

EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 14 Category 20 Multilateration Target Reports

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Abstract This document specifies the contents of ASTERIX Category 020 messages used for the transmission of Multilateration Target Reports reports.															
Keywords <table border="0"> <tr> <td>Data Exchange</td> <td>Messages</td> <td>SAC</td> <td>SIC</td> </tr> <tr> <td>Data Category</td> <td>Data Field</td> <td>Data Block</td> <td>Data Item</td> </tr> <tr> <td>ASTERIX</td> <td>UAP</td> <td>Multilateration</td> <td></td> </tr> </table>				Data Exchange	Messages	SAC	SIC	Data Category	Data Field	Data Block	Data Item	ASTERIX	UAP	Multilateration	
Data Exchange	Messages	SAC	SIC												
Data Category	Data Field	Data Block	Data Item												
ASTERIX	UAP	Multilateration													
Contact Person(s)		Tel	Unit												
Alexander Engel		+32-2-729 3355	DPS/STAN												

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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 refer to Part 1.

DOCUMENT CHANGE RECORD

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

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0.11	March 2004	Modifications after first reviewing	
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Publications

EUROCONTROL Headquarters
96 Rue de la Fusée
B-1130 BRUSSELS

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

TABLE OF CONTENTS

DOCUMENT CHARACTERISTICS	ii
DOCUMENT APPROVAL	iii
DOCUMENT CHANGE RECORD	iv
1. INTRODUCTION	1
1.1 Scope 1	
2. REFERENCES	2
2.1 General	2
2.2 Reference Documents	2
3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS	4
3.1 Definitions	4
3.2 Acronyms and Abbreviations	5
4. GENERAL PRINCIPLES	7
4.1 General	7
4.2 Time Management	7
4.2.1 Definition.....	7
4.2.2 Requirements for Time Stamping.....	7
4.3 Projection Systems and Geographical Coordinates	7
4.3.1 Coordinates Expressed in the Local 2D Coordinate Reference System (Cartesian Representation):.....	7
4.3.2 Coordinates Expressed in WGS-84 Format (Geographical Coordinates):	7
4.4 Unused Bits in Data Items.....	8
4.5 Definitions and Addressing Concepts	8
4.5.1 Sensor	8
4.5.2 System.....	8
4.5.3 Addressing Concepts: Assigning SAC/SIC Codes	8
4.6 Target Reports	8
4.7 User Application Profile and Data Blocks.....	9
4.8 Composition of Messages.....	9
5. LAYOUT OF MESSAGES	10
5.1 Standard Data Items	10
5.2 Description of Standard Data Items	11
5.2.1 Data Item I020/010, Data Source Identifier	11
5.2.2 Data Item I020/020, Target Report Descriptor.....	12

5.2.3	Data Item I020/030, Warning/Error Conditions	14
5.2.4	Data Item I020/041, Position in WGS-84 Coordinates.....	15
5.2.5	Data Item I020/042, Position in Cartesian Coordinates	16
5.2.6	Data Item I020/050, Mode-2 Code in Octal Representation	17
5.2.7	Data Item I020/055, Mode-1 Code in Octal Representation	18
5.2.8	Data Item I020/070, Mode-3/A Code in Octal Representation	19
5.2.9	Data Item I020/090, Flight Level in Binary Representation	20
5.2.10	Data Item I020/100, Mode-C Code.....	21
5.2.11	Data Item I020/105, Geometric Height (WGS-84)	22
5.2.12	Data Item I020/110, Measured Height (Local Cartesian Coordinates)	22
5.2.13	Data Item I020/140, Time of Day.....	23
5.2.14	Data Item I020/161, Track Number	23
5.2.15	Data Item I020/170, Track Status.....	24
5.2.16	Data Item I020/202, Calculated Track Velocity in Cartesian Coordinates	25
5.2.17	Data Item I020/210, Calculated Acceleration	26
5.2.18	Data Item I020/220, Target Address	26
5.2.19	Data Item I020/230, Communications/ACAS Capability and Flight Status.....	27
5.2.20	Data Item I020/245, Target Identification.....	29
5.2.21	Data Item I020/250, Mode S MB Data.....	30
5.2.22	Data Item I020/260, ACAS Resolution Advisory Report	32
5.2.23	Data Item I020/300, Vehicle Fleet Identification	33
5.2.24	Data Item I020/310, Pre-programmed Message.....	34
5.2.25	Data Item I020/400, Contributing Devices	35
5.2.26	Data Item I020/500, Position Accuracy	37
5.3	Standard User Application Profile	41

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1. INTRODUCTION

1.1 Scope

This document describes the message structure for the transmission of multilateration target reports.

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 SUR.ET1.ST05.2000-STD-01-01. "All Purpose Structured EUROCONTROL Surveillance Information Exchange – ASTERIX". Edition 2.20, Released Issue, October 2014.

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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	A ll Purpose ST ructured E urocontrol suR veillance I nformation EX change
CAT	Data Category
DOP	Dilution Of Precision
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	Special Position Identification
SSR	Secondary Surveillance Radar
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.

This document describes the target report messages. Service messages are defined as category 019.

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 MLT System Reference Point as defined in item I019/600. The height of the MLT System Reference Point is defined in item I019/610. 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 020/105 (Geometric 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 User Application Profile and Data Blocks

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

4.7.2 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.

4.8 Composition of Messages

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

4.8.2 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
I020/010	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 Code	1 FL
I020/105	Geometric Height (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 Devices	N.A.
I020/500	Position Accuracy	0.25 / 0.5 m

5.2 Description of Standard Data Items

5.2.1 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

Encoding Rule: This data item shall be present in each ASTERIX record

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

5.2.2 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	OT	

bits-8/2 (TYP) SSR = 1 Non-Mode S 1090MHz multilateration
= 0 no Non-Mode S 1090MHz multilat.

MS = 1 Mode-S 1090 MHz multilateration
= 0 no Mode-S 1090 MHz multilateration

HF = 1 HF multilateration
= 0 no HF multilateration

VDL4 = 1 VDL Mode 4 multilateration
= 0 no VDL Mode 4 multilateration

UAT = 1 UAT multilateration
= 0 no UAT multilateration

DME = 1 DME/TACAN multilateration
= 0 no DME/TACAN multilateration

OT = 1 Other Technology Multilateration
= 0 No Other Technology Multilateration

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

Encoding Rule: This data item shall be present in each ASTERIX record

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	

5.2.3 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.

5.2.4 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.

Encoding Rule : This data item shall be present in each ASTERIX record used in the scope of Wide Area Multilateration (WAM) if available. For airport applications this item is optional. In this case either item I020/041 or item I020/042 shall be sent.

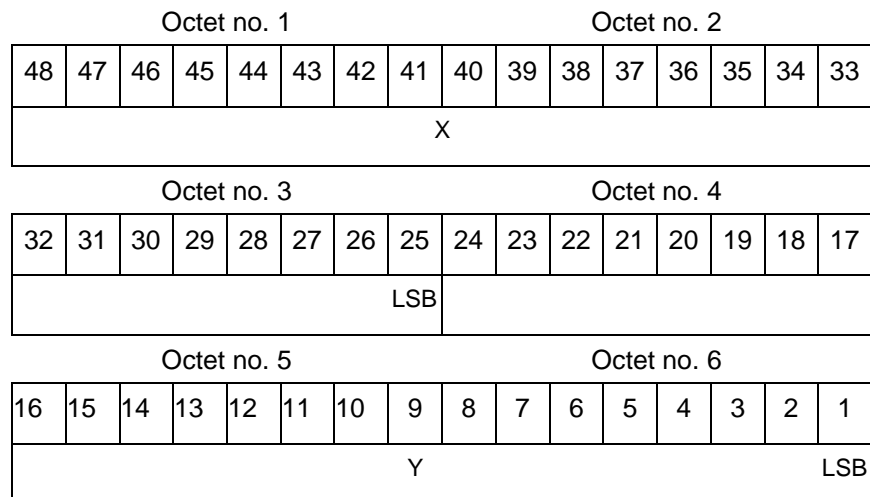
5.2.5

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= \pm 4194.3km (~2265 NM)

bits 24/1 = Y

bit 1 (LSB) = 0.5 m, max range= \pm 4194.3km (~2265 NM)

Encoding Rule : This item is optional

5.2.6 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							
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-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.

5.2.7**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-8 (V) = 0 Code validated
 = 1 Code not validated

bit-7 (G) = 0 Default
 = 1 Garbled code

bit-6 (L) = 0 Mode-1 code derived from the
 reply of the transponder
 = 1 Smoothed Mode-1 code as
 provided by a local tracker

bits-5/1 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.

5.2.8 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

1. Bit 15 (G) is set to one when an error correction has been attempted.
2. 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).

5.2.9 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 / Mode C 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.

5.2.10 Data Item I020/100, Mode-C Code

Definition: Mode-C height in Gray notation as received from the transponder together with the confidence level for each reply bit as provided by a MSSR/Mode-S station.

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

Octet no. 3								Octet no. 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	QC1	QA1	QC2	QA2	QC4	QA4	QB1	QD1	QB2	QD2	QB4	QD4

bit-32	(V)	= 0	Code validated
		= 1	Code not validated
bit-31	(G)	= 0	Default
		= 1	Garbled code
bits-30/29		Spare bits set to 0	
bits-28/17		Mode-C reply in Gray notation	
bits-16/13		Spare bits set to 0	
bits-12/1	(QXi)	= 0	High quality pulse Xi
		= 1	Low quality pulse Xi

Encoding Rule:

This data item is optional. When used, it shall only be sent when a not validated or undecodable Mode C has been received.

For Mode-C, it represents the confidence level for each reply bit of the Mode C code of the plot.

For Mode-S, if this data-item is sent because of an undecodable Mode-C Code received in a Mode-S Altitude reply, then all pulse quality bits will be set to one (high).

Notes:

1. For Mode S, bit 31 (G) is set to one when an error correction has been attempted.
2. For Mode S, D1 is also designated as Q, and is used to denote either 25ft or 100ft reporting.

5.2.11 Data Item I020/105, Geometric Height (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
Geometric Height (WGS-84)														LSB	

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

Encoding Rule: This item is optional.

5.2.12 Data Item I020/110, Measured Height (Local Cartesian Coordinates)

Definition: Height above local 2D co-ordinate system in reference to the MLT System Reference Point as defined in item I019/610, in two's complement form, based on a direct measurement not related to barometric pressure.

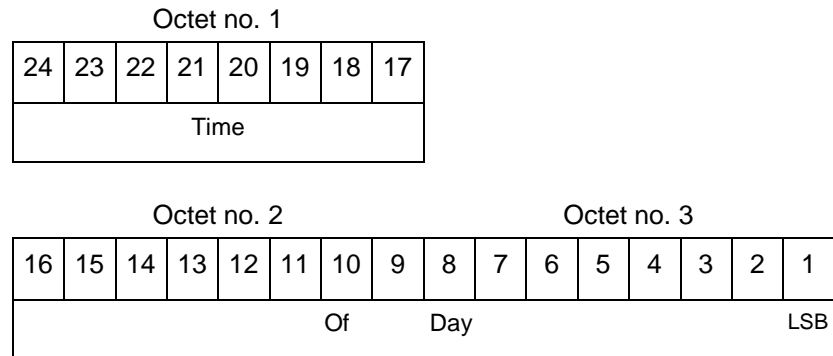
Format: Two-octet fixed length Data Item.

Structure:

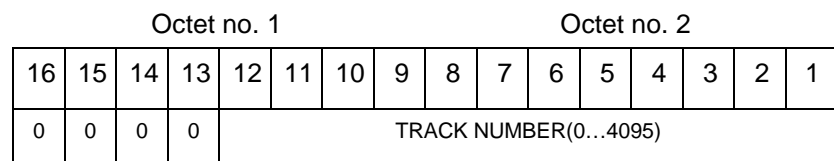
Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Measured Height														LSB	

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

Encoding Rule: This item is optional.

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:**

bit-1 (LSB) 1/128 s

NOTE - The time of day value is reset to zero each day at midnight.**Encoding Rule :** This data item shall be present in every ASTERIX record, except in case of failure of all sources of time-stamping.**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:**bits-16/13 Spare bits set to zero.
bits-12/1 Track number.**Encoding Rule:** This item is optional

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

Encoding Rule: This item is optional

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.

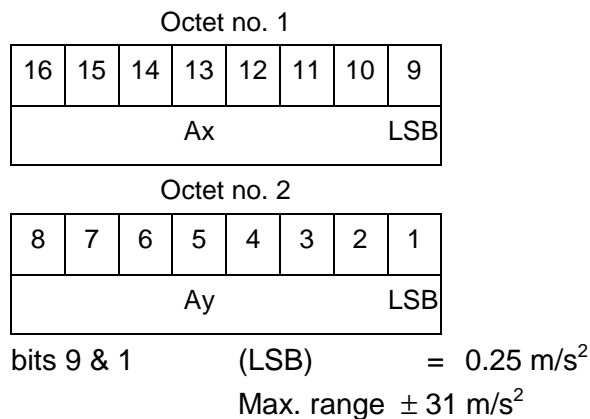
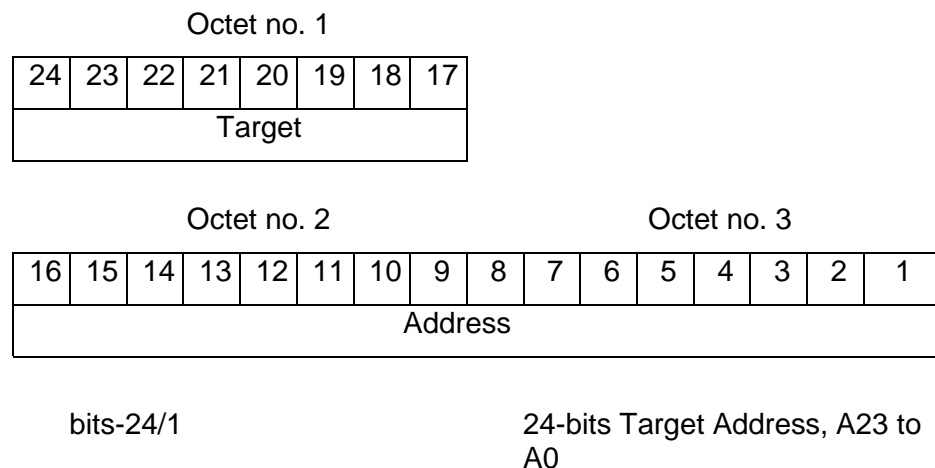
Format: Four-octet fixed length Data Item.

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

Encoding Rule: This item is optional

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:****Encoding Rule:** This item is optional**NOTE:** Maximum value means “maximum value or above”**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:****Encoding Rule:** This item is optional

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 Not assigned
		= 7 Information not yet extracted
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	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 not 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.

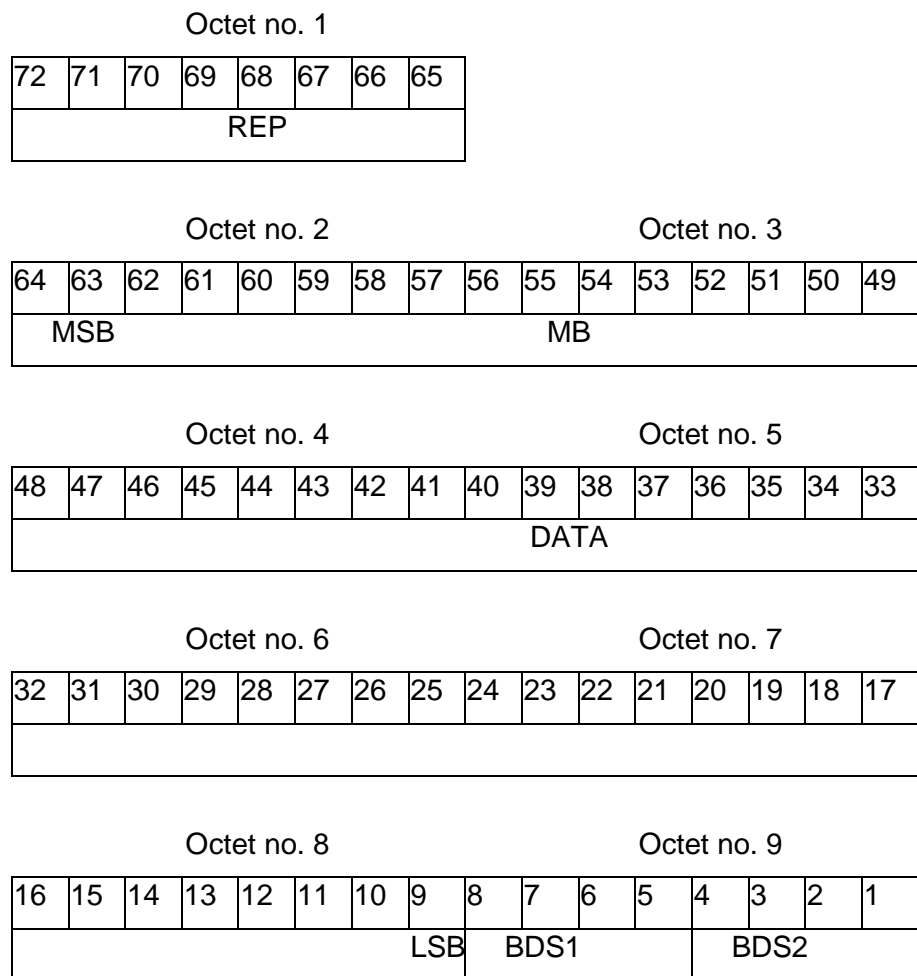
Encoding Rule: This item is optional**NOTE:** See ICAO document Annex 10, Volume IV, section 3.1.2.9 for the coding rules.

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:



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

Encoding Rule: This item is optional

NOTES

1. For the transmission of BDS20, item I020/245 is used.
2. For the transmission of BDS30, item I020/260 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)

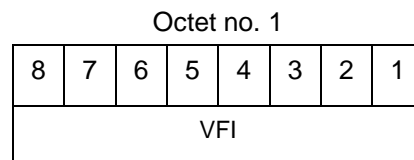
56-bit message conveying
Mode S Comm B message
data of BDS Register 3,0.

Encoding Rule:

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

NOTES

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)

Encoding Rule: This item is optional

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...)

Encoding Rule: This item is optional

5.2.25 Data Item I020/400, Contributing Devices

Definition: Overview of the devices, which have contributed to the Target Detection. In case of active Multilateration systems this may include transmitters.

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

Bits 16/9 (REP) Repetition Factor

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

Encoding Rule: This item is optional

Note: The actual meaning of the individual bits is implementation dependent.

Recommendation: For active Multilateration systems both, transmitters and receivers may be included.
 It is recommended that in such a configuration the higher bit numbers (i.e. starting at Octet no. 1) should be allocated to transmitters since it is expected that there will be a smaller number of transmitters than receivers. Such an implementation would save bandwidth in case of target reports derived from active multilateration.

NOTE: In case of more than 8 devices connected to the system, the numbering of the field “RUx Contribution” follows the standard ASTERIX rule: bits are numbered from right to left. The example below shows the case of a maximum of 16 devices with devices 1, 7 and 14 contributing to the target:

Octet no. 1							
24	23	22	21	20	19	18	17
0	0	0	0	0	0	1	0

Octet no. 2								Octet no. 3							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1

In this particular example, for an active Multilateration system transmitters should be allocated to bits 16 and lower.

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
DOP	SDP	SDH	0	0	0	0	0

Bit-8	(DOP)	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	(SDH)	Subfield #3 Standard Deviation of Geometric Height =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

Encoding Rule: This item is optional

Structure of Subfield # 1:
DOP of Position

Octet no. 1								Octet no. 2							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
DOP-x														LSB	

Octet no. 3								Octet no. 4							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
DOP-y														LSB	

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

bits-48/33 (DOP-x) DOP along x axis
 LSB= 0.25

bits-32/17 (DOP-y) DOP along y axis
 LSB= 0.25

bits-16/1 (DOP-xy) = $\rho(X,Y)$
 LSB= 0.25
 Note: if $DOP_x=0$ or $DOP_y=0$
 then $DOP_{xy}=0$

Structure of Subfield # 2:
Standard Deviation of Position

Octet no. 1								Octet no. 2							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
σ_x															LSB

Octet no. 3								Octet no. 4							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
σ_y															LSB

Octet no. 5								Octet no. 6							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
$\rho(X,Y)$															LSB

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	$(\rho(X,Y))$	Correlation coefficient in two's complement LSB= 0.25

Encoding Rule : If $\sigma_x = 0$ or if $\sigma_y = 0$ then $\rho(X,Y) = 0$

Structure of Subfield # 3:
Standard Deviation of Geometric Height (WGS 84)

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

bits-16/1 (σ_{GH}) Standard Deviation of Geometric Height
LSB= 0.5 m

NOTE - There is now a new Item for the Position Accuracy defined in the Reserved Expansion Field (REF), more complete (includes a Standard Deviation of Position in WGS-84) and is based on a different calculation method (covariance instead of correlation). It is recommended to use the new definition. Nevertheless, Item I020/500 is kept in order to prevent a full incompatibility with previous releases of ASTERIX Cat. 020 already implemented.

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