



# EUROCONTROL Specification for Surveillance Data Exchange ASTERIX

## Part 2a Category 001 Monoradar Target Reports

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**EUROCONTROL Specification  
for Surveillance Data Exchange  
ASTERIX Part 2a Category 001  
Monoradar Target Reports**

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This document describes the application of ASTERIX to the transmission of Monoradar Target Reports.		
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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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## 1. INTRODUCTION

### 1.1 General

#### 1.1.1 Purpose

The present EUROCONTROL Standard concerns the transmission of radar related data between radar data sources (e.g. radar stations, Radar Data Processing (RDP) systems) and sinks (end user data processing systems) and describes the message structure for the exchange of radar related data between radar stations and centres and between Air Traffic Control (ATC) centres, to be used in the EUROCONTROL area.

The transmission of radar data makes use of the message structure, known by the acronym **ASTERIX**, standing for **All Purpose S**tructured **EUROCONTROL Radar Information EX**change, devised by the Study Group on the Exchange of radar related data between processors of ATC systems, this group was a subgroup of the former Radar Systems Specialist Panel (RSSP), whose responsibilities have been taken over by the EATCHIP Surveillance Team as from April 1994. ASTERIX was approved by the former RSSP at their 15th Meeting held on 1/4 July 1986.

### 1.1.2 Structure of The EUROCONTROL Standard for Radar Data Exchange

This EUROCONTROL Standard for Radar Data Exchange contains the following Parts:

Part 1: All Purpose Structured EUROCONTROL Radar Information Exchange-ASTERIX

This Part contains the specifications and the conventions used in the framework of ASTERIX.

Only Edition 1.0 of Part 1 as listed in Ref [1] is applicable to this specification.

Part 2a: Transmission of Monoradar Target Reports

This Part describes the standard application of ASTERIX for the transmission of monoradar target reports (plots, tracks) from a radar station to one or more RDP system(s).

Part 2b: Transmission of Monoradar Service Messages

This Part describes the standard application of ASTERIX for the transmission of monoradar service messages from a radar station to one or more RDP system(s).

Part 3: Transmission of Monoradar Derived Weather Information

This Part describes the standard application of ASTERIX for the transmission of relatively simple meteorological images of precipitation areas of various intensity levels from a radar station to one or more RDP system(s).

**NOTE** - Other Parts were added to this EUROCONTROL Standard as new applications using the ASTERIX message structure were identified and deemed suitable to be standardised. The list of all Parts of the ASTERIX library are available from the ASTERIX website at [www.eurocontrol.int/asterix](http://www.eurocontrol.int/asterix).

## 1.2 Scope

**1.2.1** This document describes the message structure for the transmission of monoradar target reports from a stand alone radar station (conventional Secondary Surveillance Radar (SSR), monopulse, conventional primary radar or primary radar using Moving Target Detection (MTD) processing), to one or more RDP systems.

**1.2.2** This Part of the EUROCONTROL Standard specifies the message structure and contents of monoradar data from a stand alone radar station conforming to the ASTERIX Standard.

**1.2.3** In the context of this Part of this Standard monoradar data covers radar target reports from the following types of radar:

- conventional SSR;
- monopulse SSR;
- conventional primary radar;
- primary radars using MTD processing.

**1.2.4** Radar target reports are data out of Data Category 001.

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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 Standard SUR.ET1.ST05.2000-STD-01-01. All Purpose Structured EUROCONTROL Radar Information Exchange - ASTERIX. Edition 1.0, 1997.

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### 3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

#### 3.1 Definitions

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

- 3.1.1 Calculated Item:** A piece of information (e.g. the position of a target) derived from the raw radar information through an intermediate processing such as transformation of coordinates, tracking, code conversion, etc.
- 3.1.2 Catalogue of Data Items:** List of all the possible Data Items of each Data Category describing the Data Items by their reference, structure, size and units (where applicable).
- 3.1.3 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.
- 3.1.4 Data Category:** Classification of the data in order to permit inter alia an easy identification.
- 3.1.5 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.
- 3.1.6 Data Item:** The smallest unit of information in each Data Category.
- 3.1.7 Measured Item:** A piece of information (e.g. the position of a target) directly derived from the radar information and transmitted without any intermediate processing.
- 3.1.8 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
- 3.1.9 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 Standard Document the following shall apply:

°	Degree (angle)
<b>AMG</b>	ASTERIX Maintenance Group
<b>ASTERIX</b>	All Purpose <b>ST</b> ructured <b>EUROCONTROL</b> Radar Information <b>EX</b> change
<b>ATC</b>	Air Traffic Control
<b>CAT</b>	Data Category
<b>dBm</b>	The dBm is the unit of absolute power related to 1 milliwatt.
<b>f</b>	Scaling factor
<b>FL</b>	Flight Level, unit of altitude (expressed in 100's of feet)
<b>FRN</b>	Field Reference Number
<b>FSPEC</b>	Field Specification
<b>FX</b>	Field Extension Indicator
<b>ICAO</b>	International Civil Aviation Organization
<b>kt</b>	knot = NM/hour, unit of speed
<b>LEN</b>	Length Indicator
<b>LSB</b>	Least Significant Bit
<b>MSSR</b>	Monopulse Secondary Surveillance Radar
<b>MTD</b>	Moving Target Detection
<b>MTI</b>	Moving Target Indicator
<b>NM</b>	Nautical Mile, unit of distance (6 080 feet)
<b>PSR</b>	Primary Surveillance Radar
<b>RDP</b>	Radar Data Processing (system)
<b>REP</b>	Field Repetition Indicator
<b>RFS</b>	Random Field Sequencing (organization of the Data Fields in a Record)
<b>RS</b>	Random Sequence Indicator



<b>s</b>	second, unit of time
<b>SAC</b>	System Area Code
<b>SIC</b>	System Identification Code
<b>SP</b>	Special Purpose Indicator
<b>SPI</b>	Special Position Identification
<b>SSR</b>	Secondary Surveillance Radar
<b>UAP</b>	User Application Profile (see Definitions )
<b>UTC</b>	Coordinated Universal Time

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## 4. GENERAL PRINCIPLES

### 4.1 General

The transmission of monoradar information shall require the transmission of two types of messages:

- data messages or radar target reports containing plot or track information;
- radar service messages used to signal status information of the radar station to the user systems (not covered by this document).

### 4.2 Radar Target Reports

#### 4.2.1 Types of Radar Target Reports

Radar target reports shall be transmitted either in the form of plots or tracks generated by a local tracking system at the radar site.

#### 4.2.2 User Application Profiles and Data Blocks

4.2.2.1 Two User Application Profiles (UAPs) are defined and shall be used depending on whether plot or track information is provided by the radar.

4.2.2.2 Data Blocks containing radar target reports shall have the following layout.

<b>CAT = 001</b>	<b>LEN</b>	<b>FSPEC</b>	Items of the first record		<b>FSPEC</b>	Items of the last record
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where:

- Data Category (CAT) = 001, is a one-octet field indicating that the Data Block contains radar target reports;
- 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.

### **4.3 Composition of Messages**

- 4.3.1** Messages shall be composed of Data Items assembled in the order defined by the Field Reference Number (FRN) in the associated UAP.
- 4.3.2** Data Items shall be either compulsory or optional.
  - 4.3.2.1** Compulsory items represent commonly used data required by any application, they shall be implemented;
  - 4.3.2.2** Optional items represent more specific data and their implementation shall be negotiated between users.
- 4.3.3** Whether Data Items are compulsory or optional, they shall be either always transmitted or conditionally transmitted.
  - 4.3.3.1** When compulsory, they shall always be transmitted in a Record with the corresponding FSPEC bits set to one;
  - 4.3.3.2** When optional, they shall be present in a Record only if certain conditions are met (e.g. availability of the data). The corresponding FSPEC bits being set to one or to zero according to the presence or absence of the fields.

## 5. LAYOUT OF TARGET REPORT MESSAGES

### 5.1 Standard Data Items

The standardised Data Items which shall be used for the transmission of monoradar target reports are defined in Table 1 and described in the following pages.

**Table 1 - Standard Data Items of Category 001**

Data Item Ref. No.	Description	System Units
I001/010	Data Source Identifier	N.A.
I001/020	Target Report Descriptor	N.A.
I001/030	Warning/Error Conditions	N.A.
I001/040	Measured Position in Polar Coordinates	RHO: 1/128 NM THETA: $360^\circ/(2^{16})$
I001/042	Calculated Position in Cartesian Coordinates	X, Y: 1/64 NM
I001/050	Mode-2 Code in Octal Representation	N.A.
I001/060	Mode-2 Code Confidence Indicator	N.A.
I001/070	Mode-3/A Code in Octal Representation	N.A.
I001/080	Mode-3/A Code Confidence Indicator	N.A.
I001/090	Mode-C Code in Binary Representation	1/4 FL
I001/100	Mode-C Code and Code Confidence Indicator	N.A.
I001/120	Measured Radial Doppler Speed	$(2^{-14})$ NM/s
I001/130	Radar Plot Characteristics	N.A.
I001/131	Received Power	1 dBm
I001/141	Truncated Time of Day	1/128 s
I001/150	Presence of X-Pulse	N.A.
I001/161	Track/Plot Number	N.A.
I001/170	Track Status	N.A.
I001/200	Calculated Track Velocity in Polar Coordinates	Speed: $(2^{-14})$ NM/s Heading: $360^\circ/(2^{16})$
I001/210	Track Quality	N.A.

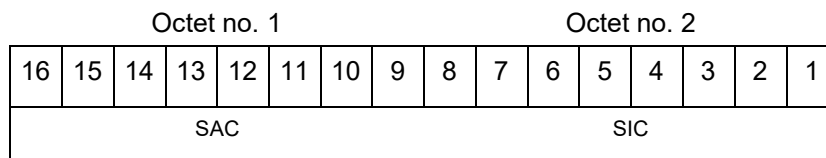
## 5.2 Description of Standard Data Items

### 5.2.1 Data Item I001/010, Data Source Identifier

**Definition:** Identification of the radar station from which the data are received.

**Format:** Two-octets fixed length Data Item.

**Structure:**



bits-16/9 (SAC) System Area Code

bits-8/1 (SIC) System Identification Code

**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 I001/020, Target Report Descriptor**

**Definition:** Type and characteristics of the radar data as transmitted by a radar station.

**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	SIM	SSR/PSR		ANT	SPI	RAB	FX

- bit-8 (TYP) = 0 Plot  
= 1 Track
- bit-7 (SIM) = 0 Actual plot or track  
= 1 Simulated plot or track
- bits-6/5 (SSR/PSR) Radar detection in last antenna scan, as follows:
  - = 00 No detection;
  - = 01 Sole primary detection;
  - = 10 Sole secondary detection;
  - = 11 Combined primary and secondary detection.
- bit-4 (ANT) = 0 Target report from antenna 1  
= 1 Target report from antenna 2
- bit-3 (SPI) = 0 Default  
= 1 Special Position Identification
- bit-2 (RAB) = 0 Default  
= 1 Plot or track from a fixed transponder
- bit-1 (FX) = 0 End of Data Item  
= 1 Extension into first extent

**NOTE -** Bit-7 (SIM) is used to identify a simulated target report as produced by a traffic simulator.

**Structure  
of First Extent:**

Octet no. 1

8	7	6	5	4	3	2	1
TST	DS1/DS2	ME	MI	0	0	0	FX

bit-8	(TST)	= 0	Default
		= 1	Test target indicator
bits-7/6	(DS1/DS2)	= 00	Default
		= 01	Unlawful interference (code 7500)
		= 10	Radio-communication failure (code 7600)
		= 11	Emergency (code 7700)
bit-5	(ME)	= 0	Default
		= 1	Military emergency
bit-4	(MI)	= 0	Default
		= 1	Military identification
bits-3/2			Spare bits set to zero
bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into next extent

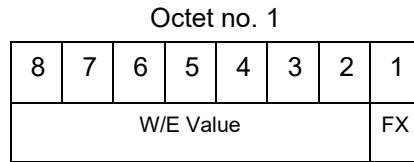


**5.2.3 Data Item I001/030, Warning/Error Conditions**

**Definition:** Warning/error conditions detected by a radar station 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 of First Part:**



bits-8/2	(W/E Value)		First warning/error condition value
bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into first extent (e.g. second W/E condition value)

**NOTES**

1. Warning/error condition values 0-63 are reserved for common standard use, whereas the values 64-127 are application dependent.
2. The following set of common W/E values is defined:
  - W/E = 0, no warning nor error condition;
  - W/E = 1, garbled reply;
  - W/E = 2, reflection;
  - W/E = 3, sidelobe reply;
  - W/E = 4, split plot;
  - W/E = 5, second time around reply;
  - W/E = 6, angels;
  - W/E = 7, terrestrial vehicles.
3. The following set of applications dependent W/E values are reserved:
  - W/E = 64, possible wrong code in Mode-3/A;
  - W/E = 65, possible wrong altitude information, transmitted when the Code C credibility check fails together with the Mode-C code in binary notation;
  - W/E = 66 possible phantom MSSR plot;
  - W/E = 80 fixed PSR plot;
  - W/E = 81 slow PSR plot;
  - W/E = 82 low quality PSR plot.

**5.2.4 Data Item I001/040, Measured Position in Polar Coordinates**

**Definition:** Measured position of an aircraft in local polar coordinates.

**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
RHO														LSB	

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

bit-17 (LSB) = 1/128 NM.  
Max. range = 512 NM

bit-1 (LSB) =  $360^\circ / (2^{16}) = 0.0055^\circ$

**NOTE -** When expressed in 16 bits, signed or unsigned azimuths have the same value.

**5.2.5 Data Item I001/042, Calculated Position in Cartesian Coordinates**

**Definition:** Calculated position of an aircraft in cartesian coordinates.

**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
X-Component														LSB	

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

bit-17 (LSB) =  $2^{(-6+f)}$   
 where f is the scaling factor applied, modifying the standard quantisation unit.  
 Max. range =  $2^{(9+f)}$  NM

bit-1 (LSB) =  $2^{(-6+f)}$   
 Max. range =  $2^{(9+f)}$  NM

**NOTES**

1. A default quantisation unit of 1/64 NM is obtained for a value of f = 0.
2. Negative values are expressed in 2's complement form, bit-32 and bit-16 shall be set to 0 for positive values and 1 for negative values.

**5.2.6 Data Item I001/050, Mode-2 Code in Octal Representation****Definition :** Reply to Mode-2 interrogation.**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 as derived from the reply of the transponder
		=	1	Smoothed Mode-2 code as provided by a local tracker
bit-13				Spare bit set to 0
bits-12/1				Mode-2 code in octal representation

**NOTES**

1. Smoothed Mode-2 data (bit-14 set to one) is used when the plot contains no Mode-2 code or the Mode-2 codes of the plot and track are different.
2. Bits-16/15 have no meaning in the case of a smoothed Mode-2 and are set to 0 for a calculated track.

**5.2.7 Data Item I001/060, Mode-2 Code Confidence Indicator**

**Definition:** Confidence level for each bit of a Mode-2 reply as provided by a monopulse SSR station.

**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	QA4	QA2	QA1	QB4	QB2	QB1	QC4	QC2	QC1	QD4	QD2	QD1

bits-16/13

Spare bits set to 0

bits-12/1 (QXi) = 0 High quality pulse Xi  
 = 1 Low quality pulse Xi

**NOTE -** This Data Item is only transmitted if at least one pulse is of low quality.

**5.2.8 Data Item I001/070, 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 as derived from the reply of the transponder  
= 1 Smoothed Mode-3/A code as provided by a local tracker
- bit-13 Spare bit set to 0
- bits-12/1 Mode-3/A reply in octal representation

**NOTES**

1. The detector signals a garbled code (bit-15 set to one) when at least two replies are overlapping.
2. Smoothed Mode-3/A data (bit-14 set to a one) are used in the case of the absence of Mode-3/A code information in the plot, or in the case of a difference between the plot and track Mode-3/A code information.
3. Bits-16/15 have no meaning in the case of a smoothed Mode-3/A and are set to 0 for a calculated track.

**5.2.9 Data Item I001/080, Mode-3/A Code Confidence Indicator**

**Definition:** Confidence level for each bit of a Mode-3/A reply as provided by a monopulse SSR station.

**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	QA4	QA2	QA1	QB4	QB2	QB1	QC4	QC2	QC1	QD4	QD2	QD1

bits-16/13

Spare bits set to 0

bits-12/1 (QXi) = 0 High quality pulse Xi  
 = 1 Low quality pulse Xi

**NOTE -** This Data Item will only be transmitted if at least one pulse is of low quality.

**5.2.10 Data Item I001/090, Mode-C Code in Binary Representation**

**Definition:** Mode-C height converted into binary 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	Mode-C HEIGHT												LSB	

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

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

bit-1 (LSB) = 1/4 FL = 25 ft.

**NOTES**

1. The detector signals a garbled code when at least two replies are overlapping.
2. The maximum height which can be represented is 204 775 ft. Practically the maximum valid value is 126 750 ft (refer to ICAO Annex 10).
3. Negative values are expressed in 2's complement form, bit-14 is set to 0 for positive values and 1 for negative values.

**5.2.11 Data Item I001/100, Mode-C Code and Code Confidence Indicator**

**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 monopulse SSR 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	B1	D1

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	QB1	QD1

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

**NOTES**

1. This Data Item is only transmitted if at least one pulse is of low quality.
2. The detector signals a garbled code when at least two replies are overlapping.

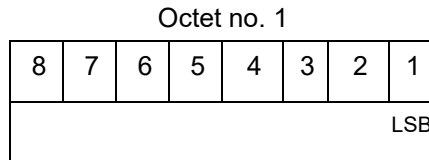


**5.2.12 Data Item I001/120, Measured Radial Doppler Speed**

**Definition:** Radial component of the ground speed as measured by means of Doppler filter banks in radar signal processors.

**Format:** One-octet fixed length Data Item.

**Structure:**



$$\text{bit-1 (LSB)} = 2^{(-14+f)} \text{ NM/s.}$$

**NOTES**

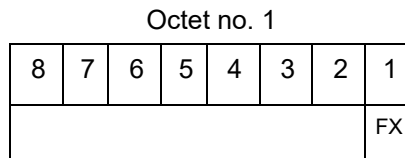
1. A default quantisation unit of 14.062 5 kt and a maximum of +/- 1 800 kt is obtained for a value of f = 6.
2. Negative values are expressed in 2's complement form, bit-8 is set to 0 for positive values and 1 for negative values.

**5.2.13 Data Item I001/130, Radar Plot Characteristics**

**Definition:** Additional information on the quality of the target report.

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

**Structure of First Part:**



bits-8/2 = Indicator. The actual meaning of the bits is application dependent.

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

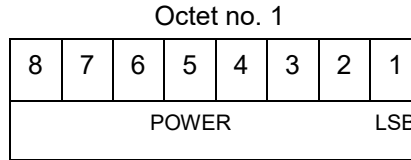
**NOTE -** This Data Item may contain parameters such as plot runlength (primary and secondary), difference between primary and secondary derived azimuth, pulse amplitude, etc.

**5.2.14 Data Item I001/131, Received Power**

**Definition:** Measurement of the received power.

**Format:** One-octet fixed length Data Item.

**Structure:**



bits-7/1 (POWER)      Decimal logarithm of the power received in dBm.  
 POWER = 0 for 0 dBm

bit-1 (LSB)      = 1 dBm

**NOTES**

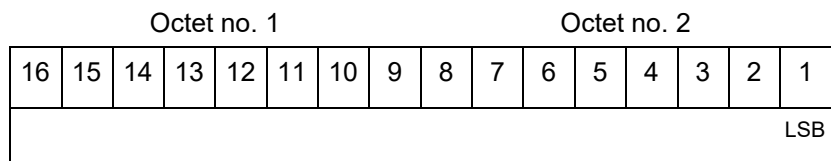
1. POWER is the measured value of the power received on the sum pattern for a plot.
2. Negative values are expressed in 2's complement form, bit-8 is set to 0 for positive values and 1 for negative values.

**5.2.15 Data Item I001/141, Truncated Time of Day**

**Definition:** Absolute time stamping expressed as Coordinated Universal Time (UTC) time.

**Format:** Two-octet fixed length Data Item.

**Structure:**



bit-1 (LSB)      =  $(2^{-7})$  s = 1/128 s

**NOTES**

1. The exchange of this Data Item allows the easy derivation of the correct UTC time value, provided that the clocks at the data source and sink(s) are less than 512 seconds out of synchronisation. Special care has to be taken at the transition of an "all ones" value to an "all zeros" value (every 512 seconds).
2. The time of day value is reset to 0 each day at midnight.
3. For time management in radar transmission applications, refer to Part 1, paragraph 5.4 [Ref. 2].

**5.2.16 Data Item I001/150, Presence of X-Pulse**

**Definition:** Presence of the X-Pulse for the various modes applied in the interrogation interlace pattern.

**Format:** One-octet fixed length Data Item.

**Structure:**

Octet no. 1							
8	7	6	5	4	3	2	1
XA	0	XC	0	0	X2	0	0

bit-8 (XA) = 0 Default  
 = 1 X-pulse received in Mode-3/A reply

bit-7 Spare bit set to 0

bit-6 (XC) = 0 Default  
 = 1 X-pulse received in Mode-C reply

bits-5/4 Spare bits set to 0

bit-3 (X2) = 0 Default  
 = 1 X-pulse received in Mode-2 reply

bits-2/1 Spare bits set to 0

**NOTE -** This Data Item is transmitted only if at least one X-pulse has been received in a Mode-A, Mode-2 or Mode-C reply.

**5.2.17 Data Item I001/161, Track Plot Number**

**Definition:** An integer value representing a unique reference to a track/plot record within a particular track/plot 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
TRACK/PLOT NUMBER (max. 65 535)															

**NOTE -** The differentiation between track and plot number is either implicit or is made via the Target Report Descriptor (Data Item I001/020).

**5.2.18 Data Item I001/170, Track Status**

**Definition:** Status of track derived either from primary and/or secondary radar information.

**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
CON	RAD	MAN	DOU	RDPC	0	GHO	FX

bit-8	(CON)	= 0	Confirmed track
		= 1	Track in initialisation phase
bit-7	(RAD)	= 0	Primary track
		= 1	SSR/Combined track
bit-6	(MAN)	= 0	Default
		= 1	Aircraft manoeuvring
bit-5	(DOU)	= 0	Default
		= 1	Doubtful plot to track association
bit-4	(RDPC)		Radar Data Processing Chain
		= 0	RDP Chain 1
		= 1	RDP Chain 2
bit-3			Spare bit set to 0
bit-2	(GHO)	= 0	Default
		= 1	Ghost track
bit-1	(FX)	= 0	End of Data Item
		= 1	Extension into first extent

**NOTES**

1. Bit-2 (GHO) is used to signal that the track is suspected to have been generated by a fake target.
2. Bit-4 (RDPC) is used to signal the discontinuity of the track numbers.

**Structure of First Extent:**

Octet no. 1							
8	7	6	5	4	3	2	1
TRE	0	0	0	0	0	0	FX

bit-8 (TRE) = 0 Default  
 = 1 Last report for a track

bits-7/2 Spare bits set to 0

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

**5.2.19 Data Item I001/200, Calculated Track Velocity in Polar Coordinates**

**Definition:** Calculated track velocity expressed in polar coordinates.

**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	
CALCULATED GROUNDSPEED (max. 2 NM/s)														LSB		

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

bit-17 (LSB) =  $(2^{-14})$  NM/s = 0.22 kt

bit-1 (LSB) =  $360^\circ/(2^{16})$  = 0.005 5°

**5.2.20 Data Item I001/210, Track Quality****Definition:** Relative track quality.**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
							FX

bits-8/2

Quality indicator.

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

**NOTE -** Actual bit signification is application dependent.

### 5.3 Transmission of Plot Information

#### 5.3.1 Standard User Application Profile

5.3.1.1 The following standard UAP shown in Table 2 shall be used for the transmission of primary, SSR or combined primary/SSR plots:

**Table 2 - Standard UAP for Plot Information**

FRN	Data Item	Information	Length in Octets
1	I001/010	Data Source Identifier	2
2	I001/020	Target Report Descriptor	1+
3	I001/040	Measured Position in Polar Coordinates	4
4	I001/070	Mode-3/A Code in Octal Representation	2
5	I001/090	Mode-C Code in Binary Representation	2
6	I001/130	Radar Plot Characteristics	1+
7	I001/141	Truncated Time of Day	2
FX	-	Field Extension Indicator	-
8	I001/050	Mode-2 Code in Octal Representation	2
9	I001/120	Measured Radial Doppler Speed	1
10	I001/131	Received Power	1
11	I001/080	Mode-3/A Code Confidence Indicator	2
12	I001/100	Mode-C Code and Code Confidence Indicator	4
13	I001/060	Mode-2 Code Confidence Indicator	2
14	I001/030	Warning/Error Conditions	1+
FX	-	Field Extension Indicator	-
15	I001/150	Presence of X-Pulse	1
16	-	Spare	-
17	-	Spare	-
18	-	Spare	-
19	-	Spare	-
20	-	Reserved for SP Indicator	-
21	-	Reserved for Random Field Sequencing (RFS) Indicator (RS-bit)	-
FX	-	Field Extension Indicator	-

where:

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

5.3.1.2 The maximum length of the corresponding FSPEC is three octets.

## 5.3.2 Encoding Rules

**5.3.2.1** Data Item I001/010 (Data Source Identifier) is compulsory and shall always be transmitted in each Data Block, at least in the first Record of a sequence of Records originating from the same data source.

**Recommendation** *The Data Source Identifier should be transmitted in every Record.*

**5.3.2.2** Data Item I001/020 (Target Report Descriptor) is compulsory and shall always be transmitted.

**NOTE -** Bit-8 of the first part of this field indicates whether the contents of the record concerns a plot or a track, and allows the user systems to apply the proper UAP to decode the remaining information within the record.

**5.3.2.3** Data Item I001/040 (Measured Position in Polar Coordinates) is compulsory and shall always be transmitted for plot information.

**5.3.2.4** Data Item I001/070 (Mode-3/A Code in Octal Representation) is compulsory for SSR or combined plots and shall be transmitted when available.

**5.3.2.5** Data Item I001/090 (Mode-C Code in Binary Representation) is compulsory for SSR or combined plots and shall be transmitted when available. The binary notation allows an easier processing by the user systems than the Gray code as received from the transponder which cannot be used without conversion. The conversion from the Gray code to the decoded altitude being made at the radar station site.

**5.3.2.6** Data Item I001/130 (Radar Plot Characteristics) is optional. When used, it shall be transmitted only if at least one bit in the field is set to 1. This Data Item allows the transmission of application dependent information on the characteristics of the plot, its contents being defined between the users concerned.

**5.3.2.7** Data Item I001/141 (Truncated Time of Day) is optional. When used, it shall be transmitted when available. This Data Item allows the time stamping of the plot information at the radar station site. This time information, coded in two-octets, being the detection time of a plot expressed as UTC time.

**NOTE -** As the LSB is 1/128 s, the coding of 24 hours will overflow the two octets. Conversion from the truncated time value to the full time value can be achieved, for instance, by reference with Data Item I002/030 (see radar service messages hereafter).

**5.3.2.8** Data Item I001/050 (Mode-2 Code in Octal Representation) is optional. When used, it shall be transmitted when available.

**5.3.2.9** Data Item I001/120 (Measured Radial Doppler Speed) is optional. When used, it shall be transmitted when available.

**5.3.2.10** Data Item I001/131 (Received Power) is optional. When used it shall be transmitted when available.

**5.3.2.11** Data Item I001/080 (Mode-3/A Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (i.e. one low quality pulse at least).

**5.3.2.12** Data Item I001/100 (Mode-C Code and Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one quality bit is set to a one (i.e. one low quality pulse at least).



**NOTE -** The quality levels provided by a monopulse radar refer to the replies in Gray notation as received from a transponder and not to the decoded Mode-C altitude. The use of this Data Item (combining Mode-C Code in Gray notation and Code Confidence Indicators) allows the use of the quality indicators without having to revert from the decoded Mode-C altitude (in binary representation) back to the Gray notation.

**5.3.2.13** Data Item I001/060 (Mode-2 Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (i.e. one low quality pulse at least).

**5.3.2.14** Data Item I001/030 (Warning/Error Conditions) is optional. When used, it shall be transmitted only if the value of the field is different from 0. The zero value for this field means no warning nor error conditions.

**5.3.2.15** Data Item I001/150 (Presence of X-Pulse) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (i.e. one X-pulse received in a Mode-3/A, 2 or C reply).

**5.3.2.16 General Notes for Encoding all Plot Information**

1. Bits-16/19 of the FSPEC are spares, being reserved for future applications, are set to zero.
2. Bit-20 of the FSPEC is reserved for the Special Purpose Field (SP) Indicator. This permits the transmission of a variable length field not included in the UAP. The contents of such a field being agreed between the users concerned, while those not concerned can skip the data. The first octet contains the field length, including the length octet itself.
3. Bit-21 of the FSPEC is reserved for the Random Field Sequence (RFS) Indicator. This permits the transmission of standard Data Items in any order. Further details can be found in chapter 6 and in Ref [1].
4. Non-standardised, specific information are transmitted using the SP field and not the RFS field(s).

## 5.4 Transmission of Track Information

### 5.4.1 Standard User Application Profile

5.4.1.1 The following UAP shown in Table 3 shall be used for the transmission of Primary, SSR or combined Primary/SSR tracks:

**Table 3 - Standard UAP for Track Information**

FRN	Data Item	Information	Length in Octets
1	I001/010	Data Source Identifier	2
2	I001/020	Target Report Descriptor	1+
3	I001/161	Track/Plot Number	2
4	I001/040	Measured Position in Polar Coordinates	4
5	I001/042	Calculated Position in Cartesian Coordinates	4
6	I001/200	Calculated Track Velocity in polar Coordinates	4
7	I001/070	Mode-3/A Code in Octal Representation	2
FX	-	Field Extension Indicator	-
8	I001/090	Mode-C Code in Binary Representation	2
9	I001/141	Truncated Time of Day	2
10	I001/130	Radar Plot Characteristics	1+
11	I001/131	Received Power	1
12	I001/120	Measured Radial Doppler Speed	1
13	I001/170	Track Status	1+
14	I001/210	Track Quality	1+
FX	-	Field Extension Indicator	-
15	I001/050	Mode-2 Code in Octal Representation	2
16	I001/080	Mode-3/A Code Confidence Indicator	2
17	I001/100	Mode-C Code and Code Confidence Indicator	4
18	I001/060	Mode-2 Code Confidence Indicator	2
19	I001/030	Warning/Error Conditions	1+
20	-	Reserved for Special Purpose Indicator (SP)	-
21	-	Reserved for RFS Indicator (RS-bit)	-
FX	-	Field Extension Indicator	-
22	I001/150	Presence of X-Pulse	1

where:

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

5.4.1.2 The maximum length of the corresponding FSPEC is four octets. FRN higher than 22 shall be set to zero.

## 5.4.2 Encoding Rules

**5.4.2.1** Data Item I001/010 (Data Source Identifier) is compulsory and shall be transmitted in each Data Block, at least in the first Record of a sequence of Records originating from the same data source.

**Recommendation** *The Data Source Identifier should be transmitted in every Record.*

**5.4.2.2** Data Item I001/020 (Target Report Descriptor) is compulsory and shall always be transmitted.

**NOTE -** Bit-8 of the first part of this field indicates whether the contents of the Record concerns a plot or a track and allows the user system to apply the proper UAP to decode the remaining information within the Record.

**5.4.2.3** Data Item I001/161 (Track/Plot Number) is compulsory and shall always be transmitted for each track.

**5.4.2.4** Data Items I001/040 (Measured Position in polar coordinates) and I001/042 (Calculated Position in cartesian coordinates). One position, either measured or calculated, shall always be transmitted in a target report, except in a track cancellation message, for which a track position is not necessary.

**NOTE -** The first item represents the measured target position of the plot associated with the track for the present antenna scan, expressed in polar coordinates in the local reference system centred on the radar station. The second item refers to a calculated track position (smoothed for instance) in cartesian coordinates since the output of a civil local monoradar tracking system is usually expressed in cartesian coordinates.

### Recommendations

1. *It should be possible to transmit either both Data Items I001/040 and I001/042 together or only one.*
2. *If only Data Item I001/042 (calculated position) is transmitted, there should be no loss of information, even in the case where there has been no detection for the track in the present antenna scan, since a calculated position is always provided by the local tracker.*
3. *To avoid loss of information in the case of plot missing (no measured position available in this antenna scan) when only Data Item I001/040 (measured position) is transmitted, this item should be interpreted as a calculated position in polar coordinates. This condition can be detected as bits six and five of the target report descriptor (Data Item I001/020) signal the absence of detection.*
4. *The consistent and permanent use of either I001/040 or I001/042 or both together should be agreed by the users concerned.*

- 
- 5.4.2.5** Data Item I001/200 (Calculated Track Velocity in polar coordinates) is optional and when used, shall always be transmitted except for a track cancellation message for which track velocity information is not required. The polar representation of the track velocity allows an easier display of the ground speed than a cartesian representation.
- 5.4.2.6** Data Item I001/070 (Mode-3/A Code in octal representation) is compulsory and shall be transmitted when available. It represents the Mode-3/A Code for the plot associated with the track for the present antenna scan or the Mode-3/A information of the track.
- NOTE -** The Mode-3/A Code for the plot associated with the track for the present antenna scan and the smoothed Mode-3/A code of the track cannot be present together in the same track report.
- 5.4.2.7** Data Item I001/090 (Mode-C Code in binary representation) is compulsory and shall be transmitted when available. It represents the Mode-C Code for the plot associated with the track for the present antenna scan or the Mode-C information of the track. The binary notation allows an easier display of the plot altitude by the user systems than the Gray code as received from the transponder which cannot be used without conversion. The conversion from the Gray code to the decoded altitude being made at the radar station site.
- 5.4.2.8** Data Item I001/141 (Truncated Time of Day) is optional. When used, it shall be transmitted when available. This Data Item allows the time stamping of the track information at the radar station site. The time information, coded in two-octets, is the validity time of the track position expressed as UTC.
- NOTE -** As the LSB is 1/128 s, the coding of 24 hours will overflow the two octets. Conversion from the truncated time value to the full time value can be achieved, for instance, by reference with Data Item I002/030 (see radar service messages hereafter).
- 5.4.2.9** Data Item I001/130 (Radar Plot Characteristics) is optional. When used, it shall be transmitted only if at least one bit in the field is set to a one. This Data Item allows the transmission of application dependent information on the characteristics of the plot associated with the track for the present antenna scan. Its contents being defined between the users concerned.
- 5.4.2.10** Data Item I001/131 (Received Power) is optional. When used, it shall be transmitted when available. This Data Item represents the received power of the primary or combined plot associated with the track for the present antenna scan.
- 5.4.2.11** Data Item I001/120 (Measured Radial Doppler Speed) is optional. When used, it shall be transmitted when available for a track which has been associated with a primary or combined plot for the present antenna scan.

- 
- 5.4.2.12** Data Item I001/170 (Track Status) is compulsory and shall be transmitted only if at least one bit in the field is set to a one. This Data Item allows the transmission of application dependent information on the quality of the track. Its contents being defined between the users concerned.
- 5.4.2.13** Data Item I001/210 (Track Quality) is optional. When used, it shall be transmitted only if at least one bit in the field is set to a one. This Data Item allows the transmission of application dependent information on the quality of the track. Its contents being defined between the users concerned.
- 5.4.2.14** Data Item I001/050 (Mode-2 Code in Octal Representation) is optional. When used, it shall be transmitted when available. This Data Item represents the Mode-2 Code for the plot associated with the track for the present antenna scan or the Mode-2 information of the track.
- NOTE -** The Mode-2 code for the plot associated with the track for the present antenna scan and the smoothed Mode-2 Code of the track cannot be present together in the same track report.
- 5.4.2.15** Data Item I001/080 (Mode-3/A Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (i.e. one low quality pulse at least). It represents the confidence level for each reply bit of the Mode-3/A code of the plot associated with the track for the last antenna scan.
- NOTE -** The order of the quality bits in this Data Item is the same as in Data Item I001/070 (Mode-3/A Identification Code).
- 5.4.2.16** Data Item I001/100 (Mode-C Code and Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one quality bit is set to a one (i.e. one low quality pulse at least). It represents the Mode-C height in Gray notation together with the confidence level for each reply bit of the Mode-C Code of the plot associated with the track for the last antenna scan.
- NOTE -** The quality levels provided by a monopulse radar refer to the replies in Gray notation as received from a transponder and not to the decoded Mode-C altitude. The use of this Data Item (combining Mode-C Code in Gray notation and Code Confidence Indicators) allows the use of the quality indicators without to revert from the decoded Mode-C altitude (in binary representation) back to the Gray notation.
- 5.4.2.17** Data Item I001/060 (Mode-2 Code Confidence Indicator) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (i.e. one low quality pulse at least). It represents the confidence level for each reply bit of the Mode-2 Code of the plot associated with the track for this antenna scan.
- NOTE -** The order of the quality bits in this Data Item is the same as in Data Item I001/050 (Mode-2 Code).
- 5.4.2.18** Data Item I001/030 (Warning/Error Conditions) is optional. When used, it shall be transmitted only if the value of the field is different from zero. The zero value for this field means no warning nor error conditions.
- 5.4.2.19** Data Item I001/150 (Presence of X-Pulse) is optional. When used, it shall be transmitted only if at least one bit of the field is set to a one (one X-pulse received in a Mode-3/A, 2 or C reply).
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#### 5.4.2.20 General Notes for Encoding all Track Information

1. Bit-20 of the FSPEC is reserved for the SP Indicator. This allows the transmission of a variable length field not included in the UAP. The contents of such a field being agreed between the users concerned, while those not concerned can skip the data. The first octet contains the field length, including the length octet itself.
2. Bit-21 of the FSPEC is reserved for the RFS Indicator. This permits the transmission of standard Data Items in any order. Further details can be found in chapter 6 and in Ref [1].
3. Non-standardised, specific information is transmitted using the SP field and not the RFS field(s).

### 6. RANDOM FIELD SEQUENCING (RFS) MECHANISM

The RFS mechanism is described in Ref [1] and repeated here for convenience.

The RFS organisation shall allow the FSPEC field to be kept short, even if Data Fields with a low rank order (i.e. high FRN) have to be occasionally exchanged.

**NOTE -** The RFS organised field is a collection of Data Fields which in contrast to the OFS organisation, can occur in any order.

The RFS organised field is depicted in Figure 1 and shall be structured as follows:

- the first octet provides the number, N, of Data Fields following;
- N fields in any arbitrary order each consisting of a one-octet FRN immediately followed by the contents of the Data Item associated with the preceding FRN.

A sequence of Data Fields, thus assembled as an RFS organised field shall require only a single bit to be reserved in the FSPEC. This bit is called the Random Sequence Indicator (RS-bit) and signals the presence or absence of an RFS organised field.

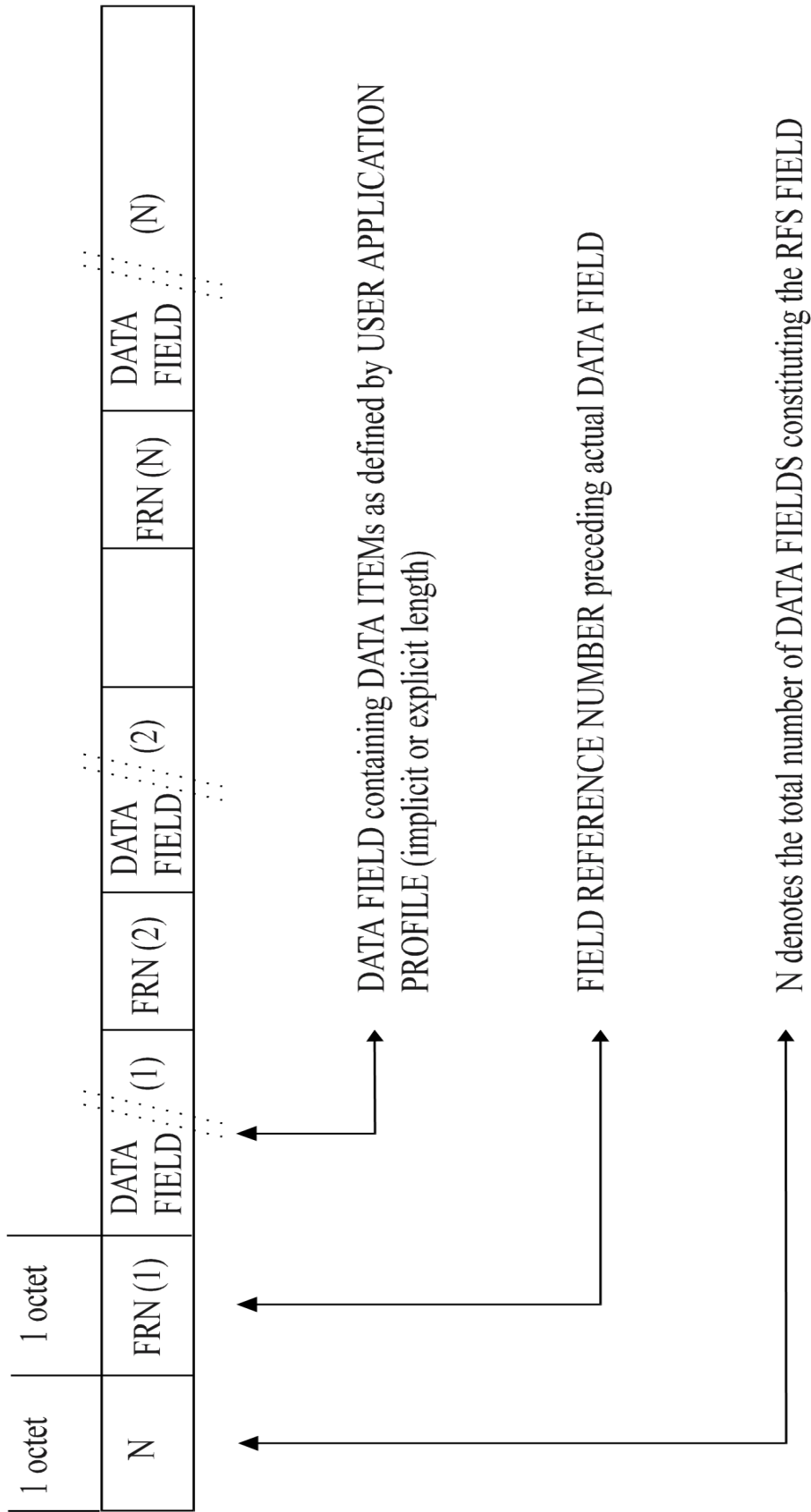


Figure 1 Random Field Sequencing Organisation

