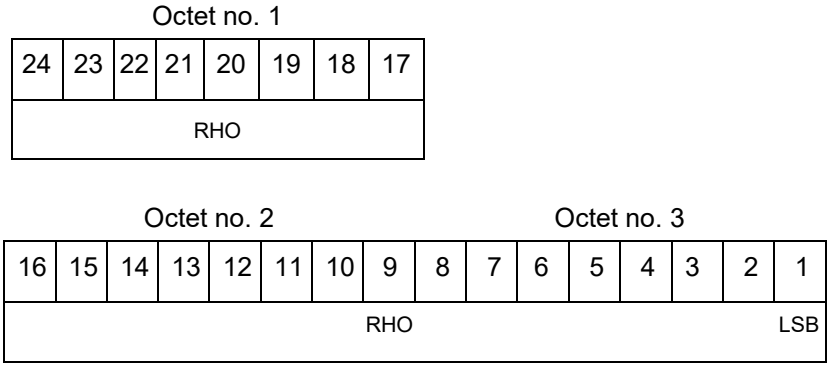
Encoding Rule :
This item is optional.

2.7 Extended Range Radar

Definition: Adaptation of data item I007/040 to extended range radars for provision of the measured position of an aircraft in local polar coordinates with a range equal to or greater than 256NM

Format: Three-octet fixed length data item.

Structure:



bit-1 (LSB) = 1/256 NM.
Max. range = 65535 NM

Encoding Rule :

This item is optional. It **shall** only be sent if the value of RHO is equal to or greater than 256NM.

NOTES

1. For radars with an operational range beyond 256 NM data item I007/040 is insufficient. These radars may use this extension to provide the target position equal to or beyond 256 NM. In such cases, data item I007/040 **shall** be transmitted **in addition to this extension.** In this case it is recommended to set bits 32/17 in data item I007/040 to “1”**.**
2. The Encoding Rule for data item I007/040 still applies.
3. This item represents the measured target position of the plot, even if associated with a track, for the present antenna scan. It is expressed in polar co-ordinates in the local reference system, centred on the radar station.
4. In case of combined detection by a PSR and an SSR, then the SSR position is sent.
5. Before migrating an ASTERIX encoder to Edition 1.7 of this specification, care has to be taken that receiving decoders allow the presence of the value 256 NM in the record. Systems applying a range check may otherwise suppress the record.

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.

EUROCONTROL

SUPPORTING EUROPEAN AVIATION

www.eurocontrol.int