EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL STANDARD DOCUMENT

FOR

SURVEILLANCE DATA EXCHANGE

Part 7 : Category 010

Transmission of Monosensor Surface Movement Data

SUR.ET1.ST05.2000-STD-07-01

Edition	**:**	**1.1**
Edition Date	**:**	**March 2007**
Status	**:**	**Released Issue**
Class	**:**	**General Public**

EUROPEAN AIR TRAFFIC MANAGEMENT

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title

Radar Data Exchange - Part 7

Transmission of Monosensor Surface Movement Data

EWP DELIVERABLE REFERENCE NUMBER

PROGRAMME REFERENCE INDEX	**EDITION :**	**1.1**
SUR.ET1.ST05.2000-STD-07-01	**EDITION DATE :**	**27 March 2007**

Abstract

This document describes the application of ASTERIX to the transmission of monosensor surface movement target reports and service messages.

Keywords

Monoradar Data	ASTERIX	Target Reports	Service Messages
Data Item	Category 10	UAP	

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DOCUMENT STATUS AND TYPE

STATUS		CATEGORY		CLASSIFICATION	
Working Draft	☐	Executive Task	☐	General Public	☑
Draft	☐	Specialist Task	☐	EATMP	☐
Proposed Issue	☐	Lower Layer Task	☑	Restricted	☐
Released Issue	☑				

ELECTRONIC BACKUP

INTERNAL REFERENCE NAME :   Asterix - Part 7

HOST SYSTEM	MEDIA	SOFTWARE(S)
Microsoft Windows	Type : Hard disk	
	Media Identification :	

DOCUMENT APPROVAL

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

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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 1998	Creation of document	ALL
0.20	April 1999	Modifications in scope and items	ALL
0.21	May 1999	Modifications in items and UAP	ALL
0.22	September 1999	Modifications in scope, items, UAP	ALL
0.23	February 2000	Modifications in scope, items and UAP	ALL
0.24	March 2000	Modifications in items and UAP	ALL
0.25	October 2000	Modifications in items and UAP	ALL
0.27	February 2001	Modifications in items	5.2
0.28	May 2001	Modifications in items	5.2
0.29	September 2001	Modifications in items	5.2
0.30	November 2001	Modifications in items	5.2
0.31	December 2001	Addition of Category Number in Title	Title
1.0	April 2005	Status changed to "Released Issue" Contact Details updated Document Approval Page updated "Cleanup" for Publication	Title,ID-Sheet ID-Sheet Page 3
1.1	27 March 2007	Signature Page updated Page numbering in section 1 corrected Editorial "Clean-Up"	

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1. INTRODUCTION

1.1 Scope

1.1.1 This document describes the message structure for the transmission of surface movement target reports and service messages, provided by equipment such as :

- surface movement radars,

- multilateration systems,

- ADS-B,

- magnetic loop systems.

1.1.2 Monosensor surface movement target reports and service messages are data out of Category 010.

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 the 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 1.28, Working Draft, December 2001.

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3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

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

3.1.1	**Catalogue of Data Items:**	List of all the possible Data Items of each Data Category describing the Data Items by their reference, structure, size and units (where applicable).
3.1.2	**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.
3.1.3	**Data Category:**	Classification of the data in order to permit inter alia an easy identification.
3.1.4	**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.
3.1.5	**Data Item:**	The smallest unit of information in each Data Category.
3.1.6	**Measured Item:**	A piece of information (e.g. the position of a target) derived from the sensor information and transmitted without any smoothing.
3.1.7	**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
3.1.8	**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 **Eurocontrol** su**R**veillance **I**nformation E**X**change
CAT	Data Category
EATMP	European Air Traffic Management Programme
FL	Flight Level, unit of altitude (expressed in 100's of feet)
FRN	Field Reference Number
FSPEC	Field Specification
FX	Field Extension Indicator
ICAO	International Civil Aviation Organization
kt	knot = NM/hour, unit of speed
LEN	Length Indicator
LSB	Least Significant Bit
NM	Nautical Mile, unit of distance (1852 metres)
PSR	Primary Surveillance Radar
RE	Reserved Expansion Indicator
REP	Field Repetition Indicator
s	second, unit of time
SAC	System Area Code
SIC	System Identification Code
SMR	Surface Movement Radar
SMS	Surface Movement System
SP	Special Purpose Indicator
SPI	Special Position Identification
SSR	Secondary Surveillance Radar
STFRDE	Surveillance Task Force on Radar Data Exchange
SURT	Surveillance Team (EATMP)
UAP	User Application Profile (see Definitions)
UTC	Co-ordinated Universal Time
WGS-84	World Geodetic System 84

4. GENERAL PRINCIPLES

4.1 General

The transmission of monosensor surface movement data shall require the transmission of two types of messages:

- target reports,

- service messages.

4.2 Time Management

4.2.1 Definition

The time stamp shall be consistent with the reported target position.

4.2.2 Requirements for Time Stamping

The timestamping shall comply with ICAO Annex 5.

4.3 Projection Systems and Geographical Co-ordinates

4.3.1 Polar Representation

The target position shall be provided as slant polar co-ordinates, with the sensor site location serving as the origin of the polar co-ordinate system. The reference for the azimuth shall be local geographical north.

4.3.2 Cartesian Representation

Two different types of co-ordinate reference systems are supported.

4.3.2.1 Co-ordinates Expressed in the Radar Plane

When no projection is performed, the 3D to 2D co-ordinate transformation process is defined by the following simple equations:

$X = RHO * SIN(THETA);$
$Y = RHO * COS(THETA);$
Whereby:
RHO = measured slant range
THETA = measured azimuth

The reference for the azimuth shall be local geographical north.

4.3.2.2   Co-ordinates Expressed in the Local 2D Co-ordinate Reference System:

The exported calculated position is expressed in a 2D Cartesian co-ordinate system, which is a plane tangential to the WGS-84 Ellipsoid at the location of the reference point. For a radar, the origin of the Cartesian co-ordinate system coincides with the radar head position. The Y-axis points to the geographical north at that position. The X-axis is perpendicular to the Y-axis and points to the east. The X, Y co-ordinates are calculated using either the measured height or an assumed target height and apply a suitable projection technique for the final 3D to 2D conversion (e.g. a stereographical projection).

The type of co-ordinate reference system in use is signalled by a flag within the Track Status Data Item I010/170.

All tracker derived information elements, shall be a consistent set of values, expressed in the same co-ordinate reference system (state vector components and the corresponding elements of the track quality vector).

4.4   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.

4.5   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.

4.5.1 Sensor

In the framework of Category 010 a Sensor is an equipment such as :

- a detection/measurement Primary radar, using a rotating or an e-scan antenna,

- a multilateration system,

- an ADS-B station,

- a magnetic loop system.

4.5.2 System

In the framework of category 010 a System is a Sensor.

4.5.3 Addressing Concepts: Assigning SAC/SIC Codes

By convention a dedicated and unambiguous SIC code shall be assigned to every System on an airport. For category 010, the SAC is fixed to zero to indicate a local data flow.

4.6   Target Reports

Target reports include :

- Reports from a surface movement radar, containing position in polar co-ordinates and/or Cartesian co-ordinates,

- Reports from a multilateration system, containing position in Cartesian co-ordinates and/or WGS-84 representation,

- ADS-B surface target reports, containing position in WGS-84 representation,

- Magnetic loop system target reports, containing position in Cartesian co-ordinates.

4.7   Service Messages

Three types of service messages have been identified:

- Start of Update Cycle (for a system using a cyclic update mechanism, these messages shall be used to signal the start of a new data renewal cycle),

- Periodic Status Messages (these messages should be used by systems to indicate their status periodically),

- Event-triggered Status Messages (these messages should be used by systems to indicate their status in case of events).

4.8 User Application Profile and Data Blocks

4.8.1 A single User Application Profile (UAP) is defined and shall be used for both target reports and service messages.

4.8.2 Data Blocks shall have the following layout.

CAT = 010	LEN		FSPEC	Items of the first record		FSPEC	Items of the last record

where:

- Data Category (CAT) = 010, is a one-octet field indicating that the Data Block contains monoradar surface movement data;

- 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.

4.9 Composition of Messages

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

4.9.2 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 monosensor surface movement data are defined in Table 1 and described in the following pages.

Table 1 - Standard Data Items of Category 010

Data Item Ref. No.	Description	Resolution
I010/000	Message Type	N.A.
I010/010	Data Source Identifier	N.A.
I010/020	Target Report Descriptor	N.A.
I010/040	Measured Position in Polar Co-ordinates	Rho: 1 m Theta : 0.0055°
I010/041	Position in WGS-84	$180°/2^{31}$
I010/042	Position in Cartesian Co-ordinates	1 m
I010/060	Mode-3/A Code in Octal Representation	N.A.
I010/090	Flight Level in Binary Representation	¼ FL
I010/091	Measured Height	6.25 ft
I010/131	Amplitude of Primary Plot	1 dBm
I010/140	Time of Day	1/128 s
I010/161	Track Number	N.A.
I010/170	Track Status	N.A.
I010/200	Calculated Track Velocity in Polar Co-ordinates	Speed : 2^{-14} NM/s Angle : $360°/2^{16}$
I010/202	Calculated Track Velocity in Cartesian Coord.	0.25 m/s
I010/210	Calculated Acceleration	$0.25 \ m/s^2$
I010/220	Target Address	N.A.
I010/245	Target Identification	N.A.
I010/250	Mode S MB Data	N.A.
I010/270	Target Size & Orientation	Size: 1 m Orient.: 360°/128
I010/280	Presence	D_Rho : 1 m D_Theta:0.15°
I010/300	Vehicle Fleet Identification	N.A.
I010/310	Pre-programmed Message	N.A.
I010/500	Standard Deviation of Position	$0.25 \ m^2$
I010/550	System Status	N.A.

5.2 **Description of Standard Data Items**

5.2.1 **Data Item I010/000, 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

8	7	6	5	4	3	2	1
MESSAGE TYPE							
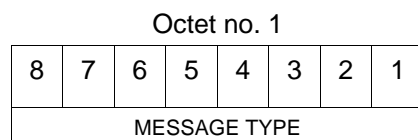
bits-8/1   Message Type

Encoding rule :

This data item shall be present in every ASTERIX record.

NOTES

1. In application where transactions of various types are exchanged, the Message Type Data Item facilitates the proper message 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 010 records:

- 001 Target Report

- 002 Start of Update Cycle

- 003 Periodic Status Message

- 004 Event-triggered Status Message

The list of items present for the four message types is defined in the following table. M stands for mandatory, O for optional, X for never present.

Table 2 – Items per Message Types

Item	Type	001 Target Report	002 Start of Update Cycle	003 Periodic Status Message	004 Event Status Message
I010/000	Message Type	M	M	M	M
I010/010	Data Source Identifier	M	M	M	M
I010/020	Target Report Descriptor	M	X	X	X
I010/040	Measured Position in Polar Coordinates	O	X	X	X
I010/041	Position in WGS-84 Coordinates	O	X	X	X
I010/042	Position in Cartesian Coordinates	O	X	X	X
I010/060	Mode-3/A Code	O	X	X	X
I010/090	Flight Level in Binary Representation	O	X	X	X
I010/091	Measured Height	O	X	X	X
I010/131	Amplitude of Primary Plot	O	X	X	X
I010/140	Time of Day	M	M	M	M
I010/161	Track Number	O	X	X	X
I010/170	Track Status	O	X	X	X
I010/200	Calculated Track Velocity in Polar Coordinates	O	X	X	X
I010/202	Calculated Track Velocity in Cartesian Coordinates	O	X	X	X
I010/210	Calculated Acceleration	O	X	X	X
I010/220	Target Address	O	X	X	X
I010/245	Target Identification	O	X	X	X
I010/250	Mode S MB Data	O	X	X	X
I010/270	Target Size & Orientation	O	X	X	X
I010/280	Presence	O	X	X	X
I010/300	Vehicle Fleet Identification	O	X	X	X
I010/310	Pre-programmed Message	O	X	X	X
I010/500	Standard Deviation of Position	O	X	X	X
I010/550	System Status	X	O	M	M

5.2.2 Data Item I010/010, 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 = 00								SIC							

bits-16/9   (SAC)   System Area Code fixed to zero

bits-8/1   (SIC)   System Identification Code

NOTE: The SAC is fixed to zero to indicate a data flow local to the airport.

5.2.3　　　**Data Item I010/020, Target Report Descriptor**

Definition:　　Type and characteristics of the data as transmitted by a system.

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

Structure
of First Part:

Octet no. 1

8	7	6	5	4	3	2	1
	TYP		DCR	CHN	GBS	CRT	FX

bits-8/6	(TYP)	= 000	SSR multilateration
		= 001	Mode S multilateration
		= 010	ADS-B
		= 011	PSR
		= 100	Magnetic Loop System
		= 101	HF multilateration
		= 110	Not defined
		= 111	Other types

bit-5	(DCR)	= 0	No differential correction (ADS-B)
		= 1	Differential correction (ADS-B)

bit-4	(CHN)	= 0	Chain 1
		= 1	Chain 2

bit-3	(GBS)	= 0	Transponder Ground bit not set
		= 1	Transponder Ground bit set

bit-2	(CRT)	= 0	No Corrupted reply in multilateration
		= 1	Corrupted replies in multilateration

bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into first extent

**Structure
of First Extent:**

Octet no. 1

8	7	6	5	4	3	2	1
SIM	TST	RAB	LOP		TOT		FX

bit-8   (SIM)   = 0   Actual target report
                                     = 1   Simulated target report

bit-7   (TST)   = 0   Default
                                     = 1   Test Target

bit-6   (RAB)   = 0   Report from target
                                                transponder
                                     = 1   Report from field
                                                monitor (fixed
                                                transponder)

bits-5/4   (LOP)   = 00   Undetermined
                                     = 01   Loop start
                                     = 10   Loop finish

bits-3/2   (TOT)   = 00   Undetermined
                                     = 01   Aircraft
                                     = 10   Ground vehicle
                                     = 11   Helicopter

bit-1   (FX)   = 0   End of Data Item
                                     = 1   Extension into next
                                                extent

**Structure
of Second Extent:**

Octet no. 1

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

bit-8   (SPI) =   0   Absence of SPI
                     =   1   Special Position Identification

bits-7/2   Spare bits set to zero

bit-1   (FX) =   0   End of Data Item
                     =   1   Extension into next extent

5.2.4   Data Item I010/040, Measured Position in Polar Co-ordinates

       Definition: Measured position of a target in local polar co-ordinates.

       Format: Four-octet fixed length Data Item.

       Structure:

Octet no. 1   Octet no. 2   LSB

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

Octet no. 3   Octet no. 4   LSB

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
								Theta							
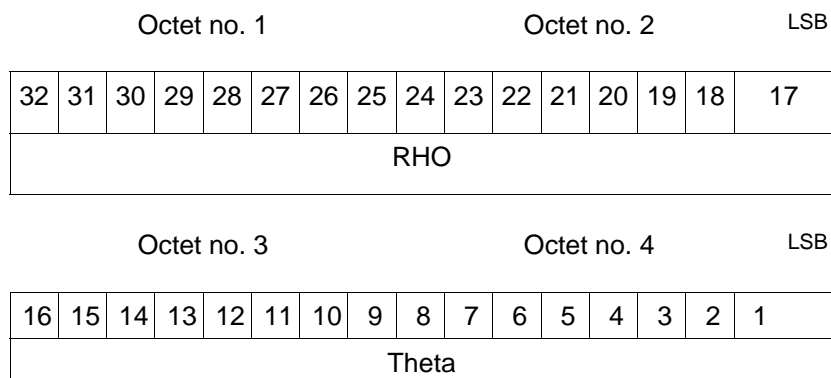
bit-17 (LSB) = 1m, max.range = 65536m, approx. 35.4NM

bit-1   (LSB) = $360°/(2^{16})$, approx. 0.0055°

5.2.5   Data Item I010/041, Position in WGS-84 Co-ordinates

Definition :   Position of a target in WGS-84 Co-ordinates.
Format :   Eight-octet fixed length Data Item
Structure:

Octet no. 1								Octet no. 2							
64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
Latitude in WGS - 84															

Octet no. 3								Octet no. 4							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
															LSB

Octet no. 5								Octet no. 6							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Longitude in WGS - 84															

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

bits-64/33   (Latitude)   In WGS.84 in two's complement.
Range -90 <= latitude <= 90 deg.

(LSB) $= 180/2^{31}$ degrees

bits-32/1   (Longitude)   In WGS.84 in two's complement.
Range -180 <= longitude < 180 deg.

(LSB) $= 180/2^{31}$ degrees

5.2.6   Data Item I010/042, Position in Cartesian Co-ordinates

Definition: Position of a target in Cartesian co-ordinates, in two's complement form.

Format: Four-octet fixed length Data Item .

Structure:

Octet no. 1   Octet no. 2   LSB

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

Octet no. 3   Octet no. 4   LSB

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Y-Component														
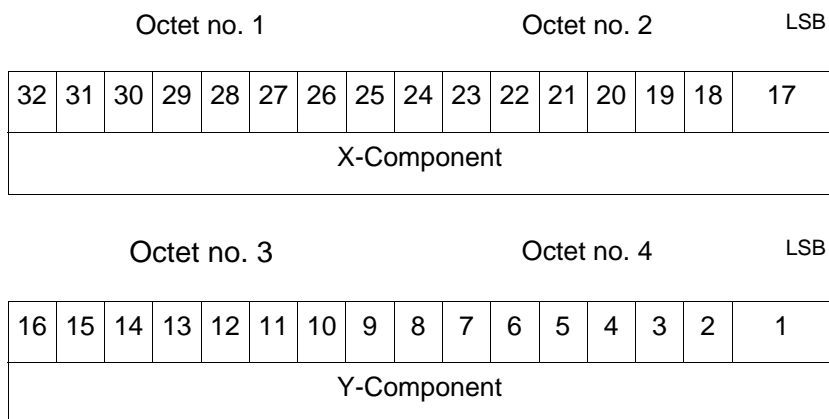
bit-17 (LSB) = 1m, max.range = ±32768m, approx.±17.7NM

bit-1   (LSB) = 1m, max.range = ±32768m, approx.±17.7NM

5.2.7   **Data Item I010/060, Mode-3/A Code in Octal Representation**

Definition: Mode-3/A code converted into octal representation.

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
V	G	L	0	A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

bit-16   (V)   = 0   Code validated
                   = 1   Code not validated

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 bit set to 0

bits-12/1   Mode-3/A reply in octal
                   representation

NOTES

1. Bit 15 has no meaning in the case of a smoothed Mode-3/A code and is set to 0 for a calculated track. For Mode S, it is set to one when an error correction has been attempted.

2. For Mode S, bit 16 is normally set to zero, but can exceptionally be set to one to indicate a non-validated Mode-3/A code (e.g. alert condition detected, but new Mode-3/A code not successfully extracted).

5.2.8 **Data Item I010/090, Flight Level in Binary Representation**

Definition: Flight Level (Mode C / Mode S Altitude) converted into binary two's complement representation.

Format: Two-octet fixed length Data Item.

Structure:

	Octet no. 1									Octet no. 2					LSB
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
V	G	Flight Level													

bit-16 (V) = 0 Code validated
= 1 Code not validated

bit-15 (G) = 0 Default
= 1 Garbled code

bits-14/1 (Flight Level) LSB= 1/4 FL

NOTES

1. The value shall be within the range described by ICAO Annex 10

2. For Mode S, bit 15 (G) is set to one when an error correction has been attempted.

5.2.9 **Data Item I010/091, Measured Height**

Definition: Height above local 2D co-ordinate reference system (two's complement) based on direct measurements not related to barometric pressure.

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
Measured Height															LSB

bits-16/1 Height
LSB= 6.25 ft
Range= +/- 204 800 ft

5.2.10 Data Item I010/131, Amplitude of Primary Plot

Definition: Amplitude of Primary Plot.
Format: One-Octet fixed length Data Item.
Structure:

Octet no. 1

8	7	6	5	4	3	2	1
				PAM			

bits-8/1   (PAM)   Range 0..255
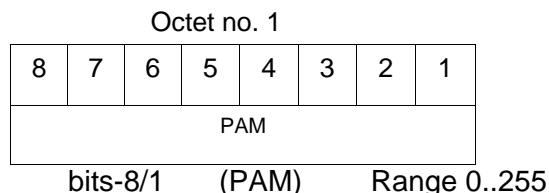
NOTE: The value is radar-dependent, 0 being the minimum detectable level for that radar.

5.2.11 Data Item I010/140, 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   LSB

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

bit-1   (LSB)   = (2^{-7})s = 1/128 s
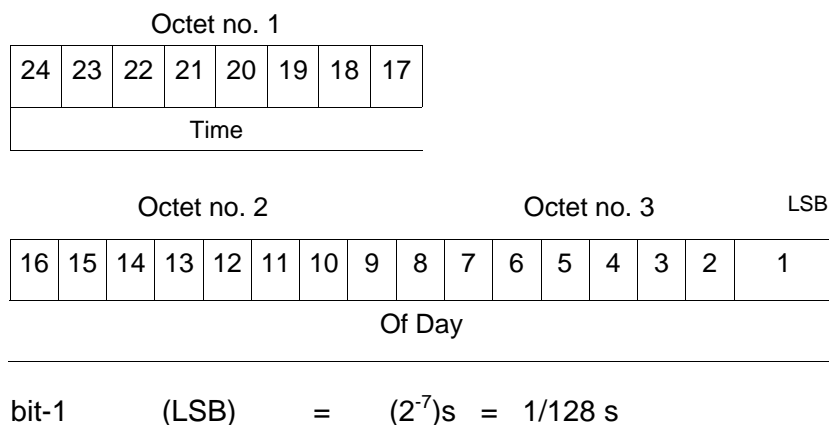
NOTE -   The time of day value is reset to zero each day at midnight.

5.2.12   Data Item I010/161, Track Number

Definition: An integer value representing a unique reference to a track record within a particular track file.

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
0	0	0	0				TRACK NUMBER(0…4095)								

bits-16/13   Spare bits set to zero.
bits-12/1   Track number.
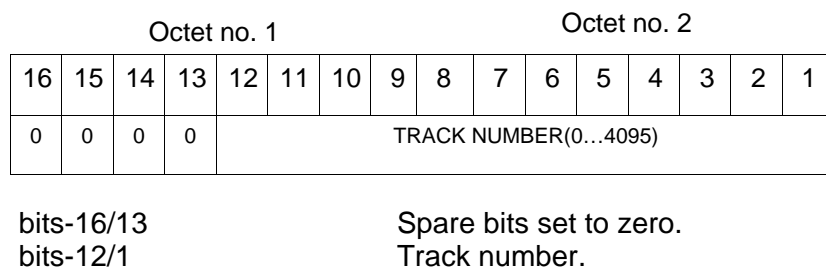
5.2.13 Data Item I010/170, Track Status

Definition: Status of track.

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

**Structure
of First Part**:

Octet no. 1

8	7	6	5	4	3	2	1
CNF	TRE	CST		MAH	TCC	STH	FX

bit-8	(CNF)	= 0	Confirmed track
		= 1	Track in initialisation phase
bit-7	(TRE)	= 0	Default
		= 1	Last report for a track
bits-6/5	(CST)	= 00	No extrapolation
		= 01	Predictable extrapolation due to sensor refresh period (see NOTE)
		= 10	Predictable extrapolation in masked area
		= 11	Extrapolation due to unpredictable absence of detection
bit-4	(MAH)	= 0	Default
		= 1	Horizontal manoeuvre
bit-3	(TCC)	= 0	Tracking performed in 'Sensor Plane', i.e. neither slant range correction nor projection was applied.
		= 1	Slant range correction and a suitable projection technique are used to track in a 2D.reference plane, tangential to the earth model at the Sensor Site co-ordinates.
bit-2	(STH)	= 0	Measured position
		= 1	Smoothed position
bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into first extent

NOTE: Some sensors are not be able to scan the whole coverage in one refresh period. Therefore, track extrapolation is performed in un-scanned sectors. CST is then set to 01.

**Structure
of First Extent**:

Octet no. 1

8	7	6	5	4	3	2	1
TOM		DOU			MRS		FX

bits-8/7   (TOM)   = 00 Unknown type of movement
                              = 01 Taking-off
                              = 10 Landing
                              = 11 Other types of movement

bits-6/4   (DOU)   = 000 No doubt
                              = 001 Doubtful correlation (undetermined reason)
                              = 010 Doubtful correlation in clutter
                              = 011 Loss of accuracy
                              = 100 Loss of accuracy in clutter
                              = 101 Unstable track
                              = 110 Previously coasted

bits-3/2   (MRS)   = 00 Merge or split indication undetermined
                              = 01 Track merged by association to plot
                              = 10 Track merged by non-association to plot
                              = 11 Split track

bit-1   (FX)   = 0   End of Data Item
                              = 1   Extension into next extent

**Structure
of Second Extent**:

Octet no. 1

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

bit-8   (GHO)   = 0   Default
                              = 1   Ghost track

bits-7/2   Spare bits set to zero

bit-1   (FX)   = 0   End of Data Item
                              = 1   Extension into next extent

NOTES
1.   Bit-8 (GHO) is used to signal that the track is suspected to have been generated by a fake target.

5.2.14   **Data Item I010/200, Calculated Track Velocity in Polar Co-ordinates**

Definition: Calculated track velocity expressed in polar co-ordinates.
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
Ground Speed															LSB

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

bits 32-17   Ground Speed
(LSB) $= 2^{-14}$ NM/s $\cong$ 0.22 kt
Max. val. = 2 NM/s = 7200kt

bit 16-1   Track Angle
(LSB) $= 360° / 2^{16} = 0.0055°$

5.2.15   **Data Item I010/202, Calculated Track Velocity in Cartesian Co-ordinates**

Definition: Calculated track velocity expressed in Cartesian co-ordinates, in two's complement representation.

Format: Four-octet fixed length Data Item .

Structure:

Octet no. 1								Octet no. 2							LSB
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Vx															

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

bit-17 & 1 (LSB) = 0.25 m/s,
     Max.range = $\pm$8192m/s

5.2.16 Data Item I010/210, Calculated Acceleration

Definition : Calculated Acceleration of the target, in two's complement form.
Format : Two-Octet fixed length data item.
Structure:

Octet no. 1

16	15	14	13	12	11	10	9
			Ax				LSB

Octet no. 2

8	7	6	5	4	3	2	1
			Ay				LSB

bits 9 & 1 (LSB) = 0.25 m/s^2

Max. range $\pm$ 31 m/s^2

5.2.17 Data Item I010/220, Target Address

Definition: Target address (24-bits address) assigned uniquely to each Target.

Format: Three-octet fixed length Data Item.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
			Target				

Octet no. 2 | | | | | | | Octet no. 3

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

bits-24/1 24-bits Target Address, A23 to A0

5.2.19 Data Item I010/245, Target Identification

Definition: Target (aircraft or vehicle) identification in 8 characters.

Format: Seven-octet fixed length Data Item.

Structure:

Octet no. 1

56	55	54	53	52	51	50	49
STI		0	0	0	0	0	0

Octet no. 2   Octet no. 3

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
MSB	Character 1						Character 2						Character 3		

Octet no. 4   Octet no. 5

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
	Character 4							Character 5							

Octet no. 6   Octet no. 7

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

bits-56/55 (STI) = 00 Callsign or registration downlinked from transponder

= 01 Callsign not downlinked from transponder

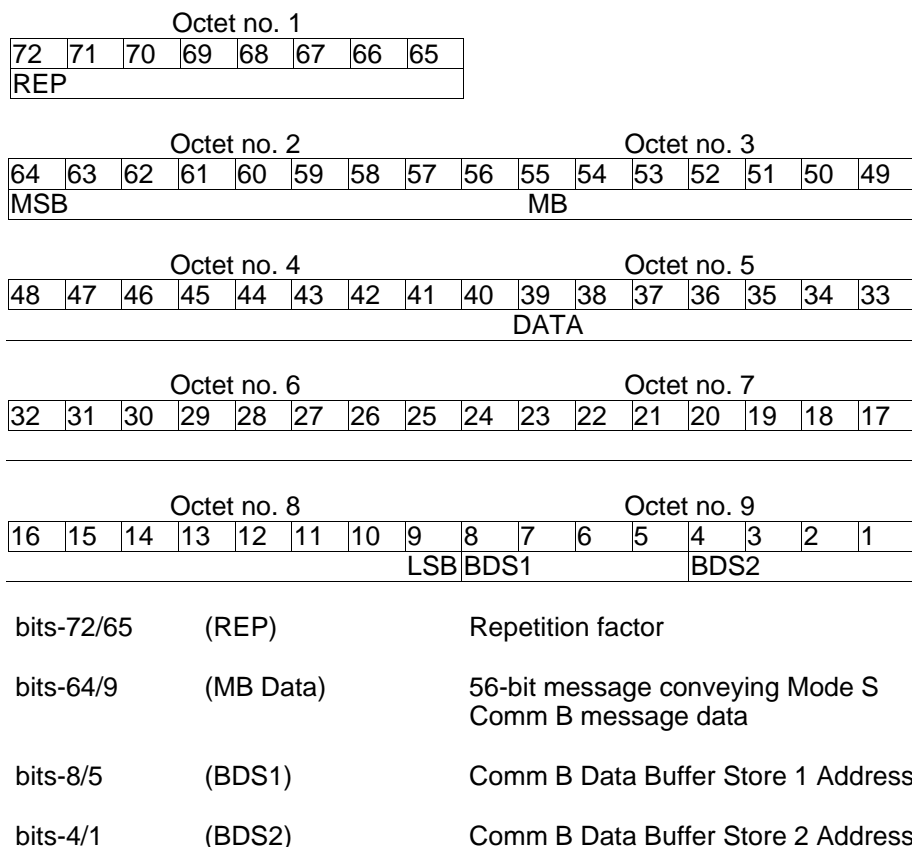= 10 Registration not downlinked from transponder

bits-54/49 Spare bits set to zero

bits-48/1 Characters 1-8 (coded on 6 bits each) defining target identification.

NOTE: See ICAO document Annex 10, Volume I, Part I, section 3.8.2.9 for the coding rules.

1.1.1   Data Item I010/250, Mode S MB Data

Definition: Mode S Comm B data as extracted from the aircraft transponder.

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one BDS report comprising one seven octet BDS register and one octet BDS code.

Structure:

Octet no. 1

72	71	70	69	68	67	66	65
REP							

Octet no. 2   Octet no. 3

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

Octet no. 4   Octet no. 5

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

Octet no. 6   Octet no. 7

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

Octet no. 8   Octet no. 9

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
							LSB	BDS1				BDS2			

bits-72/65   (REP)   Repetition factor

bits-64/9   (MB Data)   56-bit message conveying Mode S Comm B message data

bits-8/5   (BDS1)   Comm B Data Buffer Store 1 Address

bits-4/1   (BDS2)   Comm B Data Buffer Store 2 Address

NOTES

1. For the transmission of BDS20, item 245 is used.

5.2.20   Data Item I010/270, Target Size & Orientation

Definition: Target size defined as length and width of the detected target, and orientation.

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

Structure of First Part:

Octet no. 1

8	7	6	5	4	3	2	1
			LENGTH			LSB	FX

bit-2   (LSB)   = 1 m

bit-1   (FX)   = 0 End of Data Item
                                       = 1 Extension into first extent

Structure of First Extent:

Octet no. 1

8	7	6	5	4	3	2	1
			ORIENTATION			LSB	FX

bit-2   (LSB)   = 360° / 128 = approx. 2.81°

bit-1   (FX)   = 0 End of Data Item
                                       = 1 Extension into next extent

Structure of Second Extent:

Octet no. 1

8	7	6	5	4	3	2	1
			WIDTH			LSB	FX

bit-2   (LSB)   = 1 m

bit-1   (FX)   = 0 End of Data Item
                                       = 1 Extension into next extent

NOTE: The orientation gives the direction which the aircraft nose is pointing, relative to the Geographical North.

5.2.21 Data Item I010/280, Presence

Definition: Positions of all elementary presences constituting a plot.

Format: Repetitive Data Item, starting with a one octet Field Repetition Indicator (REP) indicating the number of presences associated to the plot, followed by series of two octets (co-ordinates differences) as necessary.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
REP = N							

Octet no. 2   Octet no. 3

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
DRHO							LSB	DTHETA							LSB
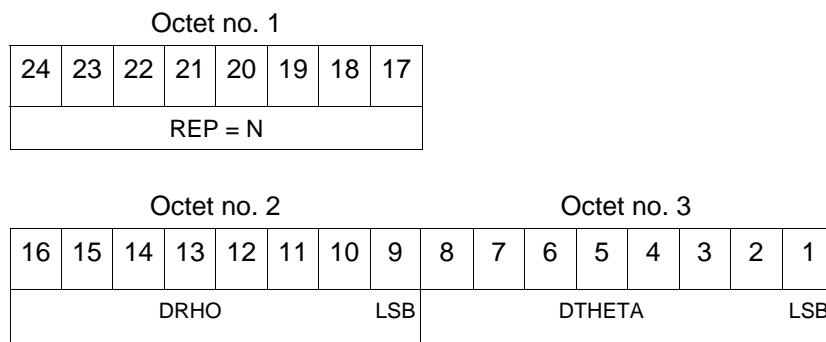
bits-24/17   (REP)   Number of presences associated to the plot

bits-16/9   (DRHO)   Difference between the radial distance of the plot centre and that of the presence.
                               LSB = 1 m
                               Max. Range = $\pm$ 127 m

bits-8/1   (DTHETA)   Difference between the azimuth of the plot centre and that of the presence.
                               LSB = 0.15°
                               Max. Range = $\pm$ 19.05°

5.2.22 Data Item I010/300, Vehicle Fleet Identification

Definition: Vehicle fleet identification number.

Format: One octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
				VFI			

Bits 8-1   (VFI)   = 0   Unknown
= 1   ATC equipment maintenance
= 2   Airport maintenance
= 3   Fire
= 4   Bird scarer
= 5   Snow plough
= 6   Runway sweeper
= 7   Emergency
= 8   Police
= 9   Bus
= 10   Tug (push/tow)
= 11   Grass cutter
= 12   Fuel
= 13   Baggage
= 14   Catering
= 15   Aircraft maintenance
= 16   Flyco (follow me)

5.2.23 Data Item I010/310, Pre-programmed Message

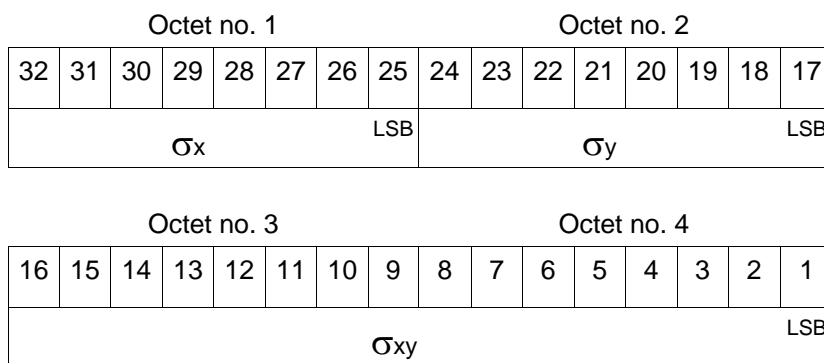**Definition**: Number related to a pre-programmed message that can be transmitted by a vehicle.

Format: One octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
TRB	MSG						

Bit-8	(TRB)	= 0	Default
		= 1	In Trouble

Bits 7-1	(MSG)	= 1	Towing aircraft
		= 2	"Follow me" operation
		= 3	Runway check
		= 4	Emergency operation (fire, medical…)
		= 5	Work in progress (maintenance, birds scarer, sweepers…)

5.2.24 Data Item I010/500, Standard Deviation of Position

Definition: Standard Deviation of Position

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
			σx				LSB				σy				LSB

Octet no. 3   Octet no. 4

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

bits-32/25 (σx) Standard Deviation of X component
LSB= 0.25 m

bits-24/17 (σy) Standard Deviation of Y component
LSB= 0.25 m

bits-16/1   (σxy) Covariance in two's complement form
LSB= 0.25 m^2

5.2.25 Data Item I010/550, System Status

Definition: Information concerning the configuration and status of a System.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
NOGO		OVL	TSV	DIV	TTF	0	0

bits-8/7   (NOGO)   Operational Release Status of the System
= 00 Operational
= 01 Degraded
= 10 NOGO

bit-6   (OVL)   Overload indicator
= 0 No overload
= 1 Overload

bit-5   (TSV)   Time Source Validity
= 0 valid
= 1 invalid

bit-4   (DIV)   = 0 Normal Operation
= 1 Diversity degraded

bit-3   (TTF)   = 0 Test Target Operative
= 1 Test Target Failure

bits-2/1   Spare bits set to zero

NOTES
1.   For a radar, bit-4 (DIV) is set to zero either when diversity is not used, or when diversity is used and operational.

5.3 Standard User Application Profile

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

Table 3 - Standard UAP

FRN	Data Item	Information	Length in Octets
1	I010/010	Data Source Identifier	2
2	I010/000	Message Type	1
3	I010/020	Target Report Descriptor	1+
4	I010/140	Time of Day	3
5	I010/041	Position in WGS-84 Co-ordinates	8
6	I010/040	Measured Position in Polar Co-ordinates	4
7	I010/042	Position in Cartesian Co-ordinates	4
FX	-	Field Extension Indicator	-
8	I010/200	Calculated Track Velocity in Polar Co-ordinates	4
9	I010/202	Calculated Track Velocity in Cartesian Coord.	4
10	I010/161	Track Number	2
11	I010/170	Track Status	1+
12	I010/060	Mode-3/A Code in Octal Representation	2
13	I010/220	Target Address	3
14	I010/245	Target Identification	7
FX	-	Field Extension Indicator	-
15	I010/250	Mode S MB Data	1+8n
16	I010/300	Vehicle Fleet Identification	1
17	I010/090	Flight Level in Binary Representation	2
18	I010/091	Measured Height	2
19	I010/270	Target Size & Orientation	1+
20	I010/550	System Status	1
21	I010/310	Pre-programmed Message	1
FX	-	Field Extension Indicator	-
22	I010/500	Standard Deviation of Position	4
23	I010/280	Presence	1+2n
24	I010/131	Amplitude of Primary Plot	1
25	I010/210	Calculated Acceleration	2
26	Spare		
27	SP	Special Purpose Field	1+
28	RE	Reserved Expansion Field	1+
FX	-	Field Extension Indicator	-

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-octets extents as necessary.