



Tower Mounted Amplifier

AISG-ST-TMA

vTMA3.0.7.4

Revision History

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Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



1. FOREWORD	4
2. SCOPE.....	5
2.1. Interpretation (Normative)	5
3. REFERENCES	6
4. VERSION COMPLIANCE (Informative).....	7
5. ABBREVIATIONS (Informative).....	8
6. TERMINOLOGY	9
7. DEFINITIONS.....	10
8. GENERAL ASPECTS	11
8.1 TMA general description	11
8.2 TMA Capabilities	11
8.2.1. LNA diagnostics capability	11
8.2.2 Bypass capability	11
8.2.3 Redundant LNA capability	11
8.2.4 Bypass diagnostic capability	12
8.2.5 Adjustable gain capability	12
8.2.6. Gain estimation capability	12
8.3. Subunit relationship	12
8.4. State models	12
8.4.1. TMA state model for layer 7	12
8.5. TMA gain ranges.....	13
8.6. Return codes	14
8.7. Default values when shipped from the factory	14
8.8. Resumption of operation	14
9. LAYER 1	15
9.1. DC power consumption.....	15
10. LAYER 2	16
11. LAYER 7	17
11.1. Subunit type	17
11.2. Overview of commands for TMA subunits	17
11.3. Updating of TMA state	17
11.3.1. Events	21
11.4. Reset	21

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



11.5. TMA commands.....21

 11.5.1. TMA Get Capabilities.....21

 11.5.2. TMA Set Mode.....23

 11.5.3. TMA Get Mode25

 11.5.4. TMA Set Gain27

 11.5.5. TMA Get Gain29

Annex A: TMA State ID (Informative):.....32

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



1. FOREWORD

This standard has been produced by the Antenna Interface Standards Group (AISG) to introduce and define new features and enhancement of the management system for antenna line devices (ALDs) with remote control and monitoring facilities. AISG v3.0 base document describes the common behaviour of antenna line devices with AISG interfaces and type-specific functionality is defined in subunit type standards. This subunit type standard covers tower mounted amplifiers (sometimes referred to as masthead or ground mounted amplifiers).

This standard is independent of previous 3GPP standards.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



2. SCOPE

AISG v3.0 specifies the standard data interface between a primary, typically a base station, and antenna line devices (ALDs) which are manageable units, usually associated with base station antennas.

The standard is divided into the base document and several subunit type standards. This subunit type standard document describes the specific behaviour of the tower mounted amplifier (TMA) subunit type.

This standard defines the functional behaviour of the TMA subunits.

2.1. Interpretation (Normative)

The text of the standard defines explicitly what is required or permitted. Anything that is not explicitly allowed is not permitted.

All statements in the current document are normative, unless indicated as informative or example.

For purposes of compliance and AISG interoperability, users should note that the implementation of this subunit type standard is optional. However, once it is selected for inclusion in a product, the entire standard becomes mandatory.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



3. REFERENCES

This AISG Standard incorporates provisions from other publications. These are cited in the text and the referenced publications are listed below. Where references are listed with a specific version or release, subsequent amendments or revisions of these publications apply only when specifically incorporated by amendment or revision of this AISG standard. For references listed without a version or release, the latest edition of the publication referred to applies.

- 1 AISG v3.0: “Base Standard AISG v3.0”
- 2 AISG v3.0 STCM: “Subunit Type Compliance Matrix”



4. VERSION COMPLIANCE (Informative)

The compliance of this standard with different version of AISG v3 baseline standard is defined in [2].

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



5. ABBREVIATIONS (Informative)

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

ALD	Antenna Line Device
DC	Direct Current
LNA	Low Noise Amplifier
MALD	Multi-primary ALD
RF	Radio Frequency
SALD	Single-primary ALD
TCC	Time-Consuming Command
TMA	Tower Mounted Amplifier
3GPP	3 rd Generation Partnership Project

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



6. TERMINOLOGY

Where the following terms are used in this document, they have the following meanings:

Bypass diagnostics	Capability to detect and report failures in the bypass circuitry.
Estimated gain	An estimation of the TMA gain in the current circumstances supplied by the TMA subunit. It may take into account, if available, information from LNA and bypass diagnostics, and possible LNA or bypass circuitry failure(s).
Gain	A factor by which signal power is increased in an amplifier, usually expressed in dB.
LNA	An amplifier that amplifies a very low power signal without significantly degrading its signal-to-noise ratio.
LNA diagnostics	Capability to detect and report failures in the LNA circuitry.
LNA gain estimation	Capability to estimate the actual gain of the LNA even in case of some failures.
LNA path	A path including LNA and possible bypass switches.
Redundant LNA	LNA architecture comprising multiple amplifiers, configured to provide some signal amplification in case of a single amplifier failure.
TMA	A unit typically providing uplink and downlink paths, containing an LNA on the uplink path and associated filters on both paths.
TMA bypass	A switchable RF path in parallel with an LNA to provide an alternative signal path used in case of a total LNA failure.
TMA bypass path	An RF path around an LNA including bypass switches.
TMA bypass switch	A functionality that switches between normal and bypass mode.
TMA gain	Uplink insertion gain between two interconnected RF ports, where referred TMA subunit has relationship with both ports.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



7. DEFINITIONS

NrOfGainRanges shall be initialised on reset to contain the number of gain ranges of the TMA subunit.

```
uint8_t NrOfGainRanges
```

GainTable shall be initialised on reset to contain the possible gain settings of the TMA subunit.

```
GainRange_t GainTable[NrOfGainRanges]
```

NrOfFrequencyRanges shall be initialised on reset to contain the number of frequency ranges of the TMA subunit.

```
uint8_t NrOfFrequencyRanges
```

FrequencyTable shall be initialised on reset to contain the supported frequency ranges of the TMA subunit.

```
FrequencyRange_t FrequencyRangeTable[NrOfFrequencyRanges]
```

NrOfTMASubunits shall be initialised on reset to contain the number of TMA subunits in the TMA.

```
uint8_t NrOfTMASubunits
```

LNAPathState array shall be initialised on reset to have space for the LNAPathState:s in the TMA.

```
uint8_t LNAPathState[NrOfTMASubunits]
```

BypassPathState array shall be initialised on reset to have space for the BypassPathState:s in the TMA.

```
uint8_t BypassPathState[NrOfTMASubunits]
```

TMAMode_t is used to indicate the normal or bypass mode of TMA subunit. TMA mode is only changed with the TMA Set Mode command and it does not change when the TMA autonomously recovers gain, for example by changing the LNA or Bypass paths.

```
Enumeration TMAMode_t: uint8_t {  
    BypassMode ← 0  
    NormalMode ← 1  
}
```

```
PERSISTENT TMAMode_t TMAMode[1..NrOfTMASubunits]
```

```
Enumeration TMAAlarmCode_t : uint16_t {  
    TMAAlarmLNAFailed ← 0x0200  
    TMAAlarmBypassFailed ← 0x0201  
    TMAAlarmNoRXConnection ← 0x0202  
}
```

```
Enumeration ActivePath_t : uint8_t {  
    LNAPath ← 0  
    BypassPath ← 1  
    None ← 2  
}
```

```
ActivePath_t TMAActivePath[1..NrOfTMASubunits]
```

```
PERSISTENT dB_t TMAGain[1..NrOfTMASubunits]
```

```
CONST uint16_t NrOfSubunitAlarms ← 3 // Number of subunit alarm types for  
// this subunit type
```



8. GENERAL ASPECTS

8.1 TMA general description

A TMA is used to amplify uplink RF signals on the antenna line. A TMA may comprise LNA(s), bypass arrangements and filtering. Besides the capability of amplifying RF signals, an implementation of a TMA subunit may support the optional capabilities defined in this standard. This standard also defines a command for the primary to query which of these capabilities is supported by a particular implementation of the TMA subunit.

8.2 TMA Capabilities

- LNA Diagnostics
- Bypass
- Redundant LNA
- Bypass Diagnostics
- Adjustable Gain
- Gain Estimation

TMACapabilities are represented by the following bitfield and are set by design.

```
Bitfield TMACapabilities_t : uint8_t {  
    LNADiagnostics      : Bit 0  
    Bypass              : Bit 1  
    RedundantLNA        : Bit 2  
    BypassDiagnostics   : Bit 3  
    AdjustableGain      : Bit 4  
    GainEstimation      : Bit 5  
}
```

TMACapabilities_t TMACapabilities

Bit value 0: Capability not supported.

Bit value 1: Capability supported.

8.2.1. LNA diagnostics capability

A TMA subunit provided with this capability is able to detect failures in an LNA path, and generate minor and major alarms based on the severity of the effect of such failures.

8.2.2 Bypass capability

A TMA subunit provided with this capability contains alternative RF paths that allow the LNA to be bypassed. This bypass can be controlled by the primary with the TMA Set Mode command. The TMA subunit may also activate this bypass path autonomously to avoid complete RF signal loss in the case of a complete LNA path failure.

8.2.3 Redundant LNA capability

A TMA subunit provided with this capability contains redundant LNAs. Failure of a single LNA does not completely break the RF signal through the LNA path, as some gain will be retained.



8.2.4 Bypass diagnostic capability

A TMA subunit provided with this capability can detect a failure causing loss of signal through its RF bypass path.

If an RF bypass failure has been detected, the TMA subunit shall reject the command from the primary to activate the bypass mode because this would cause complete loss of signal.

If the RF bypass failure has been detected while the TMA is in bypass mode, the TMA shall autonomously activate the LNA path instead of the bypass path. The TMA mode remains unchanged, see Annex A.

8.2.5 Adjustable gain capability

A TMA subunit provided with this capability has multiple settable gain values, and is able to adjust its gain based on a TMA Set Gain command received from the primary.

8.2.6. Gain estimation capability

A TMA subunit provided with this capability is able to estimate the gain produced by its LNA in the case of amplifier failures. A primary can use the TMA Get Gain command to obtain the gain estimation and may utilise this information in response to an LNA path failure.

8.3. Subunit relationship

A TMA subunit may be related to two or more RF ports with interconnections between some or all of these ports.

8.4. State models

8.4.1. TMA state model for layer 7

TMA state model has 11 states, which are listed with ID numbers in Annex A. The inputs for the state model are shown in figure 8.2.1-1 “Input to TMAState state model”, which shows the relationship between different states of the LNA path, Bypass path and TMA mode. Transitions to certain states may require diagnostic capabilities.

In LNAPathOKState the LNA path is fully operational and amplifies the signal.

In LNAPathImpairedState the LNA path is operational but with reduced amplification performance.

In LNAPathBrokenState the LNA path is unable to amplify the signal and may be heavily attenuated.

In BypassPathOKState the bypass path is fully operational and transfers the signal.

In BypassPathBrokenState the bypass path may be heavily attenuated.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```

Enumeration LNAPathState_t : uint8_t {
    LNAPathOKState          ← 0
    LNAPathBrokenState      ← 1
    LNAPathImpairedState    ← 2
}
LNAPathState_t            LNAPathState[1..NrOfTMASubunits]

Enumeration BypassPathState_t : uint8_t {
    BypassPathOKState       ← 0
    BypassPathBrokenState   ← 1
}
BypassPathState_t        BypassPathState[1..NrOfTMASubunits]
    
```

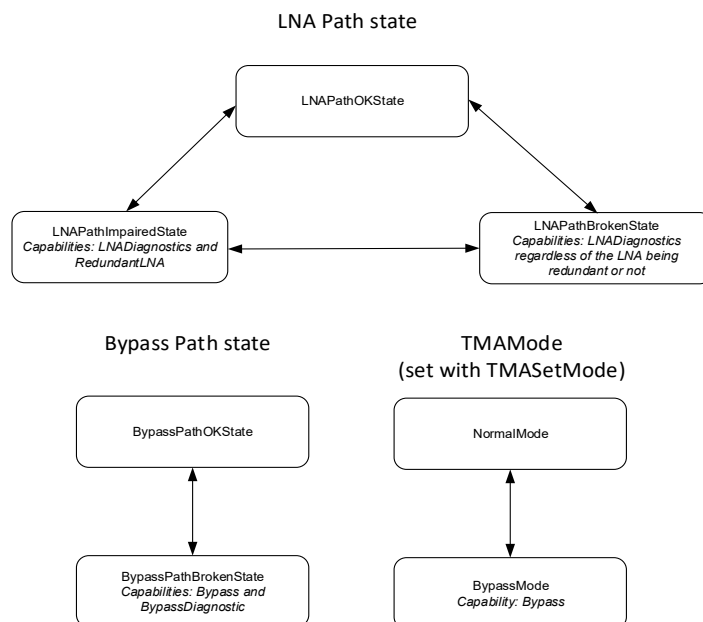


Figure 8.4.1-1 Input to TMAState state model

8.5. TMA gain ranges

The primary can query the gain ranges supported by the TMA subunit using the TMAGetCapabilities command.

If the TMA subunit has fixed gain, it shall respond to the TMAGetCapabilities command with one gain range having gain step size 0, and both the minimum gain and maximum gain values set to the fixed nominal gain value supported by the TMA subunit.

If the TMA subunit has adjustable gain range(s), it shall respond to the TMAGetCapabilities command with one or more gain ranges according to the gain range(s) that the TMA subunit supports.

See [1] for details and examples of encoding gain ranges.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



8.6. Return codes

This subunit type standard contains the following subunit type specific return codes.

```
Enumeration ReturnCode_t : uint16_t {  
    TMAUnsupportedGainValue    ← 0x0200  
    TMAMajorFault              ← 0x0201  
    TMAMinorFault              ← 0x0202  
}
```

8.7. Default values when shipped from the factory

The default values of TMAMode and TMAGain are vendor specific. The vendor shall indicate in the product documentation with which default values the TMA is shipped.

8.8. Resumption of operation

The following data are initially set at the factory, and shall be retained after reset:

- TMAMode
- TMAGain

After reset, TMA shall perform EvaluateTMAState function.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



9. LAYER 1

All definitions and standards for ALDs in [1] regarding layer 1 shall be valid for ALDs which contain TMA subunits.

9.1. DC power consumption

This subunit type standard does not define the power consumption of a TMA. See [1] for details on how power consumption is reported to the primary.

This subunit type standard does not contain any commands that switch the ALD from SteadyStatePowerMode to HighPowerMode or to SleepPowerMode.



10. LAYER 2

All definitions and standards for ALDs in [1] regarding layer 2 shall be valid for ALDs which contain TMA subunits.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



11. LAYER 7

An ALD which contains TMA subunit(s) shall support the command set which is defined in [1] in addition to those commands specified in this standard.

11.1. Subunit type

Subunit type	1-octet unsigned integer code
TMA	0x02

Table 11.1-1: Subunit type code

11.2. Overview of commands for TMA subunits

The table below shows an overview of all commands used in this TMA subunit type standard.

The following abbreviations are used in the Table 11.2-1 "Commands for TMA subunits":

- M Mandatory
- O Optional
- Not applicable

TMA Command	Code	Initiator	Subunit	Timeout	TCC	Mandatory for:			Changes the ConnectionState	Changes the PowerMode	Minimum required authority
						Primary	SALD	MALD			
TMA Get Capabilities	0x0200	Primary	>0	1 s	no	M	M	M	no	no	RO
TMA Set Mode	0x0201	Primary	>0	1 s	no	M	O	O	no	no	RW
TMA Get Mode	0x0202	Primary	>0	1 s	no	M	M	M	no	no	RO
TMA Set Gain	0x0203	Primary	>0	1 s	no	M	O	O	no	no	RW
TMA Get Gain	0x0204	Primary	>0	1 s	no	M	M	M	no	no	RO

Table 11.2-1: Commands for TMA subunits

11.3. Updating of TMA state

Function EvaluateTMAState() is called:

- on reset – to determine initial state of TMA subunit
- when user requests a change of TMA mode
- when a state of LNA path or Bypass path changes

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



The function is executed in the context of a TMA subunit. Re-raising an alarm with same severity shall result only in updating the diagnostic string associated with the alarm. TMA state IDs are described in Annex A.

```
struct AlarmDetails_t {
    Severity_t Severity
    UTF8String_t DiagnosticString
}

FUNCTION EvaluateTMAState(uint16_t Subunit) IS
//Outputs of the evaluation
AlarmDetails_t LNAAAlarm
AlarmDetails_t BypassAlarm
AlarmDetails_t RxConnectionAlarm

LNAAAlarm.Severity ← Cleared
LNAAAlarm.DiagnosticString ← ""
BypassAlarm.Severity ← Cleared
BypassAlarm.DiagnosticString ← ""
RxConnectionAlarm.Severity ← Cleared
RxConnectionAlarm.DiagnosticString ← ""
```

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



CASE LNAPathState IS

// TMA state ID 1, 2, 3, 4a and 4b

WHEN LNAPathOK:

IF BypassPathState = BypassPathBrokenState THEN

TMAActivePath ← LNAPath // TMA state ID 4a. No change to TMA subunit
// Active Path or TMA state ID 4b. TMA
// subunit set Active Path to LNAPath avoiding
// complete Rx signal loss.

BypassAlarm.Severity ← Minor

BypassAlarm.DiagnosticString ← "Bypass path failed"

ELSE

IF TMAMode = BypassMode THEN

TMAActivePath ← BypassPath // TMA state ID 3

ELSE

TMAActivePath ← LNAPath // TMA state ID 1, 2. No change to TMA
// subunit Active path. This shows where
// the execution ends in case of TMA
// state IDs 1 and 2.

ENDIF

ENDIF

// TMA state ID 5, 6, 7 and 8

WHEN LNAPathImpaired:

LNAAlarm.Severity ← Minor

LNAAlarm.DiagnosticString ← "LNA path impaired"

IF TMAMode = BypassMode THEN

IF BypassPathState = BypassPathBrokenState THEN // TMA state ID 8

TMAActivePath ← LNAPath

BypassAlarm.Severity ← Minor

BypassAlarm.DiagnosticString ← "Bypass path failed"

ELSE

TMAActivePath ← BypassPath // TMA state ID 7

ENDIF

ELSE

TMAActivePath ← LNAPath // TMA state ID 5,6

ENDIF

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



```
// TMA state ID 9, 10 and 11
OTHERWISE //i.e. LNAPathState = LNAPathBroken
    IF NOT TMACapabilities.Bypass THEN // TMA state ID 9
        TMAActivePath ← None
        RxConnectionAlarm.Severity ← Major
        RxConnectionAlarm.DiagnosticString ← “LNA path broken”
    ELSEIF BypassPathState = BypassPathOKState // TMA state ID 10
        TMAActivePath ← BypassPath
        LNAAlarm.Severity ← Major
        LNAAlarm.DiagnosticString ← “LNA path broken”
    ELSE // BypassPathState = BypassPathBrokenState, TMA state ID 11
        TMAActivePath ← None
        RxConnectionAlarm.Severity ← Major
        RxConnectionAlarm.DiagnosticString ← “LNA and bypass paths broken”
    ENDIF
ENDIF

ENDCASE

IF TMAActivePath = LNAPath
    «Switch signal path to LNA path»
ELSEIF TMAActivePath = BypassPath
    «Switch signal path to TMA bypass path»
ENDIF

CASE LNAAlarm.Severity IS
    WHEN Major:
        RAISE TMAAlarmLNAFailed SEVERITY Major ON Subunit,
        LNAAlarm.DiagnosticString
    WHEN Minor:
        RAISE TMAAlarmLNAFailed SEVERITY Minor ON Subunit,
        LNAAlarm.DiagnosticString
    OTHERWISE:
        CLEAR TMAAlarmLNAFailed ON Subunit
ENDCASE

IF RxConnectionAlarm.Severity = Cleared THEN
    CLEAR TMAAlarmNoRXConnection ON Subunit
ELSE
    RAISE TMAAlarmNoRXConnection SEVERITY Major
    ON Subunit, RxConnectionAlarm.DiagnosticString
ENDIF

IF BypassAlarm.Severity = Cleared THEN
    CLEAR TMAAlarmBypassFailed ON Subunit
ELSE
    RAISE TMAAlarmBypassFailed SEVERITY Minor
    ON Subunit, BypassAlarm.DiagnosticString
ENDIF
END
```

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



11.3.1. Events

```
ON «TMA bypass path's condition change» DO
    IF «bypass path is broken» THEN
        SWITCH BypassPathState TO BypassPathBrokenState
    ELSE
        SWITCH BypassPathState TO BypassPathOKState
    ENDIF
    EvaluateTMAState(Subunit)
DONE

ON «LNA path's condition change» DO
    IF «LNA path is broken» THEN
        SWITCH LNAPathState TO LNAPathBrokenState
    ELSE IF «at least one, but not all, redundant amplifiers have failed» THEN
        SWITCH LNAPathState TO LNAPathImpairedState
    ELSE
        SWITCH LNAPathState TO LNAPathOKState
    ENDIF
    EvaluateTMAState(Subunit)
DONE
```

11.4. Reset

```
ON Reset DO
    FOREACH SUBUNIT FROM 1 TO NrOfSubunits DO
        IF Subunits[SUBUNIT] = TMA THEN
            EvaluateTMAState(SUBUNIT)
        ENDIF
    DONE
DONE
```

11.5. TMA commands

11.5.1. TMA Get Capabilities

Description (Informative):

On receipt of the command, the TMA subunit shall respond with the capabilities and parameters indicating the functionalities of the addressed TMA subunit.

The supported gain ranges shall follow the definitions in [1]. Gain value in bypass state shall not be reported as part of the gain ranges.

The frequency ranges in the response reflect the capabilities of the TMA subunit; not the current usage by the primary.

Bit value 0 represents function is not supported. Bit value 1 represents function is supported.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



Message format:

```
PrimaryCommand TMAGetCapabilitiesCommand {
    CommandCode_t      Command ← 0x0200
    CommandSequence_t   PrimaryCommandSequence
    Subunit_t           Subunit
    DataLength_t        DataLength ← 0
}

ALDResponse TMAGetCapabilitiesResponse {
    CommandCode_t      Command ← 0x0200
    CommandSequence_t   PrimaryCommandSequence
    ReturnCode_t        ReturnCode
    DataLength_t        DataLength
    if (ReturnCode == OK) {
        TMACapabilities_t    TMACapabilities
        uint8_t             NrOfGainRanges
        GainRange_t         GainRanges[1..NrOfGainRanges]
        uint8_t             NrOfFrequencyRanges
        FrequencyRange_t     FrequencyRanges[1..NrOfFrequencyRanges]
    }
    else {
        ALDState_t          ALDState
        ConnectionState_t    ConnectionState
        // These TMA states are not sent if the response originates from the command
        // validation, see Section 12.6.2 in [1], or when the return is
        // NotAuthorised or InUseByAnotherPrimary
        if (ReturnCode not in (FormatError, UnknownCommand, InvalidSubunitNumber,
            InvalidSubunitType, NotAuthorised, InUseByAnotherPrimary)) {
            LNAPathState_t LNAPathState
            BypassPathState_t BypassPathState
        }
    }
}

Enumeration ReturnCode_t {
    // The following are return codes from command message validation (see section
    // 12.6.2 in [1])
    FormatError
    UnknownCommand
    InvalidSubunitNumber
    ProtocolVersionNotNegotiated
    InvalidSubunitType
    // The following are return codes from command pseudocode below
    NotAuthorised
    NotAControlPort
    IncorrectState
    Busy
    InUseByAnotherPrimary
    OK
}
```

Primary pseudocode:

(This section is intentionally left blank)

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



ALD pseudocode:

uint16_t CurrentPortIndex

CurrentPortIndex ← INDEX OF CurrentPort IN AISGPorts

IF ALDType = MALD

 AND ActiveAuth[CurrentPortIndex].Authority[Cmd.Subunit] = NoAccess THEN

 RETURN NotAuthorised

 EXIT

ENDIF

result ← IsCommandAllowed(LIST{ OperatingConnectionState,
 RestrictedConnectionState,
 MALDSetupConnectionState},
 Cmd.Command, CurrentPort)

UNLESS result.allowed THEN

 RETURN result.code

 EXIT

ENDIF

RETURN OK, TMACapabilities, NrOfGainRanges, LIST for every gain range {Min, Max, StepSize}, NrOfFrequencyRanges, LIST for every frequency range {LinkDescriptor, Min, Max}

CommandExit(Cmd.Command, CurrentPort)

EXIT

11.5.2. TMA Set Mode

Description (Informative):

The TMA Set Mode procedure shall only be supported if the TMA subunit can be set in bypass mode. On receipt of the command, the TMA subunit shall be set to the requested mode. If a TMA subunit in bypass mode receives the command TMASetMode to BypassMode, the command shall not be performed but the response OK shall be returned. Similarly, if a TMA subunit in normal mode receives the command TMASetMode to NormalMode, the command shall not be performed but the response OK shall be returned.

Message format:

```
PrimaryCommand TMASetModeCommand {  
    CommandCode_t      Command ← 0x0201  
    CommandSequence_t   PrimaryCommandSequence  
    Subunit_t           Subunit  
    DataLength_t        DataLength ← 1  
    TMAMode_t           Mode  
}
```

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
ALDResponse TMASetModeResponse {
    CommandCode_t      Command ← 0x0201
    CommandSequence_t   PrimaryCommandSequence
    ReturnCode_t        ReturnCode
    DataLength_t        DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t ConnectionState
        // These TMA states are not sent if the response originates from the command
        // validation, see Section 12.6.2 in [1], or when the return is
        // NotAuthorised or InUseByAnotherPrimary
        if (ReturnCode not in (FormatError, UnknownCommand, InvalidSubunitNumber,
            InvalidSubunitType, NotAuthorised, InUseByAnotherPrimary)) {
            LNAPathState_t LNAPathState
            BypassPathState_t BypassPathState
        }
    }
}

Enumeration ReturnCode_t {
    // The following are return codes from command message validation (see section
    // 12.6.2 in [1])
    FormatError
    UnknownCommand
    InvalidSubunitNumber
    ProtocolVersionNotNegotiated
    InvalidSubunitType
    // The following are return codes from command pseudocode below
    NotAuthorised
    UnsupportedCapability
    UnsupportedValue
    NotAControlPort
    IncorrectState
    Busy
    InUseByAnotherPrimary
    OK
}
```

Primary pseudocode:

(This section is intentionally left blank)

ALD pseudocode:

uint16_t CurrentPortIndex

CurrentPortIndex ← INDEX OF CurrentPort IN AISGPorts

IF ALDType = MALD THEN

 UNLESS ActiveAuth[CurrentPortIndex].Authority[Cmd.Subunit] = ReadWrite THEN

 RETURN NotAuthorised

 EXIT

 ENDIF

ENDIF

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```

UNLESS TMACapabilities.Bypass THEN
    RETURN UnsupportedCapability
EXIT
ELSEIF Cmd.Mode ≠ NormalMode AND Cmd.Mode ≠ BypassMode THEN
    RETURN UnsupportedValue
EXIT
ENDIF
result ← IsCommandAllowed( LIST{      OperatingConnectionState,
                                      RestrictedConnectionState},
                           Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

IF Cmd. Mode ≠ TMAMode THEN           // If Primary is requesting
    TMAMode ← Cmd.Mode                // different TMA mode than the
    EvaluateTMAState(Cmd.Subunit)      // current, update current mode
ENDIF                                 // and re-evaluate TMA states

RETURN OK
CommandExit(Cmd.Command, CurrentPort)
EXIT

```

11.5.3. TMA Get Mode

Description (Informative):

On receipt of the command, the TMA subunit shall respond with the mode flag indicating whether the TMA subunit is set in NormalMode or in BypassMode. TMA subunits which do not support BypassMode shall return NormalMode. The TMA subunit shall also respond with the current status of the ActivePath (LNAPath or BypassPath).

For the default mode of the TMA see section 8.5 "Resumption of operation".

Message format:

```

PrimaryCommand TMAGetModeCommand {
    CommandCode_t      Command ← 0x0202
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 0
}

```

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
ALDResponse TMAGetModeResponse {
    CommandCode_t      Command ← 0x0202
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        TMAMode_t      TMAMode
        ActivePath_t   ActivePath
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t ConnectionState
        // These TMA states are not sent if the response originates from the command
        // validation, see Section 12.6.2 in [1], or when the return is
        // NotAuthorised or InUseByAnotherPrimary
        if (ReturnCode not in (FormatError, UnknownCommand, InvalidSubunitNumber,
            InvalidSubunitType, NotAuthorised, InUseByAnotherPrimary)) {
            LNAPathState_t LNAPathState
            BypassPathState_t BypassPathState
        }
    }
}

Enumeration ReturnCode_t {
    // The following are return codes from command message validation (see section
    // 12.6.2 in [1])
    FormatError
    UnknownCommand
    InvalidSubunitNumber
    ProtocolVersionNotNegotiated
    InvalidSubunitType
    // The following are return codes from command pseudocode below
    NotAuthorised
    NotAControlPort
    IncorrectState
    Busy
    InUseByAnotherPrimary
    OK
}
```

Primary pseudocode:

(This section is intentionally left blank)

ALD pseudocode:

uint16_t CurrentPortIndex

CurrentPortIndex ← INDEX OF CurrentPort IN AISGPorts

IF ALDType = MALD

 AND ActiveAuth[CurrentPortIndex].Authority[Cmd.Subunit] = NoAccess THEN

 RETURN NotAuthorised

 EXIT

ENDIF

result ← IsCommandAllowed(LIST{ OperatingConnectionState,
 RestrictedConnectionState},
 Cmd.Command, CurrentPort)

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK, TMAMode, ActivePath
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

11.5.4. TMA Set Gain

Description (Informative):

On receipt of the command, the TMA subunit shall set its gain. The parameter Gain is defined as dB_t. See [1] for the definition of this type.

TMA Set Gain command does not change the TMA mode. In particular, if the TMA subunit is in bypass mode, and TMASetGain is received, then the gain setting shall be changed but the bypass mode shall be retained.

Gain shall be accepted if the requested gain value is supported.

For unsupported gain values the TMA subunit shall respond TMAUnsupportedGainValue.

Message format:

```
PrimaryCommand TMASetGainCommand {
    CommandCode_t      Command ← 0x0203
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 2
    dB_t              Gain
}

ALDResponse TMASetGainResponse {
    CommandCode_t      Command ← 0x0203
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
        // These TMA states are not sent if the response originates from the command
        // validation, see Section 12.6.2 in [1], or when the return is
        // NotAuthorised or InUseByAnotherPrimary
        if (ReturnCode not in (FormatError, UnknownCommand, InvalidSubunitNumber,
            InvalidSubunitType, NotAuthorised, InUseByAnotherPrimary)) {
            LNAPathState_t LNAPathState
            BypassPathState_t BypassPathState
        }
    }
}
```

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
Enumeration ReturnCode_t {  
    // The following are return codes from command message validation (see section  
    // 12.6.2 in [1])  
    FormatError  
    UnknownCommand  
    InvalidSubunitNumber  
    ProtocolVersionNotNegotiated  
    InvalidSubunitType  
    // The following are return codes from command pseudocode below  
    NotAuthorised  
    NotAControlPort  
    IncorrectState  
    Busy  
    InUseByAnotherPrimary  
    TMAMajorFault  
    TMAMinorFault  
    TMAUnsupportedGainValue  
    OK  
}
```

Primary pseudocode:

(This section is intentionally left blank)

ALD pseudocode:

uint16_t CurrentPortIndex

CurrentPortIndex ← INDEX OF CurrentPort IN AISGPorts

IF ALDType = MALD THEN

 UNLESS ActiveAuth[CurrentPortIndex].Authority[Cmd.Subunit] = ReadWrite THEN

 RETURN NotAuthorised

 EXIT

 ENDIF

ENDIF

result ← IsCommandAllowed(LIST{ OperatingConnectionState,
 RestrictedConnectionState},
 Cmd.Command, CurrentPort)

UNLESS result.allowed THEN

 RETURN result.code

 EXIT

ENDIF

IF LNAPathState = LNAPathBrokenState THEN

 RETURN TMAMajorFault

 CommandExit(Cmd.Command, CurrentPort)

 EXIT

ENDIF

IF LNAPathState = LNAPathImpairedState THEN

 RETURN TMAMinorFault

 CommandExit(Cmd.Command, CurrentPort)

 EXIT

ENDIF

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
//Not TMA fault detected
// Check if the requested gain is a gain setting that the TMA supports
FOREACH I FROM 1 TO NrOfGainRanges DO
    NEXT IF Cmd.Gain > GainTable[I].Max

    IF Cmd.Gain < GainTable[I].Min THEN
        RETURN TMAUnsupportedGainValue
    ELSEIF Cmd.Gain = GainTable[I].Min           // Special case covering
                                                // GainTable[I].StepSize = 0
        OR (Cmd.Gain – GainTable[I].Min) MOD GainTable[I].StepSize = 0 THEN
            TMAGain ← Cmd.Gain
            RETURN OK
        ELSE
            RETURN TMAUnsupportedGainValue
        ENDIF

    CommandExit(Cmd.Command, CurrentPort)
    EXIT
DONE

RETURN TMAUnsupportedGainValue

CommandExit(Cmd.Command, CurrentPort)
EXIT
```

11.5.5. TMA Get Gain

Description (Informative):

On receipt of the command, the TMA subunit shall return the TMAGain, the TMAEstimatedGain and the TMAMode.

Support for estimated gain is optional and is indicated by the TMA capability GainEstimation. The algorithm to provide the value for the TMAEstimatedGain is vendor specific. Estimated gain value, shall represent the current best estimate of the TMA gain.

If the gain estimation capability is not supported, the TMA subunit shall return the TMAGain as the TMAEstimatedGain.

A TMA with fixed gain shall return the fixed gain value as the TMAGain. A TMA with adjustable gain shall return the current TMAGain. These behaviours apply to both normal and bypass modes.

For default gain of the TMA see section 8.5 "Resumption of operation".

Message format:

```
PrimaryCommand TMAGetGainCommand {
    CommandCode_t      Command ← 0x0204
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 0
}
```

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



```
ALDResponse TMAGetGainResponse {
    CommandCode_t      Command ← 0x0204
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        dB_t           TMAGain
        dB_t           TMAEstimatedGain
        TMAMode_t      TMAMode
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
        // These TMA states are not sent if the response originates from the command
        // validation, see Section 12.6.2 in [1], or when the return is
        // NotAuthorised or InUseByAnotherPrimary
        if (ReturnCode not in (FormatError, UnknownCommand, InvalidSubunitNumber,
            InvalidSubunitType, NotAuthorised, InUseByAnotherPrimary)) {
            LNAPathState_t LNAPathState
            BypassPathState_t BypassPathState
        }
    }
}

Enumeration ReturnCode_t {
    // The following are return codes from command message validation (see section
    // 12.6.2 in [1])
    FormatError
    UnknownCommand
    InvalidSubunitNumber
    ProtocolVersionNotNegotiated
    InvalidSubunitType
    // The following are return codes from command pseudocode below
    NotAuthorised
    NotAControlPort
    IncorrectState
    Busy
    InUseByAnotherPrimary
    OK
}
```

Primary pseudocode:

(This section is intentionally left blank)

ALD pseudocode:

uint16_t CurrentPortIndex

CurrentPortIndex ← INDEX OF CurrentPort IN AISGPorts

IF ALDType = MALD

 AND ActiveAuth[CurrentPortIndex].Authority[Cmd.Subunit] = NoAccess THEN

 RETURN NotAuthorised

 EXIT

ENDIF

result ← IsCommandAllowed(LIST{ OperatingConnectionState,
 RestrictedConnectionState},
 Cmd.Command, CurrentPort)

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



```
UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

UNLESS TMACapabilities.GainEstimation THEN    // if GainEstimation capability is
                                                // not supported
    TMAEstimatedGain ← TMAGain                // return TMAGain as
                                                // the TMAEstimatedGain
ELSE                                           // if the TMA has GainEstimation
                                                // capability
    TMAEstimatedGain ← «gain estimation by TMA» // return gain estimation
ENDIF

RETURN OK, TMAGain, TMAEstimatedGain, TMAMode

CommandExit(Cmd.Command, CurrentPort)
EXIT
```



Annex A: TMA State ID (Informative):

TMA State IDs shown in the pseudocode are listed and explained in Table A-1 and Table A-2 that uses the following terms:

- “Minimum capabilities”: The minimum set of capabilities needed for the TMA to reach that particular state;
- “Inputs”: The current TMA mode, corresponding TMA Active Path and the corresponding LNA path and Bypass path states (as determined by the corresponding diagnostic);
- “Result”: The actual TMA Active path and current alarm information;
- “Actual TMA gain”; If there is no failure, the commanded (or default) TMA gain is reported. In case of failure, this is the gain after the action that the TMA has taken to compensate for a failure;
- “Note”: Overview of each of the TMA State IDs including actions the TMA has taken to compensate gain loss in case of failures.

The bold text in the table denotes a case where the actual TMA Active Path differs from the expected TMA Active Path because of action taken to compensate for gain loss caused by a failure in the LNA or bypass circuits.

Antenna Interface Standards Group

Subunit Type Standard AISG-ST-TMA

vTMA3.0.7.4

May 4th, 2026



TMA State ID	Minimum capabilities (see 8.3)	Inputs			Result		Actual TMA gain	Note
		TMA Mode / Corresponding TMA Active Path	LNA Path State	Bypass Path State	Actual TMA Active Path	TMA Alarms (Alarm, Severity, Diagnostic string)		
1	No capabilities required	Normal / LNAPath	OK	OK	LNA Path	None	TMA Gain	TMA set to normal mode. No failures.
2	Bypass	Normal / LNAPath	OK	OK	LNA Path	None	TMA Gain	TMA set to normal mode.
3	Bypass	Bypass / BypassPath	OK	OK	Bypass Path	None	< 0 dB	TMA set to bypass mode. No failures.
4a	Bypass, Bypass Diagnostics	Normal / LNAPath	OK	Broken	LNA Path	BypassFailed, Minor, "Bypass path failed"	TMA Gain	TMA set to normal mode. Bypass path broken. No effect on the TMA Active Path as TMA is not trying to use the bypass path. Alarm raised.
4b	Bypass, Bypass Diagnostics	Bypass / BypassPath	OK	Broken	LNA Path	BypassFailed, Minor, "Bypass path failed"	TMA Gain	TMA set to bypass mode. Bypass path broken. TMA switches itself to use the LNA path to avoid complete RX signal loss. Alarm raised.
5	LNA Diagnostics, Redundant LNA	Normal / LNAPath	Impaired	OK	LNA Path	LNAFailed, Minor, "LNA path Impaired"	< TMA Gain	TMA set to normal mode. Redundant LNA is impaired. Alarm raised.
6	LNA Diagnostics, Redundant LNA	Normal / LNAPath	Impaired	Broken	LNA Path	LNAFailed, Minor, "LNA path Impaired"	< TMA Gain	TMA set to normal mode. Redundant LNA is impaired. Bypass path broken. Only LNA alarm raised because bypass path is not in use. Alarm raised.
7	LNA Diagnostics, Redundant LNA	Bypass / BypassPath	Impaired	OK	Bypass Path	LNAFailed, Minor, "LNA path Impaired"	< 0 dB	TMA set to bypass mode. Redundant LNA is impaired. Alarm raised.

Table A-1: TMA State IDs 1–7

Antenna Interface Standards Group
Subunit Type Standard AISG-ST-TMA
vTMA3.0.7.4

May 4th, 2026



TMA State ID	Minimum capabilities (see 8.3)	Inputs			Outputs		Expected TMA gain	Comment
		TMA Mode / Corresponding TMA Active Path	LNA Path State	Bypass Path State	Actual TMA Active Path	TMA Alarms (Alarm, Severity, Diagnostic string)		
8	LNA Diagnostics, Redundant LNA, Bypass, Bypass Diagnostics	Bypass / BypassPath	Impaired	Broken	LNA Path	LNAFailed, Minor, "LNA Path Impaired", BypassPath, Minor, "Bypass path failed"	< TMA Gain	TMA set to bypass mode. Redundant LNA is impaired. Bypass path broken. TMA switches itself to use the LNA path to avoid complete RX signal loss. Two alarms raised.
9	LNA Diagnostics	Normal / LNAPath	Broken	NA	None	NoRXConnection, Major, "LNA path Broken"	<< 0 dB	TMA only has normal mode (does not support bypass). LNA has completely failed. RX signal lost because no bypass capability. Alarm raised.
10	LNA Diagnostics, Bypass	Normal / LNAPath Or Bypass / BypassPath	Broken	OK	Bypass Path	LNAFailed, Major, "LNA path Broken"	< 0 dB	LNA has completely failed. If TMA is in the normal mode, it switches itself to use the bypass path to avoid complete RX signal loss. Alarm raised.
11	LNA Diagnostics, Bypass, Bypass Diagnostics	Normal / LNAPath Or Bypass / BypassPath	Broken	Broken	None	NoRXConnection, Major, "LNA and bypass paths broken"	<< 0 dB	LNA has completely failed. Bypass path broken. RX signal lost. TMA active path is set to "none" because both the LNA and bypass paths have completely failed. Alarm raised.

Table A-2: TMA State IDs 8–11