

EUROCONTROL STANDARD DOCUMENT

FOR

SURVEILLANCE DATA EXCHANGE

Part 14 : Category 020

Multilateration Data

SUR.ET1.ST05.2000-STD-14-02

Edition	:	0.17
Edition Date	:	June 2005
Status	:	Working Draft
Class	:	General Public

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title
Multilateration Data

EWP DELIVERABLE REFERENCE NUMBER

PROGRAMME REFERENCE INDEX

SUR.ET1.ST05.2000-STD-14-02

EDITION :

0.17

EDITION DATE :

June 2005

Abstract

This document describes the application of ASTERIX messages to the transmission of multilateration target reports and service messages.

Keywords

Multilateration Data
Data Item

ASTERIX
Category 20

Target Reports
UAP

Service Messages

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DOCUMENT STATUS AND TYPE

STATUS		CATEGORY		CLASSIFICATION	
Working Draft	<input checked="" type="checkbox"/>	Executive Task	<input type="checkbox"/>	General Public	<input checked="" type="checkbox"/>
Draft	<input type="checkbox"/>	Specialist Task	<input type="checkbox"/>	EATCHIP	<input type="checkbox"/>
Proposed Issue	<input type="checkbox"/>	Lower Layer Task	<input checked="" type="checkbox"/>	Restricted	<input type="checkbox"/>
Released Issue	<input type="checkbox"/>				

ELECTRONIC BACKUP

INTERNAL REFERENCE NAME :

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

DOCUMENT APPROVAL

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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
0.10	March 2004	Creation of document	All
0.11	March 2004	Modifications after first reviewing	
0.12	April 2004	Corrections in header/footer and the ASTERIX Part Nr.	
0.13	Nov. 2004	Modification of section 4.3.1 Creation of I020/030 Modification of I020/170 New definition for I020/091 Modification of format of I020/400 Modification of I020/550	
0.14P	Dec. 2004	Modification of section 4.3.1 I020/060 becomes I020/070 Creation of I020/080 Creation of I020/100 I020/091 becomes I020/105 Explanation note added in I020/105	
0.15	Mar. 2005	Editorial Changes Executive Summary added Meaning of CDM in I020/170 corrected Value 11 for NOGO in I020/550 added I020/020 Updated Note added to I020/041 and I020/042 Item I020/090 Note 2 updated Item I020/245 description of bits 56/55 updated Item I020/500 updated Item I020/500 subfield #1: LSB changed to 0.25 Item I020/500 subfield #3 reference to WGS84 added	Almost all 1 25 38 5.2.3 5.2.5 / 5.2.6 5.2.9 5.2.19 5.2.25 5.2.25 5.2.25
0.16	April 2005	Document Identification Sheet updated Signature Page updated	ii iii
<u>0.17</u>	<u>June 2005</u>	<u>Item I020/050 added</u> <u>Item I020/055 added</u> <u>Item I020/070 editorial change</u> <u>Item I020/080 removed</u>	<u>5.2.7</u> <u>5.2.8</u> <u>5.2.9</u>

		<u>Item I020/100 Name changed, Confidence Indicator removed, length changed to from 4 to 2 octets, LSB set to 1FL instead of 25ft or 100ft.</u> <u>Item I020/260 editorial update</u> <u>Item I020/500 editorial update</u> <u>List of items, composition of messages and UAP adapted accordingly</u> <u>Item I020/550 moved to new Category 019</u>	<u>5.2.11</u> <u>5.2.23</u> <u>5.2.27</u>
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EXECUTIVE SUMMARY

This document describes the general concepts and the message layout for the application of ASTERIX category 20 for the transmission of information derived by multilateration systems.

INTRODUCTION

1.1 Scope

- 1.1.1** This document describes the message structure for the transmission of multilateration target reports and service messages.
- 1.1.2** A complex of MLT (transmitter)/receivers and a central processing system is seen as a mono sensor.

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 1.28, 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 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 allow for, 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	All Purpose ST ructured E urocontrol su R veillance Information EX change
CAT	Data Category
DOP	<u>Dilution Of Precision</u>
EATM	European Air Traffic Management
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
MLT	Multilateration
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
SMR	Surface Movement Radar
SMS	Surface Movement System
SP	Special Purpose Indicator
SPI	<u>Special Position Identification</u>
SSR	<u>Secondary Surveillance Radar</u>
SURT	Surveillance Team (EATM)
UAP	User Application Profile (see Definitions)
UTC	Coordinated Universal Time
WAM	Wide Area Multilateration
WGS-84	World Geodetic System 84

4. GENERAL PRINCIPLES

4.1 General

For the transmission of MLT data of the following two types of messages have been defined:

- 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 Coordinates

Two different types of Coordinate reference systems are supported.

4.3.1 Coordinates Expressed in the Local 2D Coordinate Reference System (Cartesian Representation):

The exported position can be expressed in a 2D Cartesian Coordinate system, which is a plane tangential to the WGS-84 Ellipsoid at the location of the reference point. The origin of the Cartesian Coordinate system coincides with the published system origin. 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 Coordinates 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).

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

4.3.2 Coordinates Expressed in WGS-84 Format (Geographical Coordinates):

The exported position can be expressed in a 2D or 3D WGS-84 format. In case of 3D representation the item 020/091 (Measured Height) has to be used in combination with item 020/041 (Position in WGS-84 Coordinates).

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 020 a multilateration sensor is:

- a complex of MLT (transmitter)/receivers and a central processing system

4.5.2 System

In the framework of category 020 a System is a Sensor.

4.5.3 Addressing Concepts: Assigning SAC/SIC Codes

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

4.6 Target Reports

Target reports include reports from a multilateration system.

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 = 020	LEN		FSPEC	Items of the first record	FSPEC	Items of the last record
------------------	------------	--	--------------	---------------------------	--------------	--------------------------

where:

- Data Category (CAT) = 020, is a one-octet field indicating that the Data Block contains Multilateration 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 Multilateration data are defined in Table 1 and described on the following pages.

Table 1 - Standard Data Items of Category 020

Data Item Ref. No.	Description	Resolution
I020/000	Message Type	N.A.
I020/010	Data Source Identifier	N.A.
I020/020	Target Report Descriptor	N.A.
I020/030	Warning/Error Conditions	N.A.
I020/041	Position in WGS-84 Coordinates	180/2 ^{25°}
I020/042	Position in Cartesian Coordinates	0.5 m
I020/050	Mode-2 Code in Octal Representation	N.A.
I020/055	Mode-1 Code in Octal Representation	N.A.
I020/070	Mode-3/A Code in Octal Representation	N.A.
I020/090	Flight Level in Binary Representation	¼ FL
I020/100	Mode-C Altitude	1 FL
I020/105	Geometric Altitude (WGS-84)	6.25 ft
I020/110	Measured Height (Local Coordinates)	6.25 ft
I020/140	Time of Day	1/128 s
I020/161	Track Number	N.A.
I020/170	Track Status	N.A.
I020/202	Calculated Track Velocity in Cartesian Coord.	0.25 m/s
I020/210	Calculated Acceleration	0.25 m/s ²
I020/220	Target Address	N.A.
I020/230	Comms/ACAS Capability and Flight Status	N.A.
I020/245	Target Identification	N.A.
I020/250	Mode S MB Data	N.A.
I020/260	ACAS Resolution Advisory Report	N.A.
I020/300	Vehicle Fleet Identification	N.A.
I020/310	Pre-programmed Message	N.A.
I020/400	Contributing Receivers	N.A.
I020/500	Position Accuracy	0.25 / 0.25m

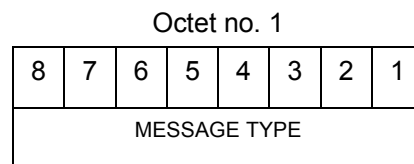
5.2 Description of Standard Data Items

5.2.1 Data Item I020/000, 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 information.

Format: One-octet fixed length Data Item.

Structure:



bits-8/1

Message Type

Encoding rule :

This data item shall be present in every ASTERIX record.

NOTES

1. In applications where data of various types is 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 020 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
I020/000	Message Type	M	M	M	M
I020/010	Data Source Identifier	M	M	M	M
I020/020	Target Report Descriptor	M	X	X	X
I020/030	Warning/Error Conditions	O	X	X	X
I020/041	Position in WGS-84 Coordinates	O	X	X	X
I020/042	Position in Cartesian Coordinates	O	X	X	X
I020/050	Mode-2 Code in octal representation	O	X	X	X
I020/055	Mode-1 Code in octal representation	O	X	X	X
I020/070	Mode-3/A Code in octal representation	O	X	X	X
I020/090	Flight Level in Binary Representation	O	X	X	X
I020/100	Mode-C <u>Altitude</u>	O	X	X	X
I020/105	Geometric Altitude (WGS-84)	O	X	X	X
<u>I020/110</u>	<u>Measured Height (Local Coordinates)</u>	<u>O</u>	<u>X</u>	<u>X</u>	<u>X</u>
I020/140	Time of Day	M	M	M	M
I020/161	Track Number	O	X	X	X
I020/170	Track Status	O	X	X	X
I020/202	Calculated Track Velocity in Cartesian Coordinates	O	X	X	X
I020/210	Calculated Acceleration	O	X	X	X
I020/220	Target Address	O	X	X	X
I020/230	Comms/ACAS Capability and Flight Status				
I020/245	Target Identification	O	X	X	X
I020/250	Mode S MB Data	O	X	X	X
I020/300	Vehicle Fleet Identification	O	X	X	X
I020/310	Pre-programmed Message	O	X	X	X
I020/400	Contributing Receivers	O	X	X	X
I020/500	Position Accuracy	O	X	X	X

5.2.2**Data Item I020/010, 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

5.2.3 Data Item I020/020, 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							FX
SSR	MS	HF	VDL4	UAT	DME	0	

bits-8/2	(TYP)	bit 8	= 1	SSR multilateration
			= 0	no SSR multilateration
		bit 7	= 1	Mode-S multilateration
			= 0	no Mode-S multilateration
		bit 6	= 1	HF multilateration
			= 0	no HF multilateration
		bit 5	= 1	VDL Mode 4 multilateration
			= 0	no VDL Mode 4 multilateration
		bit 4	= 1	UAT multilateration
			= 0	no UAT multilateration
		bit 3	= 1	DME/TACAN multilateration
			= 0	no DME/TACAN multilateration
		bit 2	=	spare bit set to 0
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
RAB	SPI	CHN	GBS	CRT	SIM	TST	FX

bit-8	(RAB)	= 0	Report from target transponder
		= 1	Report from field monitor (fixed transponder)
bit-7	(SPI)	= 0	Absence of SPI
		= 1	Special Position Identification
bit-6	(CHN)	= 0	Chain 1
		= 1	Chain 2
bit-5	(GBS)	= 0	Transponder Ground bit not set
		= 1	Transponder Ground bit set
bit-4	(CRT)	= 0	No Corrupted reply in multilateration
		= 1	Corrupted replies in multilateration
bit-3	(SIM)	= 0	Actual target report
		= 1	Simulated target report
bit-2	(TST)	= 0	Default
		= 1	Test Target
bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into next extent

5.2.4 Data Item I020/030, Warning/Error Conditions

Definition: Warning/error conditions detected by a system for the target report involved.

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
W/E Value							FX

bits-8/2 (W/E Value) Warning/error condition value

bit-1 (FX) = 0 End of Data Item
 = 1 Extension into first extent
 (next W/E condition value)

Warning/Error Code	Description
0	Not defined; never used.
1	Multipath Reply (Reflection)
3	Split plot
10	Phantom SSR plot
11	Non-Matching Mode-3/A Code
12	Mode C code / Mode S altitude code abnormal value compared to the track
15	Transponder anomaly detected
16	Duplicated or Illegal Mode S Aircraft Address
17	Mode S error correction applied
18	Undecodable Mode C code / Mode S altitude code

Encoding Rule:

This Data item is optional. When used, it shall be transmitted only if different from zero.

NOTES

1. It has to be stressed that a series of one or more W/E conditions can be reported per target report.
2. Data conveyed in this item are of secondary importance, and can generally also be derived from the processing of mandatory items.
3. Definitions can be found in SUR.ET1.ST03.1000-STD-01-01 Radar Sensor Performance Analysis.
4. The coding of Warning/Errors is kept consistent with category 048.

5.2.5 Data Item I020/041, Position in WGS-84 Coordinates

Definition : Position of a target in WGS-84 Coordinates.

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)	= $180/2^{25}$ degrees
bits-32/1	(Longitude)	In WGS-84 in two's complement. Range -180 <= longitude < 180 deg.
	(LSB)	= $180/2^{25}$ degrees

The LSB provides a resolution better than 0.6m.

NOTE: At least one of these items (I020/041 or I020/042) must be sent if available

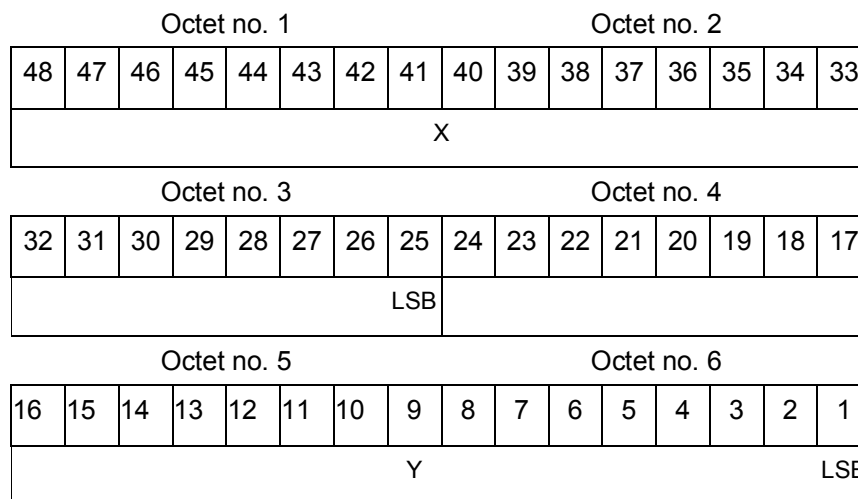
5.2.6

Data Item I020/042, Position in Cartesian Coordinates

Definition: Calculated position in Cartesian Coordinates, in two's complement representation.

Format: Six-octet fixed length Data Item.

Structure:



bits 48/25 = X

bit 25 (LSB) = 0.5 m, max range=+/-4194.3km (~2265 NM)

bits 24/1 = Y

bit 1 (LSB) = 0.5 m, max range=+/-4194.3km (~2265 NM)

NOTE: At least one of these items (I020/041 or I020/042) must be sent if available

5.2.7 Data Item I020/050, Mode-2 Code in Octal Representation**Definition:** Mode-2 code converted into octal representation.**Format:** Two-octet fixed length Data Item.**Structure:**

Octet no. 1								Octet no. 2							
<u>16</u>	<u>15</u>	<u>14</u>	<u>13</u>	<u>12</u>	<u>11</u>	<u>10</u>	<u>9</u>	<u>8</u>	<u>7</u>	<u>6</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>
<u>V</u>	<u>G</u>	<u>L</u>	<u>0</u>	<u>A4</u>	<u>A2</u>	<u>A1</u>	<u>B4</u>	<u>B2</u>	<u>B1</u>	<u>C4</u>	<u>C2</u>	<u>C1</u>	<u>D4</u>	<u>D2</u>	<u>D1</u>

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

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

bit-14 (L) = 0 Mode-2 code derived from the
reply of the transponder
= 1 Smoothed Mode-2 code as
provided by a local tracker n

bit-13 Spare bit set to 0

bits-12/1 Mode-2 reply in octal representation

Encoding Rule:

This data item is optional. It shall be sent when Mode-2 is present. Then, it represents the Mode-2 code of the plot, even if associated with a track.

5.2.8 Data Item I020/055, Mode-1 Code in Octal Representation**Definition:** Mode-1 code converted into octal representation.**Format:** One-octet fixed length Data Item.**Structure:**

Octet no. 1							
8	7	6	5	4	3	2	1
V	G	L	A4	A2	A1	B2	B1

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

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

bit-14 (L) = 0 Mode-1 code derived from the
 reply of the transponder
 = 1 Smoothed Mode-2 code as
 provided by a local tracker n

bits-12/1 Mode-1 Code in octal representation

Encoding Rule:

This data item is optional. It shall be sent when Mode-1 is present. Then, it represents the Mode-1 code of the plot, even if associated with a track.

5.2.9 Data Item I020/070, 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 update period

bit-13 Spare bit set to 0

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

Encoding Rule:

- For Mode S, once a Mode-3/A code is seen, that code shall be sent every update period, provided the MLT system is receiving replies for that aircraft.
- Bit 14 (L) will be set when the Mode 3/A Code was taken from the Track file

NOTES

- Bit 15 (G) is set to one when an error correction has been attempted.
- Bit 16 (V) 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).

5.2.10 Data Item I020/090, Flight Level in Binary Representation

Definition: Flight Level (Mode S Altitude) converted into binary two's complement 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	Flight Level												LSB	

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

Encoding Rule:

This data item shall be sent when Mode S altitude code is present and decodable. It represents the flight level of the plot, even if associated with a track.

NOTES

1. When Mode C code / Mode S altitude code is present but not decodable, the “Undecodable Mode C code / Mode S altitude code” Warning/Error should be sent in I020/030.
2. When local tracking is applied and the received Mode S altitude code corresponds to an abnormal value (i.e: the difference in altitude between the current and the previous plot exceeds a predefined system threshold), the “Mode C code / Mode S altitude code abnormal value compared to the track” Warning/Error should be sent in I020/030.
3. The value shall be within the range described by ICAO Annex 10
4. For Mode S, bit 15 (G) is set to one when an error correction has been attempted.

5.2.11 Data Item I020/100, Mode-C Altitude

Definition: Mode-C Flight Level converted into binary two's complement 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
<u>V</u>	<u>G</u>	<u>Flight Level</u>													<u>LSB</u>

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 FL

Encoding Rule:

This data item shall only be sent when Mode C altitude code is present and decodable.

5.2.12 Data Item I020/105, Geometric Altitude (WGS-84)

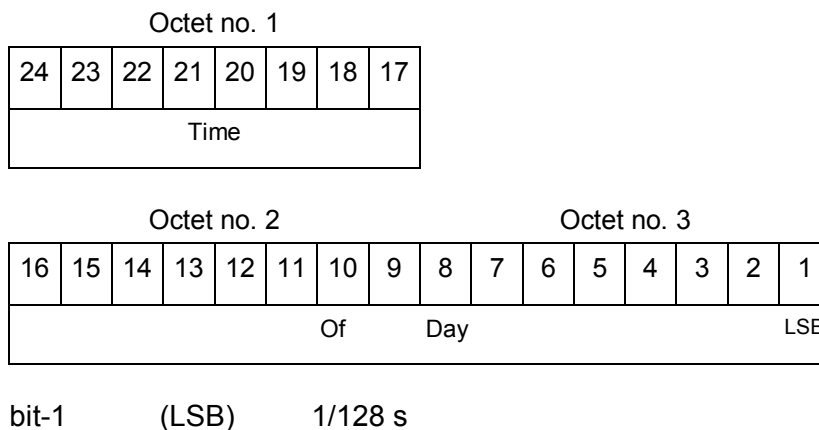
Definition: Vertical distance between the target and the projection of its position on the earth's ellipsoid, as defined by WGS84, in two's complement form.

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
<u>Geometric Altitude (WGS-84)</u>														<u>LSB</u>	

bits-16/1 Geometric Altitude (WGS-84)
LSB= 6.25 ft
Range= +/- 204 800 ft

5.2.13 Data Item I020/140, Time of Day**Definition:** Absolute time stamping expressed as UTC.**Format:** Three-octet fixed length Data Item.**Structure:****NOTE -** The time of day value is reset to zero each day at midnight.

5.2.14 Data Item I020/161, 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.

5.2.15 Data Item I020/170, 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	CDM		MAH	STH	FX

- bit-8 (CNF) = 0 Confirmed track
= 1 Track in initiation phase
- bit-7 (TRE) = 0 Default
= 1 Last report for a track
- bits-6 (CST) = 0 Not extrapolated
= 1 Extrapolated
- bit-5/4 (CDM) = 00 Maintaining
= 01 Climbing
= 10 Descending
= 11 Invalid
- bit-3 (MAH) = 0 Default
= 1 Horizontal manoeuvre
- bit-2 (STH) = 0 Measured position
= 1 Smoothed position
- 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
GHO	0	0	0	0	0	0	FX

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

Bit 7/2 Spare bits set to 0

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

NOTES

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

5.2.16 Data Item I020/202, Calculated Track Velocity in Cartesian Coordinates

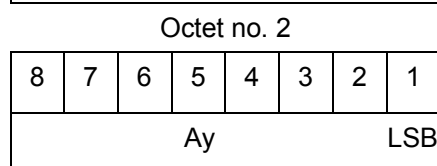
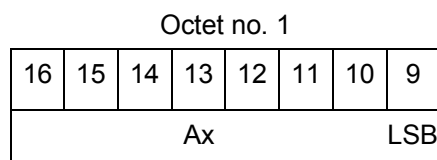
Definition: Calculated track velocity expressed in Cartesian Coordinates, in two's complement representation.

Format: Four-octet fixed length Data Item.

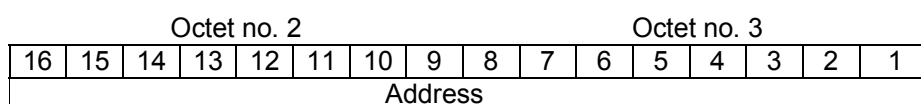
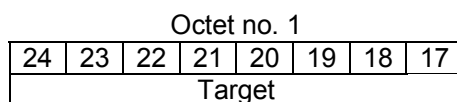
Structure:

Octet no. 1								Octet no. 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
V _x															LSB
Octet no. 3								Octet no. 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
V _y															LSB

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

5.2.17 Data Item I020/210, Calculated Acceleration**Definition :** Calculated Acceleration of the target, in two's complement form.**Format :** Two-Octet fixed length data item.**Structure:**

bits 9 & 1 (LSB) = 0.25 m/s^2
 Max. range $\pm 31 \text{ m/s}^2$

5.2.18 Data Item I020/220, Target Address**Definition:** Target address (ICAO 24-bit address) assigned uniquely to each Target.**Format:** Three-octet fixed length Data Item.**Structure:**

bits-24/1

24-bits Target Address, A23 to A0

5.2.19 Data Item I020/230, Communications/ACAS Capability and Flight Status

Definition: Communications capability of the transponder, capability of the on-board ACAS equipment and flight status.

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
COM			STAT			0	0	MSSC	ARC	AIC	B1A	B1B			

bits-16/14 (COM)

Communications capability of the transponder

= 0 No communications capability (surveillance only)

= 1 Comm. A and Comm. B capability

= 2 Comm. A, Comm. B and Uplink ELM

= 3 Comm. A, Comm. B, Uplink ELM and Downlink ELM

= 4 Level 5 Transponder capability

5 to 7 Not assigned

bits-13/11 (STAT)

Flight Status

= 0 No alert, no SPI, aircraft airborne

= 1 No alert, no SPI, aircraft on ground

= 2 Alert, no SPI, aircraft airborne

= 3 Alert, no SPI, aircraft on ground

= 4 Alert, SPI, aircraft airborne or on ground

= 5 No alert, SPI, aircraft airborne or on ground

6 - 7 Not assigned

bits-10/9 (spare)

spare bits set to zero

bit-8 (MSSC)

Mode-S Specific Service Capability

= 0 No

= 1 Yes

bit-7 (ARC)

Altitude reporting capability

= 0 100 ft resolution

= 1 25 ft resolution

bit-6 (AIC)

Aircraft identification capability

= 0 No

= 1 Yes

bit-5 (B1A)

BDS 1,0 bit 16

bits 4/1 (B1B)

BDS 1,0 bits 37/40

Encoding Rule:

This item shall be present in every ASTERIX record conveying data related to a Mode S target. If the datalink capability has not been extracted yet, bits 16/14 shall be set to zero.

5.2.20 Data Item I020/245, 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	Registration downlinked from transponder
	= 10	Callsign downlinked from transponder
	= 11	Not defined
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 IV, section 3.1.2.9 for the coding rules.

5.2.21 Data Item I020/250, 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							
64	63	62	61	60	59	58	57
MSB							
Octet no. 3							
56	55	54	53	52	51	50	49
MB							
Octet no. 4							
48	47	46	45	44	43	42	41
DATA							
Octet no. 5							
40	39	38	37	36	35	34	33
Octet no. 6							
32	31	30	29	28	27	26	25
Octet no. 7							
24	23	22	21	20	19	18	17
Octet no. 8							
16	15	14	13	12	11	10	9
LSB							
Octet no. 9							
8	7	6	5	4	3	2	1
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.

5.2.22 Data Item I020/260, ACAS Resolution Advisory Report

Definition: Currently active Resolution Advisory (RA), if any, generated by the ACAS associated with the transponder transmitting the report and threat identity data.

Format: Seven-octet fixed length Data Item.

Structure:

Octet no. 1								Octet no. 2							
56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41

Octet no. 3								Octet no. 4							
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25
MB DATA															

Octet no. 5					Octet no. 6										
24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9

Octet 7							
8	7	6	5	4	3	2	1

bits-56/1 (MB Data)

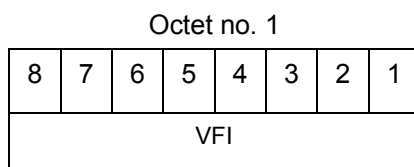
56-bit message conveying Mode S
Comm B message data of BDS
Register 3,0.

Encoding Rule:

This item shall be present when a Resolution Advisory has been generated in the last **update period**.

NOTES

1. Refer to ICAO Draft SARPs for ACAS for detailed explanations.

5.2.23 Data Item I020/300, Vehicle Fleet Identification**Definition:** Vehicle fleet identification number.**Format:** One octet fixed length Data Item.**Structure:**

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)

5.2.24 Data Item I020/310, 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...)

5.2.25 Data Item I020/400, Contributing Receivers

Definition: Overview of Receiver Units, which have contributed to the Target Detection

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one Contributing Receiver Units list comprising one octet

Structure:

Octet no. 1							
16	15	14	13	12	11	10	9
REP							

Octet no. 2							
8	7	6	5	4	3	2	1

Bits 16/9 (REP) Repetition Factor

Bit x ($1 \leq x \leq 8$) RUX Contribution
= 0 RUX has NOT contributed to the target detection
= 1 RUX has contributed to the target detection

5.2.26 Data Item I020/500, Position Accuracy**Definition:** Standard Deviation of Position**Format:** Compound Data Item, comprising a primary subfield of one octet, followed by one or more defined subfields.**Structure of Primary Subfield:**

Octet no. 1

8	7	6	5	4	3	2	1
<u>DOP</u>	SDP	SDA	0	0	0	0	0

Bit-8	(<u>DOP</u>)	Subfield #1: DOP of Position = 0 Absence of Subfield #1 = 1 Presence of Subfield #1
Bit-7	(SDP)	Subfield #2: Standard Deviation of Position = 0 Absence of Subfield #2 = 1 Presence of Subfield #2
Bit-6	(SDA)	Subfield #3 Standard Deviation of Geometric Altitude =0 Absence of Subfield #3 =1 Presence of Subfield #3
bits-5/1	(Spare)	Subfields #4/7: Spare = 0 Absence of Subfield = 1 Presence of Subfield

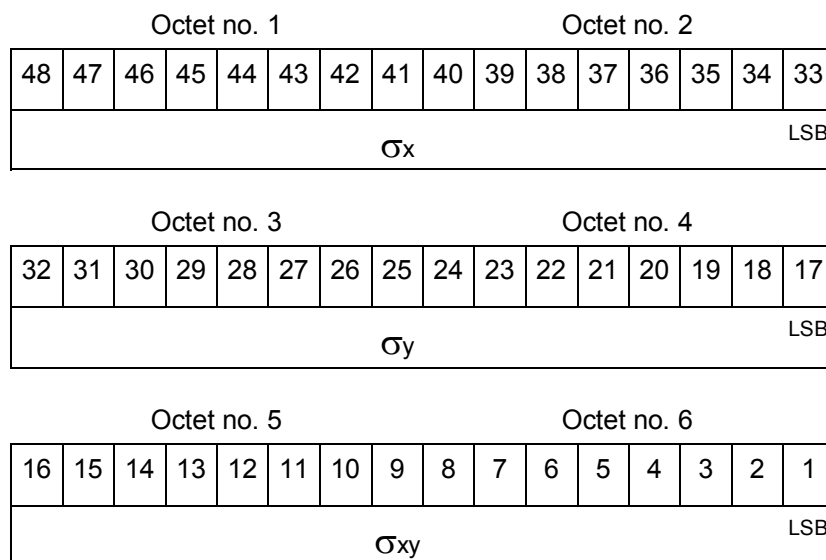
Structure of Subfield # 1:**DOP of Position**

<u>48</u>	<u>47</u>	<u>46</u>	<u>45</u>	<u>44</u>	<u>43</u>	<u>42</u>	<u>41</u>	<u>40</u>	<u>39</u>	<u>38</u>	<u>37</u>	<u>36</u>	<u>35</u>	<u>34</u>	<u>33</u>
<u>DOP-x</u>														<u>LSB</u>	

Octet no. 1								Octet no. 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
<u>DOP-y</u>														<u>LSB</u>	

Octet no. 3								Octet no. 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
<u>DOP-xy</u>														<u>LSB</u>	

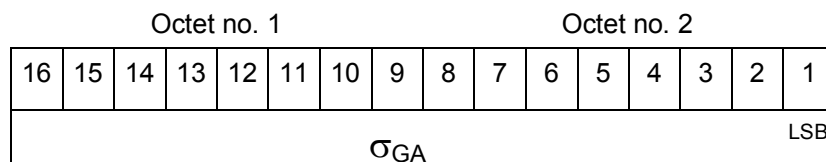
bits-32/25	(<u>DOP-x</u>)	DOP along x axis	
		LSB= 0.25	
bits-24/17	(<u>DOP-y</u>)	DOP along y axis	
		LSB= 0.25	
bits-16/1	(<u>DOP-xy</u>)	DOP	
		LSB= 0.25 ²	

Structure of Subfield # 2:**Standard Deviation of Position**bits-48/33 (σ_x) Standard Deviation of X component

LSB= 0.25 m

bits-32/17 (σ_y) Standard Deviation of Y component

LSB= 0.25 m

bits-16/1 (σ_{xy}) Covariance in two's complement formLSB= 0.25 m²**Structure of Subfield # 3:****Standard Deviation of Geometric Altitude (WGS 84)**bits-16/1 (σ_{GA}) Standard Deviation of Geometric Altitude

LSB= 0.5 m

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	I020/010	Data Source Identifier	2
2	I020/000	Message Type	1
3	I020/020	Target Report Descriptor	1+
4	I020/140	Time of Day	3
5	I020/041	Position in WGS-84 Coordinates	8
6	I020/042	Position in Cartesian Coordinates	6
7	I020/161	Track Number	2
FX	-	Field Extension Indicator	-
8	I020/170	Track Status	1+
9	I020/070	Mode-3/A Code in Octal Representation	2
10	I020/202	Calculated Track Velocity in Cartesian Coord.	4
11	I020/090	Flight Level in Binary Representation	2
12	I020/100	Mode-C Altitude	2
13	I020/220	Target Address	3
14	I020/245	Target Identification	7
FX	-	Field Extension Indicator	-
15	I020/110	Measured Height (Cartesian Coordinates)	2
16	I020/105	Geometric Altitude (WGS-84)	2
17	I020/210	Calculated Acceleration	2
18	I020/300	Vehicle Fleet Identification	1
19	I020/310	Pre-programmed Message	1
20	I020/500	Position Accuracy	1+n
21	I020/400	Contributing Receivers	1+1+
FX	-	Field Extension Indicator	-
22	I020/250	Mode S MB Data	1+8n
23	I020/230	Comms/ACAS Capability and Flight Status	1+
24	I020/260	ACAS Resolution Advisory Report	7
25	I020/030	Warning/Error Conditions	1+
26	I020/055	Mode-1 Code in Octal Representation	1
27	I020/050	Mode-2 Code in Octal Representation	2
28	-	Spare bit set to zero	-
FX	-	Field Extension Indicator	-
29	-	Spare bit set to zero	-
30	-	Spare bit set to zero	-
31	-	Spare bit set to zero	-
32	-	Spare bit set to zero	-
33	-	Spare bit set to zero	-

34	RE	Reserved Expansion Field	-
35	SP	Special Purpose Field	-
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-octet extents as necessary.