EUROCONTROL Specification for Surveillance Data Exchange ASTERIX

Part 4 Category 048
Monoradar Target Reports
Appendix A: Reserved Expansion Field

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Abstract

This document specifies the contents of the Reserved Expansion Field for ASTERIX Category 048 messages used for the transmission of Monoradar Target Reports.

Keywords

Data Exchange	Messages	SAC	SIC
Data Category	Data Field	Data Block	Data Item
ASTERIX	UAP	REF	Monoradar Targets

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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
1.0	January 2003	Creation	All
0.11	March 2003	Modification of the release numbering Modification of the size of the “length field” Correction of item MD5	
1.1	June 2005	Status of document: “Released Issue” Document ID Sheet Updated Document Approval Sheet updated Editorial “Cleanup”	 ii iii All
1.2	July 2005	Category added on title page	i
1.3	April 2007	Document ID-Sheet updated Signature Page updated Editorial “clean-up”	
1.4	June 2011	Signature Page updated Mode 5-New added Extended encoding of Mode 4 information added	iii 2.4 2.5
1.5	July 2012	Signature Page updated X-Pulse definition updated Subitem #8 (FOM) added to M5N	iii 2.3 2.4 2.4
1.6	November 2012	V, G, L bits added to MD5, SF#5 Mode 1 Code V, G, L bits added to M5N, SF#5 Mode 1 Code	2.3 2.4
1.7	September 2014	Layout changed Data Item “Radar Plot Characteristics” added	All 2.6
1.8	October 2016	Typo corrected in Mode 1 information Validity flag added to “NO” in Mode 5 data	2.3/2.4 2.3/2.4
1.9	July 2017	Extended Range Report item added	2.7
1.10	March 2022	Note added to MD5 – Subitem #5 Editorial correction in MD5 New Format – Subitem #2 Note added to MD5 New Format – Subitem #5 Range of ERR corrected (includes 256 NM) – please **check Note 5 in 2.7**.	2.3 2.4 2.4 2.7
1.11	December 2022	“subfield” replaced by “subitem” Radar Track Characteristics item added	All 2.8

		Common and Plot Characteristics item added	2.9

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Scope of this Document

This document describes the encoding of information in the Reserved Expansion Field of Monoradar Target Reports from ASTERIX Cat 048.

2. DESCRIPTION OF THE CONTENT OF RESERVED EXPANSION FIELD

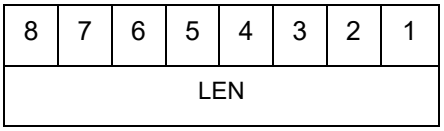
2.1 Length Indicator

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:

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
MD5	M5N	M4E	RPC	ERR	RTC	CPC	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

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

bit 3 (RTC)
= 0 Radar Track Characteristics is not present in the REF
= 1 Radar Track Characteristics is present in the REF

bit 2	(CPC)	= 0 Common and Plot Characteristics is not present in the REF = 1 Common and Plot Characteristics is present in the REF
bit 1	Spare bit set to 0 The allocation of additional items is the responsibility of the AMG and **shall** be coordinated in advance!	

Encoding Rule :

This item shall be present in every REF

2.3 MD5 – Mode 5 Reports

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

Format: Compound data item comprising one primary subitem of one octet, followed by up to 7 subitems

Note: In 2011 NATO has modified the format of the National Origin information available in subitem 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 subitem #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 Subitem 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) Subitem #1: Mode 5 Summary
=0 Absence of Subitem #1
=1 Presence of Subitem #1

bit-7, octet 1 (PMN) Subitem #2: Mode 5 PIN/ National Origin/Mission Code
=0 Absence of Subitem #2
=1 Presence of Subitem #2

bit-6, octet 1 (POS) Subitem #3: Mode 5 Reported Position
=0 Absence of Subitem #3
=1 Presence of Subitem #3

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

bit-4, octet 1 (EM1) Subitem #5: Extended Mode 1 Code in Octal Representation
=0 Absence of Subitem #5
=1 Presence of Subitem #5

bit-3, octet 1 (TOS) Subitem #6: Time Offset for POS and GA.
=0 Absence of Subitem #6
=1 Presence of Subitem #6

bit-2, octet 1 (XP) Subitem #7: X Pulse Presence
=0 Absence of Subitem #7
=1 Presence of Subitem #7

bit-1, octet 1 (FX) = 0 End of Primary Subitem
= 1 Extension of Primary Subitem into next octet

Structure of Subitem #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/report
= 1 Authenticated Mode 5 Data reply/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 Subitem #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 Subitem #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	NAV	NAT				(LSB)	0	0	MIS					(LSB)

bits-32/31	(spare)	spare bits set to 0
bits-30/17	(PIN)	PIN Code
bits-16/15	(spare)	spare bits set to 0
bit-14	(NAV)	Validity of NAT =0: National Origin is valid =1: National Origin is invalid
bits-13/9	(NAT)	National Origin
bits-8/7	(spare)	spare bits set to 0
bits-6/1	(MIS)	Mission Code

Note: Bit 14 (NAV) is set to 1 if the value for National Origin is not known or invalid. Under certain conditions PIN is available but NAT is not available. NAV then indicates that the NAT field was not actively populated.

Structure of Subitem #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 Subitem #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 Subitem #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 1 Code derived from the reply of the transponder
= 1 Mode 1 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 Subitem #1 is present, the M1 bit in Subitem #1 indicates whether the Extended Mode 1 Code is from a Mode 5 reply or a Mode 1 reply. If Subitem #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 I048/055.

Structure of Subitem #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 (Subitem #3) and Mode 5 GNSS-derived Altitude (Subitem #4) are valid is given by Time of Day (I048/140) plus Time Offset.

Note:

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

Structure of Subitem #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 Subitem #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.

Encoding Rule:

When the Reserved Expansion Field is 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 in a Mode 5 reply/report.

If condition 1 is satisfied, then Subitem #1 (Mode 5 Summary) shall be present.

If condition 2 is satisfied then Subitem #5 (Extended Mode 1 Code in Octal Representation) shall be present.

If condition 3 is satisfied, then Subitem #7 (X Pulse Presence) shall be present.

2.4 M5N – Mode 5 Reports, New Format

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 subitem of up to two octets, followed by the indicated subitems.

Encoding Rule : for data item M5N

When the REF is 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 Subitem #1 (Mode 5 Summary) shall be present.

If condition 2 is satisfied then Subitem #5 (Extended Mode 1 Code in Octal Representation) shall be present.

If condition 3 is satisfied, then Subitem #7 (X Pulse Presence) shall be present.

Note: In 2011 NATO has modified the format of the National Origin information available in subitem 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 subitem #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 Subitem 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) Subitem #1: Mode 5 Summary
=0 Absence of Subitem #1
=1 Presence of Subitem #1

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

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

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

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

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

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

bit-9, octet 1 (FX) = 0 End of Primary Subitem
= 1 Extension of Primary Subitem into next octet

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

Structure of Subitem #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:

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 Subitem #5 (Extended Mode 1 Code in Octal Representation).
5. 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.
6. 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 Subitem #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 Subitem #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 Subitem #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 Subitem #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 1 Code derived from the reply of the transponder = 1 Mode 1 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 Subitem #1 is present, the M1 bit in Subitem #1 indicates whether the Extended Mode 1 Code is from a Mode 5 reply or a Mode 1 reply. If Subitem #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 I048/055.

Structure of Subitem #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 (Subitem #3) and Mode 5 GNSS-derived Altitude (Subitem #4) are valid is given by Time of Day (I048/140) plus Time Offset.

Note:

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

Structure of Subitem #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 Subitem #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 Subitem #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 Report

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, 1st extension.

2.6 Radar Plot Characteristics

Definition: Extension to data item I048/130 for primary reports

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

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

Structure of Subitem #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 Subitem #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 Subitem #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 Subitem #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 Report

Definition: Adaptation of data item I048/040 to extended range radars for provision of the measured range of an aircraft in local polar coordinates when the range is equal to or greater than 256NM

Format: Three-octet fixed length data item.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
RHO							

Octet no. 2 Octet no. 3

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

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 I048/040 is insufficient. These radars may use this extension to provide the target position equal to or beyond 256 NM. In such cases, data item I048/040 **shall** be transmitted **in addition to this extension.** In this case it is recommended to set bits 32/17 in data item I048/040 to “1”**.**
2. The Encoding Rule for data item I048/040 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 1.10 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.

2.8 Radar Track Characteristics

Definition: Additional Track Characteristics

Format: Compound Data Item comprising a primary subitem of one-octet extensible, followed by the indicated subitems.

Structure of Primary Subitem*:*

Octet no. 1

16	15	14	13	12	11	10	9
PTL	ATL	TRN	NPP	DLK	LCK	TC	FX

bit-16 (PTL) Subitem #1: Plot/Track Link
=0 Absence of Subitem #1
=1 Presence of Subitem #1

bit-15 (ATL) Subitem #2: ADS-B/Track Link
=0 Absence of Subitem #2
=1 Presence of Subitem #2

bit-14 (TRN) Subitem #3: Turn State
=0 Absence of Subitem #3
=1 Presence of Subitem #3

bit-13 (NPP) Subitem #4: Next Predicted Position
=0 Absence of Subitem #4
=1 Presence of Subitem #4

bit-12 (DLK) Subitem #5: Data Link Characteristics
=0 Absence of Subitem #5
=1 Presence of Subitem #5

bit-11 (LCK) Subitem #6: Lockout Characteristics
=0 Absence of Subitem #6
=1 Presence of Subitem #6

bit-10 (TC) Subitem #7: Transition Code
=0 Absence of Subitem #7
=1 Presence of Subitem #7

bit-9 (FX) = 0 End of Primary Subitem
= 1 Extension of Primary

Structure of First Extension of Primary Subitem:

Octet no. 1

8	7	6	5	4	3	2	1
TLC	ASI	TES	IR	0	0	0	FX

bit-8 (TLC) Subitem #8: Track Life Cycle
=0 Absence of Subitem #8
=1 Presence of Subitem #8

bit-7 (ASI) Subitem #9: Adjacent Sensor Information
=0 Absence of Subitem #9
=1 Presence of Subitem #9

bit-6 (TES) Subitem #10: Track Extrapolation Source
=0 Absence of Subitem #10
=1 Presence of Subitem #10

bit-5 (IR) Subitem #11: Identity Requested
=0 Absence of Subitem #11
=1 Presence of Subitem #11

bits-4/2 (spare) Spare bits, set to 0

bit-1 (FX) = 0 End of Primary Subitem
= 1 Extension of Primary

Structure of Subitem #1 of "Radar Track Characteristics": Plot/Track Link

Definition: Providing link between a track and its associated plot.

Format: Fixed-length item starting with one octet for the plot components and two octets for the plot number.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
0	0	0	SCN	RC	AC	SSR	PSR

Octet no. 2 Octet no. 3

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

bits-24/22	(SPARE)	Spare Bits, set to 0
bits-21	(SCN)	Track / SCN association =0 Track is not associated with an SCN Plot =1 Track is associated with an SCN Plot
bit-20	(RC)	Roll Call Component =0 Associated Plot does not contain a Roll Call component =1 Associated Plot contains at least a Roll Call component
bit-19	(AC)	All Call Component =0 Associated Plot does not contain an All Call component =1 Associated Plot contains at least an All Call component
bit-18	(SSR)	SSR Component =0 Associated Plot does not contain an SSR component =1 Associated Plot contains at least an SSR component
bit-17	(PSR)	PSR Component =0 Associated Plot does not contain a PSR component =1 Associated Plot contains at least a PSR component

bits-16/1	(PLOTNR)	Unique reference to the associated plot record (see Note)

NOTE: (to bits-16/1): If SCN = 0, PLOTNR **shall** be set to 0.

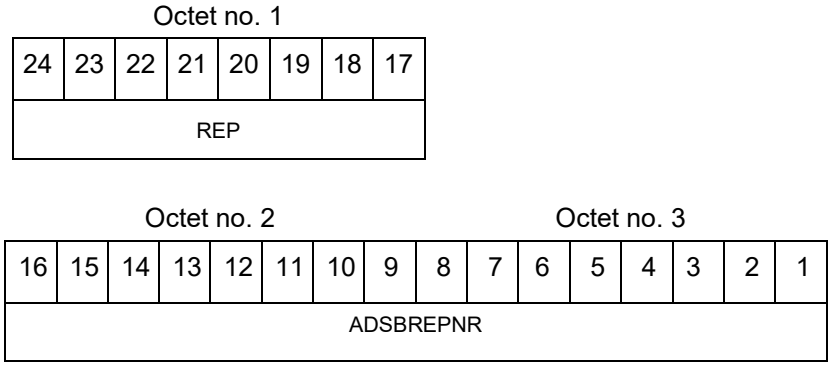
NOTE: (to bit-21): If SCN = 1, I048/020/SCN#VAL – if implemented - **shall** be set to “1”.

Structure of Subitem #2 of "Radar Track Characteristics": ADS-B/Track Link

Definition: Providing link between a track and its associated ADS-B Report.

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator followed by at least one ADS-B Report Reference Number composed of two octets.

Structure:



bits-24/17	(REP)	Repetition Factor
bits-16/1	(ADSBREPNR)	Reference to an ADS-B Report

NOTE: The presence of this information **shall** be communicated in Data Item I048/020 by setting I048/020/ADSB#VAL – if implemented - = 1.

Structure of Subitem #3 of "Radar Track Characteristics": Turn State

Definition: Turn State with probability with regards to track evolution hypothesis (Circular model).

Format: One octet fixed length data item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
PROBATURN							LSB

bits-8/1	(PROBATURN)	Probability of a Circular Model
bit-1	(LSB)	LSB = 1%

NOTE: The probability of a straight line with a Linear Model is 100%-PROBATURN.

Structure of Subitem #4 of "Radar Track Characteristics": Next Predicted Position

Definition: Next predicted position for a track update at the next expected antenna rotation in reference to the current track update.

Format: Twentytwo (22) octets fixed length data item.

Structure:

Octet no. 1 Octet no. 2

176	175	174	173	172	171	170	169	168	167	166	165	164	163	162	161
PREDRHO															LSB

Octet no. 3 Octet no. 4

160	159	158	157	156	155	154	153	152	151	150	149	148	147	146	145
PREDTHETA															LSB

Octet no. 5 Octet no. 6

144	143	142	141	140	139	138	137	136	135	134	133	132	131	130	129
EVOLRHOSTART															LSB

Octet no. 7 Octet no. 8

128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113
EVOLRHOEND															LSB

Octet no. 9 Octet no. 10

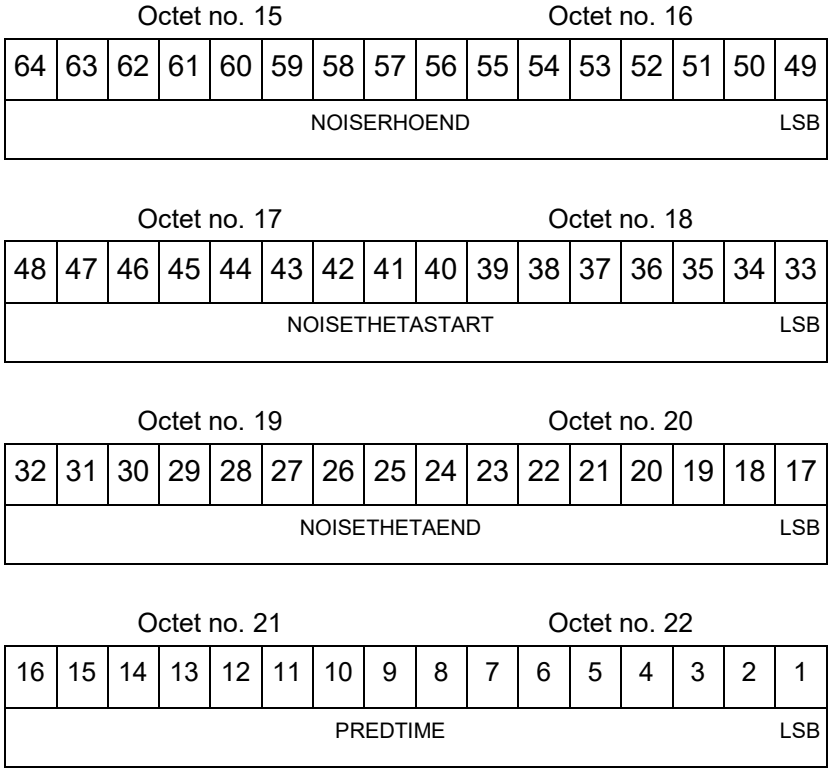
112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
EVOLTHETASTART															LSB

Octet no. 11 Octet no. 12

96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
EVOLTHETAEND															LSB

Octet no. 13 Octet no. 14

80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
NOISERHOSTART															LSB



Predicted position in polar coordinates of the target at next detection:

bits-176/161	(PREDRHO)	Predicted Range
bit-161	(LSB)	LSB = 1/128NM

bits-160/145	(PREDTHETA)	Predicted Azimuth
bit-145	(LSB)	LSB = $360^0 / 2^{16}$

Predicted window size of the target position at next detection based on the tracking algorithm (Evolution Window):

bits-144/129	(EVOLRHOSTART)	Predicted Closest Range
bit-129	(LSB)	LSB = 1/128NM

bits-128/113	(EVOLRHOEND)	Predicted Largest Range
bit-113	(LSB)	LSB = 1/128NM

bits-112/97	(EVOLTHETASTART)	Predicted Smallest Azimuth
bit-97	(LSB)	LSB = $360^0 / 2^{16}$ (see Note)

bits-96/81	(EVOLTHETAEND)	Predicted Largest Azimuth
bit-81	(LSB)	LSB = $360^0 / 2^{16}$ (see Note)

Predicted window size of the target position at next detection based on the technical radar characteristics (Noise Window):

bits-80/65	(NOISERHOSTART)	Predicted Closest Range
bit-65	(LSB)	LSB = 1/128NM
bits-64/49	(NOISERHOEND)	Predicted Largest Range
bit-49	(LSB)	LSB = 1/128NM
bits-48/33	(NOISETHETASTART)	Predicted Smallest Azimuth
bit-33	(LSB)	LSB = $360^0 / 2^{16}$ (see Note)
bits-32/17	(NOISETHETAEND)	Predicted Largest Azimuth
bit-17	(LSB)	LSB = $360^0 / 2^{16}$ (see Note)

Predicted time of next detection relative to the Time of Day of the current track update: (see Note)

bits-16/1	(PREDTIME)	Predicted Detection Time
bit-1	(LSB)	LSB = 1/128 seconds

NOTE: When the area crosses North, THETASTART is larger than THETAEND.

NOTE: Next detection = Time of Day of current track record + PREDTIME.

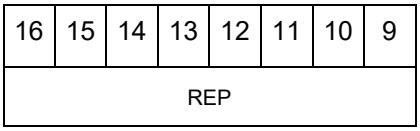
Structure of Subitem #5 of "Radar Track Characteristics": Data Link Characteristics

Definition: Active message list for the aircraft for the current scan.

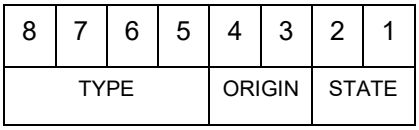
Format: Repetitive Data Item consisting of a one-octet repetition factor followed by at least one octet of the relevant information.

Structure:

Octet no. 1



Octet no. 2



bits-16/9 (REP) Repetition Factor

bits-8/5 (TYPE) Type of Message Protocol
= 0 Surveillance Mode A (alert bit or periodic)
= 1 Comm-A
= 2 Ground Initiated Comm-B
= 3 Air Initiated Comm-B
= 4 Broadcast Comm-B
= 5 Comm-C
= 6 Comm-D
= 7 – 15 Reserved for future use

bits-4/3 (ORIGIN) Frame Detection
= 0 From previous scan
= 1 New in current scan
= 2 Requested in the beam by transponder
= 3 Invalid ASTERIX value

bits-2/1 (STATE) Frame state at aircraft release
= 0 In progress
= 1 Completed
= 2 Cancelled
= 3 Invalid ASTERIX value

Structure of Subitem #6 of "Radar Track Characteristics": Lockout Characteristics

Definition: Lockout State and remaining Lockout Time

Format: Two-octet fixed length Data Item.

Structure:

	Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
LS	LOCTIM														LSB

bit-16	(LS)	Lockout State = 0 Target not locked out by this radar = 1 Target locked out by this radar
bits-15/1	(LOCTIM)	Lockout Time
bit-1	(LSB)	LSB = 1ms

Structure of Subitem #7 of "Radar Track Characteristics": Transition Codes

Definition: Indication and Counter of Transition Codes for Modes 1, 2, and 3

Format: Six-octet fixed length Data Item.

Structure:

Octet no. 1 Octet no. 2

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
0	0	0	0	0	0	0	TCOUNT1				TCODE1				
											A4	A2	A1	B2	B1

Octet no. 3 Octet no. 4

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
TCOUNT2				TCODE2											
				A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

Octet no. 5 Octet no. 6

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TCOUNT3				TCODE3											
				A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

bits-48/42	(SPARE)	Spare bits, set to 0
bits-41/38	(TCOUNT1)	Number of scans with transient Mode 1 Code
bits-37/33	(TCODE1)	Transient Mode 1 Code
bits-32/29	(TCOUNT2)	Number of scans with transient Mode 2 Code
bits-28/17	(TCODE2)	Transient Mode 2 Code
bits-16/13	(TCOUNT3)	Number of scans with transient Mode 3 Code
bits-12/1	(TCODE3)	Transient Mode 3 Code

Encoding Rule :

It **shall** only be sent if at least one TCOUNTX Element is greater than 0.

NOTE: This item indicates a difference in the value for TCODEX between the code in the track file and the code from the latest plot updating the track.

NOTE: If TCOUNTX is set to 0 then TCODEX is meaningless and all bits **shall** be set to 0.

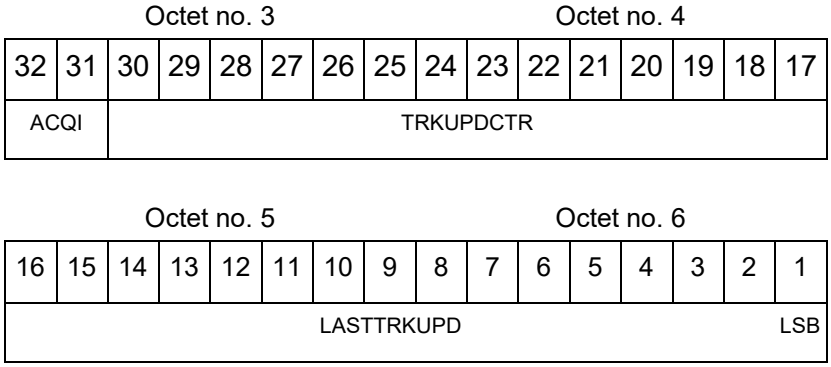
NOTE: The meaning of the individual bits in TCODEX is described in ICAO Annex 10 Volume 4 Chapter 3.1.1.6.2.

Structure of Subitem #8 of "Radar Track Characteristics": Track Lifecycle

Definition: Acquisition Status of the Track and Track Life Cycle Counters

Format: Four-octet fixed length Data Item.

Structure:



bits-32/31	(ACQI)	Acquisition Status Indicator = 0 Tentative Track with One Plot = 1 Tentative Track with at least Two Plots = 2 Pre-Confirmed Track = 3 Confirmed Track
bits-30/17	(TRKUPDCTR)	Track Update Counter
bits-16/1	(LASTTRKUPD)	Time since last Track Update
bit-1	(LSB)	LSB = 1ms

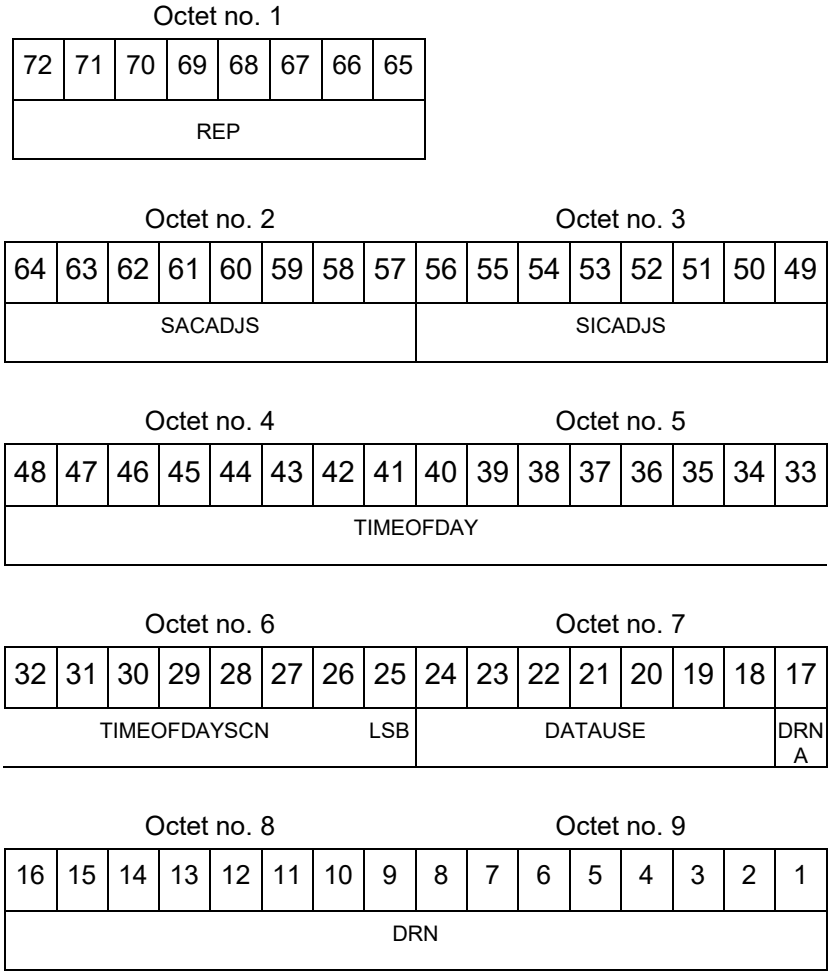
NOTE: When Subitem #8 is included, each element **shall** be properly populated.
NOTE: The setting of bits 32/31 is implementation dependent and **shall** be described in the ICD of the system generating the ASTERIX record.
NOTE: The TRKUPDCTR is initiated with a value of 1 and it is incremented by 1 each time a track is updated.
NOTE: The LASTTRKUPD is set to 0 each time a track is updated.

Structure of Subitem #9 of "Radar Track Characteristics": Adjacent Sensor Information

Definition: Adjacent Sensor information (received via SCN) for the respective Mode S address

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator followed by at least one Adjacent Sensor Record composed of eight octets.

Structure:



bits-72/65	(REP)	Repetition Factor
bits-64/57	(SACADJS)	SAC of the Adjacent Sensor
bits-56/49	(SICADJS)	SIC of the Adjacent Sensor
bits-48/25	(TIMEOFDAYSCN)	Absolute Timestamp in UTC provided by the SCN
bit-25	(LSB)	LSB = 1/128s

bits-24/18	(DATAUSE)	Use of Adjacent Sensor Data = 0 Data used by Tracker = 1 Data not used by Tracker = 2 – 127 Reserved for future use
bit-17	(DRNA)	DRN Availability = 0 DRN not available = 1 DRN available
bits-16/1	(DRN)	Duplicate Address Reference Number uniquely identifying the aircraft in case of a duplicate Mode S Address.

NOTE: When DRNA = 0, DRN **shall** be 0.

Structure of Subitem #10 of "Radar Track Characteristics": Track Extrapolation Source

Definition: Source for the extrapolation of the track information

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
TES							

bits-8/1	(TES)	Track Extrapolation Source = 0 Radar tracker calculation = 1 integrated ADS-B = 2 external ADS-B = 3 SCN = 4 – 255 reserved for future use

Structure of Subitem #11 of "Radar Track Characteristics": Identity Requested

Definition: information whether during latest scan the Mode 3/A Code was requested

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
IR	M3A						LSB

bit-8	(IR)	Identity Requested during latest scan = 0 Identity not requested = 1 Identity requested
bits-7/1	(M3A)	Age of Mode 3/A Code (I048/070)
bit-1	(LSB)	1s

2.9 Common and Plot Characteristics

Definition: Plot Characteristics and Common Characteristics for Plots and Tracks

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

Structure of Primary Subitem of Compound Data Item*:*

Octet no. 1

8	7	6	5	4	3	2	1
PNB	RPL	SNB	DATE	0	0	0	FX

bit-8 (PNB) Subitem #1: Plot Number
=0 Absence of Subitem #1
=1 Presence of Subitem #1

bit-7 (RPL) Subitem #2: Replies/Plot Link
=0 Absence of Subitem #2
=1 Presence of Subitem #2

bit-6 (SNB) Subitem #3: Scan Number
=0 Absence of Subitem #3
=1 Presence of Subitem #3

bit-5 (DATE) Subitem #4: Date
=0 Absence of Subitem #4
=1 Presence of Subitem #4

bits-4/2 (SPARE) Spare Bits, set to 0

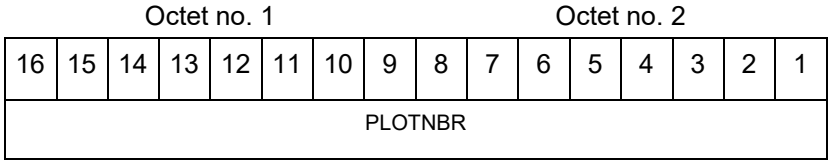
bit-1 (FX) = 0 End of Primary Subitem
= 1 Extension of Primary

Structure of Subitem #1 of "Common and Plot Characteristics": Plot Number

Definition: Unique reference to a Plot Record

Format: Two-octet fixed length Data Item.

Structure:



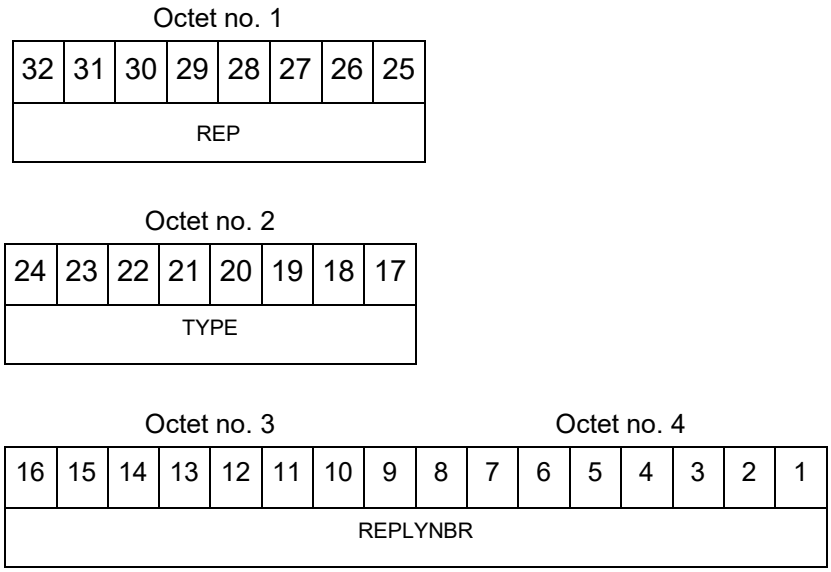
bits-16/1 (PLOTNBR) Unique Identification of a Plot Record

Structure of Subitem #2 of "Common and Plot Characteristics": Replies / Plot Link

Definition: Link between a Plot and its Replies

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator followed by at least one Plot/Link Record composed of three octets.

Structure:



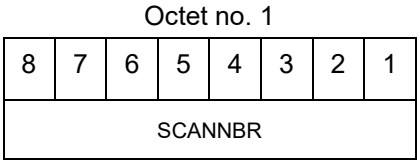
bits-32/25	(REP)	Repetition Factor
bits-24/17	(TYPE)	Reply Type = 0 PSR Echo = 1 SSR Reply = 2 All Call Reply = 3 Roll Call Reply
bits-16/1	(REPLYNBR)	Unique reference to a plot record

Structure of Subitem #3 of "Common and Plot Characteristics": Scan Number

Definition: Scan Number

Format: One-octet fixed length Data Item.

Structure:



bits-8-1 (SCANNBR) Scan Number

NOTE: The Scan Number ranges from 1 to 127 and is incremented when the radar passes North. Once SCANNBR reached 127 it will restarted at 1 with the next scan.

Structure of Subitem #4 of "Common and Plot Characteristics": Date

Definition: Current Date in the form YYYYMMDD

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
Y1				Y2				Y3				Y4			

Octet no. 3 Octet no. 4

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
M1				M2				D1				D2			

bits-32/29	(Y1)	First digit of year
bits-28/25	(Y2)	Second digit of year
bits-24/21	(Y3)	Third digit of year
bits-20/17	(Y4)	Fourth digit of year
bits-16/13	(M1)	First digit of month
bits-12/9	(M2)	Second digit of month
bits-8/5	(D1)	First digit of day
bits-4/1	(D2)	Second digit of day

NOTE: The day is incremented at midnight UTC.

Encoding Rule for the REF:

The Reserved Expansion Field is optional.

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