EUROCONTROL Specification for Surveillance Data Exchange

ASTERIX Category 240

Radar Video Transmission

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Abstract

This document specifies the contents of ASTERIX Category 240 messages used or the transmission of Radar Video information.

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Data Exchange	Messages	SAC	SIC
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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
0.1	March 2009	Creation of document	All
0.2	April 2009	New edition following comments from Thales	All
0.3	April 2009	Item I240/049 => I240/048 New Item I240/049 Modification in Item I240/050	5.2.7 5.2.8 5.2.9
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1. INTRODUCTION

1.1 Scope

This document describes the application of ASTERIX to the transmission of rotating radar video to local or remote maintenance displays or one or more Surveillance Data Processing (SDP) Systems.

Radar video is made of a stream of cells grouped by radials (i.e. cells of the same azimuth) sorted by increasing range. Radials are transmitted by increasing azimuth.

2. REFERENCES

2.1 General

The following Documents and Standards contain provisions which, through references in this text, constitute provisions of this Eurocontrol Document.

At the time of publication of this Eurocontrol Document, the editions indicated for the referenced documents and standards were valid.

Any revision of the referenced ICAO Documents shall be immediately taken into account to revise this Eurocontrol Document.

Revisions of the other referenced documents shall not form part of the provisions of this Eurocontrol Document until they are formally reviewed and incorporated into this Eurocontrol Document.

In case of a conflict between the requirements of this Eurocontrol Document and the contents of the other referenced documents, this Eurocontrol Document shall take precedence.

2.2 Reference Documents

1. Eurocontrol Standard 000-1-92. Directives for the Uniform Drafting and Presentation of Eurocontrol Standard Documents. 1992.
2. Eurocontrol Standard SUR.ET1.ST05.2000-STD-01-01. All Purpose Structured Eurocontrol Surveillance Information Exchange - ASTERIX. Edition 1.30, Released Issue, November 2007.
3. ICAO Annex 5

3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

For the purposes of this Eurocontrol Document, the following definitions shall apply:

3.1.1	**Cell:**	The elementary information of radar video amplitude; each cell is defined by its range, azimuth and amplitude.
3.1.2	**Cell range:**	A slant range polar co-ordinate based on the propagation time of radar signal from the radar site location to the cell. (Radar site location serves as the origin of the polar co-ordinate system).
3.1.3	**Cell azimuth:**	An azimuth polar co-ordinate based on the azimuth of the burst, or the radar recurrence. The reference for the azimuth shall be local geographical north.
3.1.4	**Cell amplitude:**	Based on digital level or digitized analogous signal.
3.1.5	**Cell spatial extensions:**	The cell size, which depends on the radar and on the required resolution of the video.
3.1.6	**Cell range extension:**	The smallest distance between two consecutive cells located at the same azimuth.
3.1.7	**Cell azimuth extension:**	The smallest azimuth extension between two consecutive cells located at the same range.
3.1.8	**Catalogue of Data Items:**	List of all possible Data Items of each Data Category describing the Data Items by their reference, structure, size and units (where applicable).
3.1.9	**Data Block:**	Unit of information seen by the application as a discrete entity by its contents. A Data Block contains one or more Record(s) containing data of the same category.
3.1.10	**Data Category:**	Classification of the data in order to allow for, inter alia, an easy identification.
3.1.11	**Data Field:**	Physical implementation for the purpose of communication of a Data Item. It is associated with a unique Field Reference Number and is the smallest unit of transmitted information.
3.1.12	**Data Item:**	The smallest unit of information in each Data Category.
3.1.13	**Measured Item:**	A piece of information (e.g. the position of a target) derived from the sensor information and transmitted without any smoothing.
3.1.14	**Record:**	A collection of transmitted Data Fields of the same category preceded by a Field Specification field, signalling the presence/absence of the various Data Fields
3.1.15	**User Application Profile:**	The mechanism for assigning Data Items to Data Fields, and containing all necessary information which needs to be standardised for the successful encoding and decoding of the messages.

3.2 Acronyms and Abbreviations

For the purposes of this Eurocontrol Document the following shall apply:

°	Degree (angle)
ASTERIX	**A**ll Purpose **ST**ructured **E**urocontrol su**R**veillance **I**nformation E**X**change
CAT	Data Category
EATM	European Air Traffic Management
FRN	Field Reference Number
FSPEC	Field Specification
FX	Field Extension Indicator
ICAO	International Civil Aviation Organization
LEN	Length Indicator
LSB	Least Significant Bit
NM	Nautical Mile, unit of distance (1852 metres)
PSR	Primary Surveillance Radar
RDE-FG	Radar Data Exchange Focus Group
RE	Reserved Expansion Indicator
REP	Field Repetition Indicator
s	second, unit of time
SAC	System Area Code
SIC	System Identification Code
SP	Special Purpose Field
SURT	Surveillance Team (EATM)
UAP	User Application Profile (see Definitions)
UTC	Coordinated Universal Time

4. GENERAL PRINCIPLES

4.1 General

The transmission of radar video information shall require the transmission of two types of messages:

- video summary (to deliver stream meta data: a label)
- video cells (to deliver the stream cells)

4.2 Time Management

4.2.1 Definition

The time stamp shall be consistent with the time of report transmission.

4.2.2 Requirements for Time Stamping

The time stamping shall comply with the following requirements:

- every radial shall have its own individual timestamp;
- co-ordinated Universal Time (UTC) as specified in ICAO Annex 5 shall be used to time stamp radar data.

4.3 Unused Bits in Data Items.

Decoders of ASTERIX data shall never assume and rely on specific settings of spare or unused bits. However in order to improve the readability of binary dumps of ASTERIX records, it is recommended to set all spare bits to zero.

4.4 Definitions and Addressing Concepts

In order to address sources in an unambiguous way, a simple abstract model for concepts like sensors or systems has been designed.

4.4.1 System

In the framework of category 240 a System is any device delivering or receiving ASTERIX data.

4.4.2 Addressing Concepts: Assigning SAC/SIC Codes

By convention a dedicated and unambiguous SAC/SIC code shall be assigned to every System.

4.5 User Application Profile and Data Blocks

4.8.1 A single User Application Profile (UAP) is defined.

4.8.2 A Video Data Block shall contain one or more radar video messages (i.e. one or more records) in line with the following layout.

CAT = 240	LEN	FSPEC	Items of the video record

where:

- CAT = 240 is a one-octet field indicating that the Data Block contains a video message;
- Length Indicator (LEN) is a two-octet field indicating the total length in octets of the Data Block, including the CAT and LEN fields;
- FSPEC is the Field Specification (one or two-octet field).

4.6 Composition of Messages

4.6.1 Messages shall be composed of Data Items assembled in the order defined by the Field Reference Number (FRN) in the associated UAP.

4.6.2 When sent, items shall always be transmitted in a record with the corresponding FSPEC bits set to one.

5. LAYOUT OF MESSAGES

5.1 Standard Data Items

The standardised Data Items, which shall be used for the transmission of Radar Video Messages are defined in Table 1 and described on the following pages.

Table 1 - Standard Data Items of Category 240

Data Item Ref. No.	Description	Resolution
I240/000	Message Type	N.A.
I240/010	Data Source Identifier	N.A.
I240/020	Video Record Header	N.A.
I240/030	Video Summary	N.A.
I240/040	Video Header Nano	N.A.
I240/041	Video Header Femto	N.A.
I240/048	Video Cells Resolution & Data Compression Indicator	N.A.
I240/049	Video Octets & Video Cells Counters	N.A.
I240/050	Video Block Low Data Volume	N.A.
I240/051	Video Block Medium Data Volume	N.A.
I240/052	Video Block High Data Volume	N.A.
I240/140	Time of Day	1/128 s

5.2 Description of Standard Data Items

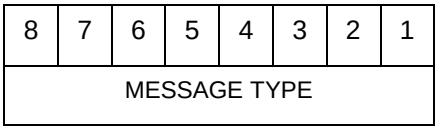
5.2.1 Data Item I240/000, Message Type

Definition : This Data Item allows for a more convenient handling of the messages at the receiver side by further defining the type of transaction.

Format : One-octet fixed length Data Item.

Structure:

Octet no. 1



bits-8/1 Message Type

Encoding Rule : This data item shall be present in every ASTERIX message.

NOTES

1. In applications where transactions of various types are exchanged, the Message Type Data Item facilitates the proper report handling at the receiver side.
2. All Message Type values are reserved for common standard use.
3. The following set of Message Types are standardised for Category 240 messages:
   - 001 Video Summary message
   - 002 Video message
4. The list of items present for the two message types is defined in the following table.

   M stands for mandatory, O for optional, X for never present.

Table 2 - Message Types

Type Item	001 Video Summary Message	002 Video Message
I240/000 Message Type	M	M
I240/010 Data Source Identifier	M	M
I240/020 Video Record Header	X	M
I240/030 Video Summary	M	X
I240/040 Video Header Nano	X	O [1]
I240/041 Video Header Femto	X	O [1]
I240/048 Video Cells Resolution & Data Compression Indicator	X	M
I240/049 Video Octets & Video Cells Counters	X	M
I240/050 Video Block Low Data Volume	X	O [2]
I240/051 Video Block Medium Data Volume	X	O [2]
I240/052 Video Block High Data Volume	X	O [2]
I240/140 Time of Day	O	O

- [1] Either Item I240/040 or I240/041 shall be present in each Video Message
- [2] Either Item I240/050 or I240/051 or I240/052 shall be present in each video message

5.2.2 Data Item I240/010, Data Source Identifier

Definition: Identification of the system from which the data are received.

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
SAC								SIC							

bits-16/9 (SAC) System Area Code

bits-8/1 (SIC) System Identification Code

Encoding Rule : This item shall be present in each ASTERIX message

NOTE: The up-to-date list of SACs is published on the EUROCONTROL Web Site (http://www.eurocontrol.int/asterix)

5.2.3 Data Item I240/020, Video Record Header

Definition : Contains a message sequence identifier.

Format : Four-Octets 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
MSG_INDEX															

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

Bits 32/1 (MSG_INDEX) Message Sequence Identifier (video record cyclic counter)

Encoding Rule : This item shall be present in each Video Message

NOTE: The Message Sequence Identifier is used by the receiving application to detect lost messages.

MSG_INDEX have a length of 32 bits to ease real time encoding.

5.2.4 Data Item I240/030, Video Summary

Definition : Contains an ASCII string (free text to define stream meta data).

Format : Repetitive Data Item, starting with a one-octet Field Repetition Indicator (REP) followed by at least one sub-field of one octet (ASCII character).

Structure:

Octet no. 1

16	15	14	13	12	11	10	9
REP							

Octet no. 2

8	7	6	5	4	3	2	1
CHAR							

bit-16/9 (REP) Number of characters following

bit-8/1 (CHAR) Character in ASCII representation

Encoding Rule : This item shall be present in each Video Summary Message

5.2.5 Data Item I240/040, Video Header Nano

Definition : Defines a group of video cells corresponding to a video radial: all cells have the same size in azimuth and range and are consecutive in range.

Format : Twelve-Octets fixed length data item.

Structure:

Octet no. 1 — Octet no. 2

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

Octet no. 3 — Octet no. 4

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

Octet no. 5 — Octet no. 6

64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
START_RG															

Octet no. 7 — Octet no. 8

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
START_RG															LSB

Octet no. 9 — Octet no. 10

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
CELL_DUR															

Octet no. 11 — Octet no. 12

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

Bits 96/81 (START_AZ) Start azimuth of the cells group

LSB = $360/2^{16}$, Range: [0;360]

Bits 80/65 (END_AZ) End azimuth of the cells group

LSB = $360/2^{16}$, Range: [0;360]

Bits 64/33 (START_RG) Starting range of the cells group, expressed in number of cells. 0 is the radar location without any bias.

Bits 32/1 (CELL_DUR) Video cell duration in nano-seconds.

LSB = 10^{-9} s

Encoding Rule : Either item I240/040 or I240/041 shall be present in each Video Message

5.2.6 Data Item I240/041, Video Header Femto

Definition : Defines a group of video cells corresponding to a video radial: all cells have the same size in azimuth and range and are consecutive in range.

Format : Twelve-Octets fixed length data item.

Structure:

Octet no. 1 — Octet no. 2

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

Octet no. 3 — Octet no. 4

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

Octet no. 5 — Octet no. 6

64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
START_RG															

Octet no. 7 — Octet no. 8

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
START_RG															LSB

Octet no. 9 — Octet no. 10

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
CELL_DUR															

Octet no. 11 — Octet no. 12

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

Bits 96/81 (START_AZ) Start azimuth of the cells group

LSB = $360/2^{16}$, Range: [0;360]

Bits 80/65 (END_AZ) End azimuth of the cells group

LSB = $360/2^{16}$, Range: [0;360]

Bits 64/33 (START_RG) Starting range of the cells group, expressed in number of cells. 0 is the radar location without any bias.

Bits 32/1 (CELL_DUR) Video cell duration in femto-seconds.

LSB = 10^{-15} s

Encoding Rule : Either item I240/040 or I240/041 shall be present in each Video Message

5.2.7 Data Item I240/048, Video Cells Resolution & Data Compression Indicator

Definition : This Data Item defines the bit resolution used in the coding of the video signal amplitude in all cells of the video group as well as an indicator whether data compression has been applied.

Format : Two-octet fixed length Data Item.

Structure:

	Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
(C)	Spare							(RES)							

Bit 16	(C)	Data Compression Indicator: 0 = No compression applied 1 = Compression applied
Bits 15/9	Spare	Spare Bits set to 0
Bits 8/1	(RES)	Bit resolution used for the coding of the amplitude of the video signal in every cell of a video group.

RES	Resolution	Coding Length in bits
1	Monobit Resolution	1
2	Low Resolution	2
3	Medium Resolution	4
4	High Resolution	8
5	Very High Resolution	16
6	Ultra High Resolution	32

NOTE: When the Data Compression Indicator (C) is set, shows that a data compression technique has been applied. The actual algorithm used and the related parameters have to be specified in a relevant ICD (Interface Control Document).

Encoding Rule : This data item shall be present in every Video Message.

5.2.8 Data Item I240/049, Video Octets & Video Cells Counters

Definition : This Data Item contains the number of “valid” octets (i.e. non-empty octets) used in the coding of the video signal amplitude and the number of “valid” cells in the video group.

Format : Five-octets fixed length Data Item.

Octet no. 1 Octet no. 2

40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25
(NB_VB)															

Octet no. 3 Octet no. 4

24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09
(NB_CELLS)															

Octet no. 5

08	07	06	05	04	03	02	01
(NB_CELLS)							

Bits 40/25	(NB_VB)	Number of “valid” octets in the Video Block Data Volume Item; i.e. one of I240/050 or I240/051 or I240/052 whichever is present
Bits 24/01	(NB_CELLS)	Number of “valid” cells in the Video Block Data Volume Item; i.e. one of I240/050 or I240/051 or I240/052 whichever is present

Encoding Rule : This item shall be present in each Video Message.

5.2.9 Data Item I240/050, Video Block Low Data Volume

Definition : Contains a group of video cells corresponding to a video radial; all cells have the same size in azimuth and range and are consecutive in range. This item shall be used in cases where a low data volume, up to 1020 bytes, will be transmitted.

Format : Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one video block of four-octets.

Structure:

Octet no. 1

40	39	38	37	36	35	34	33
REP							

Octet no. 2 Octet no. 3

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
VIDEO BLOCK															

Octet no. 4 Octet no. 5

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

Bits 40/33	(REP)	Repetition factor, indicating the number of video blocks following
Bits 32/1	(VIDEO BLOCK)	Video signal amplitude of the cells in the group, coded according to the resolution defined in Item I240/048

Encoding Rule : One of the Items I240/050, I240/051 or I240/052 shall be present in each Video Message.

NOTES:

1. The first cell in the block is always the closest to the sensor and the following cells are in increasing range order.
2. To get the range in meters of the cell at position “NU_CELL” in the data stream, the following formula shall be used:

$$D = CELL\_DUR_{(in\ seconds)} * (START\_RG + NU\_CELL - 1) * c/(2.)$$

where c = 299 792 458 m/s: light celerity.

5.2.10 Data Item I240/051, Video Block Medium Data Volume

Definition : Contains a group of video cells corresponding to a video radial; all cells have the same size in azimuth and range and are consecutive in range. This item shall be used in cases where a medium data volume, up to 16320 bytes, will be transmitted.

Format : Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one video block of sixty four-octets.

Structure:

Octet no. 1

520	519	518	517	516	515	514	513
REP							

Octet no. 2 Octet no. 3

512	511	510	509	508	507	506	505	504	503	502	501	500	499	498	497
VIDEO BLOCK															

Octet no. 64 Octet no. 65

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

Bits 520/513	(REP)	Repetition factor, indicating the number of video blocks following
Bits 512/1	(VIDEO BLOCK)	Video signal amplitude of the cells in the group, coded according to the resolution defined in Item I240/048

Encoding Rule : One of the Items I240/050, I240/051 or I240/052 shall be present in each Video Message.

NOTES:

1. The first cell in the block is always the closest to the sensor and the following cells are in increasing range order.
2. To get the range in meters of the cell at position “NU_CELL” in the data stream, the following formula shall be used:

$$D = CELL\_DUR_{(in\ seconds)} * (START\_RG + NU\_CELL - 1) * c/(2.)$$

where c = 299 792 458 m/s: light celerity.

5.2.11 Data Item I240/052, Video Block High Data Volume

Definition : Contains a group of video cells corresponding to a video radial; all cells have the same size in azimuth and range and are consecutive in range. This item shall be used in cases where a high data volume, up to 65024 bytes, will be transmitted.

Format : Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one video block of two hundred fifty six-octets.

Structure:

Octet no. 1

8200	8199	8198	8197	8196	8195	8194	8193
REP							

Octet no. 2 Octet no. 3

2048	2047	2046	2045	2044	2043	2042	2041	2040	2039	2038	2037	2036	2035	2034	2033
VIDEO BLOCK															

Octet no. 256 Octet no. 257

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

Bits 8200/8193	(REP)	Repetition factor, indicating the number of video blocks following (Max. value 254)
Bits 8192/1	(VIDEO BLOCK)	Video signal amplitude of the cells in the group, coded according to the resolution defined in Item I240/048

Encoding Rule : One of the Items I240/050, I240/051 or I240/052 shall be present in each Video Message.

NOTES:

1. The first cell in the block is always the closest to the sensor and the following cells are in increasing range order.
2. The maximum value of REP that should be used is 254, in order to keep the maximum size of the field at 64kbytes.
3. To get the range in meters of the cell at position “NU_CELL” in the data stream, the following formula shall be used:

$$D = CELL\_DUR_{(in\ seconds)} * (START\_RG + NU\_CELL - 1) * c/(2.)$$

where c = 299 792 458 m/s: light celerity.

5.2.12 Data Item I240/140, Time of Day

Definition: Absolute time stamping expressed as UTC.

Format: Three-octet fixed length Data Item.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
Time							

Octet no. 2 Octet no. 3

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

bit-1 (LSB) 1/128 s

Encoding Rule : This data item is optional.

NOTE - The time of day value is reset to zero each day at midnight.

NOTE: The time information, shall reflect the exact time of an event, expressed as a number of 1/128 s elapsed since last midnight.

5.3 Standard User Application Profile

5.3.1 The following UAP shown in Table 3 shall be used for the transmission of reports:

Table 3 - Standard UAP

FRN	Data Item	Information	Length in Octets
1	I240/010	Data Source Identifier	2
2	I240/000	Message Type	1
3	I240/020	Video Record Header	4
4	I240/030	Video Summary	1+n
5	I240/040	Video Header Nano	12
6	I240/041	Video Header Femto	12
7	I240/048	Video Cells Resolution & Data Compression Indicator	2
FX	-	Field Extension Indicator	n.a.
8	I240/049	Video Octets & Video Cells Counters	5
9	I240/050	Video Block Low Data Volume	1+4*n
10	I240/051	Video Block Medium Data Volume	1+64*n
11	I240/052	Video Block High Data Volume	1+256*n
12	I240/140	Time of Day	3
13	RE	Reserved Expansion Field	1+
14	SP	Special Purpose Field	1+
FX	-	Field Extension Indicator	n.a.

where:

- the first column indicates the FRN associated to each Data Item used in the UAP;
- the fourth column gives the format and the length of each item. A stand-alone figure indicates the octet count of a fixed-length Data Item, 1+ indicates a variable-length Data Item comprising a first part of one-octet followed by n-octet extents as necessary.

  The maximum length of the corresponding FSPEC is two octets.