EUROCONTROL Specification for Surveillance Data Exchange

ASTERIX Part 30 Category 016

Independent Non-Cooperative Surveillance System Configuration Reports

DOCUMENT IDENTIFIER : EUROCONTROL-SPEC-0149-30

Edition Number	:	**1.0**
Edition Date	:	**15 July 2019**
Status	:	**Released**
Intended for	:	**General Public**
Category	: EUROCONTROL Specification	

DOCUMENT CHARACTERISTICS

TITLE	
EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 30 **Category 016: Independent Non-Cooperative Surveillance System Configuration Reports**	
Publications Reference:	SPEC-0149-30
ISBN Number:	978-2-87497-028-3
Document Identifier / **Edition Number:**	1.0
EUROCONTROL-SPEC-0149-30 / **Edition Date:**	15/07/2019

Abstract
This document specifies the contents of ASTERIX Category 016 reports for the transmission of configuration data items of independent non-cooperative surveillance systems. When used in conjunction with ASTERIX Category 015 its use will enable data to be traced from a target report (in ASTERIX Category 015) through to the specific transmitter/receiver pair(s) in an MSPSR that contributed towards it.

Keywords			
Data Exchange	Messages	SAC	SIC
Data Category	Data Field	Data Item	UAP
ASTERIX	INCS	MSPSR	Configuration

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STATUS, AUDIENCE AND ACCESSIBILITY					
Status		**Intended for**		**Accessible via**	
Working Draft	☐	General Public	☑	Intranet	☐
Draft	☐	EUROCONTROL	☐	Extranet	☐
Proposed Issue	☐	Restricted	☐	Internet (www.eurocontrol.int)	☑
Released Issue	☑				

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.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.1-0.12	Various	Draft versions of Category 016 to cover the status reporting for Independent Non-Cooperative Surveillance Systems.	ALL
1.0	July 2019	Released Version	ALL

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1.   INTRODUCTION

1.1   Scope

This document describes the structure for the transmission of reports detailing the configuration of an Independent Non-Cooperative Surveillance (INCS) system.

The information used by the INCS system to compile the INCS Target Report (as detailed in ASTERIX Category 015) may come from various system components. As a target passes through the volume of airspace served by the sensor, the components contributing signals to formation of the Target Report are likely to change – the target may be 'illuminated' by RF signals from different transmitters and the signals emanating from the target may be received by different receivers. As such, the configuration of some INCS systems may be considered dynamic and not fixed in the conventional manner of a mono-static PSR.

When used, this ASTERIX Category 016 message format supplements the data contained in ASTERIX Category 015 (Ref Doc 2) – a generic specification for the transfer of INCS Target Reports generated by a range of INCS techniques and technologies. In ASTERIX Category 015 a data item (e.g. I015/400 Message Identifier) may be populated. The principal purpose of this ASTERIX Category 016 specification is to provide additional data items describing the configuration of the system components (the Transmitter(s) and Receiver(s)) that contributed to the Message Identifier in the ASTERIX Category 015 Target Report. This is information that specialist users may require when fault-finding, tuning or commissioning a system.

The combination of ASTERIX Category 015 Measurement Plot / Measurement Track and ASTERIX Category 016 (Sensor Configuration data) could potentially also be used in advanced trackers, particularly of a military design, to fuse overlapping coverage data from multiple sensors potentially even from different manufacturers. In this way, targets that would not be detected by an individual sensor due to an insufficient number of measurements could be elevated in to a 3D plot/track.

Further details regarding how ASTERIX Category 016 can be used to complement the use of ASTERIX Category 015 can be found in the ASTERIX Category 015 specification (Ref Doc 2).

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2.   REFERENCES

2.1   General

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

At the time of publication of this EUROCONTROL Standard 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 Standard Document.

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

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

2.2   Reference Documents

1. EUROCONTROL Specification SPEC-0149, Edition 2.4, 24 October 2016 "EUROCONTROL Specification for Surveillance Data Exchange – Part 1 All Purpose Structured EUROCONTROL Surveillance Information Exchange – ASTERIX".
2. EUROCONTROL Specification SPEC-0149-28 Edition 1.0 Dated 15 July 2019 "EUROCONTROL Specification Surveillance Data Exchange ASTERIX Part 28 Category 015 INCS Target Reports"
3. EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 26 Category 025 CNS/ATM Ground System Status Reports (EUROCONTROL-SPEC-0149-26) Edition Number 1.2 Edition Date April 2018

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3.   DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1   Definitions

Please refer to ASTERIX Part 1 [1] Chapter 3.1

3.2   Acronyms and Abbreviations

For the purposes of this EUROCONTROL Specification the following shall apply:

AMG	ASTERIX Maintenance Group
ASTERIX	All purpose STructured Eurocontrol suRveillance Information eXchange
CAT	Data Category
FRN	Field Reference Number
FSPEC	Field Specification
FX	Field Extension Indicator
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
INCS	Independent Non-Cooperative Surveillance
LEN	Length Indicator
LSB	Least Significant Bit
MSPSR	Multi-Static PSR
N.A	Not Applicable
NM	Nautical Mile, unit of distance (1852 metres)
PSR	Primary Surveillance Radar
REP	Field Repetition Indicator
s	second, unit of time
SAC	System Area Code
SIC	System Identification Code
SP	Special Purpose Indicator
UAP	User Application Profile (see Definitions)
UTC	Co-ordinated Universal Time

4.   GENERAL PRINCIPLES

4.1   General

This document describes the application of ASTERIX to Independent Non-Cooperative Surveillance (INCS) System Status Reports.

4.2   Time Management

Please refer to ASTERIX Part 1, chapter 5.3..

4.3   Unused Bits in Data Items.

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

4.4   Definitions and Addressing Concepts

4.4.1   Addressing Concepts: Assigning SAC/SIC Codes

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

4.5   INCS Configuration Reports

4.5.1   Why is Configuration Information Required?

The information used by the INCS system to compile the INCS Target Report (as detailed in ASTERIX Category 015) may come from various system components.

As a target passes through the volume of airspace served by the sensor, the components contributing to the Target Report are likely to change – the target may be 'illuminated' by RF signals from different transmitters and the signals emanating from the target may be received by different receivers.

As such, the configuration of some INCS systems may be considered dynamic and not fixed in the conventional manner. A knowledge of which system components contributed to the construction of the Target Report can be of interest to specialist users and assist with the tuning/adaptation of the system.

To compound the issue the transmitters may have further individual characteristics – they may be controlled as part of the system or may be 'Transmitters of Opportunity' (run by a 3rd party providing other services such as DVB-T, DAB or FM broadcasts).

4.5.2   Types of Configuration Components

Two component types have been identified as contributing to a system configuration:

- Transmitter (Data Item I016/410)
- Receiver (Data Item I016/420)

Each 'component' contributing to a distributed INCS sensor will be allocated a unique configuration ID. ASTERIX Category 016 provides a means to convey

details of each configuration component that contributed to an ASTERIX Category 015 Target Report.

4.5.3   Report Composition

The General ASTERIX Message Structure is described in ASTERIX Part 1, chapter 4.3.

Each ASTERIX Data Record shall have the following layout:

CAT = 016	**LEN**	**FSPEC**	Data Item	Data Item	…	Last Data Item of Record

where:

- Data Category (CAT) = 016, is a one-octet field indicating that the ASTERIX Data Record contains Independent Non-Cooperative Surveillance data
- Length Indicator (LEN) is a two-octet field indicating the total length in octets of the ASTERIX Data Record, including the CAT and LEN fields
- FSPEC is the Field Specification

NOTE: This ASTERIX Category 016 **does not follow** the blocking mechanism as used until edition 2.1 of Part 1 of ASTERIX. This means that it is **not permitted** to merge multiple ASTERIX records into an ASTERIX block.

More information is available from ASTERIX Part 1, chapter 4.3.3.

4.6   Composition of Reports

4.6.1   Sequence of Data Items

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

4.6.2   Presence of Data Items

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

5.   LAYOUT OF INCS GROUND SYSTEM CONFIGURATION

5.1   Standard Data Items

The standardised Data Items that shall be used for the transmission of ground-station service reports are defined in Table 5-1 and described in the following pages.

Table 5-1: Standard Data Items of Category 016

Data Item Ref. No.	Description	System Resolution
I016/000	Message Type	N.A.
I016/010	Data Source Identifier	N.A
I016/015	Service Identification	N.A.
I016/140	Time of Day	1/128 s
I016/200	System Configuration Reporting Period	1s
I016/300	Pair Identification	N.A
I016/400	Position of System Reference Point	N.A
I016/405	Height of System Reference Point	0.25m
I016/410	Transmitter Properties	N.A.
I016/420	Receiver Properties	N.A.

5.2   Description of Standard Data Items

5.2.1   Data Item I016/000, Message Type

Definition: This data item conveys the message type.

Format: One-octet fixed length data item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
MT
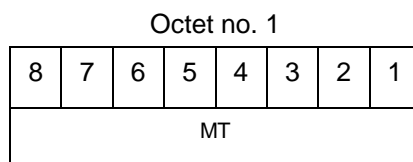
bits-8/1   (MT)   Message Type
                                        = 1   System Configuration
                                        = 2   Transmitter / Receiver Configuration

The encoding rules for each data item per message type are defined in the following table.

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

Table 5-2: Items per Message Type

Item	Type	System Configuration	Tx / Rx Configuration
I016/000	Message Type	M	M
I016/010	Data Source Identifier	M	M
I016/015	Service Identification	O	O
I016/140	Time of Day	M	M
I016/200	System Configuration Reporting Period	M	O
I016/300	Pair Identification	O	M
I016/400	System Reference Point	O	O
I016/405	Height of System Reference Point	O	O
I016/410	Transmitter Properties	X	M
I016/420	Receiver Properties	X	M

5.2.2   **Data Item I016/010, Data Source Identifier**

Definition :   Identification of the Ground System from which the data is 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: See Table 5-2: Items per Message Type

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

NOTE -   The SICs are allocated by the national authority responsible for the surveillance infrastructure.

5.2.3 Data Item I016/015, Service Identification

Definition :   Identifies the service being reported.

Format :   One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
				SID			
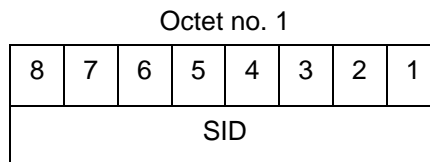
bits-8/1   (SID)   Service Identification

Encoding Rule: See Table 5-2: Items per Message Type

NOTE -   The service identification is allocated by the system.

5.2.4   **Data Item I016/140, Time of Day**

Definition :   Absolute time stamping expressed as UTC time.

Format :   Three-octet fixed length Data Item.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17

Time of Day (TOD)

Octet no. 2   Octet no. 3

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

TOD (cont.)   LSB
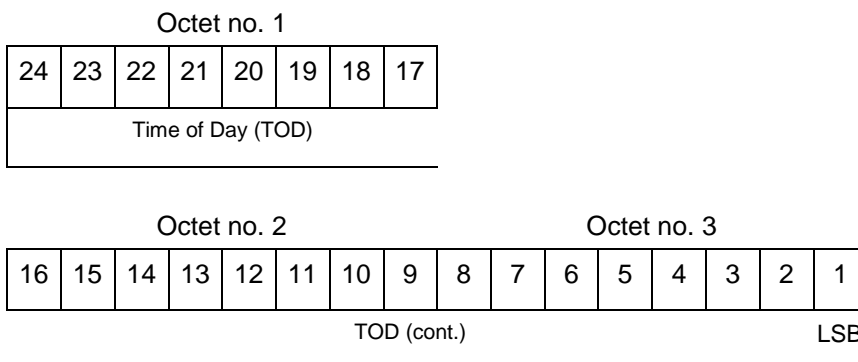
bits-24/1   (TOD)   Time of Day

bit-1   (LSB)   1/128 s

Encoding Rule: See Table 5-2: Items per Message Type

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

5.2.5 **Data Item I016/200, System Configuration Reporting Period**

Definition : Data item to indicate the reporting period of the system configuration messages.

Format : One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
SCRP							
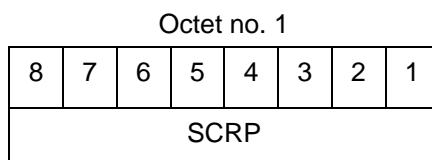
bits-8-1   (SCRP)   System Configuration Reporting Period

bit-1   (LSB)   = 1 s
                                  Valid Range 1 ≤ SCRP ≤ 255 s

Encoding Rule: See Table 5-2: Items per Message Type

NOTE - The item will be sent periodically (every SCRP) and each time a value change occurs.

5.2.6 Data Item I016/300, Pair Identification

Definition: The use of a pair identifier in this data item, that is common with its counterpart in ASTERIX Category I015/400, enables direct mapping from the INCS Target Report to the Transmitter/Receiver Pair that contributed to the target report.

This is an identifier pointing to a measurement that was created from a specific contributing pair where the Pair Identifier refers to the index that details both the transmitter characteristics (DVB-T, DAB, FM, dedicated etc) and the receiver characteristics.

Format: Repetitive Data Item starting with a one-octet field repetition indicator (REP) followed by at least one six-octet subfield.

Structure:

Octet no. 1

56	55	54	53	52	51	50	49
REP							

Octet no. 2   Octet no. 3

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Pair Identifier (PID)															

Octet no. 4   Octet no. 5

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Transmitter ID (TID)															

Octet no. 6   Octet no. 7

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Receiver ID (RID)															
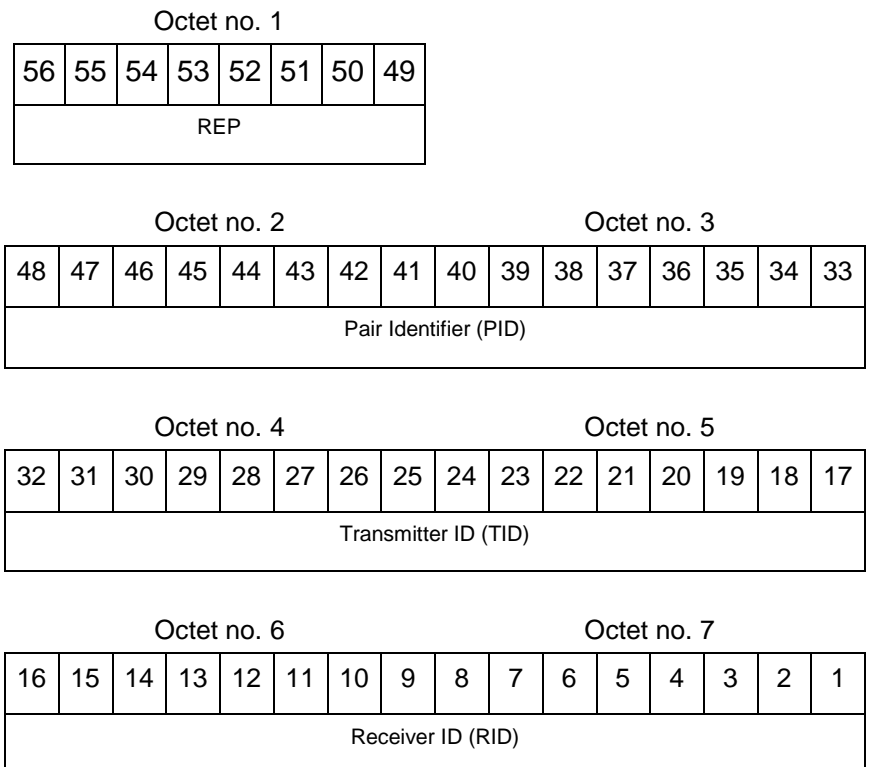
Bits-56-49   Repetition Factor

bits-48/33   Pair Identification (PID)

bits-32/17   Transmitter Identification (TID)

bits-16/1   Receiver Identification (RID)

Encoding Rule: See Table 5-2: Items per Message Type

5.2.7   Data Item I016/400, Position of the System Reference Point

Definition: Position of the system reference point 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
					Latitude in WGS-84 (cont.)										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
					Longitude in WGS-84 (cont.)										LSB
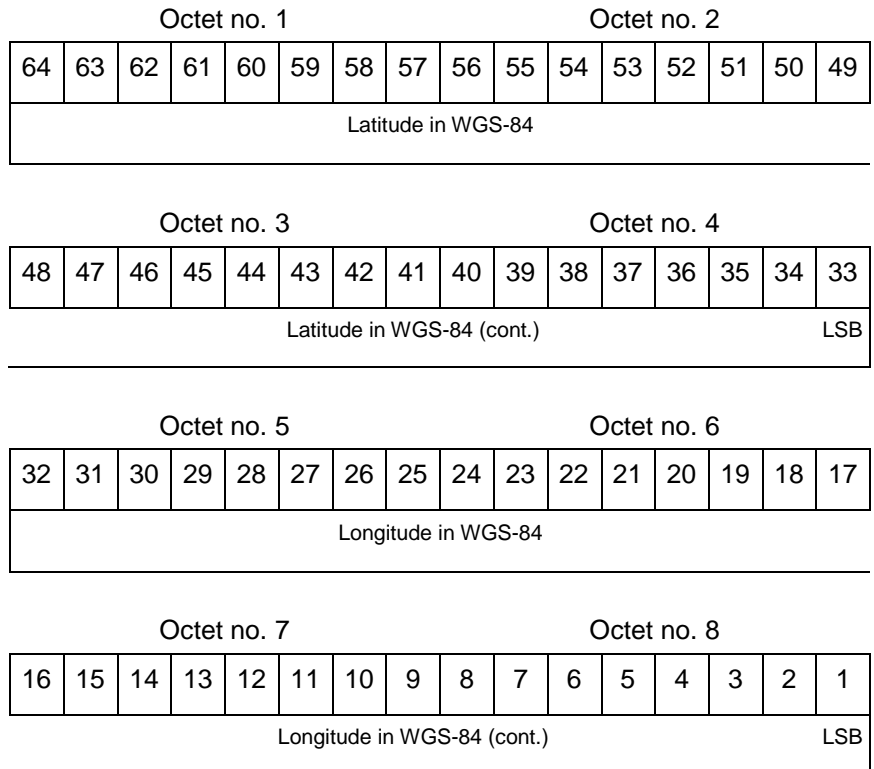
bits-64/33	(Latitude)	In WGS-84, in two's complement. max. range $\approx \pm90$ degree
bit-33	(LSB)	$= 180/2^{31}$ degree
bits-32/1	(Longitude)	In WGS-84, in two's complement. max. range $\approx \pm180$ degree
bit-1	(LSB)	$= 180/2^{31}$ degree

Encoding Rule: See Table 5-2: Items per Message Type

NOTE -   Positive longitude indicates East. Positive latitude indicates North.

NOTE -   I016/400 shall only be sent together with item I016/405 "Height of the System Reference Point".

5.2.8   Data Item I016/405, Height of System Reference Point

Definition: Height of the system reference point in Two's Complement form. The height shall use mean sea level as the zero reference level.

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
Height (WGS-84)															LSB
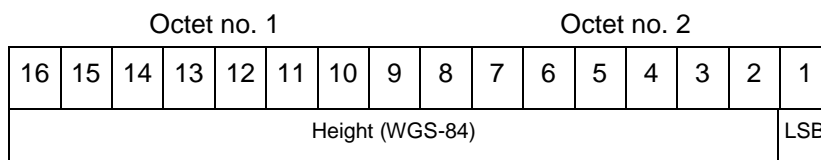
bits-16/1   Height (WGS-84) above MSL
bit-1   LSB = 0.25m
        Range $\approx$ +/- 8 192m

Encoding Rule: See Table 5-2: Items per Message Type

NOTE - I016/405 shall only be sent together with item I016/400 "Position of the System Reference Point".

5.2.9   Data Item I016/410, Transmitter Properties

Definition: This item provides properties of a transmitter component.

Format: Repetitive data item, starting with a one-octet field repetition indicator (REP) followed by at least one 21 octet subfield detailing the properties of the transmitter.

Structure of Primary Subfield:

Octet no. 1

176	175	174	173	172	171	170	169
REP							

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

168	167	166	165	164	163	162	161	160	159	158	157	156	155	154	153
TID															

Octet no. 4 | | | | | | | | Octet no. 5

152	151	150	149	148	147	146	145	144	143	142	141	140	139	138	137
Latitude in WGS-84															

Octet no. 6 | | | | | | | | Octet no. 7

136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121
Latitude in WGS-84 (cont.)															LSB

Octet no. 8 | | | | | | | | Octet no. 9

120	119	118	117	116	115	114	113	112	111	110	109	108	107	106	105
Longitude in WGS-84															

Octet no. 10 | | | | | | | | Octet no. 11

104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89
Longitude in WGS-84 (cont.)															LSB

Octet no. 12 | | | | | | | | Octet no. 13

88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73
Altitude (in reference to MSL)															LSB

		Octet no. 14									Octet no. 15				
72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57
Transmission Time Offset															

		Octet no. 16									Octet no. 17				
56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41
Transmission Time Offset (cont.)															LSB

		Octet no. 18									Octet no. 19				
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25
0	0	0	0	ATO											

		Octet no. 20					
24	23	22	21	20	19	18	17
ATO (cont.)							LSB

		Octet no. 21									Octet no. 22				
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Parallel Transmitter Index															

Bits 176/169	(REP)	Repetition Factor
bits-168/153	(TID)	Transmitter ID
bits-152/121	(Latitude)	In WGS-84, in two's complement.
		max. range $\approx$ ±90 degree
bit-121	(LSB)	= $180/2^{31}$ degree
bits-120/89	(Longitude)	In WGS-84, in two's complement.
		max. range $\approx$ ±180 degree
bit-89	(LSB)	= $180/2^{31}$ degree
bits-88/73		Altitude (WGS-84), in two's complement
		max. range $\approx$ ± 8,192 m
bit-73	(LSB)	= 0.25m
bits-72/41		Transmission Time Offset

		max. value ≈ +/- 4.29 s
bit-41	(LSB)	= 2 ns
bits-40-37		Spare bits
bits-36/17	(ATO)	Accuracy of Transmission Time Offset
		max. value ≈ 1.049 ms
bit-17	(LSB)	= 1 ns
bits-16/1	(PCI)	Parallel Transmitter Index

Encoding Rule: See Table 5-2: Items per Message Type

NOTE -   Regarding Transmitter Identification:

a. Individual channels of a transmitter are considered as separate collocated transmitters.
b. A Transmitter ID may be assigned to individual channels of a compound transmitter. i.e. a single multi-channel transmitter may be assigned several Tx ID.
c. The Tx ID shall be used in a unique way for a specific SAC/SIC.

NOTE -   Regarding Transmitter Latitude and Longitude and Altitude:

a. The Tx Location and Altitude is the position of the component in WGS-84 coordinates. The vertical distance between the component and the projection of its position on the earth's ellipsoid, as defined by WGS-84, in two's complement form.

NOTE -   Regarding Transmission Time Offset

a. Time offset of transmitter compared to the reference transmitter within the single frequency network (SFN).

NOTE -   Regarding Accuracy of Transmission Time Offset

a. The Accuracy of the Transmission Time Offset is the Standard Deviation of the measurement of the transmission time offset between the transmitter channel compared to the reference transmitter within the single frequency network (SFN).

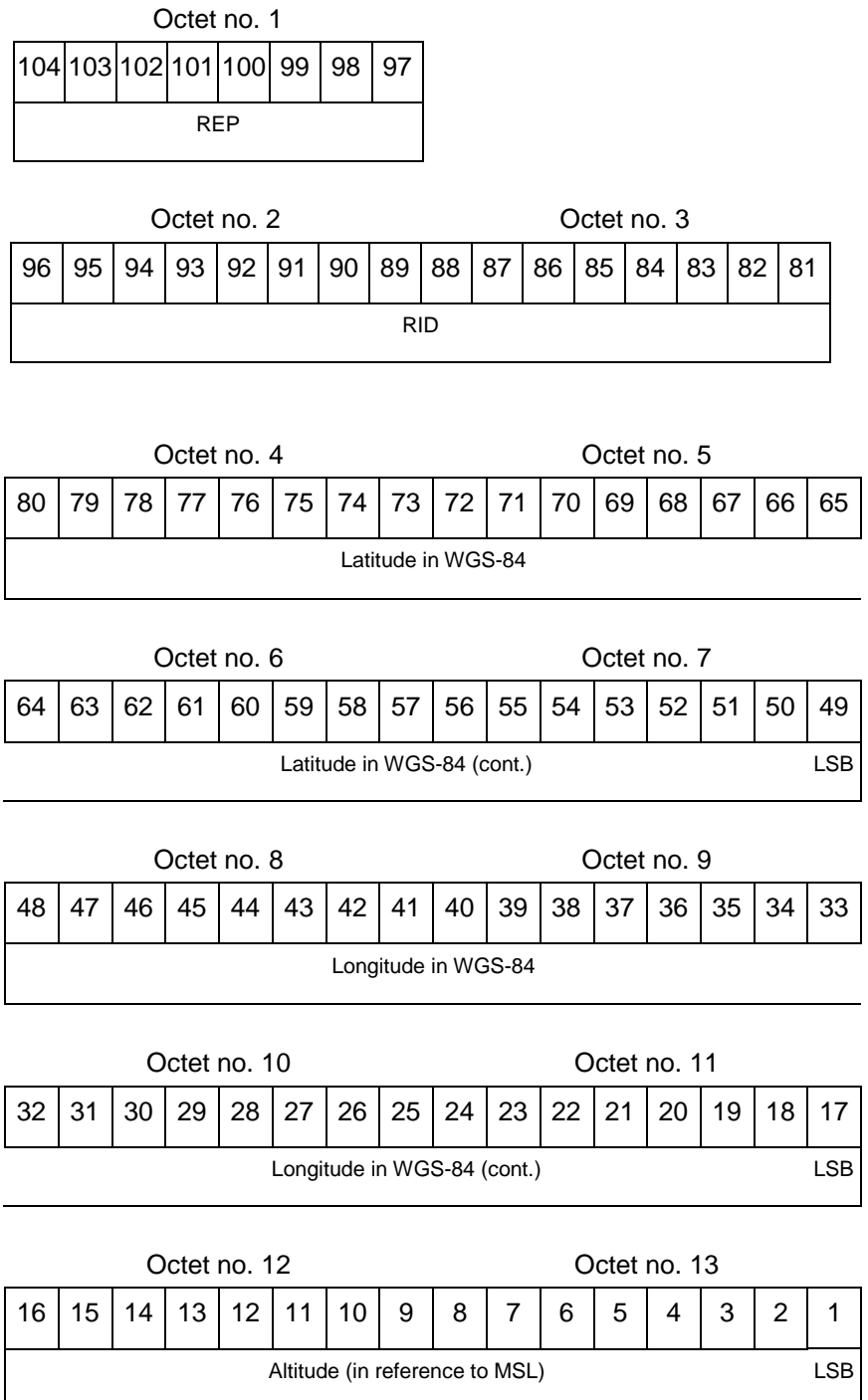**NOTE -**   Regarding Parallel Transmitter Index

a. The Parallel Transmitter Index is the identification of the transmitter via index, which is sent in parallel.
b. For referring to a one-octet index bits-16/9 shall be set to zero.
c. This index shall be used in a unique way for a specific SAC/SIC.
d. In a Single Frequency Network the parallel transmitter index is the index of the reference transmitter.

5.2.10   Data Item I016/420, Receiver Properties

Definition: This item provides properties of the receiver component.

Format: Repetitive data item, starting with a one-octet field repetition indicator (REP) followed by at least one 12 octet subfield.

Structure of Primary Subfield:

Octet no. 1

104	103	102	101	100	99	98	97
REP							

Octet no. 2   Octet no. 3

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

Octet no. 4   Octet no. 5

80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
Latitude in WGS-84															

Octet no. 6   Octet no. 7

64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
Latitude in WGS-84 (cont.)															LSB

Octet no. 8   Octet no. 9

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Longitude in WGS-84															

Octet no. 10   Octet no. 11

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Longitude in WGS-84 (cont.)															LSB

Octet no. 12   Octet no. 13

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Altitude (in reference to MSL)															LSB

Bits 104/97	(REP)	Repetition Factor
bits-96/81	(RID)	Receiver Component ID
bits-88/49	(Latitude)	In WGS-84, in two's complement. max. range $\approx$ ±90 degree
bit-49	(LSB)	= $180/2^{31}$ degree
bits-48/17	(Longitude)	In WGS-84, in two's complement. max. range $\approx$ ±180 degree
bit-17	(LSB)	= $180/2^{31}$ degree
bits-16/1		Altitude (WGS-84), in two's complement max. range $\approx$ ± 8 192m
bit-1		(LSB) = 0.25m

NOTE -   Regarding the Receiver Identification

a. The Rx ID shall be used in a unique way for a specific SAC/SIC.

NOTE - Regarding the Receiver Location and Altitude (WGS-84)

a. The Rx Location and Altitude is the of the component in WGS-84 coordinates. The vertical distance between the component and the projection of its position on the earth's ellipsoid, as defined by WGS-84, in two's complement form.

5.3   Standard User Application Profile

The following standard UAP shown in Table 2 shall be used for the transmission of INCS system service reports:

Table 2 - Standard UAP for INCS System Configuration Reports

FRN	Data Item	Data Item Description	Length
1	I016/010	Data Source Identifier	2
2	I016/015	Service Identification	1
3	I016/000	Message Type	1
4	I016/140	Time of Day	3
5	I016/200	System Configuration Reporting Period	1
6	I016/300	Pair Identification	1+n*6
7	I016/400	Position of the System Reference Point	8
FX	N.A.	Field Extension Indicator	N.A.
8	I016/405	Height of the System Reference Point	2
9	I016/410	Transmitter Properties	1+n*21
10	I016/420	Receiver Properties	1+n*12
11	SP-Data Item	Special Purpose Field	1+1+
12	-	Spare	N.A.
13	-	Spare	N.A.
14	-	Spare	N.A.
FX	N.A.	Field Extension Indicator	N.A.

where:

- the first column indicates the FRN associated to each Data Item used in the UAP;

- the fourth column gives the format and the length of each item, a stand-alone figure indicates the octet count of a fixed-length Data Item, 1+ indicates a variable-length Data Item comprising a first part of one-octet followed by n-octets extent as necessary.