AISG Extension:

Remote eAntenna

eAntenna Extension to the Control Interface for Antenna Line Devices

Extension to AISG version 2.0

Revision History

DATE	ISSUE	NOTES
14 December 2012	1.0	Provisional release; by Liyue and Stefan Feuchtinger
29 January 2013	2.1.0	First release; renamed Generic Upload and Generic Download as RAE Upload and RAE Download. Corrected errors of issue 1.0. Annexes annotated as normative or informative.
18 March 2017	2.2.0	Second release; add 2D weighting factor interface. Corrected errors of issue 2.1.0.

AISG Extension:
Remote eAntenna Extension
Standard No. AISG-ES-RAE v2.2.0

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1. FOREWORD

The Antenna Interface Standards Group (AISG) published the AISG standard to facilitate the introduction of antenna line products with remote control and monitoring facilities. The purpose of that standard is to ensure basic interoperability of antennas and control infrastructure. The AISG standard covers two basic types of Antenna Line Devices: Actuators capable of altering the electrical downtilt of the antenna and tower mounted amplifiers.
It has become evident that commercial antenna line devices are evolving beyond this set of capabilities. The AISG has decided to publish extensions to the basic standard rather than adding all possible branches to the core specification. For purposes of compliance, users should note that this entire Extension Standard is *optional*. However, once this Extension Standard is elected for inclusion in a device, the entire option becomes mandatory.

This extension to the AISG standard adds procedures for beam forming antennas (an example is shown in Annex E) that implement capabilities to store and send weighting factor data and other auxiliary information. Being able to store this antenna specific information in the antenna itself and making it retrievable by the base station will ensure the correct beam forming weighting is used by the base station, thereby avoiding unintentional use of wrong weighting factors that create false broadcast beam patterns resulting in network performance degradation.

2. SCOPE

This document contains extensions to layers 1, 2 and 7 of AISG specification, version 2.0 [1], for antennas implementing Remote eAntenna Extension (RAE).

3. REFERENCES

This AISG extension standard incorporates provisions of other publications. These provisions are cited in the text and the referenced publications are listed below. Where references are dated, subsequent amendments or revisions of these publications apply only when specifically incorporated by amendment or revision of this AISG extension specification. For undated references, the latest edition of the publication applies.

1. AISG Version 2.0, “Control Interface for Antenna Line Devices”
2. 3GPP TS25.460 UTRAN Iuant Interface General Aspects and Principles Release 6
3. 3GPP TS25.461 UTRAN Iuant Interface Layer 1, Release 6
4. 3GPP TS25.462 UTRAN Iuant Interface Signalling Transport, Release 6
5. 3GPP TS25.463 UTRAN Iuant Interface Remote Electrical Tilting (RET), Release 6
6. NIMA TR8350.2 U.S. Department of Defense World Geodetic System 1984, Third Edition - Amendment 1
7. 3GPP TS25.466 UTRAN Iuant Interface: Application Part, Release 10

NOTE: The 3GPP references are to Release 6 unless otherwise indicated. These documents are referred to in AISG Version 2.0, although they may have been superseded.

4. ABBREVIATIONS

Where abbreviations or acronyms are used in this document they have the following meanings:

RAE	Remote eAntenna Extension
TCP	Time Consuming Procedure
WGS 84	World Geodetic System 1984

5. TERMINOLOGY AND DEFINITIONS

Where the following terms are used in this document, they have the meanings listed below.

Weighting Factor	A set of amplitude and phase settings for one RF port of a beam forming antenna. The amplitude is expressed in percent of the maximum current, ranging from 0 to 100. The phase is expressed in degrees, ranging from -180.0 to +179.9, expressed in phase value times 10.
Latitude	An angular measurement in degrees ranging from 0 degree at the equator, to +90 degrees at the North pole, and −90 degrees at the South pole, as specified by WGS 84 [6]. Latitude identifies a position on Earth north or south of the equator and is reported in decimal degrees, with six decimal places of accuracy, and then multiplied by $1x10^6$ so that it may be represented by an integer.
Longitude	An angular measurement ranging from 0 degree at the prime meridian (Greenwich meridian) to +180 degrees eastward and −180 degrees westward, as specified by the WGS 84 [6] ellipsoid. Longitude identifies a position on Earth east or west of the prime meridian and is reported in decimal degrees, to six decimal places of accuracy, and then multiplied by $1x10^6$ so that it may be represented by an integer.
Altitude	The elevation of a point or object from the surface of the WGS 84 [6] geoid. Altitude is reported in meters, to one decimal place of accuracy, and then multiplied by 10 so that it may be represented by an integer.
Antenna Pattern	A mathematical function or graphical representation of the radiation properties of the antenna as a function of space coordinates.
2D Weighting Factors	The weighting factor which contains both azimuth and downtilt dimension.
Azimuith	The direction orthogonal to the axis of the antenna assembly, expressed in degree East of True North(ETN).
Vertical beamwidth	The angular distance between the half power points (-3 dB points) of the main lope in the vertical plane.
Horizontal beamwidth	The angular distance between the half power points (-3 dB points) of the main lope in the horizontal plane.

Weighting group number	The index number of a weighting group for a specific beamforming shape.

6. LAYER 1

All definitions and specifications for RET devices in references [1], [2] and [3] regarding Iuant layer 1 apply to RAE devices that comply with this Extension Standard unless otherwise stated by requirements in this document.

6.1. DC supply

6.1.1. RAE DC power consumption

Devices complying with this extension standard shall have a maximum steady-state power consumption of less than 1 W.

6.1.2. RAE Power-up characteristics

Devices complying with this extension standard shall have a maximum power-up period of 3 seconds. After the power-up period, the device shall be fully functional.

6.2. Resumption of operation after interruption of power supply

Normal operation shall be resumed after restoration of the power supply following any interruption or voltage drop below the minimum operating voltage in accordance with [3]. All data stored in the RAE shall be retained when the supply voltage falls below the minimum operating voltage and during interruption of power supply.

6.3. RAEs not requiring continuous DC power

RAE may be left unpowered for extended periods, and normal operations shall be resumed as power is supplied within power-up time specified in Para 6.1.2.

Note: RAE functionality is not required for the antenna to operate. When no DC power is supplied to the RAE, the antenna itself will work nonetheless.

7. LAYER 2

All definitions and specifications for ALDs in references [1] and [4] regarding Iuant Layer 2 shall be valid for all ALDs included in this extension standard regardless of whether the device implements any other functionality.

Extended specifications for layer 2 are defined in the following chapter.

7.1. Device Type

Table 7.1.1 shows the additional device type for this Extension Standard:

Table 7.1.1: Device type

Device Type	Acronym	1-octet unsigned integer
Remote eAntenna Extension	RAE	0x31

8. LAYER 7

The application layer includes the common elementary procedures as defined in [1] and [5] and is extended by AISG-specific procedures as specified below.

8.1. General Aspects

8.1.1. Geometry and Numbering

All RAE devices shall be defined as multiple subunit devices. Devices with single RAE units shall be implemented as multiple subunit devices with the number of subunits equal to 1. RAE subunit numbering shall start with 1.

8.1.2. Parallel Procedure Handling for TCPs

The RAE device does not define any TCPs, and parallel procedure handling is not supported by the RAE.

8.2. Return and alarm codes

A table of return and alarm codes is given in [5].

8.3. Common Elementary Procedures for the Remote eAntenna Extension

To avoid prematurely exhausting the available space in the command table through the proliferation of extensions, certain codes defined for other devices are reused by this extension. This process is called “overloading”.

For devices compliant with this extension, the overloaded code shall refer to a member of the RAE procedure set defined herein, and not to the procedure assigned by the original specification.

This section defines those procedures that are defined by overloading existing procedure codes without any significant changes in the procedure initiation message, response message, and/or return code values. For clarity, only differences from the language of the referenced specification are elaborated for these procedures.

Table 8.3.1: Common elementary procedures

RAE Procedure	Overloads	Code Value	Requirement
RAESetDeviceData	TMASetDeviceData [1]	0x74	mandatory
RAEGetDeviceData	TMAGetDeviceData [1]	0x75	mandatory
RAEAlarmIndication	TMAAlarmIndication [1]	0x76	mandatory
RAEClearActiveAlarms	TMAClearActiveAlarms [1]	0x77	mandatory
RAEGetAlarmStatus	TMAGetAlarmStatus [1]	0x78	mandatory
RAEGetNumberOfSubunits	TMAGetNumberOfSubunits [1]	0x79	Mandatory

These commands shall be implemented as specified in the corresponding paragraphs of [1], except that the term “TMA” shall be replaced by “RAE”.

RAE device extends the table C.1 in [1] used for RAESetDeviceData and RAEGetDeviceData. The new field 0x10 is to store the altitude of the antenna installed. The new field 0x11 is to store the geographic location of the antenna installed. The new field 0x30 is to store test records.

Table 8.3.2: Assigned fields for additional data (extends fields 0x10, 0x11, 0x30)

Field No.	Length (octets)	Format	Description
0x01	15	ASCII	Antenna model number
0x02	17	ASCII	Antenna serial number
0x03	2	16-bit unsigned	Antenna operating band(s)
0x08	2	16-bit unsigned	Antenna operating band(s)
0x09	2	16-bit unsigned	Antenna operating band(s)
0x04	8	4 x 16-bit unsigned	Beamwidth for each operating band in band order (deg), beginning with lowest band. The lowest band is transmitted within the first 16-bit value. (example: width for band I, width for band II)
0x05	4	4 x 8-bit unsigned	Gain [dBi] for each operating band in band order, expressed in gain value times 10, beginning with the lowest band. The lowest band is transmitted within the first 8-bit value. (example: gain for band I, gain for band III)
0x06	2	16-bit signed	Maximum supported electrical tilt [degree], expressed in tilt value times 10.
0x07	2	16-bit signed	Minimum supported electrical tilt [degree], expressed in tilt value times 10.
0x10	4	32-bit signed	Altitude [meters] of antenna over sea level, expressed in altitude value times 10.
0x11	8	2x 32-bit Signed	Geographic location, including longitude and latitude, with the format as listed in Table 8.3.3 For details refer to chapter 5. TERMINOLOGY AND DEFINITIONS.
0x21	6	ASCII	Installation date
0x22	5	ASCII	Installer's ID
0x23	32	ASCII	Base station ID
0x24	32	ASCII	Sector ID
0x25	2	16-bit unsigned	Antenna bearing [degree], in the range of 0 – 359.9 degree, expressed as bearing value times 10
0x26	2	16-bit signed	Installed mechanical tilt [degree], expressed in tilt value times 10.
0x30	69	ASCII	Reserved for facility test record (key test parameters, such as PIM, and/or S-parameters for smart antennas)

Table 8.3.3: coding for Geographic location in field 0x11

Format	Description
32-bit signed	Longitude [10^{-6}degree] according to WGS 84 [6]
32-bit signed	Latitude [10^{-6}degree] according to WGS 84 [6]

8.4. Device-Specific Elementary Procedures for RAE

This section defines procedures that are defined by overloading existing procedures in [1] and [5] that include significant changes in the procedure message initiation, response, and/or return code values or formats. For clarity, these procedures are defined completely. No requirements from the overloaded procedure clauses in [1] or [5] shall be inferred unless re-stated in this Extension Standard.

A weighting factor file can be downloaded to a subunit of the RAE device by running the RAEDownload command. The RAEDownload command contains a parameter specifying the file type. Therefore, RAE devices can identify the files to be downloaded. An antenna pattern file is stored in each subunit in RAE device which can describe the properties of the antenna. The antenna pattern file shall be read-only. The use of the antenna pattern file is optional for the RAE.

In addition, files in RAE device can be queried by running the RAEGetNumberofFiles and RAEGetFileInformation command, and can be uploaded to the primary device by running RAEUploadFile command.

The RAE device shall store two weighting factors files. One is factory weighting factors file, and the other one is active weighting factors file. The factory weighting factors file is written in the factory, and cannot be changed remotely. The active weighting factors file is written in the factory identical to the factory weighting factors file, but can be read and updated remotely in the field. The active weighting factors file can be replaced by the factory weighting factors file remotely to revert to the initial pattern setting.

Table 8.4.1: RAE specific elementary procedures

RAE Procedure	Overloads	Code Value	Requirement
RAEResetFactoryWeightingFactors	TMASetMode [1]	0x70	Mandatory
RAEDownloadStart		0x43	Mandatory
RAEDownloadFile		0x44	Mandatory
RAEDownloadEnd		0x45	Mandatory
RAEGetNumberofFiles		0x46	Mandatory
RAEGetFileInformation		0x47	Mandatory
RAEUploadFile		0x48	Mandatory
RAEGetWeightingFactor	TMAGetGain [1]	0x73	Mandatory
RAEGetSupportedFunctions	TMAGetSupportedFunctions [1]	0x7A	Mandatory

8.4.1. RAE Download Start

Table 8.4.1.1: Elementary procedure RAE Download Start

Name: **RAEDownloadStart**				
Code: **0x43**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.1.2: Initiating message parameters and format for RAE Download Start

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Weighting factors file (0x04)** **Antenna Pattern file (0x05)**

Table 8.4.1.3: Response message parameters and format for RAE Download Start

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**

Description:

On receipt of this initiating message the file download process shall be initiated.

The response time to this RAE Download Start procedure shall be less than 4 seconds.

Table 8.4.1.4: Return codes for RAE Download Start

OK	FAIL	Comment
	FormatError **Busy** **UnsupportedProcedure** **UnsupportedValue**	

8.4.2. RAE Download File

Table 8.4.2.1: Elementary procedure RAE Download File

Name: **RAEDownloadFile**				
Code: **0x44**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.2.2: Initiating message parameters and format for RAE Download File

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**Less than, or equal to MaxDataReceiveLength**	**Vendor specific**	**File data, see Annex A**

Table 8.4.2.3: Response message parameters and format for RAE Download File

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**

Description:

This elementary procedure is used once or several times to transfer file data from the primary device to the secondary device. A weighting factor file can only be downloaded to a subunit, not to the device itself.

The response time to this RAE Download File procedure shall be less than 4 seconds.

Table 8.4.2.4: Return codes for RAE Download File

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **InvalidFileContent** **InvalidProcedureSequence**	

8.4.3. RAE Download End

Table 8.4.3.1: Elementary procedure RAE Download End

Name: **RAEDownloadEnd**				
Code: **0x45**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.3.2: Initiating message parameters and format for RAE Download End

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**

Table 8.4.3.3: Response message parameters and format for RAE Download End

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**

Description:

This elementary procedure indicates the end of a multi-message data transfer to the secondary device. The secondary device shall respond after verifying the received data.

If the download file is a weighting factors file, and if the file content is OK, the RAE device shall use the downloaded weighting factors as the new active weighting factors.

The response time to this RAE Download End procedure shall be less than 10 seconds.

Table 8.4.3.4: Return codes for RAE Download End

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **ChecksumError** **InvalidFileContent** **InvalidProcedureSequence**	

8.4.4. Get Number of Files

Table 8.4.3.1: Elementary procedure for RAE Get Number of Files

Name: **RAEGetNumberofFiles**				
Code: **0x46**	Issued by: **primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.3.2: Initiating message parameters and format for RAE Get Number of Files

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**

Table 8.4.3.3: Response message parameters and format for RAE Get Number of Files

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**
3	**1 octet**	**Unsigned integer**	**Number of files**

This command is used to query the number of files in the subunit.

Table 8.4.3.4: Return codes for RAE Get Number of Files

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **WorkingSoftwareMissing** **UnsupportedProcedure**	

Description:

The Get Number of Files procedures can be applied to individual subunits of the device or to the device itself. To get the device files, the subunit number parameter shall be 0.

Included files are only antenna pattern files and active weighting factor files (the Read-Only factory weighting factor files are excluded).

8.4.5. Get File Information

Table 8.4.3.1: Elementary procedure RAE Get File Information

Name: **RAEGetFileInformation**				
Code: **0x47**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.3.2: Initiating message parameters and format for RAE Get File Information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
1	**1 octet**	**Unsigned integer**	**File index**

Table 8.4.3.3: Response message parameters and format for RAE Get File Information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**
3	**1 octet**	**Unsigned integer**	**Weighting factor file (0x04)** **Antenna pattern file (0x05)**
4	**4 octets**	**Unsigned integer**	**File size**
5	**1 octet**	**Unsigned integer**	**Length of file name**
6	**Length of file name**	**ASCII**	**File name**

Description:

This command is used to query the file size and name. The file index is numbered from 1 upwards, and the maximum number equals the total number of files in the subunit.

Table 8.4.3.4: Return codes for RAE Get File Information

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **WorkingSoftwareMissing** **UnsupportedProcedure** **UnknownParameter**	

8.4.6. RAE Upload File

Table 8.4.6.1: Elementary procedure for RAE Upload File

Name: **RAE Upload File**				
Code: **0x48**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.6.2: Initiating message parameters and format for RAE Upload File

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**File index (seeGet File Information)**
3	**4 octets**	**Unsigned integer**	**Offset address of the data to be obtained**

Table 8.4.6.3: Response message parameters and format for RAE Upload File

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**
3	**≤ MaxDataTransmitLength – 2 octets**	**Vendor specific**	**File content**

Description:

On receipt of the initiating message, the RAE shall return as many octets as possible of the file with the index “File index”, starting at “Offset”. The Upload File procedures shall be applied to individual subunits of the device.

NOTE: Query the file size and name before using the primary device to upload the file. Based on the file size, determine the maximum offset for file uploading and repeatedly transfer data. If the offset is 0 in the first time of data transfer, the offset for each successive data transfer is equal to the offset for the previous data transfer plus the size of the previous data transfer.

Table 8.4.6.4: Return codes for RAE Upload File

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **OutOfRange** **WorkingSoftwareMissing** **UnsupportedProcedure** **UnknownParameter**	

8.4.7. RAE Reset Factory Weighting Factors

Table 8.4.7.1: Elementary procedure RAE Reset Factory Weighting Factors

Name: **RAERestoreFactoryWeightingFactors**				
Code: **0x70**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.7.2: Initiating message parameters and format for RAE Reset Factory Weighting Factors

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**

Table 8.4.7.3: Response message parameters and format for RAE Reset Factory Weighting Factors

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**ReturnCode**	**Return code OK**

Description:

The RAE device shall overwrite the active weighting factors with the factory weighting factors for the addressed subunit.

The secondary device shall respond to the initiating message in less than 10 seconds.

Table 8.4.7.4: Return codes for RAE Reset Factory Weighting Factors

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **InvalidFileContent** **UnsupportedProcedure**	

8.4.8. RAE Get Weighting Factor

Table 8.4.8.1: Elementary procedure RAE Get Weighting Factor

Name: **RAEGetWeightingFactor**				
Code: **0x73**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.8.2: Initiating message parameters and format for RAE Get Weighting Factor (field number between 0x01 and 0x0A)

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Field number; value between 0x01 and 0x0A**

Table 8.4.8.3: Initiating message parameters and format for RAE Get Weighting Factor (field number equal to 0x0B)

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Field number; value equal to 0x0B**
3	**2 octets**	**Unsigned integer**	**Electrical tilt [degree], expressed in tilt value times 10.**
4	**2 octets**	**Unsigned integer**	**Broadcast beam width [degree].**
5	**2 octets**	**Unsigned integer**	**Frequency band min [MHz].**
6	**2 octets**	**Unsigned integer**	**Frequency band max [MHz].**

Description: For values of field 2 between 0x01 and 0x0A, the subunit will return antenna information data according to Table A.1.

For values of field 2 equal to 0x0B, the subunit will return the weighting factor data (3 x N octets) for the specified electrical tilt, the specified beamwidth and the specified frequency band according to Table A.2.

Table 8.4.8.4: Response message parameters and format for RAE Get Weighting Factor

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Return code**	**Return code ok**
3	**See Annex A**	**See Annex A**	**Field value, See Table A.1 ; also see Table 8.4.8.5**

Table 8.4.8.5: Interpretation of RAEGetWeightingFactor Response

Octet number	Description
1	**Amplitude [%] of port 1**
2	**Phase[degree] low octet of port 1**
3	**Phase[degree] high octet of port 1**
...	**...**
3 x N – 2	**Amplitude [%] of port N**
3 x N – 1	**Phase[degree] low octet of port N**
3 x N	**Phase[degree] high octet of port N**

Description:

The response format in table 8.4.8.5 is used for field 0x0B. The amplitude is expressed in percent of the maximum power, ranging from 0 to 100. The phase is expressed in degrees, ranging from -180.0 to +179.9, expressed in phase value times 10.

Table 8.4.8.6: Return codes for RAE Get Weighting Factor

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **WorkingSoftwareMissing** **UnsupportedProcedure** **UnknownParameter**	

8.4.9. RAE Get Supported Functions

On receipt of the initiating message, the secondary device shall respond with the function flags and parameters indicating the supported functionality of the addressed RAE.

Table 8.4.9.1: Elementary procedure RAEGetSupportedFunctions

Name: **RAEGetSupportedFunctions**				
Code: **0x7A**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.9.2: Initiating message parameters and format for RAEGetSupportedFunctions

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**

Table 8.4.9.3: Response message parameters and format for RAEGetSupported Functions

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Return code**	**Return code: OK**
3	**1 octet**	**Unsigned integer**	**Function Flags**

Table 8.4.9.4: Return codes for RAEGetSupportedFunctions

OK	FAIL	Comment
	FormatError **HardwareError** **WorkingSoftwareMissing**	

Table 8.4.9.5: Function Flags for RAEGetSupportedFunctions

Bit	7	6	5	4	3	2	1	0
Function	**Reserved**	**Antenna Pattern file download function**	**Antenna Pattern file function**	**Installed mechanical tilt sensor function deprecated**	**Antenna bearing sensor function deprecated**	**Height sensor function deprecated**	**Location sensor function deprecated**	**Weighting Factor function 1**

On receipt of the initiating message, the RAE shall respond with the function flags and parameters indicating the supported functionality of the addressed RAE unit.

Bits are numbered from 0…7, bit number 0 set to 1 represents the value 0x01
Bit value 0 indicates that the function is not supported
Bit value 1 indicates that the function is supported
Spare bits shall be set to zero

Bit 0 shall always be set to 1 because support to weighting factor function is mandatory.

If 'Location sensor function' is set, then additional data field No. 0x11 is implemented Read-Only (Set Device Data forbidden) and a sensor updates this field in real-time.

If 'Height sensor function' is set, then additional data field No. 0x10 is implemented Read-Only (Set Device Data forbidden) and a sensor updates this field in real-time.

If 'Antenna bearing sensor function' is set, then additional data field No. 0x25 is implemented Read-Only (Set Device Data forbidden) and a sensor updates this field in real-time.

If 'Installed mechanical tilt sensor function' is set, then additional data field No. 0x26 is implemented Read-Only (Set Device Data forbidden) and a sensor updates this field in real-time.

If 'Antenna Pattern file upload function' is set, then the RAE supports the upload of the antenna pattern files.

If 'Antenna Pattern file download function' is set, then the RAE supports the download of the antenna pattern files.

The bits 1 to 4, which are marked as deprecated, will in a later version be changed to obsolete.

NOTE: It is recommended to use the existing ASD and GLS devices and use the Annex B additional data fields Antenna model number and Antenna serial number to connect the sensors to the antenna.

8.4.10. RAE Get 2D Weighting Factors

Table 8.4.10.1: RAE Get 2D Weighting Factors

Name: **RAEGet2DWeightingFactors**				
Code: **0x7B**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.10.2: Initiating message parameters and format for RAE Get 2D Weighting Factors

Number	Length	Type	Description
1	1 octet	Unsigned integer	Subunit number
2	1 octet	Unsigned integer	Sub-ID number; see Annex H
3	See below	See below	See below

Table 8.4.10.3: Response message parameters and format for Get 2D Weighting Factors

Number	Length	Type	Description
1	1 octet	Unsigned integer	Subunit number
2	1 octet	ReturnCode	Return code OK
3	See Annex H	See Annex H	See Annex H

Description: The Sub-ID of RAE Get 2D Weighting Factors is defined in Annex H.

Table 8.4.10.4: Return Code of RAE Get 2D Weighting Factors

OK (0x00)	TBC (0x40)	FAIL (0x0B)	Comment
	See Chapter 8.4.11	**FormatError** **Busy** **HardwareError** **WorkingSoftwareMissing** **UnsupportedProcedure** **UnknownParameter** **InvalidProcedureSequence**	

To facilitate weight file enquiry, the parameter data field, data length and data content of each weight dimension are defined. The data field and data length occupy 2 octets and 1octet, respectively. The length of the data content depends on different parameters.

Table 8.4.10. 4: Parameter definition

Parameter	Data Field	Data Length	Data Content	Data Content Type
Band	0x0001	0x04	Band scope value	2 x 16-bit unsigned
Vertical beamwidth	0x0002	0x02	Vertical beamwidth value	16-bit unsigned
Horizontal beamwidth	0x0003	0x02	Horizontal beamwidth value	16-bit unsigned
Downtilt	0x0004	0x02	Downtilt value	16-bit signed
Azimuth	0x0005	0x02	Azimuth value	16-bit signed
Weight group number	0x0006	0x01	Weight group number	8-bit unsigned

NOTE: The weight group number is optional. Group 1 is used by default. The definition of weight group must be specified in documents of each antenna vendor.

8.4.10.1. To getfile head information

1. To get bands included in the weighting factors file

Table 8.4.10.1.1: Parameters of the command for get antenna band information

Number	Length	Type	Description
1	**1 octet**	Unsigned integer	**Subunit number**
2	**1 octet**	Unsigned integer	**Sub-ID，0x06**

2. To get beam width information

Table 8.4.10.1.2: Parameters of the command for get beam width information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID，0x07**
3	**2 octets**	**Unsigned integer**	**Data field for band，0x0001**
4	**1 octet**	**Unsigned integer**	**Data length for band，0x04**
5	**2 octets**	**Unsigned integer**	**Lower edge of band (0.1 MHz)**
6	**2 octets**	**Unsigned integer**	**Upper edge of band (0.1 MHz)**

NOTE: The lower edge and upper edge of band are expressed in 0.1 MHz, which means band value (MHz) times 10.

3. To get beam direction information

Table 8.4.10.1.3: Parameters of the command for get beam direction information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID，0x08**
3	**2 octets**	**Unsigned integer**	**Data field for band，0x0001**
4	**1 octet**	**Unsigned integer**	**Data length for band，0x04**
5	**2 octets**	**Unsigned integer**	**Lower edge of band (0.1 MHz)**
6	**2 octets**	**Unsigned integer**	**Upper edge of band (0.1 MHz)**
7	**2 octets**	**Unsigned integer**	**Data field for vertical beam width，0x0002**
8	**1 octet**	**Unsigned integer**	**Data length for vertical beam width，0x02**
9	**2 octets**	**Unsigned integer**	**Value of vertical beam width (0.1°)**
10	**2 octets**	**Unsigned integer**	**Data field for horizontal beam width，0x0003**
11	**1 octet**	**Unsigned integer**	**Data length for horizontal beam width，0x02**
12	**2 octets**	**Unsigned integer**	**Value of horizontal beam width (1°)**

4. To get the number of weighting factors group

Table 8.4.10.1.4: Parameters of the command for get number of groups

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID，0x09**
3	**2 octets**	**Unsigned integer**	**Data field for band，0x0001**
4	**1 octet**	**Unsigned integer**	**Data length for band，0x04**
5	**2 octets**	**Unsigned integer**	**Lower edge of band (0.1 MHz)**
6	**2 octets**	**Unsigned integer**	**Upper edge of band (0.1 MHz)**
7	**2 octets**	**Unsigned integer**	**Data field for vertical beam width，0x0002**
8	**1 octet**	**Unsigned integer**	**Data length for vertical beam width，0x02**
9	**2 octets**	**Unsigned integer**	**Value of vertical beam width (0.1°)**
10	**2 octets**	**Unsigned integer**	**Data length for horizontal beam width，0x0003**
11	**1 octet**	**Unsigned integer**	**Data length for horizontal beam width，0x02**
12	**2 octets**	**Unsigned integer**	**Value of horizontal beam width (1°)**
13	**2 octets**	**Unsigned integer**	**Data field for tilt，0x0004**
14	**1 octet**	**Unsigned integer**	**Data legth for tilt，0x02**
15	**2 octets**	**Signed integer**	**Value of tilt (0.1°)**
16	**2 octets**	**Unsigned integer**	**Data field for azimuth，0x0005**
17	**1 octet**	**Unsigned integer**	**Data length for azimuth，0x02**
18	**2 octets**	**Signed integer**	**Value of azimuth (1°)**

5. To get antenna port information

Table 8.4.10.1.5: Parameters of the command for get antenna port information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID，0x0A**
3	**2 octets**	**Unsigned integer**	**Data field for band，0x0001**
4	**1 octet**	**Unsigned integer**	**Data length for band，0x04**
5	**2 octets**	**Unsigned integer**	**Lower edge of band (0.1 MHz)**
6	**2 octets**	**Unsigned integer**	**Upper edge of band (0.1 MHz)**

6. Command format for get other file head information

Other file head information, e.g. version, has no connection with the dimensions of weighting factors, so no dimension parameter is carried in the get command frame.

Table 8.4.10.1.6: Parameters of the command for get other file head information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID**

8.4.10.2. Response message format for get file head information

Table 8.4.10.2.1: Parameters of the response message of get file head information

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Return code**	**Return code ok**
3 …	**See Table H-1**	**See Table H-1**	**See Table H-1**

8.4.10.3. Command format for get weighting factors

Band, vertical beam width, horizontal beam width, tilt, azimuth and group number are needed to be specified in the command frame.

Table 8.4.10.3.1: Command message of get weighting factors

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID，0x1B**
3	**2 octets**	**Unsigned integer**	**Data field for band，0x0001**
4	**1 octet**	**Unsigned integer**	**Data length for band，0x04**
5	**4 octets**	**Unsigned integer**	**Band range (Consist of the lower edge and upper edge of the band) (0.1 MHz)**
6	**2 octets**	**Unsigned integer**	**Data field for vertical beam width，0x0002**
7	**1 octet**	**Unsigned integer**	**Data length for vertical beam width，0x02**
8	**2 octets**	**Unsigned integer**	**Value of vertical beam width (0. 1°)**
9	**2 octets**	**Unsigned integer**	**Data field for horizontal beam width，0x0003**
10	**1 octet**	**Unsigned integer**	**Data length for horizontal beam width，0x02**
11	**2 octets**	**Unsigned integer**	**Value of horizontal beam width (1°)**
12	**2 octets**	**Unsigned integer**	**Data field for tilt，0x0004**
13	**1 octet**	**Unsigned integer**	**Data length for tilt，0x02**
14	**2 octets**	**Signed integer**	**Value of tilt (0. 1°)**
15	**2 octets**	**Unsigned integer**	**Data field for azimuth，0x0005**
16	**1 octet**	**Unsigned integer**	**Data length for azimuth，0x02**
17	**2 octets**	**Signed integer**	**Value of azimuth (1°)**
18	**2 octets**	**Unsigned integer**	**Data field for group number，0x0006**
19	**1 octet**	**Unsigned integer**	**Data length for group number，0x01**
20	**1 octet**	**Signed integer**	**Group number**

8.4.10.4. Response message format for get weighting factors data

Table 8.4.10.4.1: Parameters of the response message of get weighting factors data

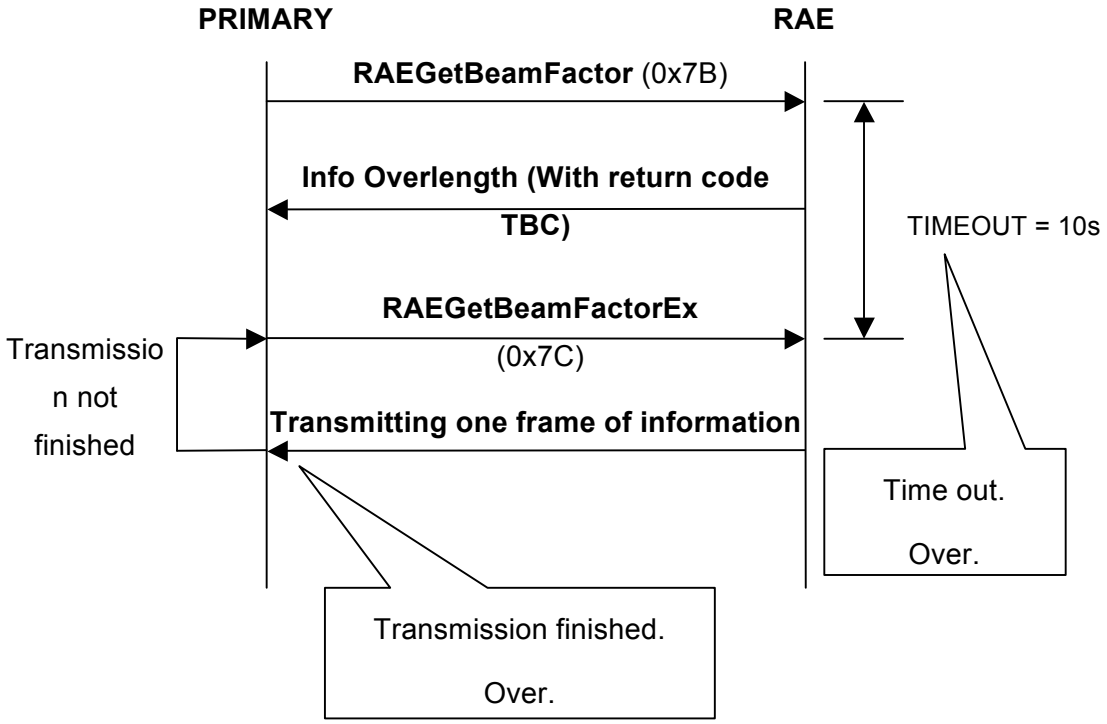
Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Return code**	**Return code OK**
3 …	**See Table 8.4.10.4.2**	**See Table 8.4.10.4.2**	**See Table 8.4.10.4.2**

Table 8.4.10.4.2: Weighting factors data form as responded

Octet number	Description
1	Amplitude (|I|*100) of port 1
2	Phase(0.1 deg) low octet of port 1
3	Phase(0.1 deg) high octet of port 1
...	...
3 x N – 2	Amplitude (|I|*100) of port N
3 x N – 1	Phase(0.1 deg) low octet of port N
3 x N	Phase(0.1 deg) high octet of port N

8.4.11. Multi-frame Enquiry (0x7C)

For some sub-IDs, e.g. 0x0A, it may not be possible to transmit the response within one AISG frame, since it exceeds the frame length limit. In this case, the following procedure shall be carried out.



TBC (To Be Continued) is a new return code supposed to be added to the RAE protocol. And the response message shall carry LENGTH, total length of the inquired information to activate the primary to initiate the multi-frame enquiry.

Table 8.4.11.1: Parameters of the response message in the case of overlength

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Return code(TBC)**
3	**4 octets**	**Unsigned integer**	**Total length of the inquired info(LENGTH)**

The primary initiates the multi-frame enquiry (0x7C) within TIMEOUT. And the multi-frame enquiry command shall carry the octet offset of the data to be inquired, staring with 0x00000000.

Table 8.4.11.2: Procedure Multi-frame Enquiry

Name: **RAEGetBeamFactorData**				
Code: **0x7C**	Issued by: **Primary device**	Procedure class: **1**	DownloadMode state: **No**	Power mode: **Low**

Table 8.4.11.3: Initiating message parameters and format for Multi-frame Enquiry

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Unsigned integer**	**Sub-ID**
3	**4 octets**	**Unsigned integer**	**Octet offset**

Table 8.4.11.4: Response message parameters and format for Multi-frame Enquiry

Number	Length	Type	Description
1	**1 octet**	**Unsigned integer**	**Subunit number**
2	**1 octet**	**Return code**	**Return code OK**
3 …	**<= MaxInfoLength - 5**	**See Table H-1**	**See Table H-1**

Table 8.4.11.5: Return codes for Multi-frame Enquiry

OK	FAIL	Comment
	FormatError **Busy** **HardwareError** **WorkingSoftwareMissing** **UnsupportedProcedure** **UnknownParameter** **InvalidProcedureSequence**	

If timeout occurs after the reception of command 0x7B, the secondary shall terminate the procedure, and shall respond with InvalidProcedureSequence if 0x7C is subsequently received.

The multi-frame enquiry procedure shall always be started with command 0x7B. If 0x7C is received without the previous reception of 0x7B, InvalidProcedureSequence is returned by RAE.

Annex A: Assigned fields for smart antenna information - including weighting factors (Normative)

Table A.1: antenna information structure

Field No.	Length (octets)	Format	Description
0x01	24	ASCII	Weighting factors information
0x02	24	ASCII	Weighting factors Version
0x03	1	8-bit unsigned	The number of electrical tilt sample points: P
0x04	2 x P	16-bit signed	<min electrical tilt (deg)> , ... ,< max electrical tilt (deg)>, expressed in tilt value times 10
0x05	1	8-bit unsigned	The number of broadcast beam widths: L
0x06	2 x L	16-bit signed	< broadcast Beam width 1(deg)> , ... ,< broadcast Beam width L(deg)>
0x07	1	8-bit unsigned	The number of frequency bands: M
0x08	4 x M	2 x 16-bit unsigned	< frequency band 1 low (MHz), frequency band 1 high (MHz)> , ... ,< frequency band M low (MHz), frequency band M high (MHz)>
0x09	1	8-bit unsigned	The number of RF ports: N
0x0A	2	16-bit signed	Antenna advanced parameters, e.g. space between antenna columns(mm)
0x0B	3 x N	8-bit unsigned, 16-bit signed	< Amplitude (|P|*100), Phase(0.1 deg)> , ... , < Amplitude (|P|*100), Phase(0.1 deg)>, (see Table A.2)

Note: The weighting factor file contains one set of weighting factors for each of the L x M x N combinations of broadcast beam widths, frequency bands and electrical tilt value. The amplitude value P refers to the far field power level in W normalized to the maximum value in the pattern

Table A.2: weighting factors data relation

		frequency band 1			.....			frequency band M		
		port 1	**.....**	**port N**	**port 1**	**.....**	**port N**	**port 1**	**.....**	**port N**
min electrical tilt	**Beam width 1**	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	.....	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Beam width L	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
electrical tilt 1		**frequency band 1**			**.....**			**frequency band M**		
		port 1	.....	port N	port 1	.....	port N	port 1	.....	port N
	Beam width 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	.....	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Beam width L	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
.....		**frequency band 1**			**.....**			**frequency band M**		
		port 1	.....	port N	port 1	.....	port N	port 1	.....	port N
	Beam width 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	.....	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Beam width L	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
max electrical tilt		**frequency band 1**			**.....**			**frequency band M**		
		port 1	.....	port N	port 1	.....	port N	port 1	.....	port N
	Beam width 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	.....	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Beam width L	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase

NOTE: Electrical tilts are sampled discretely in table A.2. If the electrical tilt required by primary device is not in table A.2, then RAE shall calculate and report a value according to the data in table A.2.

Annex B: Procedure sequence for file download and get weighting factor (Normative)

B.1 Procedure sequence for set weighting factors to a secondary device

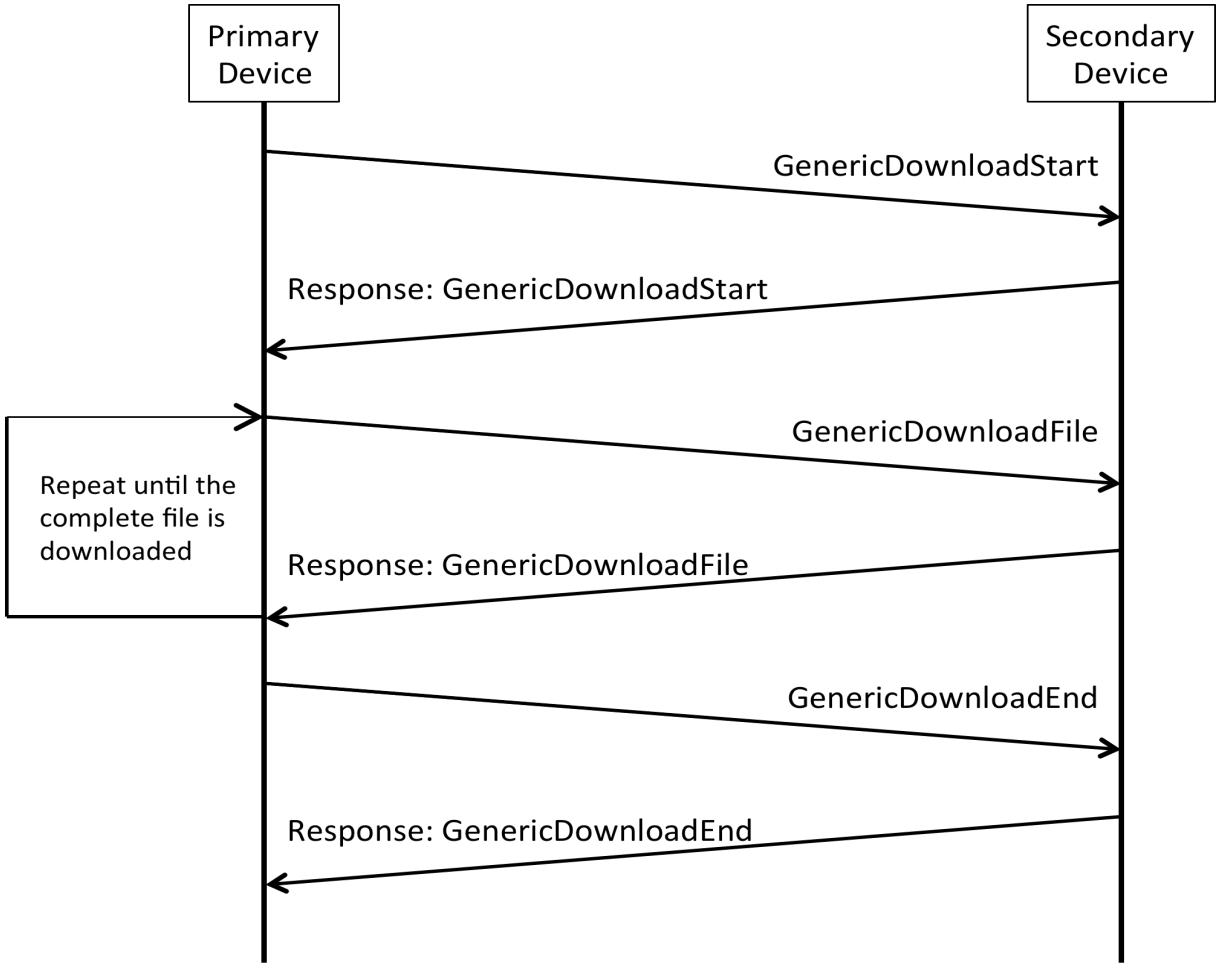


Figure B.1: Procedure sequence for RAE Download File

The data content of the RAE Download File message shall support a file validity feature to minimize the risk of accepting a faulty or invalid file.

B.2 Procedure sequence for Get Weighting Factors from a secondary device

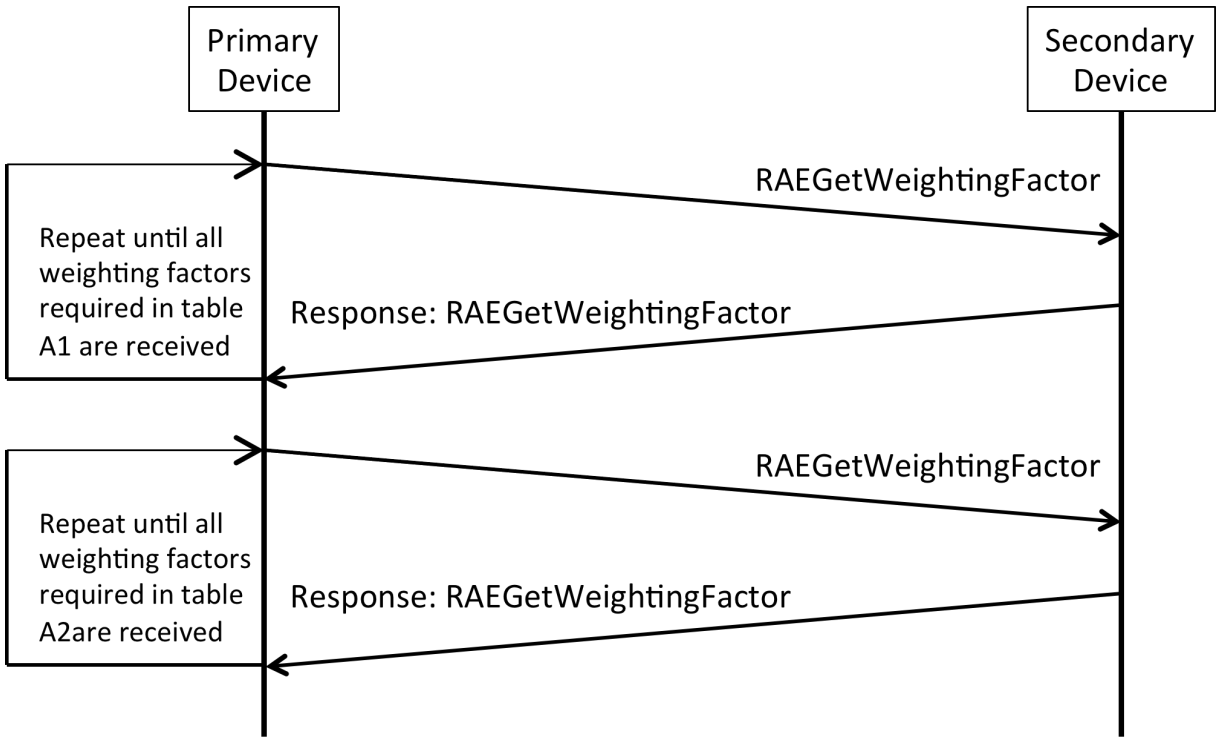


Figure B.2: Procedure sequence for Get Weighting Factors

First, the primary device shall send the command RAEGetWeightingFactor with field number 0x01 to 0x0A to the secondary device. The secondary device shall return the corresponding field number and field value, see Table A.1.

Then, the primary device shall send the command RAEGetWeightingFactor with field number 0x0B and include the electrical tilt, broadcast beam width and frequency band for which the weighting factors are inquired. The secondary device shall return the field number and the weighting factors.

B.3 Example for getting antenna weighting factors

The antenna weighting factors data in Table 2.1 are shown as part in table B.1 and table B.2, table B.1 and table B.2 are stored in the RAE device. A base station shall send RAEGetWeightingFactor command with field 0x01~0x0A to query the weighting factors information after the base station has connected to the RAE, then the RAE shall return the information highlighted in the table below:

The weighting factors of a broad range TD Smart Antenna @65°Broadcast Beam width

Vendor name	**Vendor x**								
Electrical tilt	**0°**								
Broadcast Beam width: 65°									
Frequency Range/port		**Port 1**	**Port 2**	**Port 3**	**Port 4**	**Port 5**	**Port 6**	**Port 7**	**Port 8**
1880M~1920M	**Amplitude |Ii|**	**0**	**0.45**	**1.00**	**1.00**	**0**	**0.45**	**1.00**	**1.00**
	Phase	**0**	**0**	**0**	**179.0**	**0**	**0**	**0**	**179.0**

TD_Smart_Antenna

Ver001

3 electrical tilt sample points: 0.0°, 3.0°, 6.0°

3 broadcast Beam widths: 30°, 65°, 90°

2 frequency bands: 2010~2025MHz, 1880~1920MHz

8 RF ports

70 mm space between antenna columns

The base station can check the antenna with the information above:

To query e.g. the weighting factors value of 0 deg tilt, 65 deg broadcast beam width, 1880~1920MHz frequency band, the base station will send RAEGetWeightingFactor command with field 0x0B and the field values 0, 65, 0x58, 0x07, 0x80, 0x07. The RAE will look up table B.2 and return the values: 0, 0, 45, 0, 100, 0, 100,1790, 0, 0, 45, 0, 100, 0, 100, 1790.

Table B.1: Weighting factors file structure

Field No. (Normative)	Length (octets) (Informative)	Format (Informative)	Description (Informative in HEX format)
0x01	24	ASCII	54 44 5F 53 6D 61 72 74 5F 41 6E 74 65 6E 6E 61 5F 48 75 61 77 65 69 00
0x02	24	ASCII	56 65 72 30 30 31 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x03	1	8-bit unsigned	03 P
0x04	6	16-bit signed	00 00 1E 00 3C 00
0x05	1	8-bit unsigned	03 L
0x06	6	16-bit signed	1E 00 41 00 5A 00
0x07	1	8-bit unsigned	02 M
0x08	8	2 x 16-bit unsigned	DA 07 E9 07 58 07 80 07
0x09	1	8-bit unsigned	08 N
0x0A	2	16-bit unsigned	46 00
0x0B	3 x N x (L x M x P)	8-bit unsigned, 16-bit signed	See table B.2

NOTE: Where ASCII variables are shorter than the assigned field lengths the characters are left aligned and following blanks are filled with null characters (0x00).

Table B.2: Weighting factors data relation (HEX format)

		frequency band 1			1880~1920MHz							
		port 1	.....	port 8	port 1	port 2	port 3	port 4	port 5	port 6	port 7	port 8
0.0deg	30 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	65 deg	Amp	Amp	Amp	0	2D	64	64	0	2D	64	64
		Phase	Phase	Phase	00 00	00 00	00 00	FE 06	00 00	00 00	00 00	FE 06
	90 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		frequency band 1			1880~1920MHz							
		port 1	.....	port 8	port 1	port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8
3.0deg	30 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	65 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	90 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		frequency band 1			1880~1920MHz							
		port 1	.....	port 8	port 1	port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8
6.0deg	30 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	65 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	90 deg	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
		Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase

Annex C: A sample of a broadcast beam weighting factors file (Informative)

Weighting factors file structure

The structure of the weighting factors file is a black-box for the primary device, and the file structure is flexible for every RAE device. However, RAE devices must comply with the commands of the RAE specific protocol. Based on the commands of the RAE specific protocol, the primary device can get the weighting factors by communicating with the RAE device.

The structure of the weighting factors file which includes two primary parts: The weighting factor header and the weighting factor data. It is shown as follow:

Table C1: Example of the weighting factors file structure

Weighting factors file name
Weighting factors file version number
Number of electrical downtilt entries
Number of broadcast beam width entries
Number of frequency bands
Number of RF ports
Antenna advanced parameters: space between antenna columns
Specified electrical downtilt values
Specified broadcast beam width values
Specified frequency bands
Weighting Factors Data

NOTE: Weighting factor file supports RAE Get Weighting Factor Procedure as mandatory.

NOTE: Weighting factor file cannot support RAE Get 2D Weighting Factor Procedure.

Weighting factors information

In the example, weighting factors file information include:

Weighting factors file name: HW_TD_WT_DEMO

Weighting factors file version number: Ver001

Number of electrical downtilt entries: 4

Number of broadcast beam width entries: 2

Number of frequency bands: 3

Number of RF ports: 8

Antenna advanced parameters: space between antenna columns: 70 mm

Specified electrical downtilt values: 0, 40, 70, 90 (0.1 deg)

Specified broadcast beam width values: 30, 65 deg

Specified frequency bands: 1880~1920, 2010~2025, 2500~2690 MHz

Weighting factors data

Rules of data storage

Little endian order is used for storage, octet align without pad data.

The weighting factors data consist of an amplitude value (1 octet) and a phase value (2 octets). The weighting factors table is four-dimensional, comprising electrical downtilt, broadcast beam width, frequency band number and RF port number as the dimensions.

The four-dimensional weighting factor data is sequential for storage in the weighting factors file.

For example, in the weighting factor file, the data Amplitude[i][j][k][l](1Octet) is stored in octet at the position of data[t], and the Phase[i][j][k][l](2Octets) is stored at the position of data[t+1](low part) and data[t+2](high part). The parameter i, j, k and l represent the 4 dimensions of downtilt, beam width, frequency and port number. The value of t is computed as:

t = HEAD+[(i*beam_num*freq_num+j*freq_num+k)*port_num+l]*3(Octet)

NOTE: beam_num, freq_num and port_num are the total number of broadcast beam width entries, number of frequency band entries and number of RF ports, and HEAD is the length of the weighting factor file head.

In this given example, the HEAD is 78 Octet, and the Weighting Data are 4x2x3x8x3octets=576 Octet, the complete file size is 654 Octet.

Parse weighting factors file (Example)

Weighting factor header

1: Weighting factors file name: HW_TD_WT_DEMO

2: Weighting factors file version number: Ver001

3: Number of electrical downtilt entries: 4
Number of broadcast beam width entries: 2
Number of frequency bands: 3
Number of RF ports: 8
Antenna advanced parameters: space between antenna columns [mm]: 70 (46 HEX).

4: Specified electrical downtilt values [0.1 deg]: 0, 40, 70, 90

5: Specified broadcast beam width values [deg]: 30, 65 [1E HEX, 41 HEX]

6: Specified frequency bands [MHz]: 1880~1920, 2010~2025, 2500~2690

Weighting factor data (Normalized power amplitude in [%], phases in [deg]

7: Weighting factors data for downtilt 0 (0.1 deg), broadcast beam width 30 deg, frequency band 1880~1920 MHz.

Amplitude	68	100	100	65	68	100	100	65
Phase	0	-10	20	30	0	-10	20	30

8: Weighting factors data for downtilt 0 (0.1 deg), broadcast beam width 30 deg, frequency band 2010~2025 MHz.

Amplitude	61	100	100	60	61	100	100	60
Phase	0	0	20	-20	0	0	20	-20

9: Weighting factors data for downtilt 40 (0.1 deg), broadcast beam width 65 deg, frequency band 2500~2690 MHz.

Amplitude	35	65	100	100	35	65	100	100
Phase	0	-1720	60	100	0	-1720	60	100

10: Weighting factors data for downtilt 90 (0.1 deg), broadcast beam width 65 deg, frequency band 2500~2690 MHz.

Amplitude	32	63	100	100	32	63	100	100
Phase	0	-1780	0	30	0	-1780	0	30

Annex D: File Types for RAE Upload and Download Procedures (Normative)

Table D.1: File Types for Secondary Devices

Code	Name	Comment	Download Mode State
0x04	Weighting Factors File	Contains data that have no operational impact within the secondary device.	
0x05	Antenna Pattern File	Contains the antenna radiation pattern data	

Note: RAE uses file types 0x04 and 0x05. Other file types are described for sake of completeness.

Annex E: Example of a beam forming antenna (Informative)

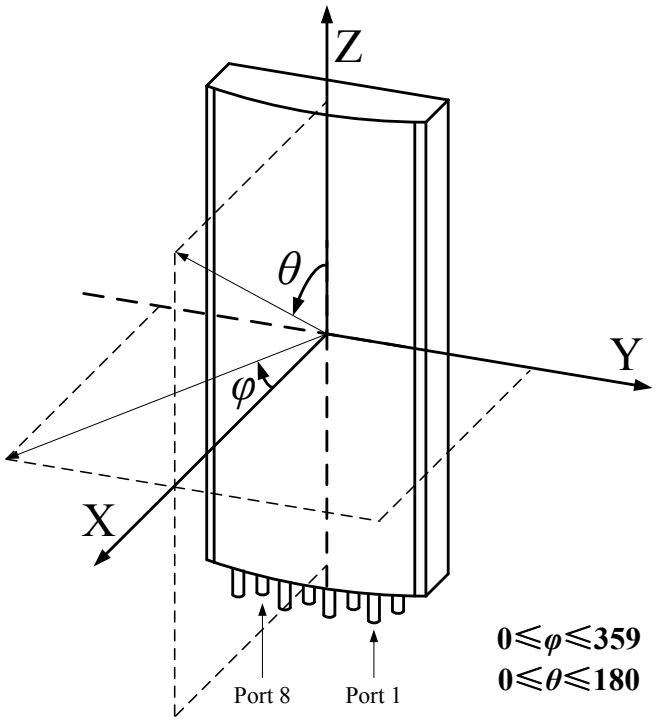


Figure E.1: Smart Antenna with 8 RF ports and 1 calibration port

Note: When using a beam forming antenna, the base station needs to be configured with the right weighting factor information to form the desired beam.

Annex F: 2D Weighting Factors -- Relationship of weighting factors dimensions (Normative)

Table F.1: Relationship of dimensions of weighting factors

Band *	Vertical Beam Width 1		Horizontal Beam Width 1			…			Horizontal Beam Width L_1		
			Azimuth 1	…	Azimuth R_{11}	Azimuth 1	…	Azimuth $R_{1…}$	Azimuth 1	…	Azimuth R_{1L1}
		Tilt1	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		…	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		$TiltP_{11}$	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
	…		Horizontal Beam Width 1			…			Horizontal Beam Width L_1		
			Azimuth 1	…	Azimuth R_{11}	Azimuth 1	…	Azimuth $R_{1…}$	Azimuth 1	…	Azimuth R_{1L1}
		Tilt1	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		…	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		$TiltP_{1…}$	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
	Vertical Beam Width S_1		Horizontal Beam Width 1			…			Horizontal Beam Width L_1		
			Azimuth 1	…	Azimuth R_{11}	Azimuth 1	…	Azimuth $R_{1…}$	Azimuth 1	…	Azimuth R_{1L1}
		Tilt1	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		…	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2
		$TiltP_{1S1}$	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2	As Table F.2

Table F.2: Amplitude and Phase

	Group 1	…	Group Y
Port 1	Amplitude	Amplitude	Amplitude
	Phase	Phase	Phase
…	Amplitude	Amplitude	Amplitude
	Phase	Phase	Phase
Port N	Amplitude	Amplitude	Amplitude
	Phase	Phase	Phase

The weighting factors file has such dimensions as band, horizontal beam width, vertical beam width, electrical downtilt, azimuth, and weighting factors group number. These dimensions have the following relationship:

- Different bands may have different number of vertical and horizontal beam widths.
- Different vertical beam widths may have different number of electrical downtilts.

- Different horizontal beam widths may have different number of azimuths.
- The number of weighting factors groups is independent of all the other dimensions.
- Different bands may use different numbers of ports.
- The number of active ports determines the weighting factor group length.

As in Table F.1, different background colours are used to indicate the nesting relationship of the dimensions. Band is the outermost layer dimension, and beam widths are the second layer, and then beam directions, and group number is the innermost layer dimension.

NOTE:

Table F.1 only demonstrates one band, expressed as *. The dimensional relationships under each band are all the same. But there may be differences in parameter numbers, like numbers of vertical beam widths, numbers of horizontal beam widths, numbers of tilts and numbers of azimuths.

Annex G: 2D Weighting Factors -- Storage Format of Weighting Factors File (Normative)

Table G.1: Storage format of weight files

	Data Content	Occupied Length (Unit: Octet)	Data Type	Remarks
File header	CRC	4	32-bit unsigned	CRC32. Based on the method for calculating the antenna pattern, the following polynomial is used to calculate the CRC result: $X^{32} + X^{26} + X^{23} + X^{22} + X^{16} + X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^5 + X^4 + X^2 + X + 1$ The initial state of X is 1.
	Total file length (including the CRC)	4	32-bit unsigned	Number of octets of the whole file
	Weight file identifier	1	8-bit unsigned	Fixed to 0x04
	Reserved	17	Not specified	Vendor-defined
	Antenna model	15	ASCII	Left aligned. If the length is less than 15 octets, add binary value 0 to the right.
	Band scope	4	2 x 16-bit unsigned	Unit: 0.1 MHz
	Format version	1	8-bit unsigned	Value: 0x02
	Weight version	24	ASCII	Left aligned. If the length is less than 24 octets, add binary value 0 to the right.
	Weight file name	62	ASCII	Left aligned. If the length is less than 62 octets, add binary value 0 to the right.
Weight table header	Weight information	24	ASCII	Inheriting AISG-ES-RAE v2.1.0
	Advanced antenna parameter	2	16-bit signed	Inheriting AISG-ES-RAE v2.1.0. The space between columns can be specified.
	Number of bands	1	8-bit unsigned	
	Band scope	4 x M	M x 2 x 16-bit unsigned	Unit: 0.1 MHz M indicates the number of bands
	Offset address of the antenna band table (table I)	4	32-bit unsigned	Stored in little-endian mode, and using the start octet of the file as the base address

	Data Content	Occupied Length (Unit: Octet)	Data Type	Remarks
	Reserved	5	Undefined	
Weight information table	Antenna band table (table I)	1	/	There is only one antenna band table (table I), whose location is determined by the offset address of the antenna band table in the weight table header. Typically, table I can be located next to the weight table header, as shown in this table. Unit of the vertical beamwidth: 0.1° Unit of the horizontal beamwidth: 1°
	Beamwidth table (table II)	1 for each band	/	Each band corresponds to one table II. Multiple beamwidth tables (table II) are available for multiple bands, without a sequential order. Unit of the downtilt step: 0.1° Unit of the downtilt scope: 0.1° Unit of the azimuth step: 1° Unit of the azimuth scope: 1°
	Beam direction table (table III)	1 for each pair of horizontal beamwidth and vertical beamwidth in each table II	/	Multiple beam direction tables (table III) are available, without a sequential order.
	Weight data table (table IV)	1 for each pair of azimuth and downtilt of each table III	/	Multiple weight data tables (table IV) are available, without a sequential order. In a weight data table, the weight data is stored in the following sequence: The weight groups are ordered by group number. The weight amplitude and phase values in each group are ordered by port sequence, a port corresponds to a pair of amplitude and phase values. Amplitude: |I| x 100 Phase: phase x 10 Amplitude I indicates the normalized current (unit: A). The result of |I| x 100 is an integer ranging from 0 to 100. The phase field indicates the phase of the current (unit: degree). The result of phase x 10 is an integer ranging from –1800 to +1800.

NOTE:

- All data is stored in the little-endian mode.
- Tables I, II, III, and IV only indicate different table types. For details about table formats, see the below tables.
- In the following weighting factors information tables, tables I to IV do not have storage path requirements. They only need to be located using offset addresses.
- 2D weighting factor file supports RAE Get 2D Weighting Factor Procedure as mandatory.
- 2D weighting factor file supports RAE Get Weighting Factor Procedure as optional.

Table G.2a: Antenna band (table I)

	Band 1	...	Band M
Antenna band (table I)	Offset address of table II	Offset address of table II	Offset address of table II
	Number of vertical beamwidths	Number of vertical beamwidths	Number of vertical beamwidths
	Vertical beamwidth list	Vertical beamwidth list	Vertical beamwidth list
	Number of horizontal beamwidths	Number of horizontal beamwidths	Number of horizontal beamwidths
	Horizontal beamwidth list	Horizontal beamwidth list	Horizontal beamwidth list
	Number of ports	Number of ports	Number of ports
	Port identifier list	Port identifier list	Port identifier list
	Polarization identifier list	Polarization identifier list	Polarization identifier list

Table G.2b: Supplement to table I

Field	Length (Octet)	Data Type	Unit
Offset address of table II	4	32-bit unsigned	
Number of vertical beamwidths (S)	1	8-bit unsigned	
Vertical beamwidth list	2 x S	16-bit unsigned	0.1°
Number of horizontal beamwidths (L)	1	8-bit unsigned	
Horizontal beamwidth list	2 x L	16-bit unsigned	1°
Number of ports (N)	1	8-bit unsigned	
Port identifier	20 x N	ASCII, left aligned, adding 0x00 to the right	
Port Polarization Mode	1 x N	8-bit unsigned	

Table G.3a: Beamwidth (table II)

Beamwidth (table II)		Horizontal beamwidth 1	...	Horizontal beamwidth L
	Vertical beamwidth 1	Offset address of table III	Offset address of table III	Offset address of table III
		Downtilt step	Downtilt step	Downtilt step
		Downtilt scope	Downtilt scope	Downtilt scope
		Azimuth step	Azimuth step	Azimuth step
		Azimuth scope	Azimuth scope	Azimuth scope
	...			
	Vertical beamwidth S			

NOTE: Data is stored in columns priority.

Table G.3b: Supplement to table II

Field	Length (Octet)	Data Type	Unit
Offset address of table III	4	32-bit unsigned	
Downtilt step	1	8-bit unsigned	0.1°
Downtilt scope <min, max>	2 x 2	16-bit signed	0.1°
Azimuth step	1	8-bit unsigned	1°
Azimuth scope <min, max>	2 x 2	16-bit signed	1°

Table G.4a: Beam direction (table III)

Beam direction (table III)		Azimuth 1	...	Azimuth R
	Electrical downtilt 1	Offset address of table IV	Offset address of table IV	Offset address of table IV
		Number of weight groups	Number of weight groups	Number of weight groups
	...			
	Electrical downtilt P			

NOTE: Data is stored in columns priority.

Table G.4b: Supplement to table III

Field	Length (Octet)	Data Type
Offset address of table IV	4	32-bit unsigned
Number of weight groups	1	8-bit unsigned

Table G.5a: Weight data (table IV)

		Group 1	...	Group Y
Weight data (table IV)	Port 1	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase
	...	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase
	Port N	Amplitude	Amplitude	Amplitude
		Phase	Phase	Phase

NOTE: Group number start from 1.

NOTE: Data is stored in columns priority.

Table G.5b: Supplement to table IV

Field	Length (Octet)	Data Type	Unit
Amplitude	1	8-bit unsigned	Maximum value: 100 Step: 1
Phase	2	16-bit signed	0.1°

NOTE: Offset addresses in the following weight information tables use start bytes of weight files as the base address.

NOTE: Red boxes in the following tables indicate a group of data that is consecutively stored.

Annex H: 2D Weighting Factors -- Sub-IDs of the Weight Inquiring Command (Normative)

Table H.1: Sub-IDs of the weight inquiring command

Sub-ID	Queried Object and Content of the Returned Message	Data Type	Remarks
0x01	Format code	8-bit unsigned	Format code of the weight file, which is 0x02 corresponding to the version
0x02	File name	ASCII, 496 bits	Weight file name
0x03	File version	ASCII, 192 bits	Corresponding to the weighting factors version specified in AISG-ES-RAE v2.1.0
0x04	File information	ASCII, 192 bits	Corresponding to the weighting factors information specified in AISG-ES-RAE v2.1.0
0x05	Advanced parameter	16-bit unsigned	Corresponding to the antenna advanced parameters, for example, space between antenna columns (unit: mm), specified in AISG-ES-RAE v2.1.0
0x06	Total number of bands, M	8-bit unsigned	To inquire band information.
	List of bands	M x 2 x 16-bit unsigned	
0x07	Total number of vertical beam width, S	8-bit unsigned	To inquire beam width information.
	List of vertical beam widths	S x 16-bit unsigned	
	Total number of horizontal beam width, L	8-bit unsigned	
	List of horizontal beam widths	L x 16-bit unsigned	
0x08	Step of tilt values	8-bit unsigned	To inquire beam direction information.
	Tilt range	2 x 16-bit signed	
	Step of azimuth values	8-bit unsigned	
	Azimuth range	2 x 16-bit signed	
0x09	Number of weighting factors group	8-bit unsigned	To inquire number of groups.
0x0A	Total number of antenna port, N	8-bit unsigned	To inquire port information. Polarization definition: 0x00：P45 0x01：PN45 0x02：P0 0x03：P90 0x04：PLC 0x05：PRC
	Port polarization mode	N x 8-bit unsigned	
	Port identifier	N x 20 x 8-bit unsigned	
0x1B	A group of weights	N x 8-bit unsigned N x 16-bit signed	<Amplitude (|I| x 100), phase (0.1°)>, ..., <amplitude (|I| x 100), phase(0.1°)>

Annex I: Antenna Pattern File Data Format (Normative)

One or more antenna pattern file can be stored in an RAE device. As shown in table I.1 A pattern file contains pattern data of one or more frequencies. The amplitude value E refers to the linear far field strength (V/m) normalized to the maximum value in the pattern.

Table I.1: Antenna Pattern data format < Amplitude (|E|*255), Phase (0.1 deg)>

			port 1			…			port s_1		
			0°	…	359°	0°	…	359°	0°	…	359°
Band 1	Frequency 1	Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		..	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt N_1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	…		port 1			…			port s_1		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt N_1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Frequency M_1		port 1			…			port s_1		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt N_1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase

			port 1			…			port $s_{…}$		
			0°	…	359°	0°	…	359°	0°	。。。	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt $N_{…}$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Frequency 1		port 1			…			port $s_{…}$		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt $N_{…}$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
…	…		port 1			…			port $s_{…}$		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt $N_{…}$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Frequency $M_{…}$		port 1			…			port $s_{…}$		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		。。。	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt $N_{…}$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
Band L	Frequency 1		port 1			…			port s_L		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt 1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		Tilt N_L	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude

			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	…		port 1			…			port s_L		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		$TiltN_L$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
	Frequency M_L		port 1			…			port s_L		
			0°	…	359°	0°	…	359°	0°	…	359°
		Tilt1	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		…	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase
		$TiltN_L$	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude	Amplitude
			Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase	Phase

The antenna pattern is a two-dimensional, and contains amplitude and phase for different frequencies and downtilts. The amplitude is the linear field strength at each bearing angle, normalized to a maximum value of 255. The phase ranges from –180 to +180, and the azimuth ranges from 0° to 359° (with the value spacing of 1°). In two-dimension files, the antenna pattern data is saved in the following sequence: <amplitude (|E| x 255), phase (0.1°)>, ..., <amplitude (|E| x 255), phase (0.1°)>. The azimuth value (from 0° to 359°) is not saved.

As shown in the following figure:

- φ indicates the azimuth of the pattern in plane H, and the 0° azimuth indicates the positive direction of the X axis in the antenna reference coordinate system. The azimuth increases from the positive direction of the X axis to the negative direction of the Y axis.

- θ indicates the pitch angle of the pattern in plane V, and the 0° azimuth indicates the positive direction of the Z axis in the antenna reference coordinate system. The azimuth increases from the positive direction of the Z axis to the positive direction of the X axis.

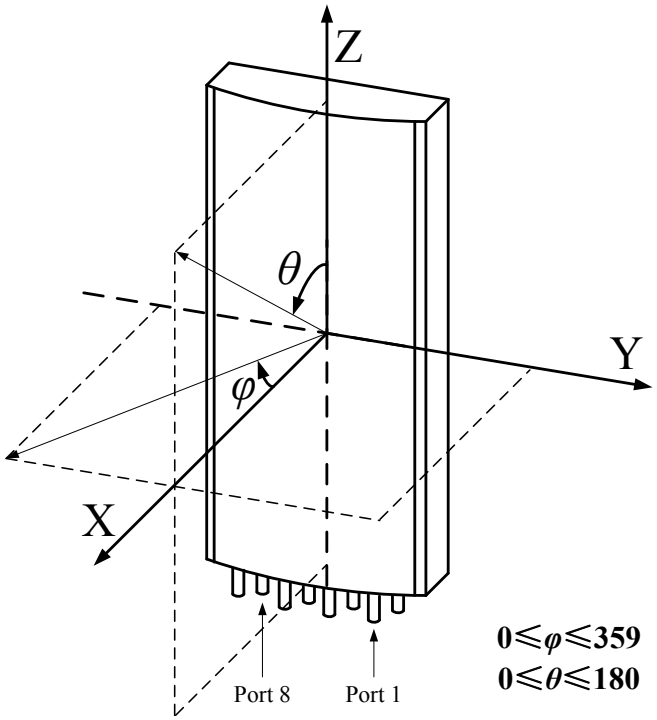


Figure I.1: Antenna reference coordinate system

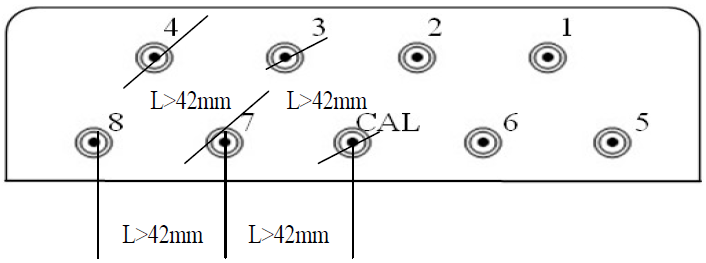


Figure I.2: External ports of the dual-polarized 8T8R smart antenna

Pattern File Format

A pattern file includes the file header and pattern data, as described in Table I.2.

Table I.2: Pattern file format

No.	Field	Length* (Octet)	Data Type	Description
1	CRC	4	32-bit unsigned integer	CRC result of the pattern file, calculated using the CRC32 algorithm. The initial state of each bit of this field is set to 1. For detailed CRC32 formula, see Annex K
2	File length	4	32-bit unsigned integer	Length of the pattern file
3	Reserved	46	ASCII code	custom information for vendor
4	File type	1	8-bit unsigned integer	0x05 (fixed)
5	Antenna model	15	ASCII code	Antenna model. If the length of this field is less than 15 octets, add spaces to the left of the field.
6	File name	62	ASCII code	Pattern file name (including the .fxt suffix). If the length of this field is less than 64 octets, add spaces to the left of the field. For details about how to name an antenna pattern file, see Annex J "**Error! Reference source not found.**."
7	File format version	1	8-bit unsigned integer	Pattern file format version, started from version 1
8	Pattern plane	1	8-bit unsigned integer	0: pattern in the horizontal plane 1: pattern in the vertical plane
9	Band quantity	1	8-bit unsigned integer	Number of bands included in a pattern (L)
10	Band	L x 4	32-bit unsigned integer	Value of L bands in a pattern. Each band occupies four octets, in which, the low bit indicate the lower band threshold, and the high bit indicate the upper band threshold (0.1 MHz). For example: [Band1_frq_low Band1_frq_high ... BandL_frq_low BandL_frq_high]
11	Maximum gain	L x 2	16-bit unsigned integer	Maximum antenna gain corresponding to each band (0.1 dBi)
12	Frequency quantity	L x 1	8-bit unsigned integer	Number of frequencies in L bands in a pattern (M_1, M_2, ..., M_L)

No.	Field	Length* (Octet)	Data Type	Description
13	Frequency	M_1 x 2 + M_2 x 2 + ... + M_L x 2	16-bit unsigned integer	Value of each frequency in L bands. Each frequency occupies two octets (0.1 MHz).
14	Electrical downtilt quantity	L x 1	8-bit unsigned integer	Number of electrical downtilts (N_1, N_2, ..., N_L)
15	Electrical downtilt	N_1 x 2 + N_2 x 2 + ... + N_L x 2	16-bit signed integer	Value of each electrical downtilt in L bands in a pattern. Each electrical downtilt occupies two octets (0.1°). The downtilts have positive values, and the uptilts have negative values.
16	Port quantity	L x 1	8-bit unsigned integer	Number of ports (S_1, S_2, ..., S_L)
17	Antenna port	S_1 x 20 + S_2 x 20 + ... + S_L x 20	ASCII code	ID of S antenna ports. Each port ID occupies 20 octets. If the length of this field is less than 20 octets, add spaces to the left of the field. The antenna port ID does not include the port name. For example, the ID of port 1 is 1.
18	Pattern data	360 x 3	8-bit unsigned integer, 16-bit signed integer	Antenna pattern data, in the sequence of <amplitude (|E|*255), phase (0.1°)>, ..., <amplitude (|E|*255), phase (0.1°)>. The amplitude occupies one octet, and the phase occupies two octets.

Annex J: Antenna Pattern File Naming Rules (Normative)

An antenna pattern file is named according to the following rules: <vendor code>_<antenna model>_<band 1>&<band 2>&...&<band L>_<H|V>_<pattern file version>.fxt

Note 1: The pattern file version is different from the file format version. The pattern file version is generated under the same file format version due to pattern content changes. The version numbering rules are determined by vendors.

Note 2: Bands are listed in ascending mode, with the unit of MHz.

For example, the following lists the file name of the BX pattern of an YY vendor XXXX antenna in band FA and plane H:

YY_XXXX_1880-1920&2010-2025_H_BX.fxt

Annex K: CRC polynomial (Normative)

$X^{32} + X^{26} + X^{23} + X^{22} + X^{16} + X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^5 + X^4 + X^2 + X + 1$

The initial state of X is 1

Annex L: Additional Return Code and Alarm Code of RAE Device (Normative)

Table M.1: Additional return code and alarm code of RAE device

Code	Name	Comment	Alarm	DownloadMode state
0x40	TBC	This return code indicates that the data to be sent cannot be finished in the current frame, that is, more frames are needed.		