EUROCONTROL Specification for Surveillance Data Exchange ASTERIX

Part 14 Category 020
Multilateration Target Reports
Appendix A: Reserved Expansion Field

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EUROCONTROL Specification for Surveillance Data Exchange
ASTERIX Part 14 Category 020 Multilateration Target Reports
Appendix A: Reserved Expansion Field

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Abstract

This document specifies the contents of the Reserved Expansion Field for ASTERIX Category 020 messages used for the transmission of Multilateration 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 please 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
1.0	April 2008	Creation	All
1.1	May 2008	Modification in Item PA, Subfield #3: Length 1 => 2 bytes, resolution (LSB) 1 ft	2.3
1.2	April 2010	Addition of: Ground Velocity Vector, Ground Velocity Accuracy, Time of Report Transmission, Data-Ages for different data-items and subfields.	2.4, 2.5, 2.6, 2.7
1.3	October 2016	Typo in Format Description of GVA corrected	2.5
1.4	December 2020	NOTE added to Data Item “Position Accuracy” SF#1 Headings of Sub-Fields in DA clarified High Precision DOP Data Item added	2.3 2.7 2.8

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Scope

This document describes the way to encode information in the Reserved Expansion Field of ASTERIX Cat 020 (Multilateration Target Reports).

2. DESCRIPTION OF THE CONTENT OF RESERVED EXPANSION FIELD

2.1 Length Indicator

Definition : This field indicates the total length in octets of the Reserved Expansion Field (including the REF length indicator itself)

Format : One-octet fixed length Data Item

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
LEN							

bits 8-1 (LEN) Length of REF in octets, including the Length Indicator itself.

Encoding Rule :

This item shall be present in every REF

2.2 Items indicator

Definition : This field indicates what are the items encoded in the REF

Format : One-octet fixed length Data Item

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
PA	GVV	GVA	TRT	DA	HP DOP	0	0

bit 8	(PA)	= 0	Position Accuracy is not present in the REF
		= 1	Position Accuracy is present in the REF
bit 7	(GVV)	=0	Ground Velocity Vector is not present in the REF.
		=1	Ground Velocity vector is present in the REF.
bit 6	(GVA)	=0	Ground Velocity Accuracy is not present in the REF.
		=1	Ground Velocity Accuracy is present in the REF.
bit 5	(TRT)	=0	Time of Report Transmission is not present in the REF.
		=1	Time of Report Transmission is present in the REF.
bit 4	(DA)	=0	Data Ages is not present in the REF.
		=1	Data Ages is present in the REF.
bit 3	(HPDOP)	=0	High Precision DOP is not present in the REF.
		=1	High Precision DOP is present in the REF.
bits 2/1	(Spare)		Spare Bits, set to “0.

Encoding Rule :

This item shall be present in every REF

2.3 PA, 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	SDC	SDH	SDW	0	0	0	0

bit-8 (DOP) Subfield #1: DOP of Position

= 0 Absence of Subfield #1

= 1 Presence of Subfield #1

bit-7 (SDC) Subfield #2: Standard Deviation of Position (Cartesian)

= 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

bit-5 (SDW) Subfield #4: Standard Deviation of Position (WGS-84)

= 0 Absence of Subfield #4

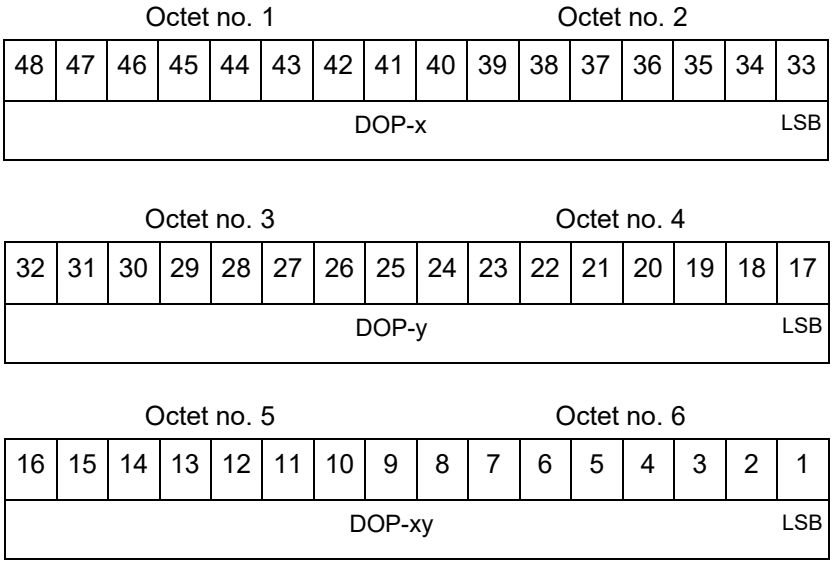
= 1 Presence of Subfield #4

bits-4/1 (Spare) Subfields #5/8: Spare

= 0 Absence of Subfield

= 1 Presence of Subfield

Structure of Subfield # 1:
DOP of Position

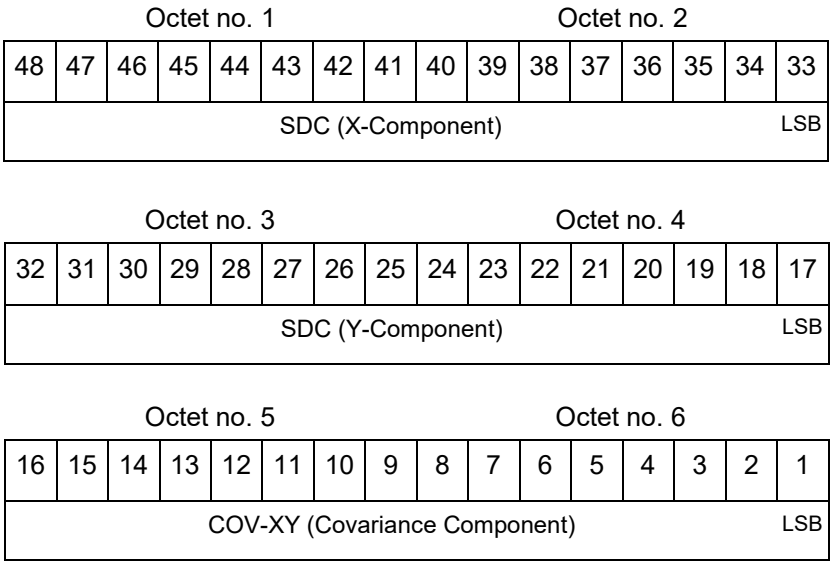


bits-48/33	(DOP-x)	DOP along x axis LSB= 0.25
bits-32/17	(DOP-y)	DOP along y axis LSB= 0.25
bits-16/1	(DOP-xy)	DOP Covariance Component in two's complement form LSB= 0.25 Maximum value = 8.191

Notes:

1. DOP Covariance Component (DOP-xy) = sign {HDOPxy} * sqrt {abs (HDOPxy)}
2. "Maximum value" means Maximum value or above.
3. From Edition 1.4 of this specification Data Item "High Precision DOP" has been defined. To prevent incompatibilities in receiving systems, the "High Precision DOP" **does not replace** this "DOP of Position" Data Item but provides **additional information**. Encoders using this "DOP of Position" Data Item **shall** continue to provide it.

Structure of Subfield # 2:
Standard Deviation of Position (Cartesian)



bits-48/17 (SDC) Standard Deviation of Position of the target expressed in Cartesian coordinates

LSB= 0.25 m

bits 16/1 (COV-XY) XY Covariance Component in two's complement form

LSB= 0.25m

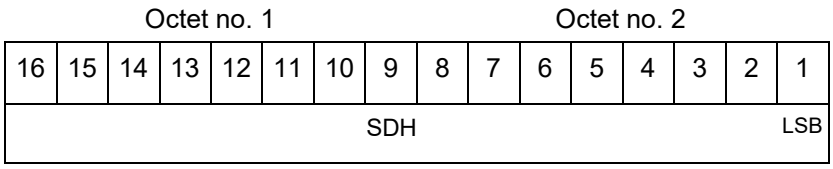
Maximum value = 8.191km

Notes:

1. XY covariance component = sign {Cov(X,Y)} * sqrt {abs [Cov (X,Y)]}

2. "Maximum value" means Maximum value or above.

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



bits-16/1 (SDH) Standard deviation of Geometric Height of the target **expressed** in WGS-84.

LSB = 1 ft

Note: Maximum value means maximum value or above.

Structure of Subfield # 4:
Standard Deviation of Position (WGS-84)

Octet no. 1															
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SDW (Latitude Component)															LSB

Octet no. 3															
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SDW (Longitude Component)															LSB

Octet no. 5															
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
COV-WGS (Lat/Long Covariance Component)															LSB

bits-48/17 (SDW) Standard Deviation of Position of the target expressed in WGS-84

LSB = $180/2^{25}$ degrees

bits 16/1 (COV-WGS) Lat/Long Covariance Component in two's complement form

LSB = $180/2^{25}$ degrees

Maximum value = 0.17578125 degrees

Notes:

1. WGS-84 covariance component = sign {Cov(Lat,Long)} * sqrt {abs [Cov (Lat,Long)]}

2. "Maximum value" means Maximum value or above.

Encoding Rule :

This Item is optional.

2.4 GVV, Ground Velocity Vector

Definition: Ground Speed and Track Angle elements of Ground Velocity Vector.

Format: Four-Octet fixed length data item.

Structure of Primary Subfield:

Octet no. 1 Octet no. 2

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

Octet no. 3 Octet no. 4

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

bits-16 (RE) “Range Exceeded” Indicator

= 0 Value in defined range

= 1 Value exceeds defined range

bits-31/17 Ground Speed referenced to WGS-84

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

0 $\leq$ Ground Speed < 2 NM/s

bits-16/1 Track Angle clockwise reference to “True North”

(LSB) = 360° / 2^{16} (approx. 0.0055°)

NOTES

1. The RE-Bit, if set, indicates that the value to be transmitted is beyond the range defined for this specific data item and the applied technology. In this case the Ground Speed contains the maximum value defined and the RE-bit indicates that the actual value is greater than the value contained in the field.
2. The True North is the geographical north at the position of the aircraft.

Encoding Rule :

This Item is optional.

2.5 GVA, Ground Velocity Accuracy

Definition: Accuracy of the Ground Speed and Track Angle elements of Ground Velocity Vector.

Format: Two-Octet fixed length data item.

Structure of Primary Subfield:

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

bits-16/9 (GSSD) Standard deviation of the Ground Speed
(LSB) = 2^{-14} NM/s ≅ 0.22 kt
0≤ GSSD <56.25 Kt

bits-8/1 (TASD) Standard deviation of the Track Angle
(LSB) = 360° / 2^{12} ≅ 0.08789°
0 ≤ TASD < 22.5 degrees

NOTE - Maximum value indicates maximum value or above.

Encoding Rule :

This Item is optional.

2.6 TRT, Time of ASTERIX Report Transmission

Definition : Time of the transmission of the ASTERIX category 020 report in the form of elapsed time since last midnight, expressed as UTC.

Format : Three-Octet fixed length data item.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
Time							

Octet no. 2 Octet no. 3

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Of ASTERIX Report Transmission															LSB

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

Encoding Rule :

This Item is optional. The Time of Report Transmission (TRT) field **shall** be provided when Data-Ages are transmitted.

NOTE - The time of ASTERIX report transmission value is reset to zero at every midnight. The Time of Report Transmission is the time used as a reference for the different data-ages provided in DA.

2.7 DA, Data-Ages

Definition: Age of specific data-items or subfields at the Time of Report Transmission provided in TRT.

Format: Compound Data Item, comprising a primary subfield of up to three octets, followed by one or more defined subfields.

Structure of Primary Subfield:

Octet no. 1

24	23	22	21	20	19	18	17
SPI	TI	MBD	M3A	FL	FS	GH	FX

Octet no. 2

16	15	14	13	12	11	10	9
TA	MC	MSS	ARC	AIC	M2	M1	FX

Octet no. 3

8	7	6	5	4	3	2	1
ARA	VI	MSG	0	0	0	0	FX

bit-24 (SPI) Subfield #1:Special Position Identification age
= 0 Absence of Subfield #1
= 1 Presence of Subfield #1

bit-23 (TI) Subfield #2: Target Identification age
= 0 Absence of Subfield #2
= 1 Presence of Subfield #2

bit-22 (MDB) Subfield #3: BDS Register Data age
= 0 Absence of Subfield #3
= 1 Presence of Subfield #3

bit-21 (M3A) Subfield #4: Mode 3/A Code age
= 0 Absence of Subfield #4
= 1 Presence of Subfield #4

bit-20 (FL) Subfield #5: Flight Level age
= 0 Absence of Subfield #5
= 1 Presence of Subfield #5

bit-19 (FS) Subfield #6: Flight Status age
= 0 Absence of Subfield #6
= 1 Presence of Subfield #6

bit-18 (GH) Subfield #7: Geometric / Measured Height age
= 0 Absence of Subfield #7
= 1 Presence of Subfield #7

bit-17 FX Extension indicator
= 0 no extension
= 1 extension

bit-16	(TA)	Subfield #8: Target Address age = 0 Absence of Subfield #8 = 1 Presence of Subfield #8
bit-15	(MC)	Subfield #9: Mode C code age = 0 Absence of Subfield #9 = 1 Presence of Subfield #9
bit-14	(MSS)	Subfield #10: Mode-S Specific Service Capability age = 0 Absence of Subfield #10 = 1 Presence of Subfield #10
bit-13	(ARC)	Subfield #11: Altitude reporting capability age = 0 Absence of Subfield #11 = 1 Presence of Subfield #11
bit-12	(AIC)	Subfield #12: Aircraft identification capability age = 0 Absence of Subfield #12 = 1 Presence of Subfield #12
bit-11	(M2)	Subfield #13: Mode-2 Code age = 0 Absence of Subfield #13 = 1 Presence of Subfield #13
bit-10	(M1)	Subfield #14: Mode-1 Code age = 0 Absence of Subfield #14 = 1 Presence of Subfield #14
bit-9	FX	Extension indicator = 0 no extension = 1 extension
bit-8	(ARA)	Subfield #15: ACAS Resolution Advisory age = 0 Absence of Subfield #15 = 1 Presence of Subfield #15
bit-7	(VI)	Subfield #16: Vehicle Fleet Identification age = 0 Absence of Subfield #16 = 1 Presence of Subfield #16
bit-6	(MSG)	Subfield #17: Pre-programmed message age = 0 Absence of Subfield #17 = 1 Presence of Subfield #17
bit-5/2		spare bits set to zero
bit-1	FX	Extension indicator = 0 no extension = 1 extension

Structure of Subfield # 1 of Data Item DA:
Special Position Identification Age

Octet no. 1

8	7	6	5	4	3	2	1
SPI							LSB

bits-8/1	(SPI)	Age of the Special Position Information (SPI) information transmitted in data item I020/020 SPI field.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 2 of Data Item DA:
Target Identification Age

Octet no. 1

8	7	6	5	4	3	2	1
TI							LSB

bits-8/1	(TI)	Age of the Target Identification information transmitted in data item I020/245.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 3 of Data Item DA:

BDS Register Data Age

Definition: Age for the BDS Register Data extracted from aircraft transponder as transmitted in Data item I020/250.

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one Difference of Time indication for the BDS Register indicated in bits 16/9.

Structure:

Octet no. 1

24	23	22	21	20	19	18	17
REP							

Octet no. 2 Octet no. 3

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

bits-24/17	(REP)	Repetition factor
bits-16/13	(BDS1)	BDS Register 1 Address
bits-12/9	(BDS2)	BDS Register 2 Address
bits-8/1	(BDSA)	Age of the information in the BDS Register indicated in bits 16/9
	(LSB)	=0.1 s Maximum value = 25.5 s

Structure of Subfield # 4 of Data Item DA:

Mode-3/A Code Age

Octet no. 1

8	7	6	5	4	3	2	1
M3A							LSB

bits-8/1	(M3A)	Age of the information transmitted in data item I020/070.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 5 of Data Item DA:
Flight Level Age

Octet no. 1

8	7	6	5	4	3	2	1
FL							LSB

bits-8/1	(FL)	Age of the information transmitted in data item I020/090.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 6 of Data Item DA:
Flight Status Age

Octet no. 1

8	7	6	5	4	3	2	1
STAT							LSB

bits-8/1	(STAT)	Age of the Flight Status information transmitted in data item I020/230 STAT subfield.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 7 of Data Item DA:
Geometric / Measured Height Age

Octet no. 1

8	7	6	5	4	3	2	1
GH							LSB

bits-8/1	(GH)	Age of the information transmitted in data item I020/105 or in data item I020/110.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 8 of Data Item DA:
Target Address Age

Octet no. 1

8	7	6	5	4	3	2	1
TA							LSB

bits-8/1	(TA)	Age of the Target Address information transmitted in data item I020/220.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 9 of Data Item DA:
Mode C Code Age

Octet no. 1

8	7	6	5	4	3	2	1
MC							LSB

bits-8/1	(MC)	Age of the information transmitted in data item I020/100.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 10 of Data Item DA:
Mode-S Specific Service Capability Age

Octet no. 1

8	7	6	5	4	3	2	1
MSSC							LSB

bits-8/1	(MSSC)	Age of the Mode-S Specific Service Capability information transmitted in data item I020/230 MSSC subfield.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 11 of Data Item DA:
Altitude Reporting Capability Age

Octet no. 1

8	7	6	5	4	3	2	1
ARC							LSB

bits-8/1	(ARC)	Age of the Altitude reporting capability information transmitted in item I020/230 ARC subfield.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 12 of Data Item DA:
Aircraft Identification Capability age

Octet no. 1

8	7	6	5	4	3	2	1
AIC							LSB

bits-8/1	(AIC)	Age of the Aircraft Identification Capability information transmitted in data item I020/230 AIC subfield.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 13 of Data Item DA:
Mode-2 Code Age

Octet no. 1

8	7	6	5	4	3	2	1
M2							LSB

bits-8/1	(M2)	Age of the information transmitted in data item I020/050.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 14 of Data Item DA:
Mode-1 Code Age

Octet no. 1

8	7	6	5	4	3	2	1
M1							LSB

bits-8/1	(M1)	Age of information transmitted in data item I020/055.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 15 of Data Item DA:
ACAS Resolution Advisory Age

Octet no. 1

8	7	6	5	4	3	2	1
ARA							LSB

bits-8/1	(ARA)	Age of the ACAS Advisory Report information transmitted in data item I020/260.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 16 of Data Item DA:
Vehicle Fleet Identification Age

Octet no. 1

8	7	6	5	4	3	2	1
VI							LSB

bits-8/1	(VI)	Age of the information transmitted in data item I020/300.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

Structure of Subfield # 17 of Data Item DA:
Pre-programmed Message Age

Octet no. 1

8	7	6	5	4	3	2	1
MSG							LSB

bits-8/1	(MSG)	Age of the information transmitted in data item I020/310.
bit-1	(LSB)	= 0.1 s Maximum value = 25.5 s

NOTES.

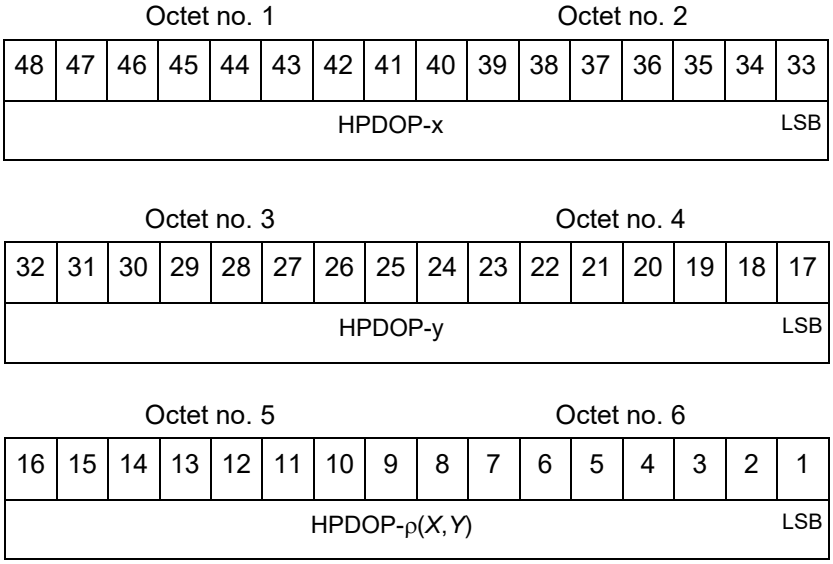
1. In all subfields, the age is the time delay since the latest update received from the target.
2. The ages are provided in reference to the time of the Target Report Transmission (TRT) provided in the message.
3. In all the subfields, the maximum value indicates “maximum value or above”.
4. If the data-item is not transmitted in the target report the corresponding age is not transmitted.
5. The Target Address is considered as received if either it has been received in clear in a message or if it has been used to decode a message associated to the target.

2.8 HPDOP, High Precision Dilution of Position

Definition : Dilution of Precision of the reported Multilateration Position in High Precision.

Format : Six-Octet fixed length data item.

Structure:



bits-48/33 (HPDOP-x) HPDOP along x axis
LSB= 1/256
Minimum value = 0
Maximum value = 256 – LSB

bits-32/17 (HPDOP-y) HPDOP along y axis
LSB= 1/256
Minimum value = 0
Maximum value = 256 – LSB

bits-16/1 (HPDOP-$\rho(X,Y)$) HPDOP “Pearson Correlation Coefficient” in two’s complement form
LSB= $2 / 2^{16}$
Minimum value = -1
Maximum value = 1 – LSB

Notes:

1. DOP “Pearson Correlation Coefficient” $\rho(X,Y)$ = DOPxy / (DOPx * DOPy) where DOPxy is the DOP Covariance Component.

2. “Maximum value” means Maximum value or above.

3. To prevent incompatibilities with existing decoders, this Data Item does **not** replace the “DOP of Position” in Data Item PA, Position Accuracy, Subfield #1. Encoders providing “DOP of Position” in Data Item PA, Position Accuracy, Subfield #1 **shall** continue to do so.

Encoding Rule: This Item is optional.

Encoding Rule:
The Reserved Expansion Field is optional. The Time of Report Transmission (TRT) field shall be provided when Data-Ages are transmitted.

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