



Base Standard

AISG v3.0

v3.0.1.1

Revision History

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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.

New functions introduced in this version of the standard include the discovery of RF cable connections and device interconnections, site mapping capabilities and the functionality necessary to control an ALD from more than one primary. These functions adhere to the AISG interoperability requirements.

This standard is independent of previous 3GPP specifications and provides a complete description of all layers of the protocol.

1.1. New Features of AISG v3.0

New features of AISG v3.0 include:

1.1.1 Platform

A standard, unified, simplified and easily expandable platform that allows ALD vendors to create antenna line devices that contain different types of subunits which work together well and are easy to install and operate. This platform supports modern complex base station sites and easy fault finding in the field.

1.1.2 Improved specification

Differing AISG v2 implementations have shown the need for more detailed specification.

AISG v3.0 includes:

- Definitions for the primary requirements
- Extensive precise pseudocode to ensure uniform implementation by different vendors
- Much improved document structure

1.1.3 Multi-primary support

Support for ALDs that can be controlled by more than one primary. Devices supporting this feature are called Multi-primary ALDs. This feature includes the capability to set the access rights of each of the connected primaries to each of the subunits contained within the ALD. Features also include the ability to set which primaries can do this setup and which can update the software of the MALD.

1.1.4 Site mapping

Site Mapping provides a set of commands that allows the primary to discover the relationships between ALDs present on the AISG bus, their capabilities and their internal connections. It enables the primary to discover details such as:

- which RET controls each logical array within an antenna
- frequency ranges supported by logical arrays within an antenna



- RF port connections to logical array(s) within an antenna
- relationships between sensors and logical arrays within an antenna
- relationships between base station RF ports and connected logical arrays within an antenna
- The relationship between RF paths and controlled subunits, such as RETs and TMAs.

1.1.5 Ping

An optional feature called Ping enables the automatic discovery of RF cable connections between ALDs and base station radios. It also enables the operators to identify RF cables that are incorrectly connected or missing.

1.1.6 Enhanced interoperability testing

Experience of AISG v2 shows that interoperability testing (IOT) needed to be improved. AISG v3.0 standards contain commands and hardware testing definitions to facilitate IOT to improve the quality of testing. These features ensure the devices adhere to the AISG v3.0 standards.



2. SCOPE

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

AISG v3.0 is divided into this base standard and several subunit type standards. This standard describes the common behaviour of antenna line devices with AISG interfaces. Type-specific functionality is defined in separate subunit type standards.

This standard defines the common behaviour of ALDs. It also specifies some recommended and some mandatory behaviour of the primary.

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



3. BACKWARD COMPATIBILITY WITH AISG v2

This standard provides tools that enable ALD vendors to build ALDs that share a bus with equipment supporting AISG v2. AISG v3.0 ALDs may be made to switch to AISG v2 mode where they can be controlled by AISG v2 primaries. AISG v3.0 ALDs operating in v3.0 mode can be used on the same bus as AISG v2 ALDs provided that the primary supports this.

Pure v2 operation is achieved by building support for AISG v2 protocol into AISG v3.0 ALDs and primaries. The v3.0 standard provides tools and methods that enable the equipment to change between AISG v2 and AISG v3.0 mode in controlled fashion.

Mixed bus operation can be achieved by separately polling v2 and v3.0 devices on a bus.

The following AISG v3.0 functionality is not available in AISG v2 mode:

- Site Mapping
- Ping functionality
- MALD setup

MALD operation is not defined in AISG v2. MALDs supporting AISG v3.0 can be controlled by AISG v2 primaries but will have limited functionality.



4. 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 ISO/IEC 8482 (1993): "Information technology –Telecommunications and information exchange between systems – Twisted pair multipoint interconnections"
- 2 TIA/EIA TSB-89-A 2003: "Application guidelines for TIA/EIA-485-A"
- 3 ETSI 3GPP TS137.113: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; E-UTRA, UTRA and GSM/EDGE; Multi standard radio base station electromagnetic compatibility"
- 4 MIL-STD 461F 2007: "Requirement for the control of electromagnetic interference characteristics of subsystems and equipment"
- 5 IEC CISPR 16-2-1 2014: "Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements"
- 6 ISO/IEC 13239 (2nd Edition, March 2000): "Information Technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures"
- 7 Vendor Codes list on <http://www.aisg.org.uk>
- 8 ITU-T X.733: "Data communication networks, Information Technology – Open Systems Interconnection – Systems management: Alarm reporting function"
- 9 RFC1549: "PPP in HDLC Framing" available from <http://www.rfc-base.org>
- 10 ITU(T) O.153-1992: "Basic parameters for the measurement of error performance at bit rates below the primary rate"
- 11 ISO/IEC 646:1991: "Information technology – ISO 7-bit coded character set for information interchange"
- 12 ETSI 3GPP TS23.003: "Digital cellular telecommunication systems (Phase 2+); Universal Mobile Telecommunication Systems (UMTS); Numbering, addressing and identification"
- 13 AISG APCC: "Antenna Port Colour Coding"
- 14 AISG XCD: "XML for ALD Configuration Data Distribution"



5. ABBREVIATIONS

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

ACK	Acknowledgment
ADB	Antenna Database
ALD	Antenna Line Device
ASD	Antenna Sensor Device
ANT	Antenna
BER	Bit Error Rate
CRC	Cyclic Redundancy Check
CPM	Configurable Power Monitor
CW	Continuous Wave
DC	Direct Current
DISC	Disconnect (frame type)
DM	Disconnected Mode (frame type)
FCS	Frame Check Sequence
FI	Format Identifier
FRMR	Frame Reject (frame type)
GI	Group Identifier
GL	Group Length
HDLC	High-Level Data Link Control
HW	Hardware
I	Information (frame type)
ID	Identifier
IM	Intermodulation
IM3	Third Order Intermodulation
IM5	Fifth Order Intermodulation
INFO	Information (field name)
ISB	Idle State Biasing
MALD	Multi-primary ALD
MSB	Most Significant Byte
NAK	Negative Acknowledgment
NRM	Normal Response Mode
OOK	On-Off Keying

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P/F	Poll/Final
PI	Parameter Identifier
PL	Parameter Length
PV	Parameter Value
RET	Remote Electrical Tilt
RF	Radio Frequency
RNR	Receive Not Ready (frame type)
RR	Receive Ready (frame type)
RX	Receive
SALD	Single-primary ALD
SNRM	Set Normal Response Mode (frame type)
SW	Software
TCC	Time-Consuming Command
TMA	Tower Mounted Amplifier
TWA	Two Way Alternate
TX	Transmit
UA	Unnumbered Acknowledgement (frame type)
UCC	Upper Camel Case
UNC	Unbalanced Operation Normal Response Mode Class
XID	Exchange ID (frame type)
3GPP	3 rd Generation Partnership Project



6. TERMINOLOGY

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

AISG bus	A layer 1 bus between an AISG port on a primary and AISG port(s) on one or more ALDs. Each ALD may have one or more AISG ports connected to the same AISG bus.
AISG port	A port, either RS-485 or OOK, on a MALD, SALD or primary. An AISG port on an ALD can only support one layer 2 link. An AISG port on a primary may support multiple layer 2 links.
Alarm	An alarm is a persistent indication of a fault.
ALD	An ALD controller and all its subunits.
ALD configuration	The complete set of data required to configure and ALD controller and all its subunits.
ALD controller	The controlling entity of an ALD. It's addressed as subunit 0.
ALD enclosure	An ALD enclosure contains only one ALD with at least one connectable AISG interface. Camouflage boxes are not ALD enclosures.
ALD type	One octet identifying the type of an ALD as either SALD or MALD.
Antenna line	A group of logical devices associated with one or more antenna systems, which may include antenna actuators, amplifiers and other equipment.
Antenna line device	A generic term for an addressable physical device. An ALD can only be a SALD or MALD in this standard.
ANT RS-485 modem	External modem at the antenna end of the antenna line (for instance a smart bias-T).
Array	An array is a logical group of single or dual polarized radiators inside the antenna radome supporting a common frequency band and a common beam shape and tilt. A single physical array comprises more than one logical array when fed through multiple band-selective filters.
Array ID	A UTF-8 string identifying an antenna array as defined in [13].
ASCII character	A character forming part of the International Reference Version of the 7-bit character set defined in [11] represented as one octet.

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BS RS-485 modem	External modem at the base station end of an AISG RS-485 bus (for instance a smart bias-T).
Configuration	The vendor specific data required to make an ALD or a subunit operational. This shall not include any aspect that can be controlled using AISG commands.
Control port	An AISG port on a MALD or SALD with a layer 2 link to a primary.
Error	A deviation of a system from normal operation.
Event	Something that happens which may be of interest. For instance a fault, a change in status, crossing a threshold or an external input to the system.
Fault	Lasting error or warning condition.
Frame	A layer 2 HDLC frame as defined in [6].
Functional relationship	A relationship between a subunit and some other entity, where the subunit has an operational impact on the other entity.
Intra frame gap	The time interval between two consecutive octets in an HDLC frame.
Layer 1 bus	A sequence of layer 1 segments carrying the same signal.
Layer 1 segment	A direct physical connection between two ports, using either the OOK or RS-485 option.
Layer 2 link	An HDLC connection between a primary and an ALD after a successful link establishment.
Listener	An ALD or primary that listens for the layer 2 Ping message.
Logical array	A subgroup of radiators connected together inside the antenna radome producing a single polarized beam in a common frequency range.
Logical relationship	A relationship between a subunit and some other entity, where the subunit has no operational impact on the other entity.
MALD setup transaction	An atomic sequence of MALD setup commands, that is, the commands are either all accepted or all rejected.
Message	A layer 2 command or response, or a layer 7 command or response.
Modem	A circuit providing a layer 1 conversion between OOK and RS-485 or the internal interface of an ALD.

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Multi-primary ALD	An ALD type capable of simultaneously supporting multiple layer 2 links on different ports.
Non-volatile	Data that is retained after after a reset.
Octet	8 bits as used in [6].
On-off keying	A modulation system in which a carrier is switched between two states, ON and OFF.
PING port	A port capable of performing OOK Ping message reception or transmission.
Ping process	The succession of commands that enables the verification of RF cabling and discovery of RF paths.
Pingee	An ALD or primary that received the layer 2 Ping message.
Pinger	An ALD that sends the layer 2 Ping message on the requested port.
Port Number	A unique 2-octet integer that identifies an RF port, AISG port or PING port within an ALD.
Primary	The entity which controls the connected ALDs using all layers.
PrimaryID	An unsigned 4-octet value identifying the AISG primary. It is defined as the leftmost 8 hexadecimal digits of the SHA1 checksum of the primary node name.
Primary node name	A UTF-8 string uniquely identifying the primary in the network. For LTE this shall be the Global eNodeB-ID (for instance enbA9F7D.enb.epc.mncEHC.mccFIN.3gppnetwork.org), see [12].
RF Path	RF signal path between a base station RF port and logical array(s) of an antenna. These paths are stored as a list of ALD UniqueIDs and logical array number(s) constituting each path.
RF Path ID	A unique 2-octet integer identifying a specific RF path.
RF Path ID Alias	A user friendly UTF-8 string identifying a specific RF Path ID.
Reset	A process by which an ALD is put in the same status that it reaches after a completed power-up. Reset can be caused by DC power-up, DC power cycle, communication timeout, an internally

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	implemented ALD watchdog timeout or the layer 2 ResetALD command.
Single-primary ALD	An ALD type supporting only one layer 2 link.
Site map	A conceptual map of antenna lines, detailing all discovered ALDs, their internal and external connections, and interdependencies.
Site mapping	The process by which a site map is generated.
Smart bias-T	A device combining/splitting DC power and RF signals and incorporating an OOK modem in the RF path.
Subunit	An ALD may comprise one or more functions such as RETs and TMAs. These are referred to as subunits. Subunits are numbered from 1 to n. The ALD controller is not considered a subunit.
Subunit type	The classification of a subunit in an ALD that describes its function, for instance RET or TMA.
Transaction	A MALD setup transaction.
UniqueID	A concatenation of the vendor code (2 octets) and an exactly 17-octet long unit specific code (for instance serial number) exclusive to each ALD.
Vendor code	A unique ASCII 2-character code assigned to each vendor in [7].
Volatile	Data that is lost after a reset.



7. DEFINITIONS

7.1. Interpretation

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to this standard and from which no deviation is permitted.

The phrase *shall, if supported*, indicates a mandatory requirement strictly to be followed in order to conform to this standard and from which no deviation is permitted, if an ALD supports a functionality declared as optional in this standard.

The word *should* indicates that among several possibilities, one is recommended as particularly suitable without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended*).

The word *may* is used to indicate a course of action permissible within the limits of the standard.

The word *can* is used for statements of capability.

Numbers prefixed with 0x are hexa-decimal. All other numbers are decimal.

7.2. Definition of AISG coding style

This section defines the coding style for primary and ALD commands and responses which is used in this standard. The AISG coding style is inspired by the C programming language, but AISG does not require that any software is programmed in the C language. When the standard states that a variable has a specific type, the mandatory requirement is only related to the described logic and data content.

7.2.1. Keywords

The keyword “CONSTANT” is used to define that the data cannot be changed.

The keyword “persistent” is used to define that the data is stored in non-volatile memory.

7.2.2. Basic data types

The following simple integer data types are used:

```
// unsigned 8-bit integer
typedef uint8_t      INTEGER RANGE 0..255

// signed 8-bit integer
typedef int8_t       INTEGER RANGE -128..127

// unsigned 16-bit integer
typedef uint16_t     INTEGER RANGE 0..65535

// signed 16-bit integer
typedef int16_t      INTEGER RANGE -32768..32767

// unsigned 32-bit integer
typedef uint32_t     INTEGER RANGE 0..4294967295

// signed 32-bit integer
typedef int32_t      INTEGER RANGE -2147483648..2147483647
```



The following floating point data types are used:

```
float    // IEEE 754 32-bit floating point
double  // IEEE 754 64-bit floating point
```

The following layer 7 message data types are used:

```
TYPEDEF CommandCode_t    uint16_t
TYPEDEF CommandSequence_t uint16_t
TYPEDEF DataLength_t     uint16_t
TYPEDEF Subunit_t        uint16_t
```

7.2.3. String data types

Strings are not NUL terminated. The following string data types are used:

```
TYPEDEF Char_t          uint8_t
TYPEDEF TextChar_t      INTEGER RANGE 0x20..0x7E
TYPEDEF UIDChar_t       INTEGER RANGE 0x00, 0x21..0x7E
```

Strings are not NUL terminated. The following string data types are used:

```
// sequence of UTF-8 characters
TYPEDEF UTF8String_t    Char_t[]

// array of ASCII characters
TYPEDEF AsciiString_t   Char_t[]

// AsciiString with characters 0x00 or 0x21..0x7E inclusive
TYPEDEF UIDString_t     UIDChar_t[]

// AsciiString with characters between 0x20 and 0x7E inclusive
TYPEDEF TextString_t    TextChar_t[]
```

The length of a UTF8String is specified in octets, not characters.

7.2.4. Combined data types

A structure is a data type that consists of a number of parameters which may have different data types. A structure is identified by the keyword “struct” followed by its name:

```
struct Name_t {
    uint8_t  parameter1
    uint8_t  parameter2
    uint16_t parameter3
}
```

An enumeration is a data type that consists of a complete ordered listing of all the named integer constants, each with an explicitly assigned value. An enumeration is identified by the keyword “Enumeration” followed by its name, a colon and the data type of the integer constants.

```
Enumeration Count_t : uint8_t {
    One ← 0
    Two ← 1
    Three ← 2
}
```

A bit field is a data type that consists of a complete ordered listing of all the named bits in an integer. A bit field is identified by the keyword “Bitfield” followed by its name, a colon and the data type of the integer containing the bit field. If all bits except bit number 0 are set to 0 and



bit number 0 is set to 1 the integer value of the entire bit field is 1. Unused bitfield flags are reserved for future use, shall always be returned as 0 by the ALD and modification attempts shall be ignored.

```
Bitfield Bitset_t : uint8_t {
    Claudia    : Bit 0
    Kari       : Bit 1
    Nicolas    : Bit 2
    Harri      : Bit 3
    Brian      : Bit 4
    Maurice    : Bit 5
    Torbjorn   : Bit 6
    Gerry      : Bit 7
}
```

7.2.5. ALD constants

The data types and constants provide information about the ALD the code is running on.

The ALDType constant is set by design to the type of the ALD that is running the pseudocode (see Section 8.1.4. “SALD and MALD”).

```
CONSTANT ALDTypes_t ALDType[MaxPort] // Port numbers start from 1 not from 0
```

The MaxPort constant is set by design to the highest port number in the ALD.

```
CONSTANT uint16_t MaxPort
```

7.2.6. Subunit information

The NrOfSubunits constant is set by design to the number of subunits in the ALD (see Section 8.1.5. “Subunits”).

```
uint16_t NrOfSubunits // number of subunits within the ALD
```

The SubunitType_t enumeration is used to identify the type of a subunit.

```
Enumeration SubunitType_t : uint8_t {
    RET ← 0x01
    TMA ← 0x02
    ADB ← 0x03
}
```

The SubunitInfo_t structure describes a subunit. Each subunit type is defined in the associated standard.

```
struct SubunitInfo_t {
    SubunitType_t Type
}
```

The Subunits array is initialised by design and describes all the subunits.

```
struct SubunitInfo_t Subunits[NrOfSubunits]
```

The SubunitTypeListElement_t structure describes a subunit and its type.

```
struct SubunitTypeListElement_t {
    Subunit_t Subunit
    SubunitType_t Type
}
```



7.2.7. Port interconnection information

The PortInterconnection_t structure describes an interconnection from a port by specifying the port it is connected to and the interconnection type.

```
struct PortInterconnection_t {
    uint16_t PortNumber
    InterconnectionType_t Type
}
```

7.2.8. Version information

The AISGVersion_t structure describes the release; major and minor version of AISG base standard and AISG subunit type standards. For the base standard major is the number b and minor is the number c as defined Section 14.1. “Base standard versions”. For the subunit type standards major is the number b and minor is the number c as defined in Section 14.2. “Subunit type standard versions”.

```
struct AISGVersion_t {
    uint8_t ReleaseVersion
    uint8_t MajorVersion
    uint8_t MinorVersion
}
```

The ConfiguredSubunitTypeVersion contains the currently configured subunit type standard version.

```
ConfiguredSubunitTypeVersion[MaxPort]
```

7.2.9. Layer 7 command information

The ReturnCode_t enumeration is used in layer 7 message responses to indicate success or the cause of a failure. All ReturnCode_t values used by this AISG v3.0 standard are listed here.

```
Enumeration ReturnCode_t : uint16_t {
    OK ← 0x0000
    Busy ← 0x0005
    GeneralError ← 0x0011 // See 12.5 Alarms on how to use
    PortInUse ← 0x0012
    OutOfRange ← 0x0013
    TransactionInProgress ← 0x0014 // Not possible to initiate MALD
    // configuration as one is already
    // started
    TransactionNotInProgress ← 0x0015 // MALD configuration commands not
    // accepted as MALD configuration
    // transaction not yet started
    IncorrectCommitCounter ← 0x0017 // MALD configuration commit counter
    // value supplied is not matching the
    // current CommitCounter value
    UploadRejected ← 0x0018
    UnknownCommand ← 0x0019
    UnsupportedFileType ← 0x0020
    InvalidFileContent ← 0x0022
    InUseByAnotherPrimary ← 0x0023 // Time consuming command (TCC) al-
    // ready triggered by another primary
    FormatError ← 0x0024
    NotAuthorised ← 0x002C
    InvalidSubunitNumber ← 0x002D
}
```


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```
InvalidPortNumber          ← 0x002E
InvalidAuthority           ← 0x002F
DataReadOnly               ← 0x003A
UnsupportedConfiguration    ← 0x003B
InvalidSettingSource       ← 0x003C
IncorrectPortType          ← 0x003D
InvalidSubunitType         ← 0x003E
InvalidRFPathID            ← 0x003F
IncorrectState              ← 0x0040
InvalidMonitorPhase        ← 0x0041 // Ping monitor phases not sent in the
                                   // right order
IncorrectDirection         ← 0x0042
TooManyArguments           ← 0x0043
ALDNotConfigured           ← 0x0044
NotCalibrated               ← 0x0045
CalibrationNotSupported    ← 0x0046
InvalidLogicalArrayNumber  ← 0x0047
UnsupportedSecuritySetting  ← 0x0048
InvalidConfTargetPortNumber ← 0x0049
InvalidConfTargetSubunitNumber ← 0x004A
NotControlCapablePort      ← 0x004B
NoAlarmSubscription        ← 0x004C
DownloadFailed              ← 0x004D
UnsupportedValue            ← 0x004E
CalibrationFailed          ← 0x004F
ALDConfigurationNotSupported ← 0x0050
InvalidProvenance          ← 0x0051
UnsupportedCapability        ← 0x0052
UnsupportedMALDSetup        ← 0x0053
UnsupportedProtocolVersion  ← 0x0054
}
```

The AlarmCode_t enumeration is used in layer 7 alarm indication message to specify which alarm is being raised or cleared.

```
Enumeration AlarmCode_t : uint16_t {
    AlarmMovementTimeout      ← 0x0000
    AlarmInternalError         ← 0x0001
    AlarmALDNotConfigured     ← 0x0002
    AlarmNotCalibrated         ← 0x0003
    AlarmActuatorJammed        ← 0x0004
    AlarmListenerTimeoutExpired ← 0x0007
    AlarmPingerTimeoutExpired  ← 0x0005
    AlarmGeneralError          ← 0x0006 // See 12.5 Alarms on how to use
}
```

The AlarmSubscribeFlag indicates which primaries have subscribed to the alarms. These flags are set for each port.

```
Boolean AlarmSubscribeFlag[MaxPort]
```

The PingMonitorRFPort variable is set to the number of the port the ALD was told to monitor during the ping process (see Section 8.4.2. “Ping process cycle”).

```
uint16_t PingMonitorRFPort
```

7.2.10. Layer 2 information

The LinkState_t enumeration defines the layer 2 link states of each AISG port (see Section 8.2.1. “State models for layer 2”).

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```
Enumeration LinkState_t {  
    NoAddress          ← 0  
    AddressAssigned   ← 1  
    Connected         ← 2  
}
```

The LinkState variable sets the layer 2 link state of each AISG port (see Section 8.2.1. “State models for layer 2”).

```
LinkState_t LinkState[MaxPort]
```

7.2.11. Layer 7 information

The ALDState_t enumeration defines the layer 7 state of the ALD (see Section 8.2.2. “State model for layer 7”).

```
Enumeration ALDState_t : uint8_t {  
    IdleState                ← 0  
    OperatingState           ← 1  
    DownloadState            ← 2  
    MALDSetupState          ← 3  
    PingerRestrictedState    ← 4  
    PingerRestrictedTransmitState ← 5  
    PingerBroadcastWaitState ← 6  
    ListenerRestrictedMonitorState ← 7  
    ListenerRestrictedPreparationState ← 8  
    ListenerBroadcastWaitState ← 9  
}
```

The ALDState variable sets the layer 7 state of the ALD. (see Section 8.2.2. “State model for layer 7”)

```
ALDState_t ALDState
```

The ConnectionState_t enumeration defines the layer 7 ConnectionState of each AISG port (see Section 8.2.2. “State model for layer 7”).

```
Enumeration ConnectionState_t : uint8_t {  
    NoConnectionState        ← 0  
    OperatingConnectionState ← 1  
    MALDSetupConnectionState ← 2  
    UploadConnectionState    ← 3  
    DownloadConnectionState  ← 4  
    DownloadFailedConnectionState ← 5  
    RestrictedConnectionState ← 6  
    DownloadNotificationConnectionState ← 7  
    OffConnectionState       ← 8  
    PingerConnectionState    ← 9  
    ListenerConnectionState  ← 10  
}
```

The ConnectionState variable sets the layer 7 connection state of each AISG port (see Section 8.2.2. “State model for layer 7”).

```
ConnectionState_t ConnectionState[MaxPort]
```

7.2.12. Upload information

UploadRemainingLength and UploadPosition are used during upload to keep track of what data to send next.



```
uint32_t UploadRemainingLength[MaxPort]
uint32_t UploadPosition[MaxPort]
```

7.2.13. Gain information

The type `ddB_t` is used to represent decibel values as deci-dB (tenths of dB).

```
TYPEDEF ddB_t int16_t //dB*10
```

The type `GainRange_t` is used to represent a range of gain values with a linear step size. A single gain value is represented as min and max having same value and a zero step size.

Gain ranges with nonlinear step sizes are represented by multiple `GainRange_t`. Starting from the lowest unallocated gain value, the next `GainRange_t` shall cover as many gain steps as possible. This allocation process shall be repeated until all gain values are allocated.

Example: 2, 4, 6, 10 shall be represented as (min 2, max 6, step size 2) and (min 10, max 10, step size 0).

```
struct GainRange_t {
    ddB_t Min
    ddB_t Max
    ddB_t StepSize
}
```

7.2.14. DC power mode information

`DCPowerMode_t` enumeration is used to identify the DC power mode of each ALD

```
Enumeration DCPowerMode_t: uint8_t {
    SteadyStatePowerMode ← 0
    HighPowerMode        ← 1
    SleepPowerMode       ← 2
}
```

7.2.15. DC power information

The type `dW_t` is used to represent power values as deci-W (tenths of W).

```
TYPEDEF dW_t uint16_t //W*10
```

The `uint8_t` value `0xFFFF` is reserved for special purposes and shall not be used to represent a real power value. Maximum power representable with this way is $65535 * 0.1W$ i.e. $6553.5W$.

The type `PowerModeStruct_t` is used to represent the power values of power modes P1, P2 and P3.

```
struct PowerModeStruct_t {
    dW_t PowerModeP1
    dW_t PowerModeP2
    dW_t PowerModeP3
}
```

7.3. Definition of layer 2 frame format

Frames in layer 2 are shown as data structures identified by the keyword "Frame" followed by its name. Frame names use Upper Camel Case (UCC) format. A frame issued by the primary



shall be identified by the keyword “PrimaryFrame”. A frame issued by the ALD shall be identified by the keyword “ALDFrame”. The name of the frame is suffixed by “Command” or “Response” as appropriate.

```
PrimaryFrame <NameCommand> {
    uint8_t Address
    uint8_t Ctrl
    uint8_t Payload[]
    uint8_t FCS1
    uint8_t FCS2
}

ALDFrame <NameResponse> {
    uint8_t Address
    uint8_t Ctrl
    uint8_t Payload[]
    uint8_t FCS1
    uint8_t FCS2
}
```

If the frame is an I-frame, the Payload contains the layer 7 message. Otherwise, the Payload contains layer 2 frame data. The minimum Payload is 0 octets and the maximum is 264 octets.

7.4. Definition of layer 7 message format

There are two types of layer 7 messages: commands and responses. Layer 7 messages are defined as data structures.

Message names use UCC format. (see Section 7.4.2. “Responses”).

A single layer 7 message must fit into a single layer 2 I-frame.

7.4.1. Commands

A command requests that the receiver executes a defined procedure and returns a response.

Commands are defined as structures.

A command issued by the primary is identified by the keyword “PrimaryCommand” and command issued by an ALD is identified by the keyword “ALDCommand”.

The names of commands have the suffix “Command”.

The first parameter in a command is the command code, which specifies the procedure to execute.

The second parameter in a command is a sequence number which is used as described below. It is called PrimaryCommandSequence in a PrimaryCommand and ALDCommandSequence in an ALDCommand.

NOTE: The command sequence number is totally unrelated to the layer 2 I-frame sequence number.

The third parameter is the subunit number (see Section 8.1.5. “Subunits”). Subunit number 0 refers to the ALD and subunit number 1..65535 identifies which subunit shall execute the procedure or return the response.



The fourth parameter of a command is the data length, which states the number of octets in the message data. The length of the data is 0 to 256 octets. The details of the data are specified by the message format for each command.

The PrimaryCommandSequence is used to match ALD responses to PrimaryCommands and is used to handle cases where the responses are processed in a different order from that in which the commands were issued. Each primary only has one wraparound PrimaryCommandSequence counter, not one per ALD.

A primary shall increment its PrimaryCommandSequence counter every time it issues a PrimaryCommand and the ALD shall copy this field unchanged into the response. The ALD shall not check or verify the PrimaryCommandSequence number in any way.

The ALDCommandSequence is used to match primary responses to ALDCommands and is used to handle cases where the responses are processed in a different order from that in which the commands were issued. Each ALD only has one ALDCommandSequence counter, not one per primary.

An ALD shall increment its ALDCommandSequence counter every time it issues an ALDCommand and the primary shall copy this field unchanged into the response. The primary shall not check or verify the ALDCommandSequence number in any way.

The maximum command message size is 264 octets.

```
PrimaryCommand <Name>Command {
    CommandCode_t      Command
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    uint8_t             Data[]
}

ALDCommand <Name>Command {
    CommandCode_t      Command
    CommandSequence_t  ALDCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    uint8_t             Data[]
}
```

7.4.2. Responses

A response is sent by the receiver of a command.

Responses are defined as structures. A response issued by the primary is identified by the keyword "PrimaryResponse" and response issued by an ALD is identified by the keyword "ALDResponse".

The names of responses have the suffix "Response".

The maximum response message size is 264 octets.

7.4.2.1. Successful execution of command

Parameter 1 specifies the procedure that was executed.

Parameter 2 is the command sequence number which must be copied verbatim from the command.



Parameter 3 has the value OK to indicate that the procedure was successfully executed.

Parameter 4 is the data length, which states the number of octets in the message data for the response.

7.4.2.2. Failed execution of command

Parameter 1 specifies the procedure that failed to execute.

Parameter 2 is the command sequence number which must be copied verbatim from the command.

Parameter 3 is the return code which identifies the cause of the failure.

Parameter 4 is the data length, which states the number of octets in the message data for the response.

Parameter 5 is the ALD state of the ALD.

Parameter 6 is the connection state of the port that the command was received on. The state information is provided to help identify the detailed cause of the failure.

```
PrimaryResponse <NameResponse> {
    CommandCode_t           Command
    CommandSequence_t       ALDCommandSequence
    ReturnCode_t            ReturnCode
    DataLength_t            DataLength
    if (ReturnCode == OK) {
        uint8_t             Data[]
    }
}

ALDResponse <Name>Response {
    CommandCode_t           Command
    CommandSequence_t       PrimaryCommandSequence
    ReturnCode_t            ReturnCode
    DataLength_t            DataLength
    if (ReturnCode == OK) {
        uint8_t             Data[]
    } else {
        ALDState_t          ALDState
        ConnectionState_t    ConnectionState
    }
}
```

7.5. Definition of UniqueID

The UniqueID is a concatenation of the vendor code (2 octets) part and an exactly 17-octet long unit specific part containing unit specific code (for instance serial number), exclusive to each ALD, provided by the vendor to whom the vendor code is assigned. The vendor code is placed in the left-most (most significant) position of the UniqueID. The vendor, to whom the vendor code is assigned, is responsible for ensuring the uniqueness of the UniqueID for each ALD. The UniqueID shall consist of ASCII characters between 0x21 and 0x7E, inclusive. If the unit specific code is shorter than 17 octets, the unit specific code is right aligned in the unit specific part and any unused octets are filled with 0x00.

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```
UIDString_t UniqueID[19]
uint8_t L // Length of unit specified code
UIDString_t U[L] // Unit specified code
UniqueID[0..1] ← VendorCode
L ← «the length of unit specific code»
U[L] ← «the unit specific code»
FOREACH N FROM 0 TO 16-L DO
    UniqueID[N+2] ← 0x00
ENDFOR
FOREACH N FROM 0 TO L-1 DO
    UniqueID[17-L+N+2] ← U[N]
ENDFOR
```



8. GENERAL ASPECTS

8.1. General

AISG v3.0 specifies the standard interface between the primary, typically a base station, and ALDs which are units close to mobile base station antennas. ALDs include one or more subunits of different subunit types such as RET, TMA and antenna sensors.

An ALD may have one or more AISG interfaces to be controlled by one or more primaries. Therefore, AISG v3.0 defines two different types of ALDs, which are termed Single-primary ALDs (SALD) and Multi-primary ALDs (MALD).

An ALD contained within an enclosure shall provide only one UniqueID. An enclosure containing more than one ALD is not allowed.

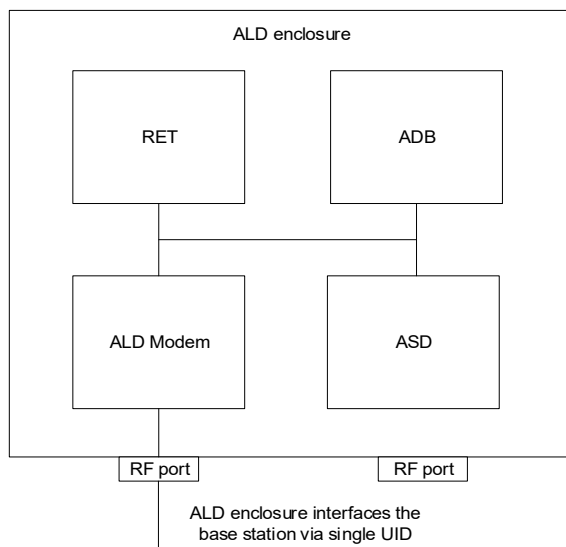


Figure 8.1-1: Example of an ALD enclosure

AISG v3.0 follows a three-layer model as a compact form of the OSI seven-layer reference model and includes only layers 1, 2 and 7:

- Layer 1 (physical layer) defines the signalling levels and basic data characteristics including data rates and OOK modem parameters.
- Layer 2 (data link layer) defines a specific class of the HDLC standard [6] used for signalling transport.
- Layer 7 (application layer) defines the data payload format and required command set. This basic functionality of the layer 7 is described in this standard and is extended by subunit type standards.



8.1.1. Layer 1

Layer 1 provides a multi-drop broadcast link between the primary and all ALDs. Any message transmitted will be received by all other ALDs. If two ALDs transmit at the same time, their messages may be garbled.

Layer 1 defines an additional type of port, which is called a PING port, which has the capability to realise OOK pinging.

8.1.2. Layer 2

Layer 2 provides:

- A data packet communication format;
- An addressing scheme;
- A master/slave relationship whereby the primary controls the half duplex timing;
- A frame checksum scheme to detect transmission errors;
- A frame sequence numbering scheme which protects layer 7 from:
 - Duplicated frames;
 - Deleted frames;
 - Receiving frames in the wrong order;
 - A flow control mechanism protecting each ALD frame receiver from being overrun by frames.

These functions provide layer 7 with a safe virtual full-duplex connection between the primary and each ALD. This virtual full-duplex connection allows both the primary and the ALD to transmit layer 7 messages between the primary and the connected ALD whenever required. Actual delivery time on layer 7 depends on the layer 2 polling frequency, which is chosen by the primary.

Each layer 2 link belongs to one primary and a primary may have multiple layer 2 links.

8.1.3. Layer 7

The function of the layer 7 is to support:

- Control of ALD subunits (for instance RET subunit, TMA subunit)
- Software and configuration download
- Alarm reporting
- Site mapping
- OOK pinging
- MALD setup.

ALD functionalities are provided by subunits, each having their own subunit type (for instance RET, TMA).



8.1.4. SALD and MALD

A SALD is controlled by a single primary, it can have only one control port. A SALD may have multiple AISG ports. Each port can simultaneously have an assigned ALDAddress. At any time, only one primary can establish a layer 2 link and activate layer 7 to a SALD.

Any port that is connected to a primary by a layer 2 link is termed a control port.

A MALD shall be able to support multiple control ports, each of which is independently connected by a layer 2 link and each control port can accept layer 7 activation from one primary at any time.

Every AISG port can become a control port.

For a MALD, the authority of the primaries to access subunits is defined by the MALD setup. This is used to limit access to specific ALD subunits by some primaries.

The port numbering scheme is vendor specific. Port numbers shall start from 1 and it is not allowed to have gaps in the port numbering sequence.

Primaries supporting AISG v3.0 (for example a handheld controller supporting AISG v3.0) can be used to setup AISG v3.0 MALDs which can then work even in scenarios that do not contain any AISG v3.0 primaries.

8.1.5. Subunits

The functionalities of an ALD are provided by one or more subunits. Each subunit has a subunit-type such as RET, TMA or ADB as defined in separate subunit type standards.

Subunits are identified by a unique subunit number incrementing sequentially from 1. A fully equipped ALD shall have no gaps in the subunit numbers. An ALD product version not fully equipped may omit certain subunit number in that sequence.

A MALD that has been setup may present any subset of its subunits on any AISG port. MALD setup does not renumber subunits. If a subunit is visible on multiple AISG buses, it shall have the same subunit number on each bus. All subunits are always reported to all connected primaries in the Site Mapping command responses, regardless of the configuration of the MALD.

A functionality, when explicitly allowed in the corresponding subunit type standard, (for example a sensor) may be presented as multiple subunits, each with its own independent settings, to allow for example different primaries to set different alarm thresholds. Such a subunit is called a split functionality subunit (SFS).

Subunit number 0 refers to the ALD controller. Subunit number 1..65535 identifies a specific subunit.

8.1.6. Subunit type

Each subunit has a dedicated subunit type which represents its functionality (for instance RET, TMA). Subunit types are identified by a 1-octet unsigned integer which is defined in the corresponding subunit type standard.



8.1.7. Ports

A port is a signal interface. Several ports may be contained in a single multi-coupling connector system. Ports are described by port properties.

An ALD shall only support link establishment on ports that supply the ALD with DC power.

8.1.7.1. Interconnections

Generally, signals pass via interconnections within an ALD from one port to one or more other port(s). Some ports, for example those on antennas and sensors, may have no interconnection to any other port.

Each interconnection is between two ports. Information about all interconnections from one port to other ports and their properties can be retrieved from the ALD. This information is primarily used during site mapping.

8.1.7.2. Subunit relationship

A port may have a relationship with one or more subunits. A subunit may have a relationship with one or more ports.

A subunit may have a functional relationship with an interconnection. In that case the subunit has functional relationships with both ports of this interconnection. As an example, in Figure 8.1.7.2-1, TMA subunit 2 has a functional relationship with ports 2 and 6 and the interconnection between them.

A RET subunit has a functional relationship with one or more ports. As an example, in Figure 8.1.7.2-1, RET subunit 1 has a functional relationship with port 1. A RET subunit is a special case, it also has a functional relationship with logical array(s).

A subunit may have a logical relationship with one or more ports. As an example, in Figure 8.1.7.2-1, ASD subunit 5 has logical relationships with ports 1 and 2.

A ADB subunit always has a logical relationship with all ports of an antenna. As an example, in Figure 8.1.7.2-1, ADB subunit 1 has logical relationships with ports 1 and 2.

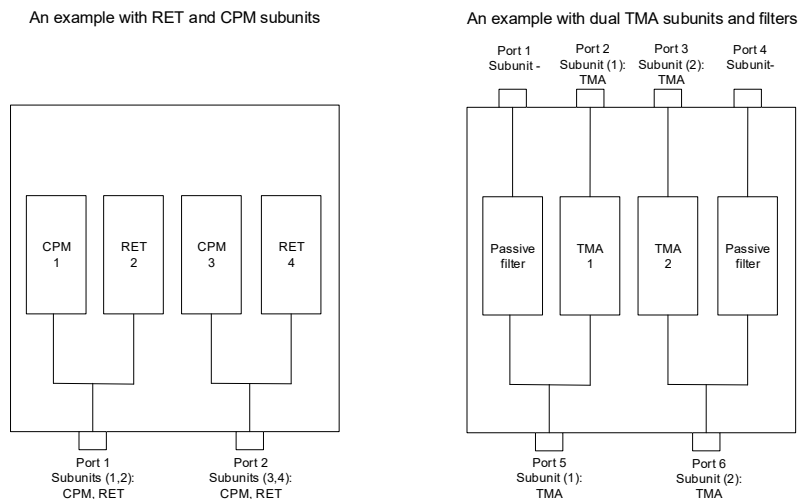




Figure 8.1.7.2-1: Subunit relationship

8.2. State models

The state model diagrams contain only the transitions from one state to another.

8.2.1. State models for layer 2

8.2.1.1. Layer 2 LinkState model of a SALD

The layer 2 LinkState model of a SALD (one per port) is shown in Figure 8.2.1.1-1: “State model for a SALD control port”. Events are written in *italic* and layer 2 and layer 7 commands are written in **bold**.

The state model is valid for all AISG input ports of a SALD with the following limitations:

- The Connected LinkState only applies to the AISG input port that first received an SNRM command. This input port is thereafter known as the control port (see Figure 8.2.1.1-1: “State model for a SALD control port”).
- SNRM commands received on any port except the control port shall be rejected and the response shall be DM.
- SNRM commands received on any port except the control port shall be rejected and after link establishment on the control port the response on any other port shall be DM.
- The ResetPort XID command shall be accepted:
 - On all AISG input ports while the SALD is not in Connected LinkState.
 - Only on the control port when the SALD is in Connected LinkState.

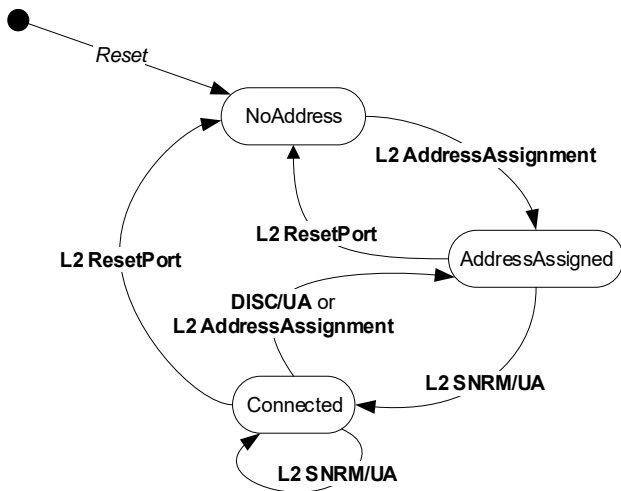


Figure 8.2.1.1-1: State model for a SALD control port

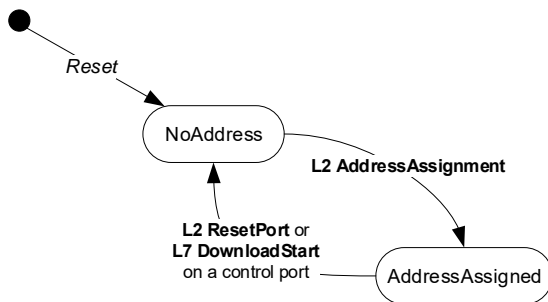


Figure 8.2.1.1-2: State model for a SALD non-control port

8.2.1.2. Layer 2 LinkState model of a MALD

The layer 2 LinkState model for the layer 2 of the MALD is shown in Figure 8.2.1.2-1: “LinkState model for a MALD AISG port”. Each AISG port has a LinkState. Events are written in *italic* and layer 2 and layer 7 commands are written **bold**.

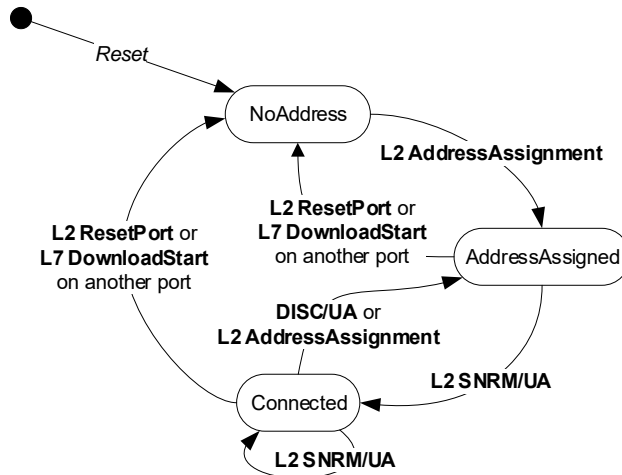


Figure 8.2.1.2-1: LinkState model for a MALD AISG port

8.2.1.3. Layer 2 LinkState model of a primary

The layer 2 LinkState model of a primary is not defined in this document. The behaviour of a primary shall be based on the LinkState models of the ALDs.

8.2.2. State model for layer 7

The state model in Figure 8.2.2-1: "ALDState state model" shows the relationship between different states of the whole ALD.

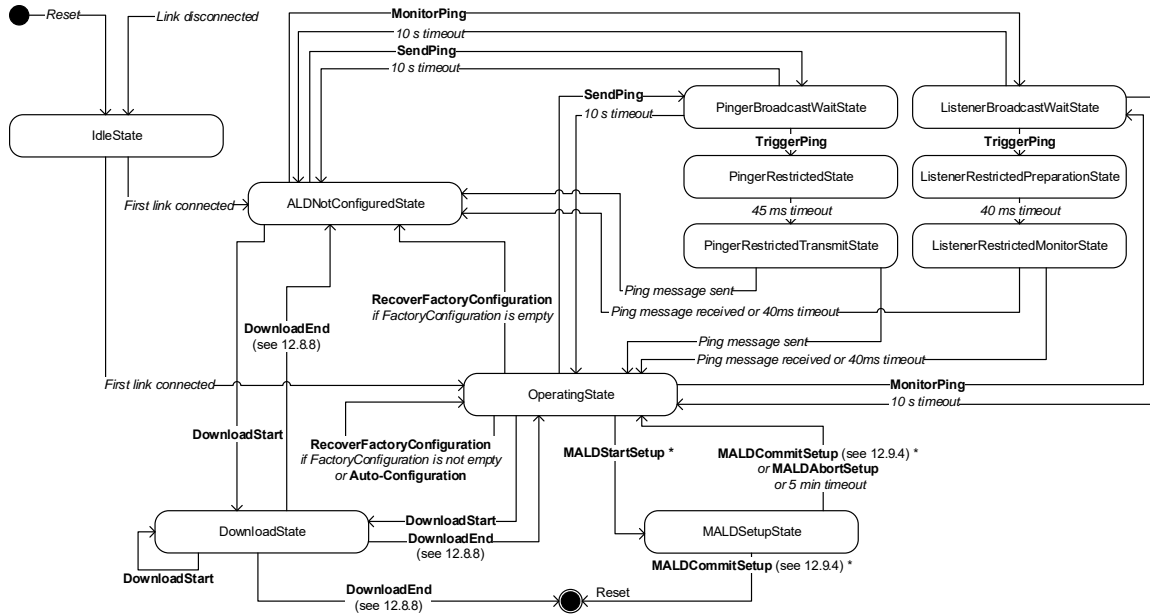


Figure 8.2.2-1 ALDState state model

The relationship between different ConnectionState states is shown in Figure 8.2.2-2: “ConnectionState state model”.

Each control port has a ConnectionState.

A MALD may operate AISG v2 and AISG v3.0 simultaneously on different control ports.

This document does not define state models for ALDs in AISG v2 mode.



To generate the complete map, the primary requires that all ALDs support AISG 3.0 and all antennas include an Antenna Database (ADB). An ADB is a specific subunit type that contains the logical array properties of an antenna. There shall exist a maximum of one ADB subunit within an ALD.

To generate a site map, the primary may execute the following steps:

1. For each ALD, retrieve the ALD input/output port details including subunit relationship;
2. For each ALD, retrieve the type of interconnection between its ports;
3. For each port of each antenna, retrieve the list of logical array numbers connected to it;
4. If available, perform the ping process to assign RF Path ID(s) to the RF ports of the ALD;
5. Assign RF Path ID(s) to the RF ports of the ALD and optionally the RF path ID alias(es). If pinging is not available, input this data manually;
6. For each logical array number, retrieve position within the sector, logical array position, polarization, logical array frequency range, sector ID, mechanical bearing and mechanical tilt;
7. For each logical array number collected on the network, assign the RF Path ID;
8. Retrieve all additional data required to complete the site map, for example controllable parameters, sector IDs etc.

The MALD shall provide separate RF Path ID and RF Path ID Alias tables for each of its control ports. Each connected primary can only set and read its associated RF Path ID and RF Path ID Alias tables.

NOTE: Step 3 allows a primary to know how many antennas and antenna ports are in its AISG network.

NOTE: Step 4 allows a primary to count the number of RF paths in its antenna line.

Each of the writable site mapping data fields has a corresponding provenance field. This field allows the primary or user to know the source of this information and judge its reliability. There are five provenance categories: Not Set, Factory, File, Automatic and Manual. The category names describe the source of the information. The ALD maintains provenance values that match the source of the information. Only manufacturing tools in the factory can set provenance to Factory.

8.4. Pinging

AISG v3.0 enables verification of the RF-cable connections in the antenna system by sending Ping messages between the RF ports of antennas, ALDs and the primary. The method can be used to diagnose crossed, missing, stolen or broken RF cables by comparing the actual connections with the site installation plan. This ping process can be used in conjunction with Site Mapping commands to automatically discover the RF paths.

During a ping process cycle a MonitorPing command is sent on one port and every ALD that receive this command listens for a subsequent Ping message.

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When a listener receives the Ping message, an RF cable connection has been identified.

The ping process repeats these ping process cycles over and over for all port combinations in order to identify all cabling in the antenna system.

Pinging is initiated and controlled by the primary.

Pinging is only possible via OOK connections.

The ALD that sends the Ping message is called the pinger.

The primary and the ALD(s) that listen for the Ping message are called listeners.

The listener that received the Ping message is called the pingee.

The ping process commands are:

- MonitorPing : A layer 7 primary command sent to the ALDs selected to listen to the Ping message. The ALD listeners monitor the requested RF port.
- SendPing : A layer 7 primary command sent to the ALD selected to be the pinger.
- TriggerPing : A layer 2 primary command broadcast to the pinger and ALD listeners. Upon reception, the pinger sends the Ping message and the listeners monitor the RF port for the Ping message.
- AbortPing : A layer 7 primary command sent to the pinger and ALD listeners aborting the ping process cycle.
- A Ping message is a layer 2 message send by the pinger when it receives the TriggerPing command.

Figure 8.4-1: “Pinger and listener” depicts a simple example of a single ping process cycle where a primary uses pinging to identify the RF path between antenna port 6 and TMA port

4. In this case the pinger is ANT-1 and the listener is the TMA-1. The Ping message is sent from ANT-1 port labelled 6 and received on the TMA-1 port labelled 4.

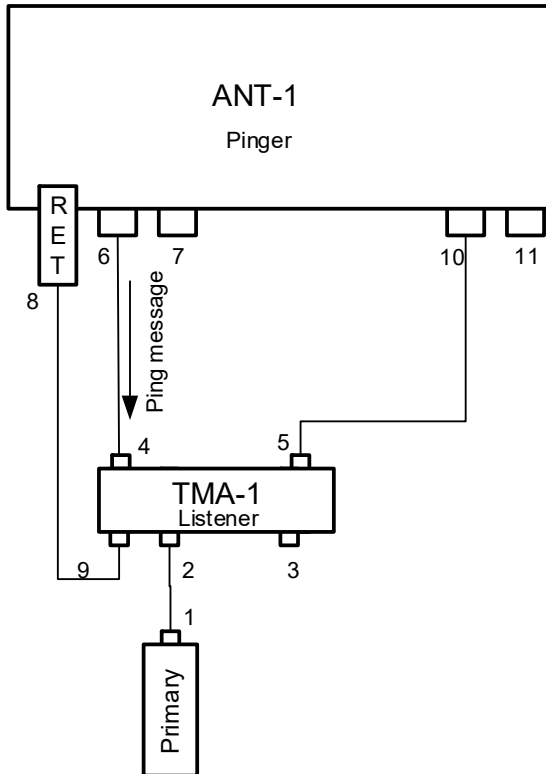


Figure 8.4-1: Pinger and Listener

8.4.1. Rules for ping process

The following rules shall apply to complete the ping process:

1. The Ping message is transmitted from a pinger (a SALD or a MALD), and monitored by listeners (SALD, MALD or primary).
2. The Ping message is transmitted towards the primary. The ping process starts from a ping-capable antenna or from the ping-capable ALD closest to an antenna. The order of the ALDs is found during the device scan.
3. Both OOK and PING ports can transmit and receive Ping messages.
4. Pinging is allowed:
 - On ports without an active layer 2 link.
 - On ports, with an active layer 2 link, that belongs to the primary running the ping process.



5. The Ping message is an OOK layer 2 message containing the 4-octet Primary ID of the primary initiating the ping process. The Ping message cannot be transmitted via an RS-485 connection.
6. During a ping process cycle the primary shall send MonitorPing commands to all ALDs, the primary selects to listen.
7. During a ping process cycle the primary shall send the SendPing command to the ALD it selects as the pinger.
8. During a ping process cycle the ALD (pinger and listener(s)) shall deactivate all internal OOK paths not belonging to another primary.

NOTE: A MALD does not inform other connected primaries about the start of the ping process cycle.

9. An ALD shall enter the ping process cycle only when it is in OperatingState.
10. If there is a ping process cycle in progress, a MALD shall reject any request to start a new ping process cycle from any other primary.
11. If there is a ping process cycle in progress, an ALD shall only accept the AbortPing command from the primary that started the ping process cycle when in ListenerBroadcastWaitState and PingerBroadcastWaitState.
12. The pinger shall wait up to 10 seconds for the TriggerPing. If the TriggerPing has not been received within the 10 seconds, the pinger switches ALDState to OperatingState.
13. The listener(s) shall wait up to 10 seconds for the TriggerPing. If the TriggerPing has not been received within the 10 seconds, the ALD listener switches ALDState to OperatingState.
14. The primary shall broadcast the TriggerPing command.
15. The primary shall not send any message for 95 ms after it has broadcast TriggerPing command.
16. Upon receiving the TriggerPing command, the pinger shall wait 45 ms before sending the layer 2 Ping message.
17. The pinger switches ALDState to PingerRestrictedTransmitState immediately after queueing the Ping message for transmission.
18. The pinger switches ALDState to OperatingState when the transmission complete event occurs.
19. The listeners(s) shall switch ALDState to ListenerRestrictedTransmitState immediately after receiving the TriggerPing command and wait 40 ms before monitoring the RF Port.
20. After the 40 ms wait, the listener switches ALDState to ListenerRestrictedMonitorState, the listener monitors the RF port for up to 40 ms.
21. If the listener receives the Ping message it switches ALDState to the OperatingState. It is now designated the pingee.
22. If no Ping message is received by a listener after the 40ms, it switches ALDState to the OperatingState.



23. If a primary receives an IncorrectState rejection (because a second primary connected to the same MALD has already initiated a ping process) the primary shall send the AbortPing command to all other ALDs.

The primary may apply a random delay before executing another ping process cycle. This reduces the possibility of deadlock between multiple primaries controlling the same ALD.

8.4.2. Ping process cycle

The Ping process cycle steps are based on PingTimers, whose accuracy shall be better than ± 1 ms.

1. The primary sends a layer 7 MonitorPing command to all the listeners, specifying the port on which they shall listen.
2. Each listener stores the requested RF port as PingMonitorRFPort, switches ALDState to ListenerBroadcastWaitState and initiates its 10-second PingTimer.
3. The primary sends a layer 7 SendPing command to the pinger, specifying the port on which the Ping message shall be transmitted.
4. The pinger stores the requested RF port as PingSendRFPort, switches ALDState to PingerBroadcastWaitState and initiates its 10-second PingTimer.
5. If a listener's PingTimer expires (after 10 seconds), it raises a AlarmListenerTimeoutExpired and switches ALDState to OperatingState.
6. If a pinger's PingTimer expires (after 10 seconds), it raises a AlarmPingerTimeoutExpired and switches ALDState to OperatingState.
7. The primary broadcasts a layer 2 TriggerPing command and initiates a 95-ms PingTimer.
8. When a listener receives the layer 2 TriggerPing command, it switches ALDState to ListenerRestrictedPreparationState and initiates a 40-ms PingTimer. It selects its PingMonitorRFPort and deactivates all OOK paths associated with the primary that initiated the ping process cycle.
9. When the pinger receives the layer 2 TriggerPing command, it switches ALDState to PingerRestrictedState, initiates its 45-ms PingTimer, selects its PingSendRFPort and deactivates all OOK paths associated with the primary that initiated the ping process cycle.
10. When each listener's PingTimer expires (after 40 ms), it sets its PingReceivedFlag to 0, clears its receive buffer, switches ALDState to ListenerRestrictedMonitorState and initiates its 40-ms PingTimer.
11. When the pinger's PingTimer expires (after 45 ms), it queues a Ping message for transmission, switches ALDState to PingerRestrictedTransmitState and deactivates all OOK paths associated with the primary that initiated the ping process cycle.
12. When the pinger's serial port has transmitted the stop bit of the closing flag of the Ping message, the ALD switches back to the AISG port on which it received the SendPing command, switches ALDState to OperatingState and activates all previously deactivated OOK paths.



13. When a listener receives the Ping message, it stores the primary's ID as PrimaryID, sets its PingReceivedFlag to 1, switches back to the AISG port on which it received the MonitorPing command, switches ALDState to OperatingState and activates all previously deactivated OOK paths.
14. If a listener's PingTimer expires, it switches back to the AISG port on which it received the MonitorPing command, switches ALDState to OperatingState and activates all previously deactivated OOK paths.
15. When the primary's 95-ms PingTimer expires, it may continue with the next ping process cycle.

8.4.3. Flow diagrams

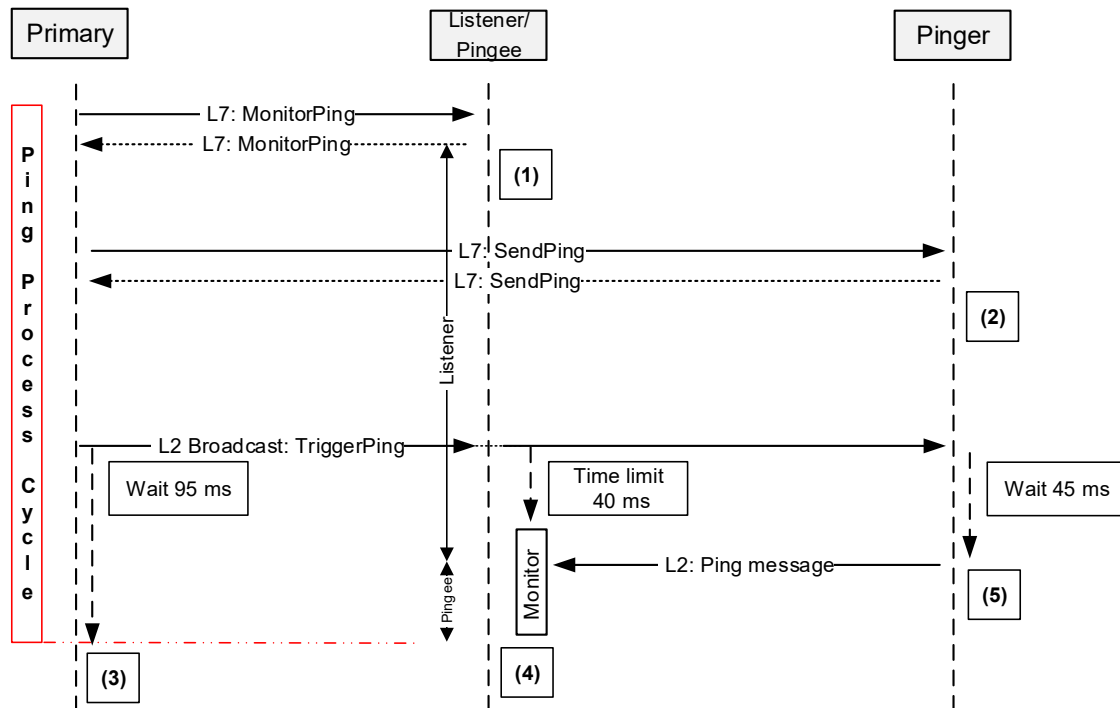


Figure 8.4.3-1: Sequence diagram for a ping process cycle

NOTE 1: Once the response is sent, the listener sets its ListenerBroadcastWaitState timeout to 10 seconds and switches back to OperatingState when the timer expires.

NOTE 2: Once the response is sent, the pinger sets its PingerBroadcastWaitState timeout to 10 seconds and switches back to OperatingState when the timer expires.

NOTE 3: Once TriggerPing is sent, the primary waits for 95 ms and may continue with the ping process cycle.

NOTE 4: Once TriggerPing is received, the listener waits for 40 ms during which time it deactivates all OOK paths associated with the primary that initiated the ping process cycle,



monitors the port for up to 40 ms and returns to the OperatingState. (see Section 8.4.2. “Ping process cycle” item 14).

NOTE 5: Once TriggerPing is received, the pinger waits 45 ms, sends the Ping message and returns to the OperatingState.

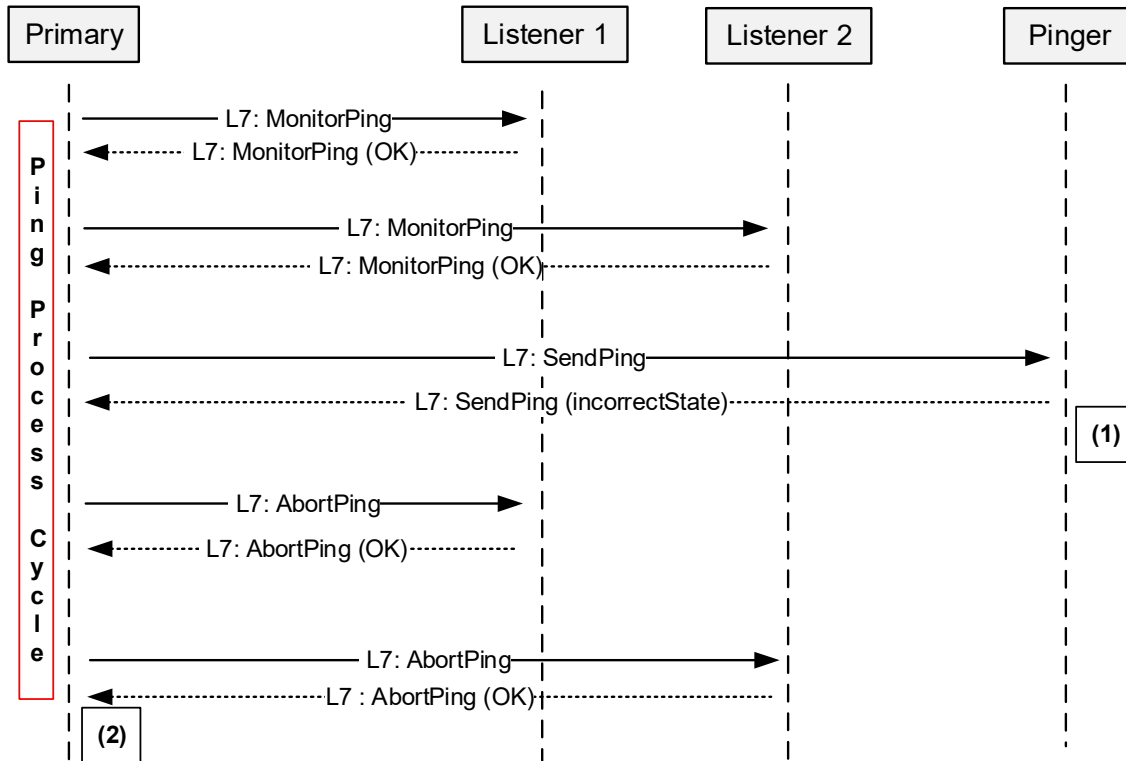


Figure 8.4.3-2: Sequence diagram when the MALD rejects the Ping Process

NOTE 1: The MALD rejects the SendPing command with the ReturnCode_t IncorrectState because another primary has already initiated the ping process.

NOTE 2: The primary may apply a random delay before retrying and start the ping process again.

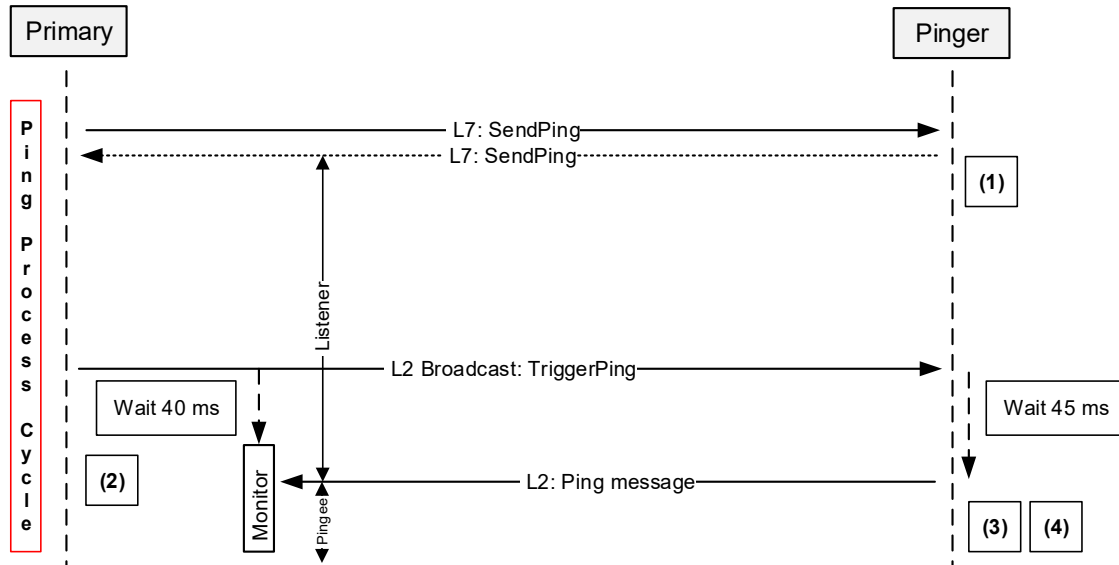


Figure 8.4.3-3: Sequence diagram when the primary receives the Ping message

NOTE 1: Once the response is sent, the pinger sets its PingerBroadcastWaitState timeout to 10 seconds and returns to OperatingState if it expires.

NOTE 2: Once TriggerPing is received, the primary listener waits for 40 ms and then monitors the port for up to 40 ms.

NOTE 3: Once TriggerPing is received, the pinger waits 45 ms, sends the Ping message and switches ALDState to OperatingState.

NOTE 4: If the primary does not receive the Ping message within 95 ms, it may continue the ping process cycle.

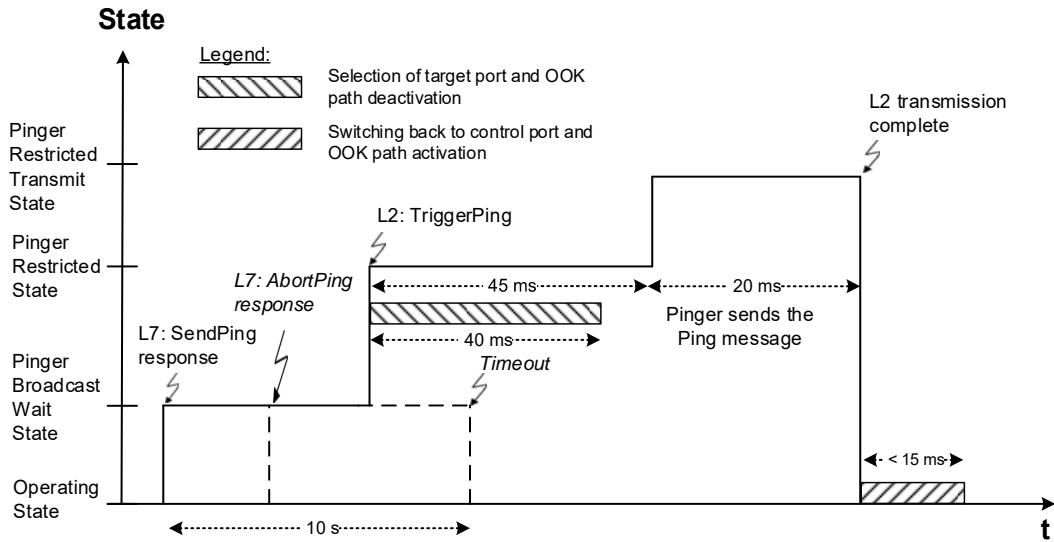


Figure 8.4.3-4: Pinger ALDState timing diagram

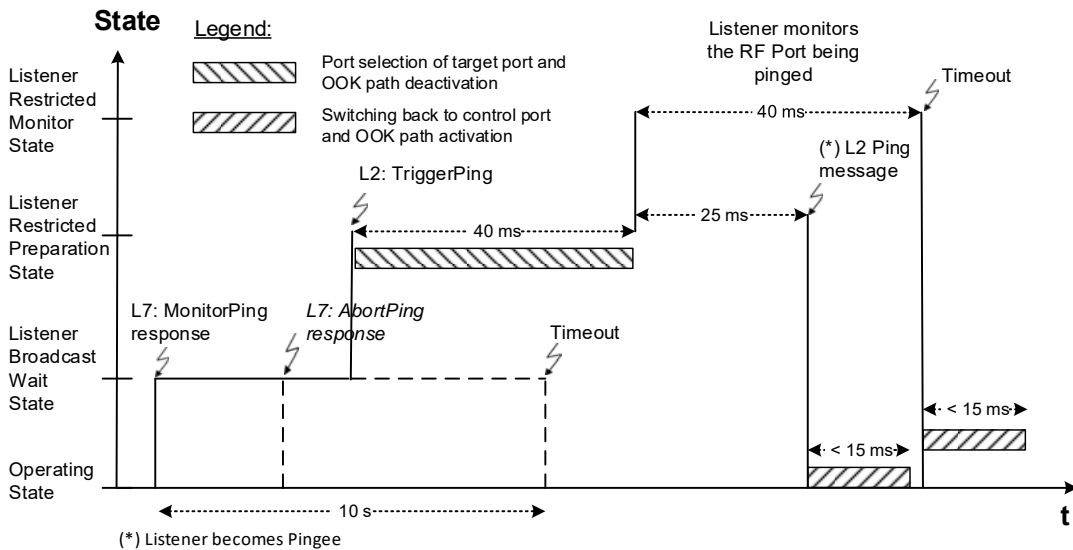


Figure 8.4.3-5: Listener ALDState timing diagram

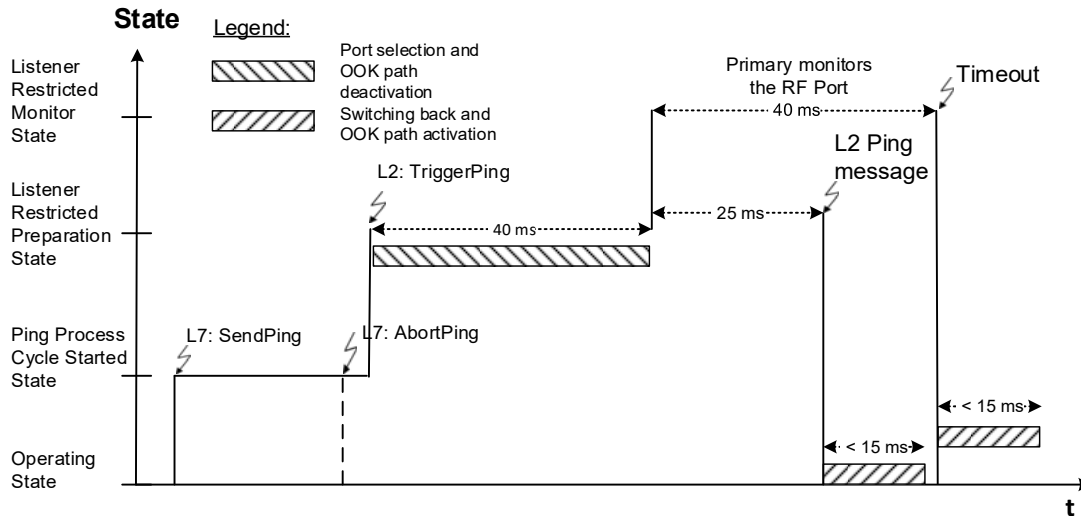


Figure 8.4.3-6: State diagram when the primary receives the Ping message

NOTE: The states in Figure 8.4.3-6: “State diagram when the primary receives the Ping message” apply to the primary only.

8.5. MALD setup

8.5.1. Introduction

MALD setup is performed to control the authorities of the connected primaries. It assigns the control of different subunits to the primaries connected to the MALD.

The concept of MALD setup consists of two domains: MALD authority and MALD security.

MALD setup provides a method for a primary to setup the control authorities (ReadWrite, ReadOnly or NoAccess) of each primary in respect of the subunits of a MALD.

This is achieved by setting the authorities of the control ports; these ports have PortPropertiesType RS485ControlPort or RFControlPort. Any primary connected to a MALD port and having MALDSetupPermission = Allowed security setting can configure all authorities within the MALD.



Subunit	Control Port 1 (Primary 1)	Control Port 2 (Primary 2)
1	ReadWrite	ReadOnly
2	ReadOnly	ReadWrite
3	NoAccess	ReadWrite

Table 8.5.1-1: Example of authority settings in MALD setup (MALD with 3 subunits and 2 control ports)

MALD Set Security Setting command provides a method for a primary to modify the MALD security settings of each primary in respect of MALD Setup Permission and MALD SW Download Permission. These settings control which primaries are allowed to perform MALD setup and MALD SW download.

Security type	Control Port 1 (Primary 1)	Control Port 2 (Primary 2)
MALD Setup Permission	Allowed	Not Allowed
MALD SW Download Permission	Allowed	Not Allowed

Table 8.5.1-2: Example of MALD security settings (MALD with 2 control ports)

These methods are not applicable to a SALD.

```

Enumeration AuthorityType_t : uint8_t {
    NoAccess          ← 0
    ReadOnly          ← 1
    ReadWrite         ← 2
}

Enumeration SecurityType_t : uint8_t {
    MALDSetupPermission ← 0
    MALDSWDownloadPermission ← 1
}

Enumeration SecuritySettingType_t : uint8_t {
    NotAllowed ← 0
    Allowed ← 1
}

Enumeration SettingSourceType_t : uint8_t {
    Active ← 0
    Volatile ← 1
}

// Subunits are indexed from 0, but index 0 is never used here
struct MALDAuthType_t {
    AuthorityType_t Authority[NrOfSubunits+1]
    SecurityType_t MALDSetupPermission
    SecurityType_t MALDSWDownloadPermission
}

struct MALDAuthType_t VolatileAuth[MaxPort]
uint16_t VolatileCommitCounter
persistent struct MALDAuthType_t ActiveAuth[MaxPort]
persistent uint16_t ActiveCommitCounter
    
```



8.5.2. MALD setup transactions

The MALD setup and MALD security settings are modified using MALD setup transactions. These are used to prevent a second transaction from being started until the previous transaction has been completed.

All MALD setup commands belonging to the same transaction must be initiated and performed on the same AISG port. For the period of the transaction, this port shall be referred to as the transaction port.

MALDStartSetup copies the active setup to the volatile copy where it can be edited without affecting the current MALD setup or MALD security settings. It then puts the MALD into MALDSetupState and starts the 5-minute timer.

MALDAbortSetup can be used to discard the changes, end the MALD setup transaction and enter the OperatingState.

MALDSetSubunitAuthority is used to edit the MALD setup in volatile memory.

MALDSetSecuritySetting is used to edit the MALD security setting in volatile memory.

MALDCommitSetup checks the validity of the volatile copy and if it is valid, it saves the contents of the volatile copy as the active setup and finally performs a reset of the MALD (which in effect makes the MALD enter the IdleState).

The process to modify a setup is to issue a MALDStartSetup, a sequence of MALDSetSubunitAuthority commands to edit the current setup and finally a MALDCommitSetup to apply the changes.

The process to modify the MALD security settings is to issue a MALDStartSetup, a sequence of MALDSetSecuritySetting commands to edit the current MALD security settings and finally a MALDCommitSetup to apply the changes.

Both MALDSetSubunitAuthority and MALDSetSecuritySetting commands can be used within the same transaction.

MALD setup and MALD security settings are edited in the volatile copy. Changes in the volatile copy have no effect on the MALD setup or MALD security settings. Once all desired settings are completed, the content of the volatile copy is validated, and if valid it is saved as the active setup and the MALD resets (in effect applying the new setup).

The MALDSetupState has a 5-minute timeout, which is cleared every time a MALDSetSubunitAuthority or MALDSetSecuritySetting command is sent. If the timeout expires the transaction is aborted, any uncommitted changes are discarded and the MALD enters the OperatingState.

The MALD maintains a persistent 16-bit wrap-around MALDCommitSetup counter, incremented by one on each successful commit. The counter starts with a value of 0 and wraps around from 65535 to 1 (not to 0). The counter is not allowed to wrap around to 0 since this represents the default setup. If this counter has not changed, the primaries can assume that the MALD setup has not been changed. If the MALDCommitSetup counter equals 0, the primary knows that the MALD is in the default setup.

MALDResetSetup can be used to re-initialise the MALD to its default setup (see Section 8.5.3.3. "MALD default setup"). This command also sets the MALDCommitCounter to 0.



After the MALD operation has resumed, primaries can discover the reset cause using the GetResetCause command. If the reset cause is MALDSetupChanged all the previous information about the MALD setup may have become invalid and each primary should now discover the current MALD setup.

In the default setup all control ports have ReadWrite authorities for all subunits within the MALD. MALDResetSetup returns a MALD to the default setup.

NOTE: The default setup is provided to allow an AISG v2 primary to access a MALD that has never been setup.

MALDGetInformation command provides information about the physical organisation of the MALD. It provides:

- setup commit counter value
- number of control ports within the MALD
- list of control port numbers
- number of subunits within the MALD
- list of subunit number and type tuples

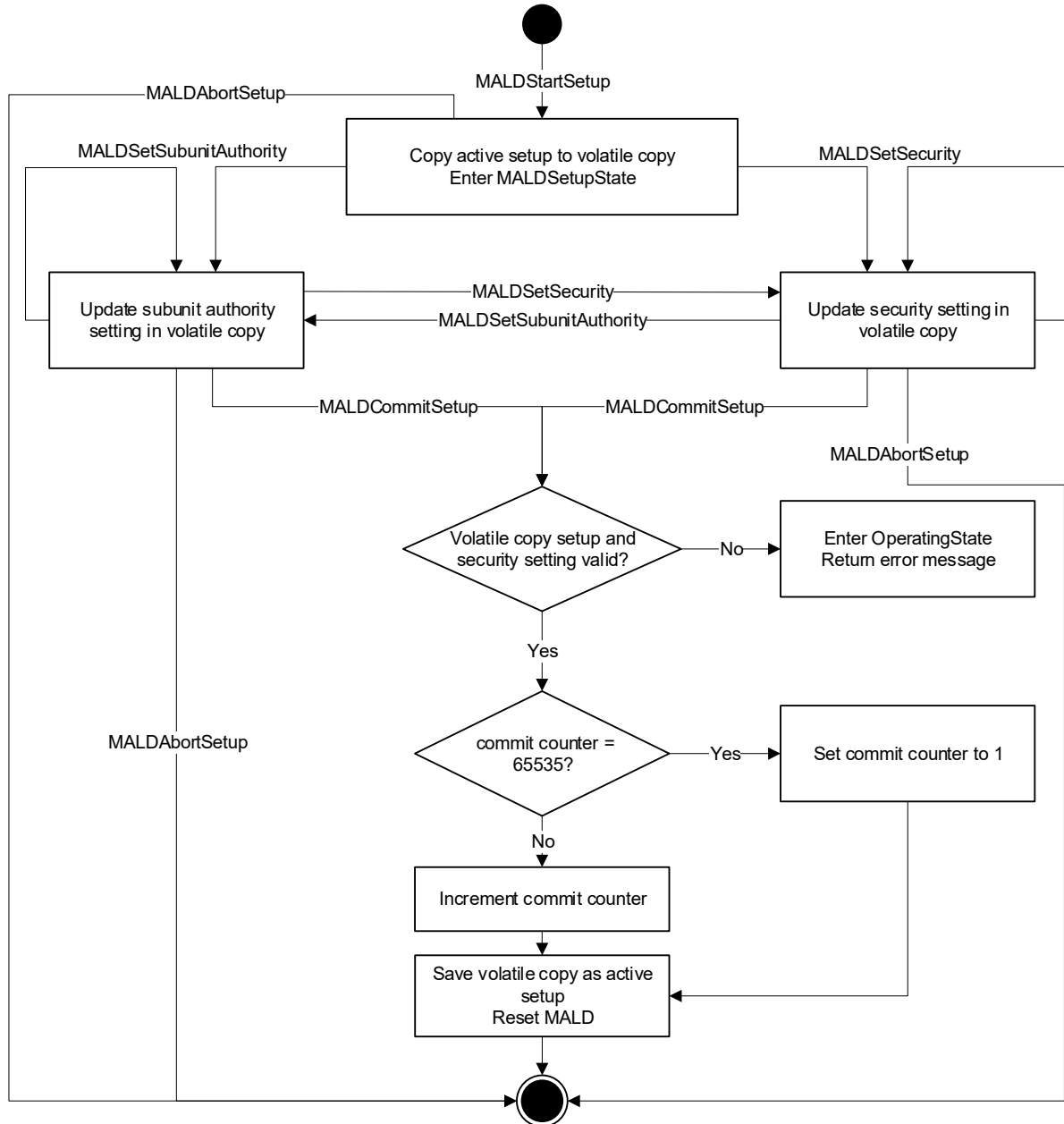


Figure 8.5.2-1: MALD Setup Flow Chart

8.5.3. MALD Authority control

8.5.3.1. Subunit authorities

Each primary has the following possible authorities: ReadWrite (RW), ReadOnly (RO) or NoAccess (NA).



If a primary has RW authority over a subunit, that subunit shall execute all commands addressed to it from that primary.

If a primary has RO authority over a subunit, that subunit shall execute only those commands which are designated for read-only.

If a primary has NA authority over a subunit, that subunit shall not be visible from that primary on layer 7.

If a primary connected to a MALD has NA authority to all the subunits of the MALD, the MALD shall execute commands not related to subunits (for instance MALDGetInformation or GetInformation).

The setting of authority for subunit number 0 (that is the entire MALD) is not permitted. Every MALD setup command addressed to subunit number 0 shall be rejected.

Commands that may have limitation in authority are identified in this standard and relevant subunit type standards.

8.5.3.2. Subunit authorities setup

The authority of each primary to control or monitor the subunits within the MALD is setup using the MALD setup command set.

MALDSetSubunitAuthority edits the setup in the volatile copy.

MALDGetSubunitAuthority can be used to read the contents of the active and volatile setup. The volatile setup can only be read when a MALD is in the MALDSetupState.

The MALD setup commands are sent to subunit 0. They include parameters for the subunit whose authority is being set and to which control port this authority applies.

8.5.3.3. MALD default setup

Before a MALD setup is set for the first time, it is in the default setup. After the first setup transaction is successfully completed, the MALD will no longer be in the default setup. The only way to return the MALD to the default setup is to use the MALDResetSetup command.

In the MALD default setup all primaries have ReadWrite authorities over all subunits. After the MALD setup is set one primary can have ReadWrite authority over a subunit, it is also allowed to have no primary with access authority over a subunit, effectively hiding the subunit.

The purpose of the MALD default setup is to allow a primary to control a MALD without having to configure it. This is beneficial for AISG v2 primaries which do not support AISG v3.0, and therefore cannot configure a MALD. Since in default setup more than one primary can control the same subunit, a risk of conflicting commands exists (e.g. two primaries commanding different tilts to same RET subunit). Users must exercise extra care when using the default setup as AISG v3.0 authority control that prevents conflicting write type commands is not in effect.

NOTE: Using MALD in the default setup is only recommended in situations where setting up it is not feasible.



8.5.3.4. MALD setup security

MALD security settings define the ability of each connected primary to configure the MALD or to perform Software downloads.

The MALD security type parameter that controls the ability of the primaries connected to a MALD to configure the MALD is called MALDSetupPermission and the security type parameter that controls the ability of the primaries connected to a MALD to update the MALD SW is called MALDSWDownloadPermission. These parameters can have two values, Allowed and NotAllowed.

MALDSetSecuritySetting enables editing of the MALD security settings in the volatile copy.

MALDGetSecuritySetting is used to read the security parameters from the active MALD security setting or volatile copy. The volatile MALD security settings copy can only be read when the MALD is in the MALDSetupState.

A scenario in which no primary has the right to do MALD setup is not allowed. This means that at least one primary shall have the right to configure the MALD at all times. To ensure that this is the case, the primary is not allowed to remove its right to configure the MALD.

If the right to configure the MALD needs to be transferred to another primary, the transfer of the right has to happen in two steps. In the first step the primary, that currently has the right to configure the MALD, gives the other primary the right to control the MALD by modifying the MALD security setting accordingly. In the second step, the primary that just received the right to configure the MALD then removes the right to configure the MALD from the original primary.

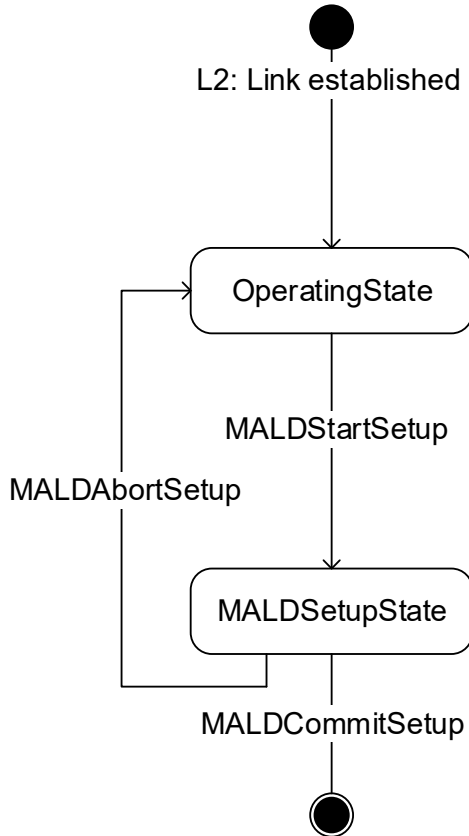


Figure 8.5.3.4-1: MALDSetupState

8.6. Download

The download process provides the capability of downloading files of certain file types to the ALD. The architecture allows only one file of each file type to exist within the ALD or any subunit. Since only one file per file type is permitted, there is no need for file names or indexes. Downloading a file will replace the existing file of the same file type. Download can be performed to the ALD itself, indicated by subunit number 0, or to an individual subunit. The file to be downloaded is indicated by its file type. The supported file types and their allowable destinations (ALD or subunit) are defined in Section 12.8.6. "Download Start".

The command DownloadStart selects the file type to be downloaded and starts the download process.

The file is downloaded by the primary issuing a series of DownloadFile commands. With each command a block of 256 octets in size is sent from the primary to the ALD until the complete file has been transferred. The last command in a sequence may transfer a block of less than 256 octets.

To indicate the successful completion of the Download process the primary sends the DownloadEnd command with the OptionCode Complete.

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After a successful firmware download the ALD will restart. After a successful configuration file download the ALD will apply the changes, but not restart. After a successful information file download the ALD does not restart.

To terminate the Download prematurely the primary sends the DownloadEnd command with the OptionCode Cancel or the DownloadStart command (to re-start a new download immediately after cancelling the previous one). Regardless, the ALD does not restart.

If DownloadFile detects an invalid file or some hardware problems or is unable to store the data, it returns an error code and will reject further DownloadFile commands. The primary must cancel the download as described in previous paragraph.

Parallel execution of another download process or any other layer 7 command is not allowed even from different subunits within the same ALD. However, the ALD may send AlarmIndication commands during a download.

The data content of the DownloadFile command is vendor specific, but it is recommended to implement an application software validation feature that prevents the risk of downloading faulty or invalid application software. After a failed SW download the ALD shall not be left into a state where it has no working software.

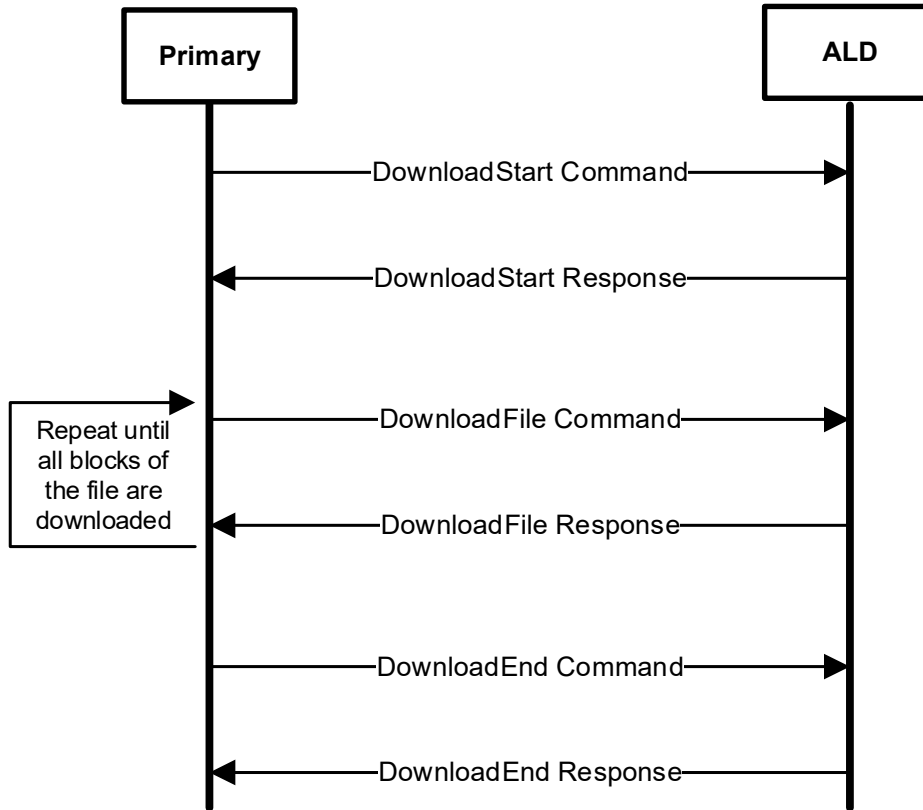


Figure 8.6-1: Command sequence for Download

8.7. Upload

The upload process provides the capability of uploading files of certain file types from the ALD. The architecture allows only one file of each file type to exist within the ALD or any subunit. Since only one file per file type is permitted, there is no need for file names or indexes. Upload can be performed from the ALD itself, indicated by subunit number 0, or from an individual subunit. The file to be uploaded is indicated by its file type. The supported file types and their allowable sources (ALD or subunit) are defined in Section 12.8.6. “Download Start”.

Using the command UploadInfo, the primary can query the size of the file to be uploaded. The command returns the size of the file in octets. If the file does not exist, an error is returned.

The command UploadStart selects the file to be uploaded and starts the upload process.

The file is uploaded by the ALD issuing a series of UploadFile commands. With each command a block of 256 octets in size is sent from the ALD to the primary until the complete file has been transferred. The last command in a sequence may transfer a block of less than 256 octets.

The ALD will send the UploadEnd command to the primary to indicate the successful completion of the Upload process.



Parallel execution of another upload process or any other Layer 7 command on the same port is not allowed (even from different subunits). However, the ALD may send AlarmIndication commands during an upload.

8.8. Resumption of operation

The following data shall be retained after reset:

- Firmware
- MALD Authority settings
- MALD Setup Permission settings
- MALD SW Download Permission settings
- RF Path IDs
- RF Path ID Aliases

Each subunit type standard may have additional requirements for retaining information.



9. AISG PSEUDOCODE

9.1. Global AISG code definitions

The following definitions are required for the pseudocode environment.

9.1.1. Port information

The following variables are required to provide information about the ALD ports.

```
uint16_t CurrentPort // The port number the command was received on  
uint16_t DownloadPort
```

9.1.2. ALD information

ALDType_t is set by design to the type of the ALD.

```
Enumeration ALDType_t {  
    SALD ← 0  
    MALD ← 1  
}
```

9.1.3. Subunit information

NrOfSubunits is initialised during start-up to the number of subunits within the ALD.

```
uint16_t NrOfSubunits // number of subunits within the ALD
```

9.1.4. Diagnostic information

RAISE is a function that, for an alarmcode, sets the alarm severity and stores a descriptive string for an alarmcode.

CLEAR is a function that, for an alarmcode, sets the alarm severity to Cleared and sets the descriptive string to an empty string.

9.1.5. Ping process

```
Boolean PingReceivedFlag
```

9.1.6. Logical array definitions

Following a reset MaxLogicalArray is set by the ALD to the highest logical array number in the antenna.

```
uint16_t MaxLogicalArray
```



9.1.7. Filetype definitions

```
Enumeration FileType_t: uint8_t {
    FirmwareFile      ← 0
    ConfigurationFile ← 1
    LogFile           ← 2
    InformationFile   ← 3
}
FileType_t ReceivedFileType
```

9.1.8. Primary IDs

PrimaryIDs contains the PrimaryID for each port.

```
uint32_t PrimaryIDs[MaxPort] // PrimaryID of each port
```



10. LAYER 1

10.1. General

There are two layer 1 connectivity options:

- RS-485 option: A screened multicore cable, which supports a conventional RS-485 serial multi-drop bus.
- OOK option: A coaxial cable, which is shared with DC and RF signals.

Both layer 1 options support the transmission of two-way serial data and DC power to a connected ALD. At least one of these options shall be supported by any primary or ALD.

Data rate: 9.6 kbps \pm 3%.

An ALD shall not communicate through an AISG port that has AISG communication but no applied DC power. The ping process is allowed on AISG OOK ports whether or not DC power is applied on that port.

10.1.1. One / zero relationship

The relationship between an idle bus, 1, 0, the RS-485 differential voltages and OOK levels shall be according to Figure 10.1.1-1: "One / zero relationship".

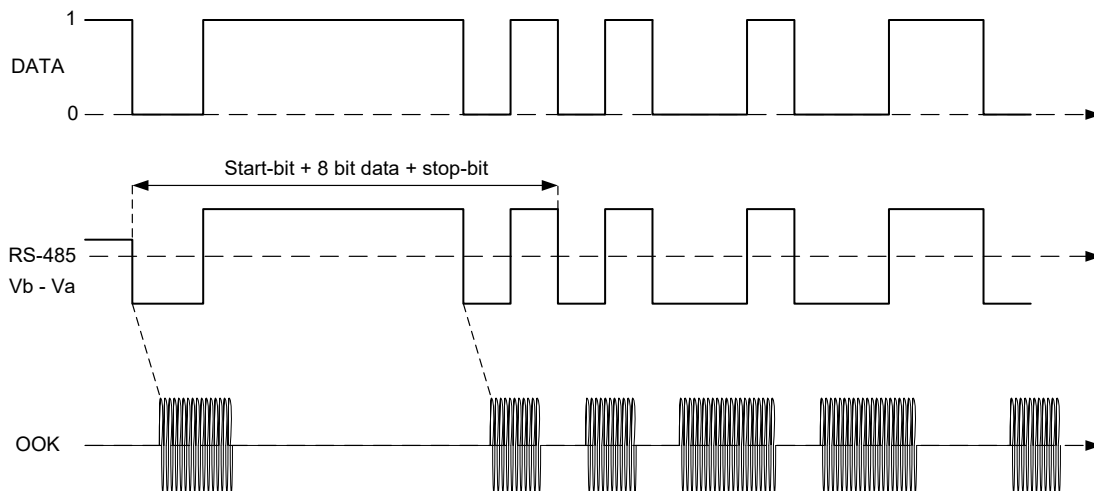


Figure 10.1.1-1: One / zero relationship

10.2. RS-485 option

The RS-485 bus used in AISG is a 2-wire half duplex bus supporting multi-drop. The bus shall be used together with separate wires for DC supply and DC return. The mapping of mark/space to logical one and zero as referred in [1] shall be according to Figure 10.2-1: "Format and order of transmitted data".

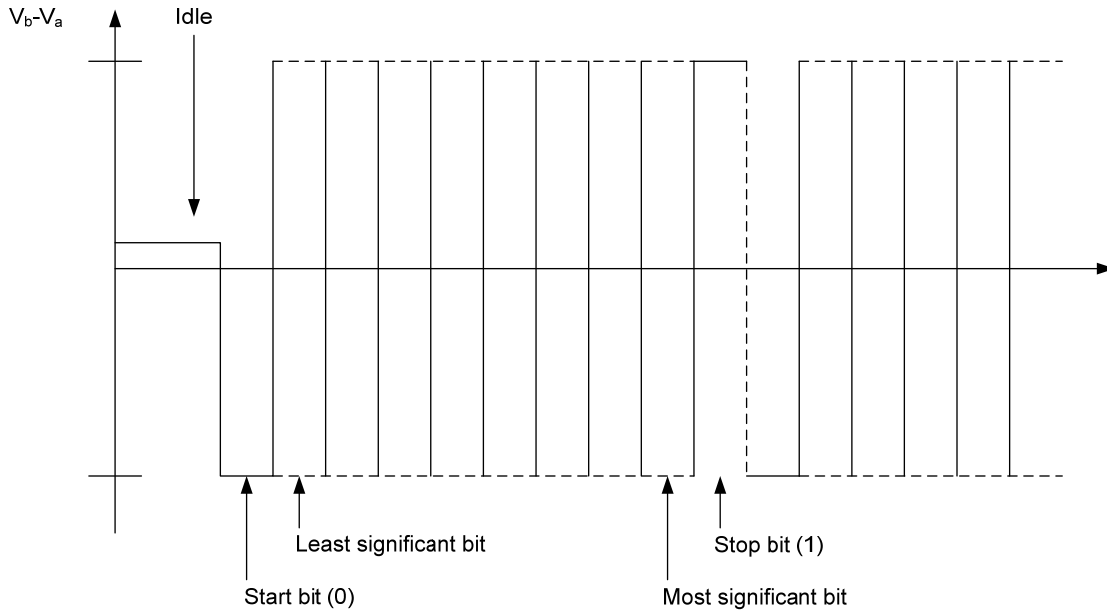


Figure 10.2-1: Framing and order of transmitted data

10.2.1. RS-485 bus load

An RS-485 bus interface shall present a bus load less than or equal to a unit bus load defined in [1]. One unit load is approximately 12 kohm.

10.2.2. RS-485 bus termination

It is not necessary to provide an external termination for the RS-485 bus.

10.2.3. RS-485 idle state biasing

Idle state bias is mandatory. Within one RS-485 bus only one ISB source is allowed.

Primaries and ANT RS-485 modems shall provide ISB. (see [2])

The ISB circuits shall provide approximately 120-ohm source impedance to the bus.

The polarity of the idle-state bias shall be $V_b > V_a$.

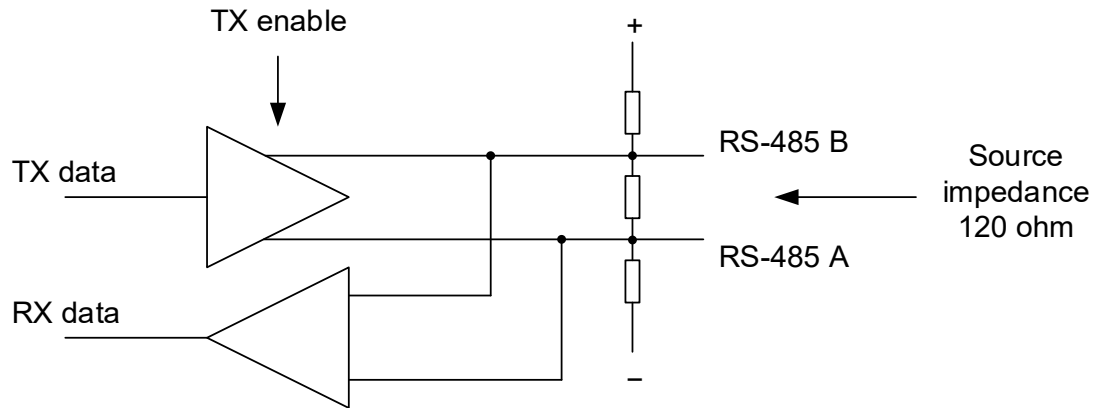


Figure 10.2.3-1: RS-485 transceiver

The ISB source shall be sufficient to guarantee at least 220 mV bias voltage when the bus is externally terminated with a 120-ohm load termination resistor.

10.2.4. Bus collisions

The RS-485 bus in AISG may be subject to bus data collisions. The ALD shall survive any type of bus collisions within the operating conditions allowed by [1] and [2].

10.2.5. Voltages

The AISG RS-485 bus shall accommodate different bus driver voltages provided that the line voltages are within the RS-485 standard common mode voltage range [1]. The bus shall operate correctly if 3.3 volt and 5-volt RS-485 circuits are mixed on the same bus.

10.2.6. RS-485 timing

The RS-485 transmitter shall be set to drive the bus not later than the leading edge of the first start bit, and held active until the last stop bit is sent. The RS-485 transmitter shall stop driving the bus not later than 2 ms after the last stop bit is sent.

10.3. OOK Option

The OOK option is a signal connection via modems via a coaxial cable which is shared with DC supply and RF signals.

10.3.1. Modem configurations

The connection between a base station and an ALD is provided by 2 modems, a BS RS-485 modem or a BS modem on the primary side and an ANT RS-485 modem or an ALD modem on the secondary side. A modem is not an ALD.

A BS RS-485 modem shall be connected to the antenna connector of the BS. The BS modem is integrated in the BS.



A ANT RS-485 modem is located between the antenna feeder cable and an ALD or an antenna, which in this context should be understood to contain an ALD. An ANT RS-485 modem can be integrated into an ALD or the antenna.

A ALD Modem can be integrated into an ALD. An ALD modem does not provide an RS-485 connection.

A modem may contain a PING port for mapping of RF ports in the antenna line system. A PING port is a special version of the RF port of an ALD or a BS modem. It is only capable of delivering RF and OOK signals. It is not capable of sourcing or consuming DC power. A PING port is only allowed to transmit or receive the Ping messages. All specifications for an ALD or BS modem also apply to a modem with a PING port.

Figure 10.3.1-1: “Reference planes for typical configurations at the antenna end” and Figure 10.3.1-2: “Reference planes for typical configurations at the BTS end” show different modem configurations in the antenna line. The reference planes, DC and RS-485 reference points are defined as reference points for the modem specifications. The antenna feeder cable shall transmit DC power, RF and OOK signals between the modems. In the case of an antenna with an integrated modem, the reference plane 4 is between the modem (with a Bias-T) and the antenna.

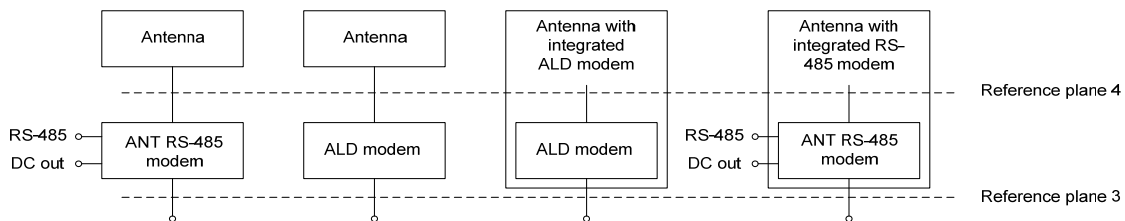


Figure 10.3.1-1: Reference planes for typical configurations at the antenna end

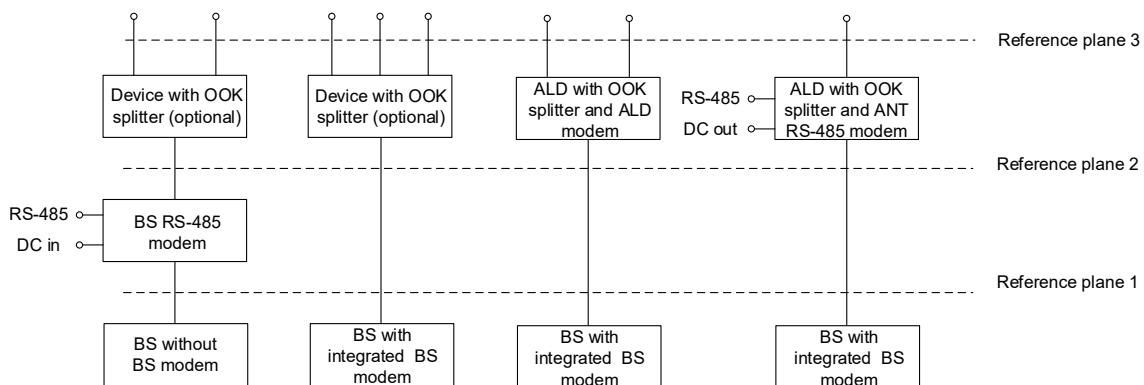


Figure 10.3.1-2: Reference planes for typical configuration options at the BS end

10.3.2. Modem operating frequency band

The modem is designed to operate in one or several uplink and downlink operating bands. The operating frequency bands of the BS RS-485 modem, ANT RS-485 modem or ALD modem shall be declared by the manufacturer in the datasheet. In the case of an ALD modem, the ALD shall report the operating frequency band according to structured frequency coding. The



operating frequency band(s) shall be reported for all RF ports of an ALD. The reporting is detailed in Chapter 13 “Structured frequency coding”.

10.3.3. Modem attenuation

The BS RS-485 modem shall provide less than attenuation between reference plane 2 and reference plane 1 not less than that shown in Figure 10.3.3-1: “Modem attenuation” to protect the BS from emissions of the antenna or modem.

The BS RS-485 modem emissions at reference plane 1 shall be attenuated at least as shown in Figure 10.3.3-1: “Modem attenuation” with respect to the levels specified for the modem spectrum emission mask in Figure 10.3.11.3-2: “BS RS-485 Modem spectrum emission mask at reference plane 1” to protect the BS from emissions of the BS modem.

The ANT RS-485 modem or ALD modem shall provide attenuation between reference plane 3 and reference plane 4 1 not less that shown in Figure 10.3.3-1: “Modem attenuation” to protect other radio systems from emissions of the modem.

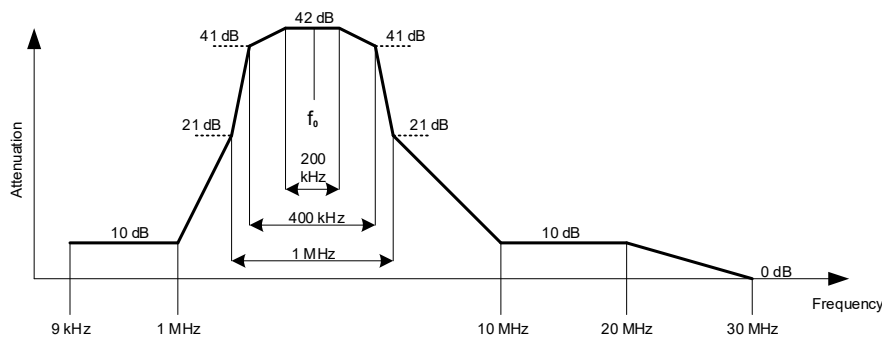


Figure 10.3.3-1: Modem attenuation

10.3.4. DC port isolation

For an ANT RS-485 modem the minimum isolation between the DC-out reference point and reference planes 3 and 4 shall comply with the values shown in Figures 10.3.4-1 “Isolation between DC in and RF port” and 10.3.4-2 “Detailed isolation requirement around the OOK carrier frequency”.

For a BS RS-485 modem without an integrated power supply, the isolation between the DC-in reference point and reference planes 1 and 2 shall comply with the values shown in Figures 10.3.4-1 “Isolation between DC in and RF port” and 10.3.4-2 “Detailed isolation requirement around the OOK carrier frequency”.

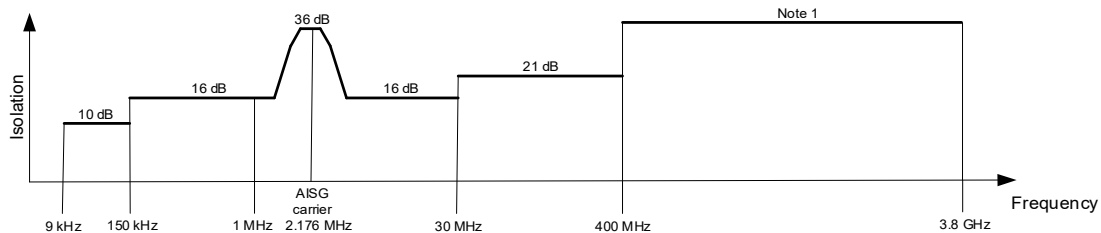


Figure 10.3.4-1: Minimum isolation between DC-in and RF port

NOTE: 38 dB, except for uplink and downlink operating bands where it is 65 dB.

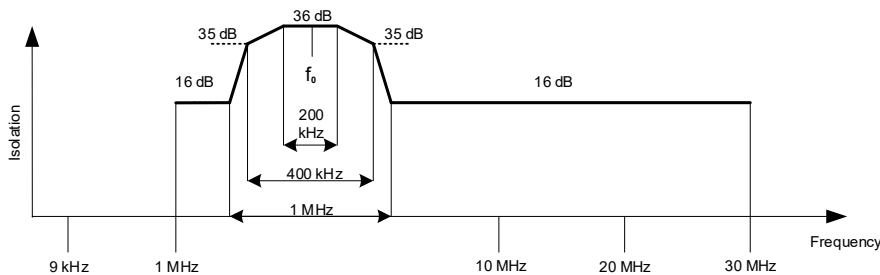


Figure 10.3.4-2: Detailed minimum isolation requirement around the OOK carrier frequency

10.3.5. Modem intermodulation attenuation

The modem intermodulation attenuation is specified in terms of the power in intermodulation products of WCDMA modulated carriers present at reference plane 1 or reference plane 3.

For two downlink carriers of 43 dBm the power of third order intermodulation products in the defined operating uplink frequency band for the BS RS-485 modem, ANT RS-485 modem and ALD modem shall not exceed:

- 130 dBm/100 kHz for frequencies <1 GHz
- 120 dBm/1 MHz for frequencies \geq 1 GHz

For the worst input configuration of power and number of carriers declared by the modem manufacturer the power of any intermodulation product for BS RS-485 modem, ANT RS-485 modem and ALD modem shall not exceed:

- 98 dBm/100 kHz

In addition, for the worst input configuration of power and number of carriers declared by the modem manufacturer the power of fifth or higher order intermodulation products in the defined operating frequency band for the BS RS-485 modem, ANT RS-485 modem and ALD modem shall not exceed:

- 135 dBm/100 kHz for frequencies <1 GHz
- 125 dBm/1 MHz for frequencies \geq 1 GHz



The conversion between modulated and CW signals shall be as follows:

- The requirement for IM3 below 1 GHz shall be relaxed by 15 dB and tested with CW interferers at the specified levels.
- The requirement for IM3 above 1 GHz shall be relaxed by 5 dB and tested with CW interferers at the specified levels.
- The requirement for IM5 or higher below 1 GHz shall be relaxed by 10 dB and tested with CW interferers at the specified levels.
- The requirement for IM5 or higher above 1 GHz shall be relaxed by 0 dB and tested with CW interferers at the specified levels.

10.3.5.1. Emission requirement below noise floor

As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy and sensitivity when measuring close to or below the noise floor, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

10.3.5.2. Conversion between modulated and CW for IM measurement

The requirement for IM3 below 1 GHz shall be relaxed by 15 dB and tested with CW interferers at the specified levels.

The requirement for IM3 above 1 GHz shall be relaxed by 5 dB and tested with CW interferers at the specified levels.

The requirement for IM5 or higher below 1 GHz shall be relaxed by 10 dB and tested with CW interferers at the specified levels.

The requirement for IM5 or higher above 1 GHz shall be relaxed by 0 dB and tested with CW interferers at the specified levels.

Example: A -130 dBm/100 kHz requirement below 1 GHz with two WCDMA-modulated carriers at 43 dBm is converted to a -115 dBm requirement with two CW carriers at 43 dBm.

10.3.6. Modem impedance

The RF ports of the BS RS-485, ANT RS-485 and ALD modems that support OOK signals shall provide constant impedance:

- Nominal impedance Z_0 : 50 ohms;
- Return loss at modem carrier frequency ± 0.1 MHz >10 dB;
- Return loss of RF ports in the defined operating frequency bands >20 dB;
- DC impedance of PING port: > 1 kohm.

10.3.7. Modem insertion loss in RF bands

The maximum insertion loss of the BS RS-485 and ANT RS-485 modem in the RF operating frequency bands shall be ≤ 0.3 dB.



The actual insertion loss of BS RS-485 and ANT RS-485 modem shall be declared in the manufacturer's datasheet.

10.3.8. Modem power consumption

All modems shall be able to operate with a supply voltage range of 10 V – 30 V. The maximum power consumption of BS RS-485 and ANT RS-485 modems shall each be less than 2 W. A BS RS-485 modem shall cause a voltage drop less than 2 V between reference points DC-in and 2. An ANT RS-485 modem shall cause a voltage drop less than 2 V between reference points 2 and DC-out and less than 2 V between reference points 3 and DC-out. These voltage drops shall be measured at the declared maximum operating current.

A modem shall fulfil the DC power-up characteristics specified in Section 10.4.3 "DC power-up and steady state mode".

If a modem is integrated in an ALD, the maximum voltage drop between RF port and RS-485 port caused by the external load is undefined. The maximum current supported by the RS-485 interface and the voltage drop at that current, including the internal highest current consumption, shall be declared by the manufacturer in the datasheet.

10.3.9. Modem RF time delay and accuracy

The BS RS-485 and ANT RS-485 modem RF time delays and their accuracy in the operating bands, shall be declared in the manufacturer's datasheet.

10.3.10. Modem timing

Modem timing shall comply with the requirements of Para 10.2.6.

Modem data delay shall be less than or equal to 0.2 ms in each direction.

10.3.11. Modulator characteristics

10.3.11.1. Carrier frequency and accuracy

The following carrier frequency shall be used:

2.176 MHz \pm 100 ppm

10.3.11.2. Levels

ON-Level: +3 dBm \pm 2 dB

OFF-Level: \leq -40 dBm

The modulator signal levels are referred to the RF port of the modem or ALD.

10.3.11.3. Spectrum emission mask

The modem spectrum emission mask is specified in Figure 10.3.11.3-1: "Modem spectrum emission mask". Intermediate values may be obtained by linear interpolation between the points shown. The corresponding measurement bandwidths are specified in Table 10.3.11.3-1: "Modem spectrum emission mask".



For modem configurations according to Figure 10.3.1-2: “Reference planes for typical configuration options at the BS end” the BS RS-485 modem emissions shall not exceed the limits of the spectrum emission mask at reference plane 2. For modem configurations according to Figure 10.3.1-2: “Reference planes for typical configuration options at the BS end” the modem emissions from a BS with integrated BS modem shall not exceed the limits of the spectrum emission mask at reference plane 1 for frequencies below 20 MHz. ANT RS-485 or ALD modem emissions shall not exceed the limits of the spectrum emission mask at reference planes 2 and 3 according to Figure 10.3.1-1: “Reference planes for typical configurations at the antenna end” and Figure 10.3.1-2: “Reference planes for typical configuration options at the BS end”.

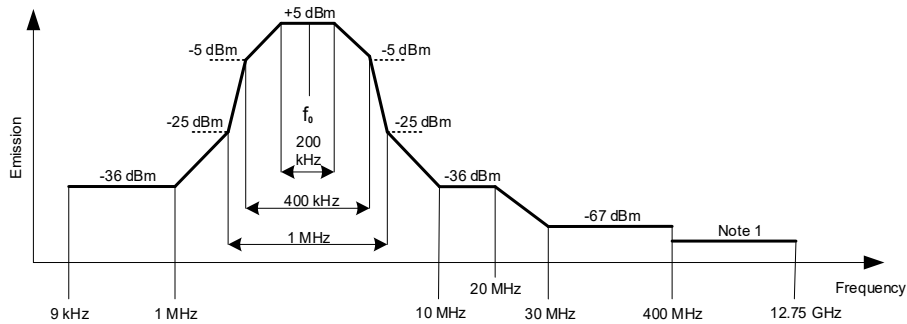


Figure 10.3.11.3-1: Modem spectrum emission mask

NOTE: For frequencies below 1 GHz the general emission limit is -108 dBm, except at modem operating band uplink frequencies where the emission limit is -135 dBm. For frequencies above 1 GHz the general emission limit is -98 dBm, except at modem operating band uplink frequencies where the emission limit is -125 dBm.

Band	Measurement Bandwidth
9 kHz - 150 kHz	1 kHz
150 kHz - 30 MHz	10 kHz
30 MHz - 1 GHz	100 kHz
1 GHz - 12.75 GHz	1 MHz

Table 10.3.11.3-1: Modem spectrum emission mask measurement bandwidth

For modem configurations according to Figure 10.3.1-2: “Reference planes for typical configuration options at the BS end” the BS RS-485 modem emissions shall not exceed the limits of the spectrum emission mask at reference plane 1 according to Figure 10.3.11.3-2: “BS RS-485 Modem spectrum emission mask at reference plane 1”.

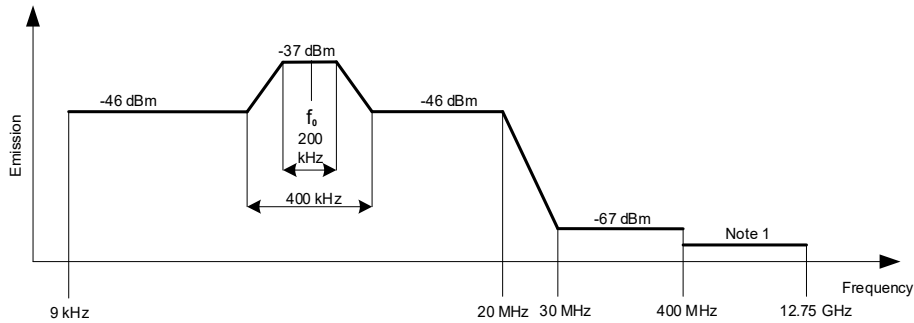


Figure 10.3.11.3-2: BS RS-485 Modem spectrum emission mask at reference plane 1

NOTE: For frequencies below 1 GHz the general emission limit is -108 dBm, except modem operating band uplink frequencies where the emission limit is -135 dBm. For frequencies above 1 GHz the general emission limit is -98 dBm, except at modem operating band uplink frequencies where the emission limit is -125 dBm.

10.3.11.4. Spectrum mask and emission testing

The spectrum mask and emission requirement shall be tested both with a consecutive series of “0” and an alternating sequence of “0” and “1”.

10.3.12. Demodulator characteristics

The demodulator shall fulfil the following requirements for selectivity and duty cycle variation.

10.3.12.1. Demodulator selectivity

The following signals at the RF port of ALD shall not result in detection of the ON-state:

Centre frequency of interfering CW signal	Interfering CW signal level	OOK signal level at 2.176 MHz
9 kHz – 1.25 MHz	-13 dBm	< -18 dBm
3.7 MHz – 12.75 GHz	-13 dBm	< -18 dBm
The defined TX carrier frequency band of ALD RF port	The defined maximum acceptable TX carrier signal level of ALD RF port	< -18 dBm

Table 10.3.12.1-1: The definitions of signal levels for ON-state

The following signals at the RF port of ALD shall not result in detection of the OFF-state:



Centre frequency of interfering CW signal	Interfering CW signal level	OOK signal level at 2.176 MHz
9 kHz – 1.25 MHz	-13 dBm	-12 dBm – +5 dBm
3.7 MHz – 12.75 GHz	-13 dBm	-12 dBm – +5 dBm
The defined TX carrier frequency band of ALD RF port	The defined maximum acceptable TX carrier signal level of ALD RF port	-12 dBm – +5 dBm

Table 10.3.12.1-2: The definitions of signal levels for OFF-state

10.3.12.2. Duty cycle variation

For transmission through a coaxial cable, two modems are required, one converting from a bit stream to OOK and one from OOK back to a bit stream. In order to guarantee proper transmission of data bits through the processes of modulation and demodulation of BS RS-485 and ANT RS-485 modems, the following system duty cycle limits shall be met for a carrier ON-Level between +5 dBm and -12 dBm and a carrier OFF-Level less than -18 dBm. Levels between -12 dBm and -18 dBm are undefined.

$$\Delta DC_{SYSTEM} = |DC_{RX} - DC_{TX}| \leq 10 \%$$

Where: ΔDC_{SYSTEM} is the difference between the duty cycles of the transmitted and received bit streams,

DC_{TX} = Duty cycle for the input bit stream, and

DC_{RX} = Duty cycle for the output bit stream.

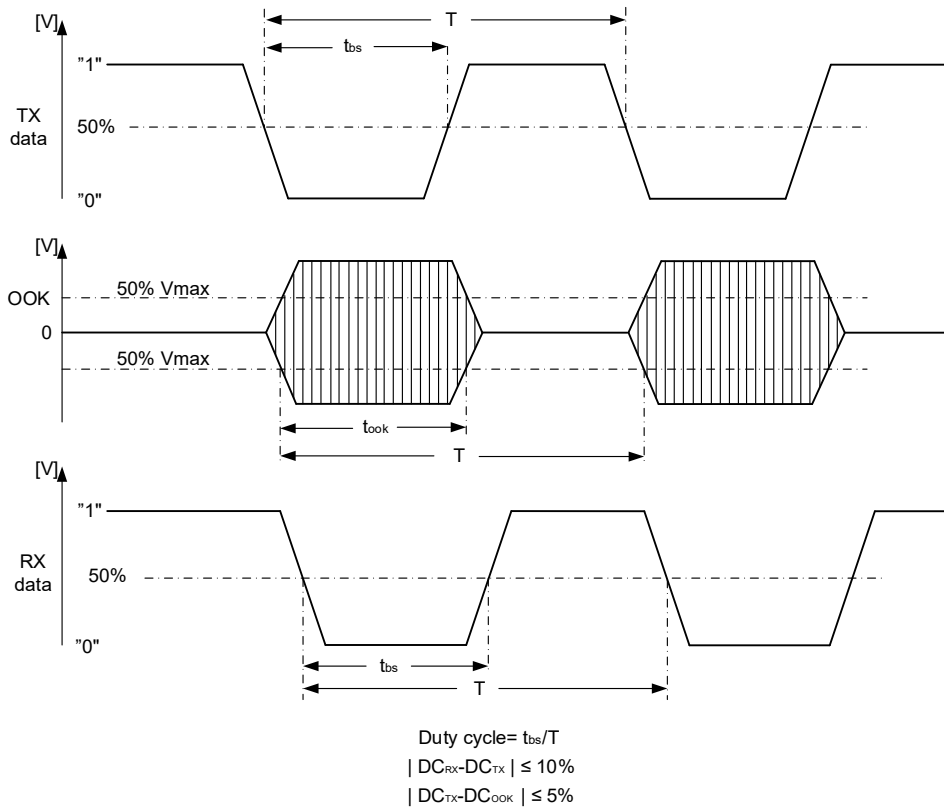


Figure 10.3.12.2-1: Duty cycles of the bit stream and OOK modulated subcarrier

For an input bit stream with a duty ratio of 50%, the cascaded modulator and demodulator shall provide an output bit stream with a duty ratio within the limits 40% – 60%, measured in each case at 0.5 times peak amplitude (see Figure 10.3.12.2-1. “Duty cycles of the bit stream and OOK modulated subcarrier”).

The permitted duty cycle limit for a single BS RS-485 or ANT RS-485 modem is 45% – 55%. The duty cycle of a single modem can be measured by testing it both as modulator and demodulator, paired with another known modem. The duty cycle of a single modem can also be determined by measuring the time between the points at 50% of maximum voltage of the OOK signal (see Figure 10.3.12.2-1. “Duty cycles of the bit stream and OOK modulated subcarrier”).

10.3.13. OOK combiners and splitters

It is permissible to combine and split the DC+RF+OOK signal.

All external inputs and outputs on splitting devices must be matched to 50 ohms, both for the OOK band and the specified RF band must meet the following requirements:



1. Return loss: ≥ 14 dB at 2.176 MHz ± 100 kHz
2. Maximum insertion loss at 2.176 MHz ± 100 kHz
 - Two-way split: 4.5 dB
 - Three-way split: 6.3 dB

The values for the maximum voltage drop and the maximum operating current shall be declared by the manufacturer in the datasheet.

If an OOK-combiner or an OOK-splitter is integrated into an ALD, the OOK signals generated, used and by-passed by such a device are permitted to have the same level of insertion loss as is specified for an external splitting device as above.

10.3.14. Active regeneration of the OOK signal at ALD

It is allowed to regenerate the OOK signal at an ALD to implement a bi-directional OOK repeater. The data stream between different RF port ALD modems can be implemented by any means. The maximum OOK signal delay between RF ports of the ALD is 0.2 ms.

10.3.15. OOK bypass in ALD

An OOK bypass creates a path for the OOK signal between specific RF ports of the ALD. In the case of OOK combining or splitting, the ALD modem may be common to several OOK bypass paths.

If pinging is supported, OOK bypass paths shall provide an attenuation of at least 23 dB at the OOK frequency during the `FingerRestrictedTransmitState` or the `ListenerRestrictedMonitorState`.

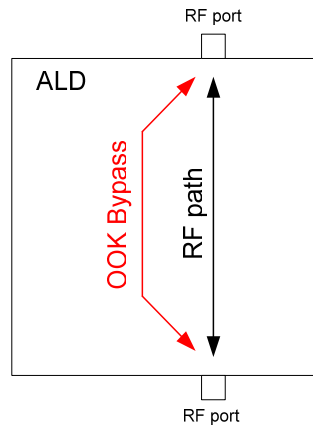


Figure 10.3.15-1: OOK bypass

10.3.16. Conducted emissions

The levels of generated conducted noise and ripple on DC power supply shall be within the following limits:

Item	Limit	Frequency	Remarks
ANT RS-485 modem, RF port	15 mVp-p	0.15-30 MHz	Generated noise and ripple at RF feeder (in RX mode)
ANT RS-485 modem, DC port	20 mVp-p	0.15-30 MHz	Allowed noise and ripple at external DC port (in TX mode)

Table 10.3.16-1: Noise and ripple

The noise and ripple measurement setup is defined in Section 10.5.1. "Noise and ripple".

10.3.17. Spurious emissions at modem input

Spurious emissions at the DC input of a BS RS-485 modem shall not generate spurious emissions, at reference plane 1, above a level that will violate the spectrum emission mask requirement according to Section 10.3.11.3. "Spectrum emission mask". The DC port isolation according to Section 10.3.4. "DC port isolation" shall be taken into account.

10.4. ALD DC power supply

10.4.1. DC supply level

An ALD shall support a DC supply operational voltage of 10.0 – 30.0 V DC.



NOTE: An ALD bypassing a layer 2 link via an OOK or RS-485 port in the ANT direction shall supply DC power on that port.

10.4.2. Definition of DC power modes

ALDs may have up to three different power modes: SteadyStatePowerMode, HighPowerMode and SleepPowerMode.

SteadyStatePowerMode is the normal operating condition of the ALD.

HighPowerMode is a specific condition requested by the primary for an ALD having higher DC power consumption compared to SteadyStateMode.

SleepPowerMode is a specific condition saving DC power.

On receipt of a GetAISGPortDCPowerInformationCommand, the ALD shall report the DC power consumption for these modes as integers with a resolution of 0.1 watt. All stored values shall be worst case values over all specified operating conditions.

In the case of MALD, the stored values are for the condition when DC power is supplied by only one AISG port (OOK or RS-485).

P1 is the maximum SteadyStatePowerMode consumption for a specific ALD. The stored value concerns this ALD only.

P2 is the HighPowerMode power consumption for a specific ALD. An ALD shall only switch into the HighPowerMode in response to a layer 2 or layer 7 command explicitly permitting the ALD to do so. For ALDs having no HighPowerMode, P2 is equal to P1.

P3 is the SleepPowerMode consumption for a specific ALD. An ALD shall only switch into the sleep power mode in response to a layer 2 or layer 7 command explicitly permitting the ALD to do so. For ALDs having no SleepPowerMode, P3 is equal to P1.

Subunit type standards may optionally declare an upper limit for one or more of these values.

10.4.3. DC power-up and steady state mode

DC power-up requirements shall be fulfilled at start-up, after a DC power cycle defined in Section 10.4.4. "Reset triggered by DC power cycle", and at start-up after reset.

DC power-up requirements shall be fulfilled at any ALD voltage within the AISG specified operating voltage range.

DC power-up requirements shall be fulfilled for all AISG OOK and RS-485 DC input interfaces.

DC power-up requirements are verified using an ALD input voltage having a maximum rise time of 100 microseconds to 90% of the final voltage.

SteadyStatePowerMode starts 10 seconds after power is supplied to an ALD, at which time the ALD shall be ready to receive layer 2 commands. An ALD remains in SteadyStatePowerMode unless commanded to an alternative power mode. Once an alternative power mode is completed, the ALD shall return to SteadyStatePowerMode.



10.4.3.1. Allowed initial energy consumption at power-up

The initial consumed energy per AISG DC input port shall be less than or equal to 1 mJ during the first 0.2 milliseconds.

10.4.3.2. Allowed initial current consumption at power-up

The peak current consumption from 0.2 milliseconds to 50 milliseconds shall be less than or equal to the declared SteadyStatePowerMode consumption P1 divided by 30 volts.

The peak current consumption from 50 milliseconds to 10 seconds shall be less than or equal to the declared SteadyStatePowerMode consumption P1 divided by the ALD voltage.

10.4.3.3. Minimum DC input impedance at low voltages

AISG DC input ports shall provide a DC impedance ≥ 1000 ohms for voltages < 3.5 volts.

10.4.4. Reset triggered by DC power cycle

If the AISG port voltage is below 3.5V for more than 3 seconds for all its AISG ports simultaneously, an ALD shall execute reset when the port voltage of at least one of its AISG ports reaches the ALD DC supply operational voltage range.

An ALD shall be ready to receive layer 2 commands within 10 seconds after reset is initiated.

10.4.5. ALD DC power supply management

An ALD having integrated ANT-RS-485 modem, the whole DC power delivery to an AISG RS-485 DC output port shall be taken from the OOK port having an internal connection to RS-485 bus.

If the voltage falls below 3.5V for at least 3 seconds on an AISG port, means shall be provided by which AISG layer 2 and layer 7 are informed.

10.4.5.1 Redundant DC power supply management

An ALD operates in redundant power supply configuration when able to source DC power from multiple primaries. SteadyStatePowerMode DC power of an ALD may be provided by any combination of AISG interface input ports. At least the difference between HighPowerMode DC power and SteadyStatePowerMode DC power shall be taken from the AISG interface port that requested HighPowerMode. A short circuit on any port shall not interfere with the operation of any other port. Replacing a primary shall be possible without an interruption of the operation of an ALD. NOTE: When an ALD can source DC from multiple primaries, any primary may see zero DC power consumption

10.4.6. Multi-pole connector

Connector type: Conforming to AISG C485.



Pin number	Signal	Requirement	Description
1	Not used		NOTE 1
2	Not used		NOTE 1
3	RS-485 B	Mandatory	Line voltage Vb
4	Not used		NOTE 2
5	RS-485 A	Mandatory	Line voltage Va
6	10 V–30 V DC	Mandatory	
7	DC return	Mandatory	NOTE 3
8	Not used		

Table 10.4.6-1: RS-485 interface multi-pole connector pin-out

NOTE 1: This pin has been used as a DC supply pin in earlier AISG versions.

NOTE 2: This pin has been an optional RS-485 ground pin in earlier AISG versions.

NOTE 3: DC return is preferably not grounded for any device deriving its DC power through this connector. If the DC return is grounded there is a risk of unwanted ground currents and also of higher lightning current inside the RS-485 cables. If this pin is grounded the DC feeding circuit must be mounted close to the ALD and both must have the same ground potential.

10.4.6.1. Polarity of multi-pole connectors

The polarity of the multi-pole connector pins shall follow the principle that live male connector pins are not exposed at any point, for example:

Primary:	Where the RS-485 interface is provided: Output socket(s) with female pins;
ALD or antenna:	When ALD or antenna contains an ANT RS-485 modem; Output socket(s) with female pins; When ALD or antenna control is to be independent of the RF cable: One input socket with male pins and optionally a second output socket with female pins;
Interconnecting cables:	Plug with male pins at one end and plug with female pins at the other end.

10.4.6.2. Daisy chaining with multi-pole connectors

At least mandatory pins shall be connected through for daisy chaining. Building a passive RS-485 splitter into an ALD is not recommended.



10.5. Emission and immunity requirements for ALDs

10.5.1. Noise and ripple

The levels of generated conducted noise and ripple on the ports of the ALD (unless other limits are defined in ALD specific standards) shall be within the following limits:

Item	Limit	Frequency	Remarks
ALD, RF port	15 mVpp	0.15-30 MHz	Generated noise and ripple at RF feeder (without OOK transmission)
ALD, DC port	20 mVpp	0.15-30 MHz	

Table 10.5.1-1: Noise and ripple

The noise and ripple measurement setup is defined in Section 10.5.1. “Noise and ripple”. The emissions and immunity for different BTS ancillary equipment ports and enclosure are defined in [3].

10.5.2. Conducted noise and ripple measurement

In order to achieve accurate, reproducible and comparable noise and ripple measurement results the following measurement guidelines shall be followed. Comparable test results are accomplished using an interface with a characteristic impedance of 50 ohms at the measurement port.

The conducted noise and ripple shall be measured with a 50-microhenry impedance stabilizing network (ISN). This device incorporates a 50-ohm impedance interface and filters the noise from the DC power supply. The conducted noise can be measured from the RF port or the RS-485 DC port of the ALD.

The measurement instrument needs to have a 50-ohm interface. The measurement instrument can be a measuring receiver, spectrum analyser or oscilloscope. The peak detector shall be used with a measuring receiver. When an oscilloscope is used, a 50-ohm shunt resistor shall be placed next to the probe and an additional low pass filter is needed to limit the measurement frequency to 30 MHz.

Test setup for the ALD port consuming DC current shall be configured as shown in Figure 10.5.2-1: “The test setup for conducted noise and ripple measurement”.

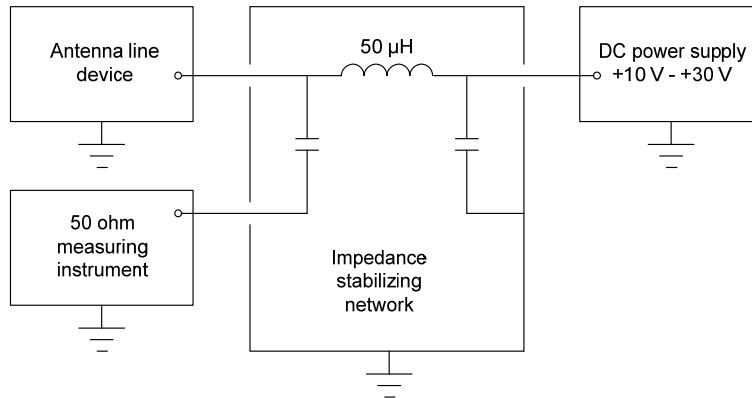


Figure 10.5.2-1: The test setup for conducted noise and ripple measurement

In the case where an ALD has RF port, the ALD power mode may be controlled by connecting the modem to the interface used by the 50-ohm measuring instrument, and disconnecting it before the noise measurement is made.

The test setup for an ALD with a DC current feed shall be as shown in Figure 10.5.2-2: “The test setu for an ALD with DC current feed”.

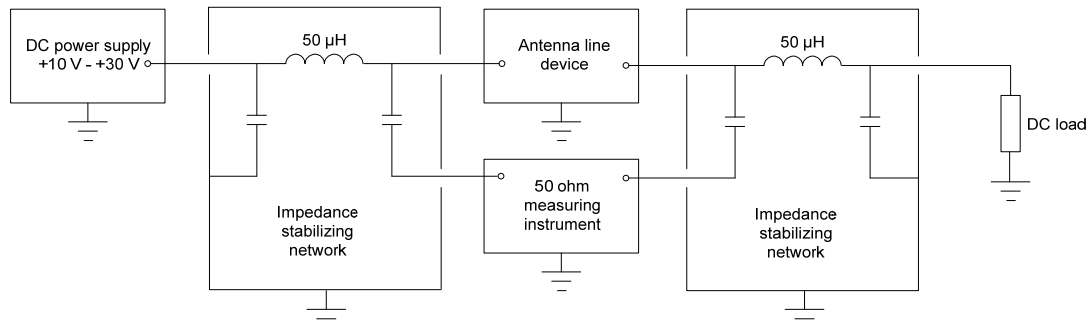


Figure 10.5.2-2: The test setup for an ALD with DC current feed

More specific information can be found in [4] and [5].

10.6. Primary DC supply

It is not allowed to establish a layer 2 link on any port without supplying DC-Power on that port. This requirement includes both cases OOK option and RS-485 option.

10.6.1. Primary DC supply for MALD

All primaries connected to MALD must be able to provide DC power simultaneously. The primary performing the MALD setup shall be able to provide all idle mode DC power.

A primary issuing a command for a HighPowerMode command must be able to provide the additional power required by the HighPowerMode command.

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A primary, which has a connection to a MALD port delivering power to an ANT RS-485 modem, must be able to provide all the DC power required by the devices connected to the connected RS-485 bus.



11. LAYER 2

11.1. General

Layer 2 is based on HDLC Class UNC1,15.1 TWA, according to Section 6.10. in [6].

This comprises the following subset of HDLC:

- Unbalanced operation (master / slave operation)
- Normal response mode (sequence numbers in data frames)
- XID negotiation
- Start and stop transmission with basic transparency
- Two Way Alternate (TWA) (half-duplex)

NOTE: Two different data stations are defined in [6], which are called primary station and secondary station. In this standard primary stations are called primary and secondary stations are called ALD.

11.2. Frame receiver

The ALD frame receiver requires a set of states per port. The frame receiver is defined to be called every time a port receives a character or other serial port event.

The term framing error is used to indicate that the stop bit had the wrong value.

```
struct AISGPortRxFrameStatus_t {
    uint8_t address           // Assigned ALDAddress,
                           // 0 means NoAddress Linkstate
    Boolean in_frame         // Inside a frame (between HDLC flags)
    Boolean control_escape   // As defined in [6]
    uint16_t count           // Number of received octets
    uint16_t last_rx_time    // Time in ms when last octet was received
    uint16_t fcs             // Frame check sum
    uint8_t buffer[266]     // Received octets
}
```

```
// Per port state variable for frame receiver
AISGPortRxFrameStatus_t status
```

ALD specification (Normative):

ON Reset DO

```
    status.in_frame ← false
```

DONE

ON ReceivedEvent DO

// Serial port receive event

```
uint8_t C
```

```
uint16_t Now
```

```
    IF «framing error» THEN
```

// If stop bit had wrong value

```
        status.in_frame ← false
```

```
        EXIT
```

```
    ENDIF
```



```
C ← «received character»
Now ← «current ms timer»

IF Now – status.last_rx_time > 10 THEN // Frame timeout
    status.in_frame ← false
ENDIF

status.last_rx_time ← Now // From a free running millisecond timer
IF C = 0x7E THEN // HDLC flag
    IF status.in_frame = true THEN
        IF status.control_escape = true THEN // HDLC abort frame
            status.in_frame ← false
            status.control_escape ← false
            EXIT
        ENDIF
        IF status.count > 3 AND status.fcs = 0xF0B8 THEN // Closing flag
            uint8_t address
            status.in_frame ← false
            // Only process frames addressed to us or the all-station address
            address ← status.buffer[0]

            IF address = 0 THEN
                EXIT
            ENDIF

            IF address = status.address OR address = 0xFF THEN
                Queue frame for processing
            ENDIF
            EXIT
        ENDIF
    ENDIF

    status.fcs ← 0xFFFF // Opening flag
    status.count ← 0
    status.in_frame ← true
    status.control_escape ← false
    EXIT
ENDIF

IF status.in_frame= false THEN // Avoids processing out of frame octets
    EXIT
ENDIF

IF C = 0x7D THEN // HDLC transparency control escape
    status.control_escape ← true
    EXIT
ENDIF
```



```
IF status.control_escape = true THEN
    C ← C bitwise XOR 0x20
    status.control_escape ← false
ENDIF

IF status.count >= Size of status.buffer THEN
    status.in_frame ← false // Discard excessive frame
ENDIF

status.fcs ← pppfcs16(status.fcs, C, 1) // Calculate new FCS according to [9]
status.buffer[status.count] ← C // Store character
status.count ← status.count + 1
DONE
```

11.3. Frame transmitter

The ALD frame transmitter needs a set of states per port. The frame transmitter is defined to be called every time a port is ready to transmit one or more characters.

```
Enumeration AISGTxFramState_t {
    DeQueue ← 0 // Get next message to transmit
    SendOctet ← 1 // Send next octet
    ControlEscape ← 2 // Send transparency modified octet
    FCS1 ← 3 // Frame check sum octet 1
    FCS2 ← 4 // Frame check sum octet 2
    ClosingFlag ← 5 // Send closing flag
}

struct AISGPortTxFrameStatus_t {
    AISGTxFramState_t state // Current state of frame transmitter
    uint16_t count // Number of octets to transmit
    uint16_t pos // Index of next octet to transmit
    uint16_t fcs // Frame check sum
    uint8_t buffer[266] // Octets to transmit
}

// Per port state variable for frame transmitter
AISGPortTxFrameStatus_t status
```

ALD specification (Normative):

FUNCTION SendMessage(uint8_t message[length]) IS

```
IF length > «Size of status.buffer» THEN
    EXIT
ENDIF

«Queue message on transmit queue»
// Enabling port transmitter will trigger TransmitterReadyEvent if serial port is idle
// Enable serial port tx
// Enables RS-485 transmitter. Does nothing if transmitter is active
END

ON Reset DO
    status.state ← DeQueue
DONE
```

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```
ON TransmitterReadyEvent DO
  uint8_t C      // Character to send
  CASE status.state IS
    WHEN DeQueue:
      IF «transmit queue is empty» THEN
        «Disable serial port tx»      // Disables RS-485 transmitter
        EXIT
      ENDIF

      «Copy message to status.buffer»
      «Remove message from transmit queue»
      status.count ← «length of message»
      status.pos ← 0
      status.fcs ← 0xFFFF
      «Send 0x7E»                          // Opening flag
      status.state ← SendOctet
      EXIT

    WHEN SendOctet:
      C ← status.buffer[status.pos]
      status.fcs ← pppfcs16(status.fcs, C, 1) // Calculate new FCS

      IF C = 0x7E OR C = 0x7D THEN
        status.state ← ControlEscape
        «Send 0x7D»
        status.buffer[pos] ← C bitwise XOR 0x20
        EXIT
      ENDIF

      «Send C»
      status.pos ← status.pos + 1

      IF status.pos = status.count THEN
        status.state ← FCS1
      ENDIF

      EXIT

    WHEN ControlEscape:
      C ← status.buffer[status.pos]
      «Send C»
      status.pos ← status.pos + 1

      IF status.pos = status.count THEN
        status.state ← FCS1
      ELSE
        status.state ← SendOctet
      ENDIF
```



```
EXIT
WHEN FCS1:
    status.buffer[0] ← status.fcs MOD 256
    status.buffer[1] ← status.fcs DIV 256
    C ← status.buffer[0]
    IF C = 0x7E OR C = 0x7D THEN
        «Send 0x7D»
        status.buffer[0] ← C bitwise XOR 0x20
        EXIT
    ENDIF
    «Send C»
    status.state ← FCS2
    EXIT
WHEN FCS2:
    C ← status.buffer[1]
    IF C = 0x7E OR C = 0x7D THEN
        «Send 0x7D»
        status.buffer[1] ← C bitwise XOR 0x20
        EXIT
    ENDIF
    «Send C»
    status.state ← ClosingFlag
    EXIT
WHEN ClosingFlag:
    «Send 0x7E»
    status.state ← DeQueue
    EXIT
ENDCASE
DONE
```

11.4. Invalid reception

Frames shall be discarded if a framing error or data overrun occurs.

11.5. Frame lengths

All ALDs shall support HDLC frame lengths between 4 and 268 octets.

NOTE: The maximum layer 2 frame length is 4 octets plus the maximum payload length (see Section 7.3. "Definition of layer 7 message format").

NOTE: The maximum layer 7 message size is 264 octets (see Section 7.4. "Definition of layer 7 message format").



NOTE: The opening, closing flag and transparency are excluded from the calculation of the frame length.

11.6. Default address

After reset, an ALD shall use the no-device address (0x00). While it has the no-device address, it shall only respond to XID messages.

11.7. Window size

All ALDs shall support a window size of 1.

11.8. Frame timing

An ALD shall, after reception of a frame with the P bit set, start transmitting a response between 3 ms and 10 ms from the end of the stop bit of the closing flag.

A primary shall, after reception of a response with the F bit set, start transmitting a frame no sooner than 3 ms from the end of the stop bit of the closing flag. If no such response received, the primary may start transmitting after a 15-ms timeout.

Intra frame gap is not allowed for either primary or ALDs.

The data rate is specified in Section 10.1. "General".

11.9. Frame completion

A frame is completed after a transmitting station (either the primary or an ALD) has sent the closing flag.

Further transmission shall not be allowed for this frame after the closing flag is sent.

11.10. ALD types

Two ALD types are defined and identified by the assigned 1-octet unsigned integer in this layer.

If the ALD is a SALD it shall use the ALD type SALD, and if the ALD is a MALD it shall use the ALD type MALD.

ALD type	1-octet unsigned integer
SALD	64
MALD	65

Table 11.10-1: ALD types and codes

NOTE: The subunit types, which are defined in subunit type standards (such as RET and TMA), shall not be used on layer 2.



11.11. XID frames

XID frames shall use the standard format (see Sections 5.5.3.1. - 5.5.3.2.3.2. in [6]). All Group Length (GL) fields have a size of 1 octet.

Any parameter 11.11.1 (AISG parameters) in an XID command shall be supported by all ALDs. XID parameters that are not defined in Section 11.11.1. "AISG parameters" shall be ignored.

The order of PIs in an XID frame is defined in the layer 2 message definition.

NOTE: In AISG v2 PIs could be sent in any order, but this not permitted in AISG v3.0.

XID Command	Primary	SALD	MALD
Device Scan	Mandatory	Mandatory	Mandatory
AISG v2 Address Assignment	Mandatory	Mandatory	Mandatory
AISG v3 Address Assignment	Mandatory	Mandatory	Mandatory
Reset Port	Mandatory	Mandatory	Mandatory
ResetALD	Mandatory	Mandatory	Mandatory
Trigger Ping	Optional	Optional	Optional
Ping Message	Optional	Optional	Optional
Disable OOK Bypass	Optional	Optional	Optional

Table 11.11-1: XID command set

11.11.1. AISG parameters

Format Identifier (FI) shall be 0x81 and Group Identifier (GI) shall be 0xF0. Table 11.11.1-1: "HDLC parameters for ALDs" provides an overview of all Parameter Identifiers which are defined in this standard.



PI	PL	Description of PV	PV Type
1	0-19	Subset of UniqueID	UIDString_t
2	1	ALD Address	uint8_t
3	0-19	Bit mask (for subset of UniqueID), indicates a device scan in AISG v2.0 mode	bit mask
4	1	ALD type (see Table 11.10-1: "ALD types and codes")	ALDType_t
5	1	Not used	-
6	2	Vendor code as given in [7]	AsciiString_t
7	0	Reset port	-
8	0-19	Bit mask (for subset of UniqueID), indicates a device scan in AISG v3 mode	bit mask
9	1	Reserved (by prior standard)	uint8_t
10	0-2	Port number	uint16_t
11	0-2	Bit mask (for Port number)	bit mask
12	1	Disable OOK bypass	uint8_t
19	1	Device Scan Version	uint8_t
22	3-225	List of base standard version tuples	struct AISGVersion_t[PL/3]
24	0	ResetALD	-
25	0	TriggerPing	-
26	4	PrimaryID	uint32_t
27	1-255	List of subunit types	SubunitType_t[PL]
28	1	Ping Frame	-

Table 11.11.1-1: HDLC parameter for ALDs

NOTE: For multi-octet integers in XID frames, the higher-order bits shall be sent in the first octet transmitted, according to Section 5.5.3.1.2. in [6].

For AsciiStrings, the left-most characters shall be transmitted first.

Bit masks which apply to AsciiStrings shall be sent in the same order as AsciiStrings.

Bit masks which apply to multi-octet integers shall be sent in the same order as multi-octet integers.

XID parameters are presented by the following struct in the following sections:

XID parameter with a parameter length is not equal to 0:

```
struct XidParameter_t (Identifier, Value){
    uint8_t PI      ← Identifier      // parameter identifier
    uint8_t PL      ← length(Value)   // parameter length
    uint8_t PV[PL] ← Value           // parameter value
}
```

XID parameters with a parameter length is equal to 0:

```
struct XidParameter_t (Identifier){
    uint8_t PI      ← Identifier      // parameter identifier
    uint8_t PL      ← 0              // parameter length
}
```



11.11.2. Device scan

Description (Informative):

The device scan messages may be utilised by the primary to identify all ALDs in the NoAddress LinkState on an interface. For this purpose the primary may use PI = 8 to scan only AISG v3 compliant ALDs and may use PI = 3 to scan AISG v2.0 ALDs.

AISG release	Device scan version
2.0	Not applicable
3.0.0	1

Table 11.11.2-1: AISG releases and device scan versions

Command specification (Normative):

Frame format for an AISG v3.0 device scan command:

```
PrimaryFrame AisgV3DeviceScanCommand {
    uint8_t address ← 0xFF           // All-station address
    uint8_t Ctrl ← 0xBF             // Control field for XID
    uint8_t FI ← 0x81              // Format identifier
    uint8_t GI ← 0xF0              // Group identifier
    uint8_t GL ← 0xF0              // Length of the following octets
    XidParameter(1, UniqueID)
    XidParameter(8, BitMaskUniqueID)
    XidParameter(10, PortNumber)
    XidParameter(11, BitmaskPort)
    XidParameter(19, DeviceScanVersion)
}
```

Frame format for an AISG v2 device scan command:

```
PrimaryFrame AisgV2DeviceScanCommand {
    uint8_t address ← 0xFF           // All-station address
    uint8_t Ctrl ← 0xBF             // Control field for XID
    uint8_t FI ← 0x81              // Format identifier
    uint8_t GI ← 0xF0              // Group identifier
    uint8_t GL ← 0xF0              // Number of following octets
    XidParameter(1, UniqueID)
    XidParameter(3, Bitmask)
}
```

Frame format for an AISG v3.0 device scan response:

```
ALDFrame AisgV3DeviceScanResponse {
    uint8_t address ← 0x00           // No-station address
    uint8_t Ctrl ← 0xBF             // Control field for XID
    uint8_t FI ← 0x81              // Format identifier
    uint8_t GI ← 0xF0              // Group identifier
    uint8_t GL ← 0xF0              // Number of following octets
    XidParameter(1, UniqueID)
    XidParameter(4, ALDType)
    XidParameter(6, VendorCode)
    XidParameter(10, PortNumber)
}
```

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```
// List of supported AISG base standard versions
// PL must be a multiple of 3 since the size of struct AISGVersion is 3
XidParameter(22, AISGVersion_t[PL/3])
XidParameter(27, ListOfSubunitTypes)
}
```

Frame format for an AISG v2 device scan response:

```
ALDFrame AisgV2DeviceScanResponse {
    uint8_t address      ← 0x00          // No-station address
    uint8_t Ctrl        ← 0xBF          // Control field for XID
    uint8_t FI          ← 0x81          // Format identifier
    uint8_t GI          ← 0xF0          // Group identifier
    uint8_t GL          // Number of following octets
    XidParameter(1, UniqueID)
    XidParameter(4, ALDType)
    XidParameter(6, VendorCode)
}
```

Primary specification (Normative):

An AISG primary shall perform an AISG v3.0 device scan with DeviceScanVersion ← 1. If the primary supports AISG v2 device scan it shall then perform an AISGv2 device scan.

This ensures that all AISG v3-compliant ALDs will act in AISG v3.0 mode and not in AISG v2 backward compatible mode.

During the device scan, ALD addresses shall be assigned to all detected ALDs so that they do not respond to further device scan messages. This applies to AISG v3.0 and AISG v2 device scans.

During an AISG v2 device scan, care must be taken to ensure that the communication timeout timer does not expire, causing the ALD to perform a reset.

The device scan will utilise both PI = 10 (Port number) and PI = 1 (UniqueID). The two PIs should be considered as a 21-octet pattern by the ALD.

NOTE: It might happen that a primary is connected to several AISG ports of an ALD. In this case the ALD responds to the same UniqueID pattern on all of these ports, which will end up in a collision on the AISG bus. Considering the two PIs as a 21-octet pattern solves this by ensuring a unique response from the ALD.

Primary specification (Normative):

Perform an AISG v3.0 device scan with DeviceScanVersion ← 1

```
IF «AISG v2 device scan is supported» THEN
    «Perform an AISG v2 device scan»
ENDIF
```

EXIT

ALD specification (Normative):

```
IF the LinkState ≠ NoAddress THEN
    EXIT
ENDIF
```



```
IF «the frame contains UniqueID (PI = 1) »
    «AND the frame contains BitmaskUniqueID (PI = 8)»
    «AND the frame contains PortNumber (PI = 10)»
    «AND the frame contains BitmaskPortNumber (PI = 11)»
    «AND the frame contains DeviceScanVersion (PI = 19)» THEN
    AISGv3DeviceScan()
ELSEIF «the frame contains UniqueID (PI = 1)»
    AND «the frame contains Bitmask (PI = 3)» THEN
    AISGv2DeviceScan()
ENDIF
EXIT
AISGv3DeviceScan():
    uint8_t Version
    uint8_t MaskedValue[19]
    uint8_t Length
    uint8_t MaskLength
    uint16_t RxPortNumber
    uint8_t N
    Version ← DeviceScanVersion (PI = 19)

    IF Version ≠ 1 THEN
        EXIT
    ENDIF

    Length ← «length (PL) of PortNumber (PI = 10)»
    MaskLength ← «length (PL) of BitmaskPortNumber (PI = 11)»

    IF MaskLength ≠ Length OR Length > 2 THEN
        EXIT
    ENDIF

    RxPortNumber ← «port number on which the frame was received»
    MaskedValue[0..Length - 1] ← «length right-most octets of RxPortNumber»
    MaskedValue ← «MaskedValue bitwise AND BitmaskPortNumber (PI = 11)»

    IF MaskedValue ≠ PortNumber (PI = 10) THEN
        EXIT
    ENDIF

    Length ← «length (PL) of UniqueID (PI = 1)»
    MaskLength ← «length (PL) of BitmaskUniqueID (PI = 8)»

    IF MaskLength ≠ Length OR MaskLength > 19 THEN
        EXIT
    ENDIF
```



```
IF MaskLength ≥ 1 THEN
    // Compare the vendor code as follows:
    N ← min(L,2)
    MaskedValue [N] ← «N left-most octets of the UniqueID»
    B[N] ← «N left-most octets of BitMaskUniqueID (PI = 8) »
    MaskedValue ← MaskedValue bitwise AND B
    C ← «N-left most octets of UniqueID (PI = 1)»

    IF MaskedValue ≠ C THEN
        EXIT
    ENDIF
ENDIF

IF MaskLength ≥ 3 THEN
    // Compare the right-most characters of the UniqueID as follows:
    N ← MaskLength - 2
    MaskedValue [N] ← «the N right-most octets of the ALD UniqueID»
    B[N] ← «N right-most octets of BitMaskUniqueID (PI = 8) »
    MaskedValue ← MaskedValue bitwise AND B
    C ← «N right-most octets of UniqueID (PI = 1) »

    IF MaskedValue ≠ C THEN
        EXIT
    ENDIF
ENDIF

«Send AisgV3DeviceScanResponse with the ALD identification data in the fields PI = 1
(complete UniqueID), PI = 4 (ALD type), PI = 6 (vendor code), PI = 10 (port number), the list
of base standard versions supported by the DeviceScanVersion (PI = 22) and PI = 27
(complete list of subunit types supported by this ALD)»
EXIT

AISGv2DeviceScan():
    uint8_t variable K ← «the length (PL) of UniqueID (PI = 1)»
    uint8_t variable L ← «the length (PL) of Bitmask (PI = 3)»

    IF L ≠ K OR L > 19 THEN
        EXIT
    ENDIF

    IF L ≥ 1 THEN
        // Compare the vendor code as follows:
        uint8_t N ← min (L,2)
        uint8_t A[N] ← «N left-most octets of the ALD UniqueID»
        uint8_t B[N] ← «the N left-most octets of Bitmask (PI = 3)»
        A ← A bitwise AND B
        uint8_t C[N] ← «the N left-most octets of UniqueID (PI = 1)»
```



```
        IF A ≠ C THEN
            EXIT
        ENDIF
    ENDIF

    IF L ≥ 3 THEN
        // Compare the right-most characters of the UniqueID as follows:
        uint8_t N ← L-2
        uint8_t A[N] ← «the N right-most octets of the ALD UniqueID»
        uint8_t B[N] ← «the N right-most octets of Bitmask (PI = 3)»
        A ← A bitwise AND B
        uint8_t C[N] ← «N right-most octets of UniqueID (PI = 1)»

        IF A ≠ C THEN
            EXIT
        ENDIF
    ENDIF
```

«Send AisgV2DeviceScanResponse with the ALD identification data in the fields PI = 1 (complete UniqueID), PI = 4 (ALD type) and PI = 6 (vendor code)»
EXIT

NOTE: All ALDs which support AISG v3.0 and higher shall support device scan with PI = 8.

NOTE: All ALDs which support AISG v2 or lower shall support device scan with PI = 3.

NOTE: The DeviceScanVersion enables future updates of the device scan process. In later releases the meaning of DeviceScanVersion greater than 1 may be defined.

NOTE: Due to different drive capabilities of individual RS-485 components, one ALD may overpower the signal from the other ALDs. In order to detect any overpowered ALDs, the primary shall perform suitable extra device scan commands.

11.11.3. Address assignment

Description (Informative):

The XID command AddressAssignment is used by the primary to assign an ALDAddress to an ALD.

Command specification (Normative):

```
PrimaryFrame AisgV3AddrAssignCommand {
    uint8_t address ← 0xFF          // All-station address
    uint8_t Ctrl   ← 0xBF          // Control field for XID
    uint8_t FI     ← 0x81          // Format identifier
    uint8_t GI     ← 0xF0          // Group identifier
    uint8_t GL     // number of following octets

    XidParameter(2, ALDAddress)
    XidParameter(22, BaseStandardVersion) // PL = 3
    XidParameter(26, PrimaryID) // PrimaryID PI, PL = 4
```

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```
Optional XidParameter(1, UniqueID) // UniqueID can be supplied
// partially
Optional XidParameter(4, ALDType)
Optional XidParameter(6, VendorCode)
Optional XidParameter(10, PortNumber)
}

PrimaryFrame AisgV2AddrAssignCommand {
uint8_t address ← 0xFF // All-station address
uint8_t Ctrl ← 0xBF // Control field for XID
uint8_t FI ← 0x81 // Format identifier
uint8_t GI ← 0xF0 // Group identifier
uint8_t GL // Number of following octets

XidParameter(2, ALDAddress)

Optional XidParameter(1, UniqueID) // UniqueID can be supplied partially
Optional XidParameter(4, ALDType)
Optional XidParameter(6, VendorCode)
}

ALDFrame AisgV3AddrAssignResponse {
uint8_t address // Assigned ALDAddress
uint8_t Ctrl ← 0xBF // Control field for XID
uint8_t FI ← 0x81 // Format identifier
uint8_t GI ← 0xF0 // Group identifier
uint8_t GL // Number of following octets

XidParameter(1, UniqueID) // ALD UniqueID
XidParameter(4, ALDType)
XidParameter(10, PortNumber)
}

ALDFrame AisgV2AddrAssignResponse {
uint8_t address // Assigned ALDAddress
uint8_t Ctrl ← 0xBF // Control field for XID
uint8_t FI ← 0x81 // Format identifier
uint8_t GI ← 0xF0 // Group identifier
uint8_t GL // Number of following octets

XidParameter(1, UniqueID) // ALD UniqueID
XidParameter(4, ALDType)
}
```

Primary specification (Normative):

The primary broadcasts the XID command to which all matching ALD(s) will respond. The primary shall ensure that only one ALD matches the supplied parameter(s).

The UniqueID field can be supplied partially with a length of 1 to 19 octets. If the UniqueID field (PI = 1) is supplied partially, the right-most PL octets shall be supplied.

If the primary discovered an ALD during an AISG v2 device scan, it shall assign a unique ALDAddress to the ALD with an AisgV2AddrAssign command.

If the primary discovered an ALD during an AISG v3.0 device scan with DeviceScanVersion ← 1, it shall assign a unique ALDAddress using an AisgV3AddrAssign command, specifying the selected AISG base standard version.

It is not permitted to send more than one AISG base standard version.



ALD specification (Normative):

```
IF LinkState ≠ NoAddress THEN
    EXIT
ENDIF

IF the «frame contains the ALDAddress (PI = 2)»
    AND «the frame contains BaseStandardVersion (PI = 22) » THEN
    «Continue with AISGv3AddrAssign()»
    EXIT
ENDIF

IF «the frame contains ALDAddress (PI = 2)» THEN
    «Continue with AISGv2AddrAssign()»
    EXIT
ELSE
    EXIT
ENDIF

AISGv3AddrAssign():
uint8_t L ← «length (PL) of BaseStandardVersion (PI = 22)»

IF L ≠ 3 OR «BaseStandardVersion is not supported» THEN
    EXIT
ENDIF

IF «the frame contains UniqueID (PI = 1)» THEN
    uint8_t N ← «the length of the ALD UniqueID»
    uint8_t L ← «length (PL) of UniqueID (PI = 1)»

    IF L > N THEN
        EXIT
    ELSE
        uint8_t A[L] ← «the L right-octets of the ALD UniqueID»
        uint8_t B[L] ← «UniqueID (PI = 1)»

        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF

IF «the frame contains ALDType (PI = 4)» THEN
    uint8_t L ← «length (PL) of ALDType (PI = 4)»

    IF L ≠ 1 THEN
        EXIT
    ELSE
        uint8_t A ← the ALDType
        uint8_t B ← ALDType (PI = 4)
```



```
        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF
IF «the frame contains the VendorCode (PI = 6)» THEN
    uint8_t L ← «length (PL) of VendorCode (PI = 6)»
    IF L ≠ 2 THEN
        EXIT
    ELSE
        uint8_t A[L] ← «the ALD Vendor code»
        uint8_t B[L] ← «VendorCode (PI = 6)»
        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF
IF «frame contains PortNumber (PI = 10)» THEN
    uint8_t L ← «length (PL) of PortNumber (PI = 10)»
    IF L ≠ 2 THEN
        EXIT
    ELSE
        uint8_t A[L] ← «the port number on which the frame was received»
        uint8_t B[L] ← PortNumber (PI = 10)
        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF
«Send AisgV3AddrAssignResponse with the ALD identification data in the fields PI = 1
(complete UniqueID) and PI = 4 (ALDType), and PI = 10 (PortNumber on which the request
was received)»
PrimaryIDs[CurrentPort] ← «PV of PI = 26»
EXIT
AISGv2AddrAssign():
IF «frame contains the UniqueID (PI = 1)» THEN
    uint8_t variable N ← «the length of the ALD UniqueID»
    uint8_t variable L ← «the length (PL) of UniqueID (PI = 1)»
```



```
IF L > N THEN
    EXIT
ELSE
    uint8_t A[L] ← «the L right-octets of the ALD UniqueID»
    uint8_t B[L] ← «UniqueID (PI = 1) »

    IF A ≠ B THEN
        EXIT
    ENDIF
ENDIF
ENDIF
ENDIF
IF «frame contains the ALDType (PI = 4)» THEN
    uint8_t variable L ← «the length (PL) of ALDType (PI = 4)»

    IF L ≠ 1 THEN
        EXIT
    ELSE
        uint8_t A ← the ALDType
        uint8_t B[L] ← ALDType (PI = 4)

        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF
ENDIF
IF «frame contains the VendorCode (PI = 6)» THEN
    uint8_t L ← «the length (PL) of VendorCode (PI = 6)»

    IF L ≠ 2 THEN
        EXIT
    ELSE
        uint8_t A[L] ← «the ALD VendorCode»
        uint8_t B[L] ← «VendorCode (PI = 6)»

        IF A ≠ B THEN
            EXIT
        ENDIF
    ENDIF
ENDIF
ENDIF
«Send AisgV2AddrAssignResponse with the ALD identification data in the fields PI = 1
(complete UniqueID) and PI = 4 (ALDType)»
EXIT
```



11.11.4. Reset port

Description (Informative):

The ResetPort command is used to reset the layer 2 link of the ALD and to switch an AISG port into the NoAddress LinkState.

Command specification (Normative):

```
PrimaryFrame ResetPortCommand {
    uint8_t address           // All-station address or ALDAddress
    uint8_t Ctrl ← 0xBF      // Control field for XID
    uint8_t FI ← 0x81        // Format identifier
    uint8_t GI ← 0xF0        // Group identifier
    uint8_t GL ← 0x02
    XidParameter(7)          // Reset port PI
}

ALDFrame ResetPortResponse {
    uint8_t address           // ALDAddress
    uint8_t Ctrl ← 0xBF      // Control field for XID
    uint8_t FI ← 0x81        // Format identifier
    uint8_t GI ← 0xF0        // Group identifier
    uint8_t GL ← 0x02
    XidParameter(7)          // Reset port PI
}
```

Primary specification (Normative):

ALD specification (Normative):

```
IF «any other XID parameter than the ResetPort parameter is supplied in the frame» THEN
    EXIT
ENDIF

IF «the PL value of the ResetPort field» ≠ 0 THEN
    EXIT
ENDIF

IF «the XID command is received as addressed to the ALD» THEN
    «Send the ResetPort response»
ENDIF

SWITCH LinkState[Port] TO NoAddress // without performing a reset
EXIT
```

11.11.5. Reset ALD

Description (Informative):

The ResetALD command is used to perform a reset on an ALD. This command affects the whole ALD and communication with other primaries connected to the ALD.

This command can also be broadcast to all ALDs. In such case it can be targeted to a specific ALD through the use of the UniqueID XID parameter.

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Command specification (Normative):

```
PrimaryFrame ResetALDCommand {
    uint8_t address // All-station address or ALDAddress
    uint8_t Ctrl ← 0xBF // Control field for XID
    uint8_t FI ← 0x81 // Format identifier
    uint8_t GI ← 0xF0 // Group identifier
    uint8_t GL // Number of following octets
    XidParameter(24) // ResetALD PI
    XidParameter(1, UniqueID) // Entire ALD UniqueID
}

ALDFrame ResetALDResponse {
    uint8_t address // ALDAddress
    uint8_t Ctrl ← 0xBF // Control field for XID
    uint8_t FI ← 0x81 // Format identifier
    uint8_t GI ← 0xF0 // Group identifier
    uint8_t GL // Number of following octets
    XidParameter(24) // ResetALD PI
    XidParameter(1, UniqueID) // Entire ALD UniqueID
}
```

Primary specification (Normative):

ALD specification (Normative):

```
IF «the frame contains any other XID parameters the ResetALD (PI = 24)» AND «UniqueID
    (PI = 1)» THEN
    EXIT
ENDIF
```

```
IF the «PL value of the ResetALD field ≠ 0» THEN
    EXIT
ENDIF
```

```
IF «the frame is addressed to the all-station address»
    AND «contains the XID parameter UniqueID (PI = 1)» THEN
    uint8_t L
    uint8_t A[19]
    uint8_t B[19]
    L ← «Length (PL) of UniqueID (PL = 1)»

    IF L ≠ 19 THEN
        EXIT
    ENDIF

    A[L] ← «the ALD UniqueID»
    B[L] ← «UniqueID (PL = 1)»

    IF A ≠ B THEN
        EXIT
    ENDIF
ENDIF
```

```
ENDIF
```

```
IF «the XID command is received as addressed to the ALD» THEN
    «Send the ResetALD response»
ENDIF
```



«Perform a reset»
EXIT

11.11.6. Trigger ping

Description (Informative):

The XID command TriggerPing is used by the primary to synchronise the sending and monitoring of a Ping message.

See Section 8.4. “Pinging” for details.

Command specification (Normative):

```
PrimaryFrame TriggerPing {  
    uint8_t address ← 0xFF          // All-station address  
    uint8_t Ctrl   ← 0xBF          // Control field for XID  
    uint8_t FI     ← 0x81          // Format identifier  
    uint8_t GI     ← 0xF0          // Group identifier  
    uint8_t GL     ← 25            // Number of following octets  
    XidParameter(25)              // TriggerPing PI  
}
```

Primary specification (Normative):

ALD specification (Normative):

```
IF the «XID command is not addressed to the all-station address» THEN  
    EXIT  
ENDIF
```

```
IF PL value ≠ 0 THEN  
    EXIT  
ENDIF
```

```
IF ALDState = PingerBroadcastWaitState THEN  
    SWITCH ALDState TO PingerRestrictedState  
    «Initiate the PingTimer at 45 ms»  
    «Select the PingSendRFPort RF port»  
    IF «the ALD is a MALD» THEN  
        «Deactivate all OOK paths that do not have active layer 2 links  
        to other primaries»  
    ELSE  
        «Deactivate all OOK paths»  
    ENDIF  
ENDIF
```

```
ELSEIF ALDState = ListenerBroadcastWaitState THEN  
    SWITCH ALDState TO ListenerRestrictedPreparationState  
    «Initiate the PingTimer at 40 ms»  
    «Select the PingMonitorRFPort»  
ENDIF
```



```
IF «the ALD is a MALD» THEN
    «Deactivate all OOK paths that do not have active layer 2 links to other
    primaries»
ELSE
    «Deactivate all OOK paths»
ENDIF
```

```
ENDIF
EXIT
```

11.11.7. Ping message

Description (Informative):

The XID response PingMessage is used to detect the connected RF path between ports and provides the pingee with the primary's ID.

NOTE: The PingMessage does not follow the concept of unbalanced data links according to [6] and is an AISG-specific exception to the HDLC standard.

Command specification (Normative):

```
ALDFrame PingMessage {
    uint8_t address ← 0xFF           // All-station address
    uint8_t Ctrl   ← 0xBF           // Control field for XID
    uint8_t FI     ← 0x81           // Format identifier
    uint8_t GI     ← 0xF0           // Group identifier
    uint8_t GL     // Number of following octets
    XidParameter(28) // Ping message
    XidParameter(26, PrimaryID) // PrimaryID PI, PL = 4
}
```

Primary specification (Normative):

ALD specification (Normative):

```
IF ALDState = ListenerRestrictedMonitorState THEN
    «Store PV of PI = 26 as PrimaryID»
    PingReceivedFlag ← 1
    «Select the initiating AISG port»
    «Activate all previously deactivated OOK paths»
    SWITCH ALDState TO OperatingState
ENDIF
EXIT
```

11.11.8. Disable OOK bypass

Description (Informative):

The primary shall use this command to enable and disable the OOK bypasses between RF ports within an ALD. This command is used during the device scan to discover the order of ALDs.



Command specification (Normative):

```
PrimaryFrame DisableOOKBypassCommand {
    uint8_t address ← 0xFF          // All-station address
    uint8_t Ctrl    ← 0xBF          // Control field for XID
    uint8_t FI      ← 0x81          // Format identifier
    uint8_t GI      ← 0xF0          // Group identifier
    uint8_t GL      // Number of following octets

    XidParameter(12, Flag)          // PI = Disable OOK bypass
                                    // 1: Disable OOK bypass
                                    // 0: Enable OOK bypass
}
```

Primary specification (Normative):

ALD specification (Normative):

```
IF «any other XID parameter than the DisableOOKBypass parameter is supplied in the
    frame» THEN
    EXIT
ENDIF
```

```
IF «the PL value of the DisableOOKBypass field» ≠ 1 THEN
    EXIT
ENDIF
```

```
IF «the flag is 1» THEN
    «Close all OOK bypasses belonging to the port at which the frame was received»
ELSE
    «Open all OOK bypasses belonging to the port at which the frame was received»
ENDIF
EXIT
```

11.12. Link establishment

Description (Informative):

Once the ALD has been assigned an ALDAddress via an AISG port, the primary may initiate the link establishment by sending the SNRM command frame on this AISG port.

Command specification (Normative):

```
PrimaryFrame SNRM {
    uint8_t address // ALDAddress
    uint8_t Ctrl    ← 0x93 // SNRM (Set Normal Response Mode)
}

ALDFrame UA {
    uint8_t address // ALDAddress
    uint8_t Ctrl    ← 0x73 // UA (Unnumbered acknowledge)
}

ALDFrame DM {
    uint8_t address // ALDAddress
    uint8_t Ctrl    ← 0x1F // DM (Disconnected mode)
}
```

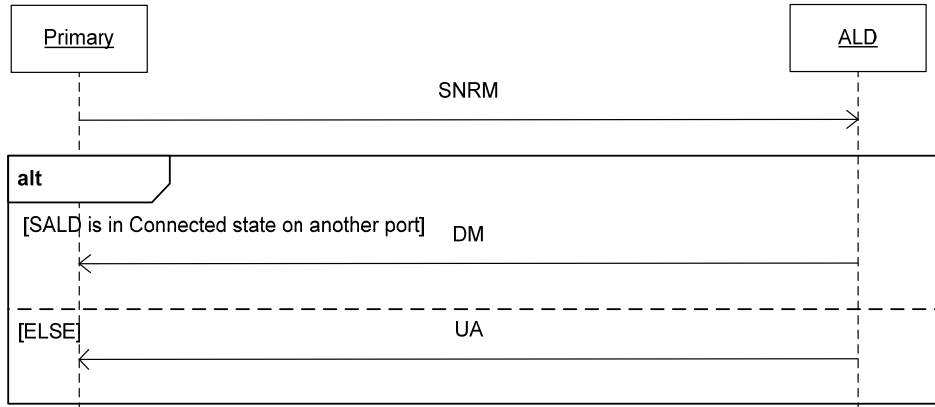



Figure 11.12-1: Sequence diagram for link establishment

Primary specification (Normative):

The primary shall use this command to establish an active layer 2 link to every ALD which it can detect on the AISG bus.

NOTE: These active links are needed so that the ALD is aware of active AISG communication on these ports and associated ports and does not deactivate its internal OOK bypasses due to an ongoing ping process started by another primary.

ALD specification (Normative):

```

IF «the ALD is a SALD» THEN
    IF «the SALD is not in Connected LinkState»
        OR «the SALD is in Connected Linkstate on
            the same port where the frame was received» THEN
        SWITCH LinkState TO Connected
        «Assign the AISG input port that received the SNRM command as
            the control port»
        «Respond with UA frame»
        EXIT
    ELSE
        Respond with DM frame»
        EXIT
    ENDIF
ELSEIF «the ALD is a MALD» THEN
    «Change the HDLC link state to Connected LinkState»
    «Respond with UA frame»
    EXIT
ENDIF
EXIT
    
```

11.13. Communication timeout

An ALD shall implement a communication timeout timer that is common for all AISG ports, which is started immediately after reset with a timeout of 24 hours. Whenever the ALD receives



a valid HDLC frame addressed to itself, or to the all-station address, on any AISG port, it shall restart the communication timeout timer with a timeout of 3 minutes.

In either case, if the communication timeout timer expires, the ALD shall perform a reset.

11.14. HDLC description

This is an overview of the defined HDLC Class UNC1,15.1 TWA according to [6].

In the descriptions below, station A refers to the transmitting station (a primary or an ALD) and station B refers to the receiving station (an ALD or a primary).

11.14.1. Basic structure

In AISG v3.0 the primary controls the bus and a number of ALDs which are only allowed to transmit when the primary gives them permission to do so.

All frames are transmitted with the layout shown in Table 11.14.1-1: “Format of an HDLC frame”.

Flag 1 octet	ADDR 1 octet	Control 1 octet	INFO N octets	FCS 2 octets	Flag 1 octet
0x7E	Address	Control bits	Variable length	CRC	0x7E

Table 11.14.1-1: Format of an HDLC frame

All frames begin with a starting flag (0x7E) and end with a closing flag (0x7E).

Station A calculates a Frame Check Sequence (CRC16) on all octets which follow the starting flag but not including the FCS octets. The checksum is calculated using the code found in Section A.1. in [9]. The checksum is transmitted as FCS in little endian order and is followed by the closing flag.

Station B calculates the checksum using the same procedure on all octets between the flags. When it finds the closing flag it compares the checksum to 0xF0B8. If it is a match, the frame is processed otherwise it is discarded.

The address field contains the ALDAddress of the targeted ALD. The ALD shall evaluate every frame which is sent to its ALDAddress.

If the primary sends the frame, it is called a (layer 2) command and the address field contains the ALDAddress of the ALD as destination.

If the ALD sends the frame, it is called a (layer 2) response and the address field contains the ALDAddress of the ALD as source.

NOTE: ALDs cannot communicate directly with each other.

11.14.2. All-station address

An ALD shall evaluate every frame which is sent to the all-station address (0xFF).



11.14.3. No-station address

An ALD shall send device scan responses from the no-station address (0x00).

11.14.4. Basic transparency conversion

Since the frame may contain 0x7E, basic transparency is used, which means that 0x7E is transmitted as 0x7D 0x5E and 0x7D is transmitted as 0x7D 0x5D. The receiving station converts back on reception.

Basic transparency conversion is performed after the checksum has been calculated and added to the frame, that is the basic transparency conversion also applies to the checksum.

11.14.5. Layer 2 frame types

Three different frame types are defined in the layer 2:

- I-frames contain data as well as a send and receive counter
- S frames contain a receive counter (RR/RNR frames)
- U frames are unnumbered (XID, UA, DM, SNRM and FRMR frames)

The INFO field is only present in I-frames, XID frames and FRMR frames.

Table 11.14.5-1: "Frame types:" lists the valid frame types that may be sent by the primary and the ALDs.

Primary	ALD
Frame type I	Frame type I
Frame type RR	Frame type RR
Frame type RNR	Frame type RNR
Frame type SNRM	Frame type UA
Frame type XID	Frame type DM
Frame type DISC	Frame type XID
	Frame type FRMR

Table 11.14.5-1: Frame types

11.14.5.1. SNRM frame (Set Normal Response Mode)

On reception of this command the ALD enters the Connected LinkState, re-initialise its sequence number variables and then responds with UA. If the ALD rejects the SNRM it responds with DM.

11.14.5.2. DISC frame (Disconnect)

On reception of this command while the ALD is in the Connected LinkState, it enters the AddressAssigned LinkState and then response with UA. Otherwise, it responds with DM.



11.14.5.3. UA frame (Unnumbered Acknowledge)

This response is used by the ALD to confirm that the ALD received and acted on an SNRM or DISC command.

11.14.5.4. DM frame (Disconnected Mode)

This response is used by the ALD to inform the primary that the ALD is disconnected or it cannot enter the Connected LinkState.

11.14.5.5. RR frame (Receiver Ready)

This frame is used by station A to inform station B (primary or ALD) that station A is ready to receive an I-frame, that is that it has empty buffers. This aspect is used for flow control.

The RR frame also contains the sequence number of the next frame station A expects to see. This works both as an ACK and a NAK depending on the value of the transmitted sequence number.

If a station does not receive an ACK in the defined timeout (see Section 11.8. “Frame timing”), it shall retransmit the frame with the same sequence number.

11.14.5.6. RNR frame (Receiver Not Ready)

This frame is used by station A to inform station B (primary or ALD) that station A is not ready to receive an I-frame, for instance because it has no empty buffers. Station B shall then stop transmitting I-frames. This aspect is used for flow control.

An ALD shall have at least two I-frame buffers for each primary that it can support.

The RNR frame also contains the sequence number of the next frame that station A expects to see. This works both as an ACK and a NAK depending on the value of the transmitted sequence number.

If a station does not receive an ACK in the defined timeout (see Section 11.8. “Frame timing”), it shall retransmit the frame with the same sequence number.

NOTE: At some point the primary may give up and report an alarm.

11.14.5.7. I-Frame (Information)

This frame is used to transfer a block of data together with its sequence number. The frame also includes the sequence number of the next frame station A expects to see. This way, it works as an RR. Like RR, it enables transmission of I-frames from station B.

If a station does not receive an ACK in the defined timeout (see Section 11.8. “Frame timing”), it shall retransmit the frame with the same sequence number.

The INFO field in an I-frame contains the layer 7 messages.

11.14.5.8. FRMR (Frame Reject)

This response is used by the ALD to indicate an error condition in the following cases:



- The ALD receives an invalid (layer 2) command. (The text of the standard defines explicitly what is required or permitted. An invalid command is anything that is not defined in this standard, for instance an SREJ or incorrectly formatted XID frame.)
- ALD receives an I-frame or XID-frame with an information field which exceeded the maximum information field length which can be accommodated by the receiving station.
- The ALD receives an invalid N(R) which identifies an I-frame which has previously been transmitted and acknowledged or an I-frame which has not been transmitted and is not the next sequential I-frame awaiting transmission.
- The ALD receives a (layer 2) command containing an information field, where no information field is permitted by the associated control field.

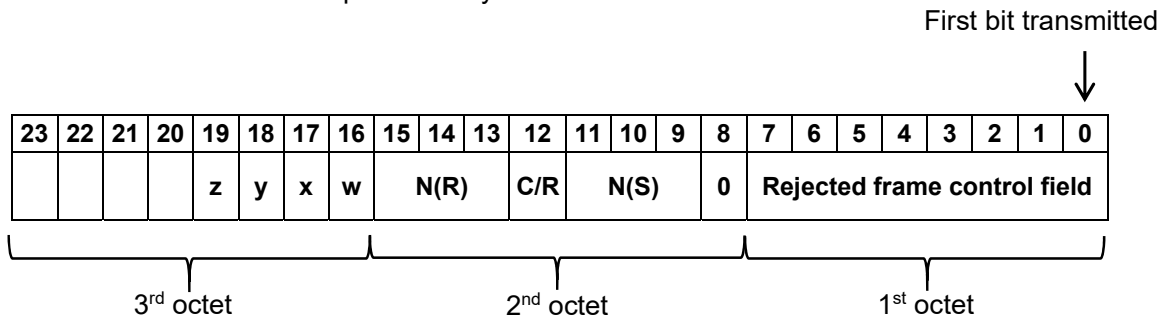


Table 11.14.5.8-1: Format of the INFO field of an FRMR frame

11.14.6. XID frame

XID frames are used to scan the AISG bus, to negotiate AISG parameters and to broadcast commands from the primary to all ALDs or from one ALD to the primary.

XID frames use the following format in the INFO field to transfer parameters:

FI	GI	GL	PI	PL	PV	PI	PL	PV
----	----	----	----	----	----	----	----	----

Table 11.14.6-1: Format of the INFO field of an XID frame

The parameters are identified by a one octet Format Identifier (FI) code and a one octet Group Identifier (GI) code. The Group Length (GL) is a one octet unsigned integer giving the length in octets of the parameters following it.

A parameter consists of a sequence of PI/PL/PV values. The Parameter Identifier (PI) is a one octet code identifying the parameter. Parameter Length (PL) is a one octet unsigned integer giving the length in octets of the Parameter Value (PV).

The parameter order is defined for every AISG XID command.

11.14.7. Control field definition

Table 11.14.7-1: "Definition of control fields" defines the control field for every layer 2 frame type.



First bit transmitted
↓

Control field format for	Control field bits							
	7	6	5	4	3	2	1	0
I-frame	N(R)			P/F	N(S)			0
RR frame	N(R)			P/F	0	0	0	1
RNR frame	N(R)			P/F	1	0	0	1
UA frame	0	1	1	P/F	0	0	1	1
SNRM frame	1	0	0	P/F	0	0	1	1
FRMR frame	1	0	0	P/F	0	1	1	1
DM frame	0	0	0	P/F	1	1	1	1
XID frame	1	0	1	P/F	1	1	1	1

Table 11.14.7-1: Definition of control fields

NOTE: N(S) = transmitting send sequence number (bit 1 = low-order bit)

N(R) = transmitting receive sequence number (bit 5 = low-order bit)

11.14.8. Poll

A poll is a frame from the primary where the P/F (Poll / Final) bit in the control field is set to 1. This informs the ALD that it is allowed to transmit a response frame.

All I-frames, S-frames and U-frames from the ALD shall have the P/F bit set.

A broadcast frame shall not have the P/F bit set.

U-frames require a specific U-frame response (for instance an SNRM/UA exchange).

When the ALD receives an I-frame or S-frame, it shall transmit the oldest queued I-frame, if any; otherwise it shall transmit an S-frame.



12. LAYER 7

12.1. General

Layer 7 defines the commands and responses for direct communication between a primary and an ALD.

This section outlines and defines commands that are common and applicable to all ALDs, while subunit type-specific commands and functionality are defined in subunit type standards.

12.2. Integer representation in layer 7

Multi-octet integer values are transmitted in little endian order. Signed integers are represented as 2-complement values.

12.3. Services expected from layer 2

Layer 7 requires an assured in-sequence delivery service from layer 2. Layer 7 must be informed by layer 2 if the assured in-sequence delivery service is no longer available.

12.4. Layer 7 message timing

ALD commands shall, unless otherwise specified, provide a response message within 1 second. Commands declared as Time-Consuming Commands (TCC) have a longer maximum response time.

The response time is measured from the time the message frame was received by layer 2 to the time the response message is ready for transfer by layer 2.

12.5. Alarms

In some situations, a command may cause a change of operating conditions; for instance, a SetTilt command might cause a RET subunit to discover that an actuator is jammed or that a previously jammed actuator works again. In these cases, an AlarmIndication reporting the change of operating conditions shall be issued in addition to the response message to those primaries that have subscribed to alarms.

An alarm informs the receiver of a fault. There is no response to an alarm. Alarms are cleared when the cause of the fault has ceased.

Response code GeneralError is a special response for the ALD vendor to provide more information about the issue ALD is having. When using response code GeneralError, the ALD shall provide meaningful additional information about the reason why GeneralError was issued by using the GetDiagnosticInformation command.



12.6. General command handling

This section defines the general behaviour of ALDs.

The primary shall support all return codes listed both in this document and in subunit type standards that it supports.

12.6.1. Alarm handling

An ALD shall have an array LinkAlarms which contains the current alarm state (both common alarms and subunit alarms) for every layer 2 link.

```
Enumeration Severity_t : uint8_t {
    Cleared          ← 0
    Warning          ← 1
    Minor           ← 2
    Major           ← 3
    Critical         ← 4
}
```

The Alarm severity state is defined in [8]. Severity Indeterminate, defined in [8], is not used in this standard.

```
struct AlarmState_t {
    AlarmCode_t    Alarm
    Severity_t     Severity
}

struct SubunitAlarmStates_t {
    AlarmState_t Alarms[NrOfSubunitAlarms]
}

struct LinkAlarmStates_t {
    AlarmState_t CommonAlarms[NrOfCommonAlarms]
    SubunitAlarmStates_t SubunitAlarms[NrOfSubunits]
}

LinkAlarmStates_t LinkAlarms[NrOfLinks]
```

The table CommonAlarms contains all alarms relevant for the whole ALD and the tables SubunitAlarms contain all subunit-specific alarms. NrOfSubunitAlarms specifies the number of defined subunit alarm types. It is subunit type-specific and defined in the relevant subunit type standard. All the tables shall be initialised with Severity = Cleared for every Alarm during the startup of the ALD.

After a reset, all alarm states shall be cleared.

```
IF «the ALD responds with an error message» AND the «ReturnCode_t is also an
AlarmCode» THEN
    «Set the corresponding alarm state to 1 in the corresponding tables»
ELSEIF «the ALD detects a fault, which is valid for the whole ALD» THEN
    «Set the corresponding alarm state to 1 in CommonAlarms for every layer 2 link»
ELSEIF «the ALD detects that a fault no longer exists» THEN
    «Set the corresponding alarm state to 0 in the corresponding tables»
ENDIF
EXIT
```




12.6.2. Command message interpretation

The following rules shall be used if an ALD receives a command.

The following conditions shall be checked before the parsing of command-specific behaviour.

```
IF «the command is shorter than 4 octets» THEN
    EXIT
ELSEIF «the command has a length inconsistent with its "Number of data octets" field value»
THEN
    RETURN FormatError
ELSEIF «the command is undefined for this ALD type»
    OR «the command is undefined for this subunit type»
    OR «the command is optional and not supported for this ALD type»
    OR «the command is optional and not supported for this subunit type» THEN
    RETURN UnknownCommand
ELSEIF «the command has a length inconsistent with the defined message length in the
command definition» THEN
    RETURN FormatError
ENDIF
EXIT
```

12.6.2.1. Validation of subunit number and type

The following condition for subunit number and type shall be checked before parsing of command-specific behaviour for all commands specified in Subunit Type Standards:

```
IF UpperOctet(Cmd.Command) ≠ 0 THEN
    IF Cmd.Subunit is not one of 1..NrOfSubunits THEN
        RETURN InvalidSubunitNumber
    EXIT
ENDIF
```

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```

IF Subunits[Cmd.Subunit].Type ≠ UpperOctet(Cmd.Command) THEN
    RETURN InvalidSubunitType
    EXIT
ENDIF
ENDIF
    
```

12.6.3. Overview of commands (informative):

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

The following abbreviations are used in the Table 12.6.3-1: “Commands for ALDs”:

- M Mandatory
- O Optional
- Not applicable
- RF Mandatory if the ALD has RF ports, otherwise not applicable
- P Mandatory if the ALD supports pinger functionality, otherwise not applicable
- L Mandatory if the ALD supports listener functionality, otherwise not applicable
- P/L Mandatory if the ALD supports pinger or listener functionality, otherwise not applicable

	Code	Initiator	Subunit	Timeout	TCC	Mandatory for:			Changes the Connection State	Minimum required authority	MALD Setup Permission	MALD SW Download Permission
						Primary	SALD	MALD				
Common commands												
Get Alarm Status	0x0004	Primary	any	1 s	no	O	M	M	no	RO	—	—
Get Information	0x0005	Primary	0	1 s	no	O	M	M	no	—	—	—
Clear Active Alarms	0x0006	Primary	any	1 s	no	O	M	M	no	RW	—	—
Alarm Subscribe	0x0012	Primary	0	1 s	no	O	M	M	no	—	—	—
Alarm Indication	0x0007	ALD	any	—	—	O	M	M	no	RO	—	—
Download Start	0x0040	Primary	0	21 s	yes	M	M	M	yes	—	—	yes
Download File	0x0041	Primary	0	1 s	no	M	M	M	no	—	—	yes
Download End	0x0042	Primary	0	10 s	yes	M	M	M	yes	—	—	yes
Get Subunit List	0x0008	Primary	0	1 s	no	O	M	M	no	—	—	—
Get Reset Cause	0x0009	Primary	0	1 s	no	O	M	M	no	—	—	—
Get AISG Port DC Power Information	0x001D	Primary	0	1 s	no	O	M	M	no	—	—	—
Get Diagnostic Information	0x000B	Primary	any	1 s	no	O	M	M	no	RO	—	—
Set Subunit Type Standard Versions	0x000C	Primary	0	1 s	no	M	M	M	no	—	—	—
Get Subunit Type Standard Versions	0x000D	Primary	0	1 s	no	M	M	M	no	—	—	—

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	Code	Initiator	Subunit	Timeout	TCC	Mandatory for:			Changes the Connection State	Minimum required authority	MALD Setup Permission	MALD SW Download Permission
						Primary	SALD	MALD				
ALD Set Installation Info	0x0010	Primary	0	1 s	no	M	M	M	No	RW	—	—
ALD Get Installation Info	0x0011	Primary	0	1 s	no	M	M	M	No	R	—	—
Upload Info	0x003C	Primary	0	1 s	no	M	M	M	no	—	—	—
Upload Start	0x003D	Primary	0	2 s	no	M	M	M	yes	—	—	—
Upload File	0x003E	ALD	0	1 s	no	M	M	M	no	—	—	—
Upload End	0x003F	ALD	0	2 s	no	M	M	M	yes	—	—	—
Send Layer 1 Test Pattern	0x00B1	Primary	0	1 s	no	O	M	M	no	—	—	—
Generate Test Alarm	0x00B2	Primary	any	1 s	no	O	M	M	no	—	—	—
GetALDConfigurationChecksum	0x002B	Primary	0	1s	no	M	M	M	no	—	—	—
Vendor specific command	0x0090	Primary	any			O	O	O	no	—	—	—
Clear Configuration	0x002A	Primary	0	1s	no	M	O	O	no	RW	—	—
MALD Setup Commands												
MALD Download Initiated	0x0013	ALD	0	1 s	no	M	—	M	yes	—	—	—
MALD Get Information	0x0014	Primary	0	1 s	no	O	—	M	no	—	—	—
MALD Start Setup	0x0018	Primary	0	2 s	no	O	—	M	yes	—	yes	—
MALD Commit Setup	0x0019	Primary	0	2 s	no	O	—	M	yes	—	yes	—
MALD Abort Setup	0x001A	Primary	0	2 s	no	O	—	M	yes	—	yes	—
MALD Reset Setup	0x0017	Primary	0	2 s	no	O	—	M	yes	—	yes	—
MALD Set Subunit Authority	0x0015	Primary	0	1 s	no	O	—	M	no	—	yes	—
MALD Get Subunit Authority	0x0016	Primary	0	1 s	no	O	—	M	no	—	—	—
MALD Set Security Setting	0x001B	Primary	0	1 s	no	O	—	M	no	—	—	—
MALD Get Security Setting	0x001C	Primary	0	1 s	no	O	—	M	no	—	—	—
SiteMapping Commands												
Get Number Of Ports	0x001E	Primary	0	1 s	no	O	M	M	no	—	—	—
Get Port Info	0x001F	Primary	0	1 s	no	O	M	M	no	—	—	—
Get RF Port Frequency Info	0x0025	Primary	0	1 s	no	O	RF	RF	no	—	—	—
Get Port Interconnections	0x0020	Primary	0	1 s	no	O	M	M	no	—	—	—
Set RF Path IDs	0x0021	Primary	0	1 s	no	O	M	M	no	—	—	—
Set RF Path ID Alias	0x0022	Primary	0	1 s	no	O	M	M	no	—	—	—
Get RF Path IDs	0x0023	Primary	0	1 s	no	O	M	M	no	—	—	—
Get RF Path ID Alias	0x0024	Primary	0	1 s	no	O	M	M	no	—	—	—



	Code	Initiator	Subunit	Timeout	TCC	Mandatory for:			Changes the ConnectionState	Minimum required authority	MALD Setup Permission	MALD SW Download Permission
						Primary	SALD	MALD				
Get Connector Plate Marking Info	0x0029	Primary	0	1 s	no	O	M	M	no	—	—	—
Ping Commands												
Send Ping	0x0026	Primary	0	2 s	no	O	P	P	yes	—	—	—
Monitor Ping	0x0027	Primary	0	2 s	no	O	L	L	yes	—	—	—
Abort Ping	0x0028	Primary	0	2 s	no	O	P/L	P/L	yes	—	—	—

Table 12.6.3-1: Commands for ALDs

12.6.4. Layer 7 timeout definitions

If a command is rejected then the error response must be transmitted within 1 second.

If a command is accepted the maximum response time is specified in Table 12.6.3-1: “Commands for ALDs”.

If a command changes the ConnectionState, this change may require up to 1 second for other commands to finish. This time is included in the maximum response time specified in Table 12.6.3-1: “Commands for ALDs”.

12.7. Parallel command handling

Parallel execution of primary commands on the same layer 2 link is not permitted and the second command will be rejected with Busy. In the case of a MALD, parallel execution of TCCs on multiple layer 2 links is not allowed and the second command will be rejected with InUseByAnotherPrimary.

A MALD will wait for all non-TCCs on other layer 2 link(s) to be completed before executing a command which changes any ConnectionState.

Global variables

```

Mutex StateLock // Mutual exclusion
uint16_t CommandCount // The number of Commands running
Boolean ActiveTCC // Shows if a TCC-Command is running
Boolean PendingConnectionStateChange // Shows if the ALD waits to change state(s)
    
```



Variables for each command

```
Boolean IsTCC[CommandCode]           // True if this Command is a TCC
```

Variables for each layer 2 link

```
Boolean ActiveCommand[MaxPort]       // Shows if a command is running for a layer 2  
// link
```

```
struct StateAllowed_t {  
    Boolean allowed  
    ReturnCode_t code  
}
```

```
FUNCTION IsCommandAllowed(ConnectionState_t AcceptedStates[],CommandCode_t  
CurrentCommand, uint16_t CurrentPort) RETURNING StateAllowed_t result IS
```

```
    uint8_t L  
    LOCK StateLock  
    result.allowed ← false  
    L ← «length of AcceptedStates»  
    FOREACH N FROM 0 TO L-1 DO  
        IF AcceptedStates[N] = ConnectionState[CurrentPort] THEN  
            result.allowed ← true  
        ENDIF  
    ENDFOR  
    IF NOT result.allowed THEN  
        result.code ← IncorrectState  
    ELSEIF ActiveCommand[CurrentPort] THEN  
        result.allowed ← false  
        result.code ← Busy  
    ELSEIF PendingConnectionStateChange THEN  
        result.allowed ← false  
        result.code ← InUseByAnotherPrimary  
    ELSE  
        IF IsTCC[CurrentCommand] THEN  
            IF ActiveTCC THEN  
                result.allowed ← false  
                result.code ← InUseByAnotherPrimary  
            ELSE  
                ActiveTCC ← true  
            ENDIF  
        ENDIF  
        IF result.allowed THEN  
            CommandCount ← CommandCount + 1  
            ActiveCommand[CurrentPort] ← true  
        ENDIF  
    ENDIF  
    UNLOCK StateLock  
END
```



```
FUNCTION IsStateChangeAllowed(ConnectionState_t AcceptedStates[],CommandCode_t
CurrentCommand, uint16_t CurrentPort) RETURNING StateAllowed_t result IS
```

```
    LOCK StateLock
```

```
    uint8_t L
```

```
    result.allowed ← false
```

```
    L ← «length of AcceptedStates»
```

```
    FOREACH N FROM 0 TO L-1 DO
```

```
        IF AcceptedStates[N] = ConnectionState[CurrentPort] THEN
```

```
            result.allowed ← true
```

```
        ENDIF
```

```
    ENDFOR
```

```
    IF NOT result.allowed THEN
```

```
        result.code ← IncorrectState
```

```
    ELSEIF ActiveCommand[CurrentPort] THEN
```

```
        result.allowed ← false
```

```
        result.code ← BUSY
```

```
    ELSEIF PendingConnectionStateChange THEN
```

```
        result.allowed ← false
```

```
        result.code ← InUseByAnotherPrimary
```

```
    ELSEIF ActiveTCC THEN
```

```
        result.allowed ← false
```

```
        result.code ← InUseByAnotherPrimary
```

```
    ELSE
```

```
        PendingConnectionStateChange ← true
```

```
        IF CommandCount > 0 THEN
```

```
            UNLOCK StateLock
```

```
            WAIT UNTIL CommandCount = 0
```

```
            LOCK StateLock
```

```
        ENDIF
```

```
        CommandCount ← CommandCount + 1
```

```
        ActiveCommand[CurrentPort] ← true
```

```
        ActiveTCC ← IsTCC[CurrentCommand]
```

```
    ENDIF
```

```
    UNLESS result.allowed THEN
```

```
        UNLOCK StateLock
```

```
    ENDIF
```

```
END
```

```
FUNCTION CommandExit(CommandCode_t CurrentCommand, uint16_t CurrentPort) IS
```

```
    LOCK StateLock
```

```
    IF ActiveCommand[CurrentPort] THEN
```

```
        CommandCount ← CommandCount - 1
```

```
        ActiveCommand[CurrentPort] ← false
```

```
        ActiveTCC ← false
```

```
    ENDIF
```



UNLOCK StateLock
END

12.8. Common commands

12.8.1. Get Alarm Status

Description (Informative):

On successful completion of GetAlarmStatus command, the ALD return the alarm code and severity of all active alarms.

Message format (Normative):

```
PrimaryCommand GetAlarmStatusCommand {
    CommandCode_t      Command ← 0x0004
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 0
}

ALDResponse GetAlarmStatusResponse {
    CommandCode_t      Command ← 0x0004
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint8_t        NrOfActiveAlarms
        AlarmState_t   ActiveAlarms[NrOfActiveAlarms]
    }
    else {
        ALDState_t     ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    NotAuthorised
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF Cmd.Subunit = 0 THEN
    RETURN OK «and CommonAlarms for this layer 2 link»
    EXIT
ELSEIF Cmd.Subunit is not one of 1..NrOfSubunits THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF
```



```
IF ALDType = MALD
    AND ActiveAuth[CurrentPort].Authority[Cmd.Subunit] = NoAccess THEN
    RETURN NotAuthorised
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK and SubunitAlarms for requested subunit
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.8.2. Get Information

Description (Informative):

On successful completion of GetInformation command, the ALD returns its product number, serial number, hardware version and software version.

Message format (Normative):

```
PrimaryCommand GetInformationCommand {
    CommandCode_t      Command ← 0x0005
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse GetInformationResponse {
    CommandCode_t      Command ← 0x0005
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint8_t         LengthOfProductNumber
        UTF8String_t    ProductNumber
        uint8_t         LengthOfSerialNumber
        UTF8String_t    SerialNumber
        uint8_t         LengthOfHwVersion
        UTF8String_t    HwVersion
        uint8_t         LengthOfSWVersion
        UTF8String_t    SWVersion
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```




```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```

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

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

```
RETURN OK, length(ProductNumber), ProductNumber, length(SerialNumber),
SerialNumber, length(HwVersion), HwVersion, length(SWVersion), SWVersion
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.8.3. Clear Active Alarms

Description (Informative):

On successful completion of the ClearActiveAlarms command, the ALD clears all stored alarm states and diagnostic information, including all test alarms.

Message format (Normative):

```
PrimaryCommand ClearActiveAlarmsCommand {
    CommandCode_t      Command ← 0x0006
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 0
}
```



```
ALDResponse ClearActiveAlarmsResponse {
    CommandCode_t           Command ← 0x0006
    CommandSequence_t       PrimaryCommandSequence
    ReturnCode_t            ReturnCode
    DataLength_t            DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t          ALDState
        ConnectionState_t    ConnectionState
    }
}
```

```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    NotAuthorised
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF Cmd.Subunit = 0 THEN
    «Clear all CommonAlarms for this layer 2 link»
    RETURN OK
    EXIT
ENDIF

IF Cmd.Subunit is not one of 1..NrOfSubunits THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF ALDType = MALD
    AND ActiveAuth[CurrentPort].Authority[Cmd.Subunit] ≠ ReadWrite THEN
    RETURN NotAuthorised
    EXIT
ENDIF

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

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



«Clear all SubunitAlarms for the requested subunit for this layer 2 link»

RETURN OK

CommandExit(Cmd.Command, CurrentPort)

EXIT

12.8.4. Alarm Subscribe

Description (Informative):

On successful completion of the AlarmSubscribe command, the ALD starts reporting alarms to the primary by sending AlarmIndication commands to the primary.

NOTE: The reason alarms are not reported before the primary subscribes to alarms is that the primary may not be ready to receive them.

Message format (Normative):

```
PrimaryCommand AlarmSubscribeCommand {
    CommandCode_t      Command ← 0x0012
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse AlarmSubscribeResponse {
    CommandCode_t      Command ← 0x0012
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ADLState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```

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



```
UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF
AlarmSubscribeFlag[CurrentPort] ← true
RETURN OK
IF «at least one Alarm in LinkAlarms for this layer 2 link is raised» THEN
    «Send AlarmIndication»
ENDIF
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.8.5. Alarm Indication

Description (Informative):

The ALD issues the AlarmIndication command to report alarm state changes to the primary.

NOTE: This command is only issued if the primary has subscribed to alarms since the ALD reset.

Message format (Normative):

```
ALDCommand AlarmIndicationCommand {
    CommandCode_t      Command ← 0x0007
    CommandSequence_t  ALDCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    uint8_t            NrOfAlarms
    for (i = 0; i < NrOfAlarms; i++) {
        AlarmState_t   AlarmState
    }
}
```

```
FOREACH layer 2 link DO
    IF AlarmSubscribeFlag for this layer 2 link is not set THEN
        CONTINUE
    ENDIF
    FOR every subunit
        IF «SubunitAlarms for this subunit has changed» AND
            ActiveAuth[CurrentPort].Authority[Cmd.Subunit] ≠ NoAccess THEN
            «Send AlarmIndication with subunit number and all
            alarm states changes that have not been reported for this layer 2 link»
        ENDIF
    ENDFOR
    IF «the table CommonAlarms for this layer 2 link has changed» THEN
        «Send AlarmIndication with subunit number 0 and all changes in
        CommonAlarms that have not been reported for this layer 2 link»
    ENDIF
```



ENDFOR
EXIT

12.8.6. Download Start

Description (Informative):

The DownloadStart command initiates the download process for data or firmware files.

The supported file types defined in this standard are listed in Table 12.8.6-1: “Description of the file types”. Additional file types may be defined by subunit type standards. The filetypes not listed in any AISG standard are unknown.

Usage of the file types for download and upload is defined in Table 12.8.6-2: “Usage of the file types”. A download or upload to the ALD is indicated by specifying subunit 0 to the DownloadStart and UploadStart command.

Name	Description
Firmware File	Contains the executable binary of the ALD
Configuration File	Configuration data for the ALD and all subunits
Log File	For diagnostic use
Information File	Contains data that have no operational impact within the ALD

Table 12.8.6-1: Description of the file types

Name	Download to ALD	Download to subunit	Upload from ALD	Upload from subunit
Firmware File	X			
Configuration File	X			
Log File			X	X
Information File	X		X	

Table 12.8.6-2: Usage of the file types

A firmware file is used to update the firmware of the ALD by downloading it to the ALD. The format of the firmware file is vendor specific.

A configuration file is a file that is used to configure the ALD. The format of the configuration file is vendor specific. Configuration files are downloaded to the ALD. Data contained in the file is transferred internally to the target subunit or to the ALD based on vendor specific instructions contained within the file.

A log file provides a method to record the history of internal events and errors for analysis. It is possible to upload log files from both the ALD itself and from any subunit. Log file contents and logging behaviour are vendor specific.

An information file allows the storage and retrieval of data that have no operational impact on the ALD. For example, the storage of a read.me file or information related to the installation of the device.

Message format (Normative):

```
// Number of MALD ports waiting for a response  
uint16_t MALDDownloadInitiatedResponseCounter
```

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```
PrimaryCommand DownloadStartCommand {
    CommandCode_t      Command ← 0x0040
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 1
    FileType_t         FileType
}

ALDResponse DownloadStartResponse {
    CommandCode_t      Command ← 0x0040
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnsupportedFileType
    IncorrectState
    NotAuthorised
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF Cmd.FileType is not supported or is unknown THEN
    RETURN UnsupportedFileType
    EXIT
ENDIF

IF ALDType = MALD AND Cmd.FileType = FirmwareFile
    AND ActiveAuth[CurrentPort].SWDownloadPermission = NotAllowed THEN
    RETURN NotAuthorised
    EXIT
ENDIF

result ← IsStateChangeAllowed( LIST{ OperatingConnectionState,
                                     DownloadConnectionState,
                                     DownloadFailedConnectionState},
                               Cmd.Command, CurrentPort)

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

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```
SWITCH ConnectionState[CurrentPort] TO DownloadConnectionState
SWITCH ALDState TO DownloadState
ReceivedFileType ← Cmd.FileType
DownloadPort ← CurrentPort
MALDDownloadInitiatedResponseCounter ← 0

FOREACH PORT FROM 1 TO MaxPort DO
    NEXT IF PORT = DownloadPort
    IF ALDType = MALD AND LinkState[PORT] = Connected THEN
        SWITCH ConnectionState[PORT] TO DownloadNotificationConnectionState
        «Queue MALDDownloadInitiatedCommand for transmission on port PORT»
MALDDownloadInitiatedResponseCounter ← MALDDownloadInitiatedResponseCounter +1
    ELSE // It is a SALD's non-control port or MALD's port without Layer 2 link
        SWITCH ConnectionState[PORT] TO OffConnectionState
        SWITCH LinkState[PORT] TO NoAddress
        «Disable serial port PORT»
    ENDIF
ENDIFOR

IF MALDDownloadInitiatedResponseCounter = 0 THEN
    SWITCH ConnectionState[DownloadPort] TO DownloadConnectionState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    RETURN OK
    CommandExit(Cmd.Command, CurrentPort)
    EXIT
ELSE
    «Initialise DownloadInitialDelayTimer at 10 seconds»
ENDIF

EXIT

ON DownloadInitialDelayTimer OR StartDownloadEvent DO
    UNLESS MALDDownloadInitiatedResponseCounter = 0 THEN
        FOREACH PORT FROM 1 TO MaxPort DO
            IF ConnectionState[PORT] = DownloadNotificationConnectionState THEN
                SWITCH ConnectionState[PORT] TO OffConnectionState
                SWITCH LinkState[PORT] TO NoAddress
                Disable serial port PORT
            ENDIF
        ENDFOR
    ENDIF

    SWITCH ConnectionState[CurrentPort] TO DownloadConnectionState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    RETURN OK on DownloadPort
    CommandExit(Cmd.Command, DownloadPort)
```



DONE

NOTE: The list of file type codes may be extended by subunit type standards.

NOTE: To prevent simultaneous downloads the DownloadPort is stored, so a second attempt to download on a different port can be rejected.

12.8.7. Download File

Description (Informative):

This command is used once or several times to transfer data from the primary to the ALD.

All blocks except the last shall be 256 octets. The last block may not be 0 octets.

Message format (Normative):

```
PrimaryCommand DownloadFileCommand {
    CommandCode_t      Command ← 0x0041
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    uint8_t            Block[DataLength]
}

ALDResponse DownloadFileResponse {
    CommandCode_t      Command ← 0x0041
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidFileContent
    InvalidSubunitNumber
    DownloadFailed
    GeneralError
}
```

Primary pseudocode (Normative):

*(This section is intentionally left blank)*ALD pseudocode (Normative):

```
result ← IsCommandAllowed( LIST{      DownloadConnectionState,
                                     DownloadFailedConnectionState},
                           Cmd.Command, CurrentPort)
```

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




```
IF ConnectionState[CurrentPort] = DownloadFailedConnectionState THEN
    RETURN DownloadFailed
    CommandExit(Cmd.Command, CurrentPort)
    EXIT
ENDIF

Collect data and verify the data format and size

IF «the ALD detects invalid data» THEN
    RETURN InvalidFileContent
ELSE
    Store data to memory

    IF «the ALD detects a hardware error during storing data» THEN
        // Replace "Hardware error" with a text describing the problem
        RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
        RETURN GeneralError
    ELSE
        RETURN OK
    ENDIF
ENDIF

ENDIF

IF Response.Returncode ≠ OK
    LOCK StateLock
    SWITCH ConnectionState[CurrentPort] TO DownloadFailedConnectionState
    UNLOCK StateLock
ENDIF

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

12.8.8. Download End

Description (Informative):

This command signals the end of a multi-message data transfer to the ALD.

Message format (Normative):

```
Enumeration OptionCode_t : uint8_t {
    Complete ← 0
    Cancel ← 1
}

PrimaryCommand DownloadEndCommand {
    CommandCode_t      Command ← 0x0042
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 1
    OptionCode_t       Option
}
```

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```
ALDResponse DownloadEndResponse {
    CommandCode_t      Command ← 0x0042
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidFileContent
    DownloadFailed
    OutOfRange
    InvalidSubunitNumber
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
result ← IsStateChangeAllowed( LIST{ DownloadConnectionState,
                                     DownloadFailedConnectionState},
                               Cmd.Command, CurrentPort)
```

```
UNLESS result.allowed THEN
```

```
    RETURN result.code
```

```
    EXIT
```

```
ENDIF
```

```
UNLESS Cmd.Option = Complete THEN
```

```
    IF Cmd.Option = Cancel THEN
```

```
        RETURN OK
```

```
    ELSE
```

```
        RETURN OutOfRange
```

```
    ENDIF
```

```
    SWITCH ALDState TO OperatingState
```

```
    SWITCH ConnectionState[CurrentPort] to OperatingConnectionState
```

```
    PendingConnectionStateChange ← false
```

```
    FOREACH PORT FROM 1 TO MaxPort DO
```

```
        NEXT IF PORT = CurrentPort
```

```
        SWITCH ConnectionState[PORT] TO NoConnectionState
```

```
        «Enable serial port PORT»
```

```
    ENDFOR
```

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```
        UNLOCK StateLock
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF

    IF ConnectionState[CurrentPort] = DownloadFailedConnectionState THEN
        RETURN DownloadFailed
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF

    «Verify the whole downloaded file»
    IF «the ALD detects a hardware error» THEN
        // Replace "Hardware error" with a text describing the problem
        RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
        RETURN GeneralError
        SWITCH ALDState TO OperatingState
        SWITCH ConnectionState[CurrentPort] TO OperatingConnectionState
        PendingConnectionStateChange ← false

        FOREACH PORT FROM 1 TO MaxPort DO
            NEXT IF PORT = CurrentPort
            SWITCH ConnectionState[PORT] TO NoConnectionState
            Enable serial port PORT
        ENDFOR

        UNLOCK StateLock
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF

    IF «the ALD detects a corrupted file» THEN
        RETURN InvalidFileContent
        SWITCH ALDState TO OperatingState
        SWITCH ConnectionState[CurrentPort] TO OperatingConnectionState
        PendingConnectionStateChange ← false

        FOREACH PORT FROM 1 TO MaxPort DO
            NEXT IF PORT = CurrentPort
            SWITCH ConnectionState[PORT] TO NoConnectionState
            Enable serial port PORT
        ENDFOR

        UNLOCK StateLock
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF
    RETURN OK
```



```
// If the filetype is InformationFile do nothing, since it is already stored
```

```
IF ReceivedFileType = FirmwareFile THEN
    «Select the new firmware as the active firmware»
    «Wait for layer 2 acknowledgement (RR) from the primary»
    «Immediately perform a reset»
ELSEIF ReceivedFileType = ConfigurationFile THEN
    «Select the new configuration as the active configuration»
ENDIF

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

12.8.9. Get Subunit List

Description (Informative):

The ALD returns the number of subunits for which it has ReadWrite or ReadOnly authority. In the case of a SALD, every subunit is reported.

Message format (Normative):

```
PrimaryCommand GetSubunitListCommand {
    CommandCode_t      Command ← 0x0008
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse GetSubunitListResponse {
    CommandCode_t      Command ← 0x0008
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t        NrOfVisibleSubunits
        SubunitTypeListElement_t  Subunits[NrOfVisibleSubunits]
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
uint8_t I
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF
result ← IsCommandAllowed( LIST{ OperatingConnectionState,
                                RestrictedConnectionState},
                           Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF
I ← 0
FOREACH N FROM 0 TO NrOfSubunits - 1 DO
    IF ALDType = MALD AND ActiveAuth[CurrentPort].Authority[N] = NoAccess THEN
        NEXT
    ENDIF
    Response.Subunits[I].Subunit ← N
    Response.Subunits[I].SubunitType ← Subunits[N].Type
    I ← I + 1
ENDFOR

Response.NrOfVisibleSubunits ← I
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.8.10. Get Reset Cause

Description (Informative):

The ALD returns the cause of the last executed reset.

Message format (Normative):

```
Enumeration ResetCause_t : uint8_t {
    SWUpdate          ← 0
    Layer2Reset       ← 1
    InternalError     ← 2
    PowerUp           ← 3 // This covers both power up and power
                        // cycle
    MALDSetupChanged ← 4
    Layer2Timeout     ← 5 // See Section 11.13. "Communication timeout"
}

PrimaryCommand GetResetCauseCommand {
    CommandCode_t      Command ← 0x0009
    CommandSequence_t PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}
```



```
ALDResponse GetResetCauseResponse {
    CommandCode_t      Command ← 0x0009
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        ResetCause_t   ResetCause
        If (ResetCause = PowerUp
            OR ResetCause = Layer2Reset
            OR ResetCause = SWUpdate
            OR ResetCause = MALDSetupChanged) {
            uint16_t Portnumber
        }
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```

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

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

```
IF «the last reset was due to a power on» THEN
    RETURN OK, «Reset Cause ← PowerUp and the port number at which the power on
was processed»
ELSEIF «the last reset was due to a SW Update» THEN
    RETURN OK, «Reset Cause ← SWUpdate and the port number at which the download
was processed»
ELSEIF «the last reset was due to layer 2 reset sent by a primary» THEN
    RETURN OK, «Reset Cause ← Layer2Reset and the port number at which the layer 2
reset was sent»
```



```
ELSEIF «the last reset was due to internal error» THEN
    RETURN OK, «Reset Cause ← InternalError»
ELSEIF «the last reset was due to MALDSetupChanged» THEN
    RETURN OK, «Reset Cause ← MALDSetupChanged and the port number at which
MALD setup was initiated»
ELSEIF «the last reset was due to communication timeout» THEN
    RETURN OK, «Reset Cause ← Layer2Timeout»
ENDIF
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

NOTE: The list of reset causes may be extended by subunit type standards.

12.8.11. Get AISG Port DC Power Information

Description (Informative):

The ALD returns its DC power consumption information according to Section 10.4.2. "Definition of power modes".

Message format (Normative):

```
PowerModePowers PowerModeStruct_t

PrimaryCommand GetAISGPortDCPowerInformationCommand {
    CommandCode_t      Command ← 0x001D
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse GetAISGPortDCPowerInformationResponse {
    CommandCode_t      Command ← 0x001D
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t P1
        uint16_t P2
        uint16_t P3
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK, PowerModePowers           // As defined in Section 10.4.2. "Definition
                                     // of DC power modes" and section 7.2.15 "DC
                                     // power information"

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

12.8.12. Get Diagnostic Information

Description (Informative):

The response to this command shall provide useful additional vendor specific information about the cause of the active alarm. Providing such additional information is mandatory for the General Error alarm and optional for all other alarms.

Message format (Normative):

```
PrimaryCommand GetDiagnosticInformationCommand {
    CommandCode_t      Command ← 0x000B
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 2
    AlarmCode_t        Alarm
}

ALDResponse GetDiagnosticInformationResponse {
    CommandCode_t      Command ← 0x000B
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint8_t         ProductSpecificDiagnosticCode
        uint8_t         LengthOfDiagnosticString
        UTF8String_t    DiagnosticString // max 254 octets
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```




```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    NotAuthorised
    OutOfRange
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF «Cmd.Subunit is not one of 0..NrOfSubunits» THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF ALDType = MALD
    AND ActiveAuth[CurrentPort].Authority[Cmd.Subunit] = NoAccess THEN
        RETURN NotAuthorised
        EXIT
    ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

IF «the requested AlarmCode is not supported» THEN
    RETURN OutOfRange
ELSEIF «the requested AlarmCode is not raised for the requested subunit» THEN
    RETURN OK, «ProductSpecificDiagnosticCode = 0 and LengthOfDiagnosticString = 0»
ELSE
    RETURN OK, «the related ProductSpecificDiagnosticCode, the
    LengthOfDiagnosticString and the corresponding DiagnosticString»
ENDIF
```



CommandExit(Cmd.Command, CurrentPort)
EXIT

12.8.13. Set Subunit Type Standard Version

Description (Informative):

The ALD sets one common subunit type standard version (numbers a, b and c according to Chapter 14) for all subunits of the requested subunit type visible on a port.

Subunits do not have a default subunit type standard version, therefore the primary needs to set the subunit type standard version after every restart to get access to the subunits.

Message format (Normative):

```
PrimaryCommand SetSubunitTypeStandardVersionCommand {
    CommandCode_t      Command ← 0x000C
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 4
    SubunitType_t      SubunitType
    AISGVersion_t      Version
}
```

```
ALDResponse SetSubunitTypeStandardVersionResponse {
    CommandCode_t      Command ← 0x000C
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```

```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    InvalidSubunitType
    UnsupportedProtocolVersion
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```



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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

FOREACH I FROM 1 TO NrOfSubunits DO
    IF Subunits[I].Type = Cmd.SubunitType THEN
        IF «the requested subunit type standard version is not supported» THEN
            RETURN UnsupportedProtocolVersion
        ELSE
            ConfiguredSubunitTypeVersion[Cmd.CurrentPort] ← Cmd.Version
            RETURN OK
        ENDIF
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF
ENDFOR

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

12.8.14. Get Subunit Type Standard Versions

Description (Informative):

The ALD returns currently configured subunit type standard version information (variables a, b and c according to Section 14.2. “Subunit type standard versions”) for the subunit types visible on the port on which the command was received. These versions are used by all subunits of the same type.

Message format (Normative):

```
PrimaryCommand GetSubunitTypeStandardVersionsCommand {
    CommandCode_t      Command ← 0x000D
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 1
    SubunitType_t      SubunitType
}
```



```
ALDResponse GetSubunitTypeStandardVersionsResponse {
    CommandCode_t      Command ← 0x000D
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        AISGVersion_t  ConfiguredVersion
        unit8_t         NrOfSupportedVersions
        AISGVersion_t  SupportedVersions[NrOfSupportedVersions]
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    InvalidSubunitType
    InvalidSubunitNumber
    IncorrectState
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

IF «the requested SubunitType is not supported» THEN
    RETURN InvalidSubunitType
ELSE
    Response.ConfiguredVersion ← ConfiguredSubunitTypeVersion[Cmd.CurrentPort]
    Set Response.SupportedVersions TO «the list of supported
    standard versions for the requested subunit type»
    RETURN OK «and the list of currently configured subunit standard version(s) of the
    subunit types(s) visible on the port that the command was received on»
ENDIF

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



12.8.15. ALD Set Installation Info

Description (Informative):

On the receipt of this command the ALD stores installation data in the non-volatile memory. The ALD stores this information separately for each port.

Message format (Normative):

```
PrimaryCommand ALDSetInstallationInfoCommand {
    CommandCode_t      Command ← 0x0010
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength
    uint8_t            LengthOfInstallersID      // max 32 octet
    TextString         InstallersID
    Provenance_t       InstallersIDProvenance
    uint8_t            LengthOfBaseStationID    // max 32 octet
    TextString         BaseStationID
    Provenance_t       BaseStationIDProvenance
}

ALDResponse ALDSetInstallationInfoResponse {
    CommandCode_t      Command ← 0x0010
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    UnknownCommand
    Busy
    InvalidSubunitNumber
    NotAuthorised
    IncorrectState
    InvalidProvenance
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```



```
IF ALDType = MALD
    AND ActiveAuth[CurrentPort].Authority[Cmd.Subunit] = NoAccess THEN
    RETURN NotAuthorised
    EXIT
ENDIF

// Factory provenance is reserved to be used by
// production equipment and is never allowed
// in the field commanded by the primary

IF InstallersIDProvenance = (Factory OR File) OR BaseStationIDProvenance = (Factory OR
File) THEN
    RETURN InvalidProvenance
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

«Store the data for Cmd.PortNumber to non-volatile memory including the provenances»

IF the ALD detects a hardware error THEN
    // Replace "Hardware error" with a text describing the problem
    RAISE AlarmGeneralError SEVERITY Major ON ALD,"Hardware error"
    RETURN GeneralError
ELSE
    RETURN OK
ENDIF

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

12.8.16. ALD Get Installation Info

Description (Informative):

On the receipt of this command the ALD returns the installation data from the non-volatile memory.

Message format (Normative):

```
PrimaryCommand ALDGetInstallationInfoCommand {
    CommandCode_t      Command ← 0x0011
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}
```



```
ALDResponse ALDGetInstallationInfoCommand {
    CommandCode_t      Command ← 0x0011
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        // All
        uint8_t         LengthOfInstallersID // max 32 octet
        TextString      InstallersID
        Provenance_t    InstallersIDProvenance
        uint8_t         LengthOfBaseStationID // max 32 octet
        TextString      BaseStationID
        Provenance_t    BaseStationIDProvenance
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    UnknownCommand
    Busy
    InvalidSubunitNumber
    NotAuthorised
    IncorrectState
    GeneralError
}
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF ALDType = MALD
    AND ActiveAuth[CurrentPort].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
```



Retrieve the data for Cmd.PortNumber from the non-volatile memory

IF the ALD detects a hardware error THEN

// Replace "Hardware error" with a text describing the problem

RAISE AlarmGeneralError SEVERITY Major ON ALD,"Hardware error"

RETURN GeneralError

ELSE

RETURN OK

ENDIF

CommandExit(Cmd.Command, CurrentPort)

EXIT

12.8.17. Upload Info

Description (Informative):

The UploadInfo command requests information about the uploadable files available within the ALD.

Message format (Normative):

```
PrimaryCommand UploadInfoCommand {
    CommandCode_t      Command ← 0x003C
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 1
    FileType_t         FileType      // See Section 12.8.6. "Download Start"
}
```

```
ALDResponse UploadInfoResponse {
    CommandCode_t      Command ← 0x003C
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint32_t FileLength
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```

```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    UnsupportedFileType
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
IF «Cmd.FileType is not supported» THEN
    RETURN UnsupportedFileType
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK «and the file FileLength of the requested file type»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

NOTE: Upload Info Command cannot be used while Upload is already started.

12.8.18. Upload Start

Description (Informative):

The UploadStart command initiates the upload process of the requested file type from the ALD.

The supported file types defined in this standard are listed in Table 12.8.6-1: “Description of the file types”. Additional file types may be defined by subunit type standards.

How the file types may be used in download and upload is defined in Table 12.8.6-2: “Usage of the file types”.

Message format (Normative):

```
PrimaryCommand UploadStartCommand {
    CommandCode_t      Command ← 0x003D
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 1
    FileType_t         FileType      // See Section 12.8.6. “Download Start”
}

ALDResponse UploadStartResponse {
    CommandCode_t      Command ← 0x003D
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint32_t FileLength
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```



```
Enumeration ReturnCode_t {  
    OK  
    FormatError  
    Busy  
    IncorrectState  
    UnsupportedFileType  
    InvalidSubunitNumber  
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF the FileType is not supported THEN  
    RETURN UnsupportedFileType  
    EXIT  
ENDIF
```

```
result ← IsStateChangeAllowed( LIST{ OperatingConnectionState},  
                               Cmd.Command, CurrentPort)
```

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

```
FOREACH PORT FROM 1 to MaxPort DO  
    NEXT IF PORT = CurrentPort  
    SWITCH ConnectionState[Port] TO RestrictedConnectionState  
ENDIFOR
```

```
SWITCH ConnectionState[CurrentPort] TO UploadConnectionState  
PendingConnectionStateChange ← false  
UNLOCK StateLock  
UploadRemainingLength[CurrentPort] ← length(requested file)  
UploadPosition[CurrentPort] ← 0  
RETURN OK  
Signal UploadFileEvent(CurrentPort)  
CommandExit(Cmd.Command, CurrentPort)  
EXIT
```

NOTE: The list of file type codes may be extended by subunit type standards.

12.8.19. Upload File

Description (Informative):

The UploadFile command transfers a block of file from the ALD to the primary.

All blocks except the last shall be 256 octets. The last block may not be 0 octets.



Message format (Normative):

```
ALDCommand UploadFileCommand {
    CommandCode_t      Command ← 0x003E
    CommandSequence_t  ALDCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    uint8_t            Block[DataLength]
}

PrimaryResponse UploadFileResponse {
    CommandCode_t      Command ← 0x003E
    CommandSequence_t  ALDCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
    }
}

Enumeration ReturnCode_t {
    OK
    UploadRejected
}
```

Primary pseudocode (Normative):

```
IF «primary detects any problem storing the upload file block» THEN
    RETURN UploadRejected
ENDIF
```

ALD pseudocode (Normative):

```
ON UploadFileEvent(uint16_t PORT, UploadStatus_t Status)
    Cmd.result ← Event.Status
    LOCK StateLock

    UNLESS ConnectionState[PORT] = UploadConnectionState THEN
        // This is for the case when there is no upload in progress.
        Signal UploadEndEvent(PORT, failed)
        UNLOCK StateLock
        EXIT
    ENDIF

    UNLOCK StateLock

    IF «UploadFileResponse(PORT) is out of sequence» THEN
        Signal UploadEndEvent(PORT, failed)
        EXIT
    ENDIF

    IF UploadRemainingLength[PORT] = 0 THEN
        Signal UploadEndEvent(PORT, success)
        EXIT
    ENDIF
```



```
IF UploadRemainingLength[PORT] > 256 THEN
    «Store 256 octets from UploadPosition[PORT] in file in Cmd.Block»
    «Queue UploadFileCommand for transmission on port PORT»
    Increase UploadPosition[PORT] by 256
    Decrease UploadRemainingLength[PORT] by 256
ELSE
    «Store UploadRemainingLength[PORT] octets from
        UploadPosition[PORT] in file in Cmd.Block»
    «Queue UploadFileCommand for transmission on port PORT»
    UploadRemainingLength[PORT] ← 0
ENDIF
DONE
```

12.8.20. Upload End

Description (Informative):

This command indicates successful completion of the upload process.

Message format (Normative):

```
ALDCommand UploadEndCommand {
    CommandCode_t      Command ← 0x003F
    CommandSequence    ALDCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength ← 1
    Boolean             UploadSuccessful
}

PrimaryResponse UploadEndResponse {
    CommandCode_t      Command ← 0x003F
    CommandSequence    ALDCommandSequence
    ReturnCode_t       ReturnCode ← OK
    DataLength_t       DataLength ← 0
}
```

Primary pseudocode (Normative):

RETURN OK

ALD pseudocode (Normative):

```
ON UploadEndEvent(PORT) DO
    IF UploadRemainingLength[PORT] = 0 THEN
        UploadSuccessful ← True
    ELSE
        UploadSuccessful ← False
    ENDIF

    Queue «UploadEnd for transmission on port PORT»
    LOCK StateLock
    PendingConnectionStateChange ← true
```



```
IF CommandCount > 0 THEN
    UNLOCK StateLock
    WAIT UNTIL CommandCount = 0
    LOCK StateLock
END

SWITCH ConnectionState[PORT] TO OperatingConnectionState
PendingConnectionStateChange ← false
UNLOCK StateLock
```

DONE

12.8.21. Send Layer 1 Test Pattern

Description (Informative):

The SendLayer1TestPattern command is used to transmit test patterns for the specified time so that the signal levels, emission levels and BER on the OOK and the RS-485 ports can be measured.

While the ALD is transmitting the test pattern it shall ensure that the communication timeout timer does not expire.

During the test transmission period regular AISG communication on the AISG bus is not possible. The only way to interrupt the test transmission is to perform DC power cycle.

Concurrent execution of SendLayer1TestPattern is allowed on more than one AISG port.

Message format (Normative):

```
Enumeration PatternType_t : uint8_t {
    CW                ← 0 // This test signal is not useful for RS-485
    Octet             ← 1
    PseudoRandomCode ← 2
}

PrimaryCommand SendLayer1TestPatternCommand {
    CommandCode_t      Command ← 0x00B1
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength
    PatternType_t      Type
    uint32_t            Time // Up to ca 49710 days
    if (Type == CW) {
    }
    elseif (Type == Octet) then {
        uint8_t      TestPattern
    }
    elseif (Type == PseudoRandomCode) then {
        uint16_t     Seed
    }
}
```



```
ALDResponse SendLayer1TestPatternResponse {
    CommandCode_t      Command ← 0x00B1
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

RETURN OK

IF Type = CW THEN
    «Send continuous logical 0 for Time seconds»
ELSEIF Type = Octet THEN
    «Send a continuous stream of TestPattern octets for Time seconds»
ELSE
    «Send the pseudorandom test pattern generated from Seed for Time seconds according to
    [10] Section 2.1.»
ENDIF
```



CommandExit(Cmd.Command, CurrentPort)
EXIT

12.8.22. Generate Test Alarm

Description (Informative):

The ALD generates a test alarm when it receives this command with an alarm severity other than Cleared.

When an ALD receives this command with alarm severity Cleared, the ALD will clear the alarm indicated by the Alarm Code.

The test alarm works exactly the same way as a real alarm, except that alarms do not clear automatically. Normal alarm behaviour is defined in Section 12.6.1. "Alarm handling"

NOTE: ClearActiveAlarms command cancels all alarms.

Message format (Normative):

The Alarm severity state is defined in [8].

```
PrimaryCommand GenerateTestAlarmCommand {
    CommandCode_t      Command ← 0x00B2
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    AlarmCode_t        AlarmCode
    Severity_t         Severity
    uint8_t            Length
    UTF8String_t       Text
}

ALDResponse GenerateTestAlarmResponse {
    CommandCode_t      Command ← 0x00B2
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    InvalidSubunitNumber
    IncorrectState
    NoAlarmSubscription
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
IF «Cmd.Subunit is not one of 0..NrOfSubunits» THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

RETURN OK

IF AlarmSubscribeFlag[CurrentPort] = true THEN
    IF Cmd. Severity = Cleared THEN
        CLEAR Cmd.AlarmCode ON Cmd.Subunit
    ELSE
        RAISE Cmd.AlarmCode SEVERITY Cmd.Severity ON Cmd.Subunit, Cmd.Text
    ENDIF
ELSE
    RETURN NoAlarmSubscription
ENDIF

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

12.8.23. Get ALD Configuration Checksum

Description (Informative):

This command is used to read the SHA1 checksum of the ALD configuration, which uniquely identifies the ALD configuration used.

If the ALD is not configured, this command returns an empty string. Otherwise it returns the 40-character SHA1 checksum of the vendor code, product number and ALD configuration data.

The ALD configuration checksum has no meaning except to verify that two devices from the same vendor have the same device configuration, or that the device is unconfigured. The vendor should provide the checksum together with configuration file in the AISG XCD file (see [14]).

The ALD configuration checksum can be used to verify that an ALD already uses a specific configuration.

Message format (Normative):

```
PrimaryCommand GetALDConfigurationChecksumCommand {
    CommandCode_t      Command ← 0x002B
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength
}
```




```
ALDResponse GetALDConfigurationChecksumResponse {
    CommandCode_t      Command ← 0x002B
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint8_t        ChecksumLength      // 0 or 40
        AsciiString_t  Checksum
    }
    else {
        ALDState_t     ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    UnknownCommand
    Busy
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF ALDState = DeviceNotConfigured THEN
    RETURN OK, ""
ELSE
    RETURN OK, SHA1(vendor code, product number, ALD configuration data)
ENDIF
EXIT
```

12.8.24. Recover Factory Configuration

Description (Informative):

This command is used to recover the ALD-level factory configuration of the ALD and all its subunits. This may result in the ALD being returned to ALDNotconfiguredState or to a fully functional configuration. If the factory configuration leaves the ALD not configured, execution of the command will raise the AlarmALDNotConfigured.

ALDs that do not support downloading of file type ConfigurationFile shall return UnknownCommand. Primary can use GetCapabilities to determine whether and ALD supports this command or not.

The ability to return the ALD to ALDNotConfiguredState is useful in interoperability testing.

This command is not required before downloading file type ConfigurationFile.

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If the factory configuration is changed (using some vendor specific method), the ALD configuration checksum representing it must change.

Message format (Normative):

```
PrimaryCommand RecoverFactoryConfigurationCommand {
    CommandCode_t      Command ← 0x002A
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse RecoverFactoryConfigurationResponse {
    CommandCode_t      Command ← 0x002A
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    UnknownCommand
    Busy
    InvalidSubunitNumber
    InvalidSubunitType
    NotAuthorised
    IncorrectState
    ALDConfigurationNotSupported
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF ALDType = MALD THEN
    UNLESS ActiveAuth[CurrentPort].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

UNLESS Capabilities.ConfiguredByDesign THEN
    «Erase ALD configuration»
    RAISE AlarmALDNotConfigured SEVERITY Warning ON ALD
    RETURN OK
ELSE
    RETURN ALDConfigurationNotSupported
ENDIF

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

12.8.25. Vendor specific command

Description (Informative):

This command code is reserved to allow the addition of vendor-specific functionality (for example production testing). Only the structure of the command is defined here. Vendor-specific commands shall not be used to work around possible problems within this standard. In particular, the vendor should check the subunit and (if applicable) the MALD setup authority.

NOTE: The ALD may support vendor-specific commands defined by other vendor(s).

Message format (Normative):

```
PrimaryCommand VendorSpecificCommand {
    CommandCode_t      Command ← 0x0090
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit
    DataLength_t       DataLength
    AsciiString_t      VendorCode[2]
    // more data defined by the vendor
}
```



```
ALDResponse VendorSpecificResponse {
    CommandCode_t      Command ← 0x0090
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    AsciiString_t      VendorCode[2]
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    InvalidSubunitNumber
    OutOfRange
    //more ReturnCode_ts as defined by the vendor
}
```

Primary pseudocode (Normative):

```
IF Cmd.Subunit is not one of 0..NrOfSubunits THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF Cmd.VendorCode is not in ListOfSupportedVendorCodes
    RETURN 0x???? (UnsupportedVendorCode)
    EXIT
ENDIF
```

This pseudo code above describes the global checks, the behaviour during processing of the vendor specific part of this command is defined by the vendor (Normative).

12.9. MALD commands

12.9.1. MALD Download Initiated

Description (Informative):

The MALD sends this command to notify the other connected primaries that one primary has initiated a download of a file.

Message format (Normative):

```
ALDCommand MALDDownloadInitiatedCommand {
    CommandCode_t      Command ← 0x0013
    CommandSequence_t  ALDCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

PrimaryResponse MALDDownloadInitiatedResponse {
    CommandCode_t      Command ← 0x0013
    CommandSequence_t  ALDCommandSequence
    ReturnCode_t       ReturnCode ← OK
    DataLength_t       DataLength ← 0
}
```



Primary pseudocode (Normative):

```
«Send DownloadInitiatedResponse»  
«Try to re-establish the layer 2 link to the MALD»  
EXIT
```

ALD pseudocode (Normative):

```
ON «receipt of the MALDDownloadInitiatedResponse(PORT)» DO  
    UNLESS ConnectionState[PORT] = DownloadNotificationConnectionState THEN  
        EXIT  
    ENDIF  
  
    Decrement MALDDownloadInitiatedResponseCounter by 1  
    SWITCH ConnectionState[PORT] TO OffConnectionState  
    SWITCH LinkState[PORT] TO NoAddress  
    «Disable serial port PORT»  
  
    IF MALDDownloadInitiatedResponseCounter = 0 THEN  
        SIGNAL StartDownloadEvent  
    ENDIF  
  
DONE
```

12.9.2. MALD Get Information

Description (Informative):

The ALD provides information about MALD physical organisation. The ALD returns the following:

- setup commit counter value
- number of control ports within the MALD
- list of control port numbers
- number of subunits within the MALD
- list of subunit number and type tuples

Message format (Normative):

```
PrimaryCommand MALDGetInformationCommand {  
    CommandCode_t      Command ← 0x0014  
    CommandSequence_t  PrimaryCommandSequence  
    Subunit_t          Subunit ← 0  
    DataLength_t       DataLength ← 0  
}
```



```
ALDResponse MALDGetInformationResponse {
    CommandCode_t      Command ← 0x0014
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t        MALDCommitSetupCounter
        uint16_t        NrOfMALDControlPorts
        uint16_t        MALDControlPortNumber[NrOfMALDControlPorts]
        uint16_t        NrOfSubunits
        SubunitTypeListElement_t  Subunits[NrOfSubunits]
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    UnknownCommand
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
```

ENDIF

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

```
UNLESS result.allowed THEN
```

```
    RETURN result.code
```

```
EXIT
```

ENDIF

```
RETURN OK, «setup commit counter value, number of control ports, list of control ports
numbers, number of subunits, the list of subunits including subunit number and subunit type»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```



12.9.3. MALD Start Setup

Description (Informative):

The ALD copies the active setup to the volatile setup copy and enters the MALDSetupState. The control port used to issue the command is stored as the transaction port and the 5-minute transaction timeout timer is started.

Message format (Normative):

```
PrimaryCommand MALDStartSetupCommand {
    CommandCode_t      Command ← 0x0018
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           MALDCommitSetupCounter
}

ALDResponse MALDStartSetupResponse {
    CommandCode_t      Command ← 0x0018
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    IncorrectCommitCounter
    NotAuthorised
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF ActiveAuth.[CurrentPort].SetupPermission = NotAllowed THEN
    RETURN NotAuthorised
EXIT
ENDIF
```



```
UNLESS Msg.MALDCommitSetupCounter = ActiveCommitCounter THEN
    RETURN IncorrectCommitCounter
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

VolatileAuth ← ActiveAuth
SWITCH ALDState TO MALDSetupState

FOREACH PORT FROM 1 TO MaxPort DO
    NEXT IF PORT = CurrentPort
    SWITCH ConnectionState[Port] TO RestrictedConnectionState
ENDFOR

SWITCH ConnectionState[CurrentPort] TO MALDSetupConnectionState
PendingConnectionStateChange ← false
UNLOCK StateLock
RETURN OK
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.9.4. MALD Commit Setup

Description (Informative):

The ALD validates the setup in the volatile copy and if validation is successful:

- Copies the volatile MALD setup to the active setup
- Sets the transaction state to inactive
- Increments the MALD commit setup counter by 1 (by 2 if it was 65535)
- Activates the new setup
- Performs a reset

Message format (Normative):

```
PrimaryCommand MALDCommitSetupCommand {
    CommandCode_t      Command ← 0x0019
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}
```




```
ALDResponse MALDCommitSetupResponse {
    CommandCode_t      Command ← 0x0019
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    UnsupportedMALDSetup
    InvalidSubunitNumber
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
uint16_t COUNT
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

result ← IsStateChangeAllowed( LIST{ MALDSetupConnectionState},
                               Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

IF VolatileAuth[CurrentPort].SetuPermission = NotAllowed
    OR «supplied setup is unsupported» THEN
    RETURN UnsupportedMALDSetup
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    CommandExit(Cmd.Command, CurrentPort)
EXIT
ENDIF

FOREACH N FROM 1 TO NrOfSubunits DO
    COUNT ← 0
```



```
    FOREACH PORT FROM 1 TO MaxPort DO
        IF VolatileAuth[PORT].Authority[N] = ReadWrite THEN
            COUNT ← COUNT + 1
        ENDIF
    ENDFOR

    IF COUNT > 1 THEN
        RETURN UnsupportedMALDSetup
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF
ENDFOR

IF ActiveCommitCounter = 65535 THEN
    VolatileCommitCounter ← 1
ELSE
    VolatileCommitCounter ← ActiveCommitCounter + 1
ENDIF

«Store VolatileAuth in ActiveAuth»
«Store VolatileCommitCounter in ActiveCommitCounter»

IF «the ALD detects a hardware error» THEN
    // Replace "Hardware error" with a text describing the problem
    RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
    RETURN GeneralError
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    CommandExit(Cmd.Command, CurrentPort)
    EXIT
ENDIF

RETURN OK
«Wait for layer 2 acknowledgement (RR) from the primary»
«Perform a reset»
EXIT
```

12.9.5. MALD Abort Setup

Description (Informative):

The ALD discards the contents of the volatile setup, exits the MALDSetupState and returns to the OperatingState.

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Message format (Normative):

```
PrimaryCommand MALDAbortSetupCommand {
    CommandCode_t      Command ← 0x001A
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse MALDAbortSetupResponse {
    CommandCode_t      Command ← 0x001A
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

result ← IsStateChangeAllowed( LIST{ MALDSetupConnectionState},
                               Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

RETURN OK
SWITCH ALDState TO OperatingState
SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
PendingConnectionStateChange ← false
UNLOCK StateLock
CommandExit(Cmd.Command, CurrentPort)
EXIT
```



12.9.6. MALD Reset Setup

Description (Informative):

The ALD re-initialises all configurable authorities within the MALD to the default setup.

Message format (Normative):

```
PrimaryCommand MALDResetSetupCommand {
    CommandCode_t      Command ← 0x0017
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse MALDResetSetupResponse {
    CommandCode_t      Command ← 0x0017
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    InvalidSubunitNumber
    IncorrectState
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

result ← IsStateChangeAllowed( LIST{ MALDSetupConnectionState},
                               Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

FOREACH PORT FROM 1 TO MaxPort DO
    VolatileAuth[PORT].SetupPermission = Allowed
    VolatileAuth[PORT].SWDownloadPermission = Allowed
```



```
FOREACH SUBUNIT FROM 1 TO NrofSubunits DO
    VolatileAuth[PORT].Authority[SUBUNIT] = ReadWrite
ENDFOR

ENDFOR

VolatileCommitCounter ← 0
«Store VolatileAuth in ActiveAuth»«Store VolatileCommitCounter in ActiveCommitCounter»

IF «the ALD detects a hardware error» THEN
    // Replace "Hardware error" with a text describing the problem
    RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
    RETURN GeneralError
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    CommandExit(Cmd.Command, CurrentPort)
    EXIT
ENDIF

RETURN OK
«Wait for layer 2 acknowledgement (RR) from the primary»
«Perform a reset»
EXIT
```

12.9.7. MALD Set Subunit Authority

Description (Informative):

The ALD modifies the authority of the specified setup target subunit for the specified setup target control port (that is, for the primary connected to that port).

This is stored in the volatile setup copy.

Message format (Normative):

```
PrimaryCommand MALDSetSubunitAuthorityCommand {
    CommandCode_t      Command ← 0x0015
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 5
    Subunit_t          ConfTargetSubunit
    uint16_t           ConfTargetPortNumber
    AuthorityType_t    Authority
}
```



```
ALDResponse MALDSetSubunitAuthorityResponse {
    CommandCode_t      Command ← 0x0015
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```

```
Enumeration ReturnCode_t{
    OK
    FormatError
    Busy
    UnknownCommand
    IncorrectState
    InvalidSubunitNumber
    InvalidAuthority
    InvalidConfTargetSubunitNumber
    InvalidConfTargetPortNumber
    NotControlCapablePort
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF Cmd.Subunit ≠ 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.ConfTargetSubunit is not one of 1..NrOfSubunits» THEN
    RETURN InvalidConfTargetSubunitNumber
EXIT
ENDIF

IF «Cmd.ConfTargetPortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidConfTargetPortNumber
EXIT
ENDIF

UNLESS PortProperties[Cmd.ConfTargetPortNumber] = RS485ControlPort
OR PortProperties[Cmd.ConfTargetPortNumber] = RFControlPort THEN
    RETURN NotControlCapablePort
EXIT
ENDIF IF «Cmd.Authority is not one of AuthorityType» THEN
    RETURN InvalidAuthority
EXIT
ENDIF

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



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

```
VolatileAuth[Cmd.ConfTargetPortNumber].Authority[Cmd.ConfTargetSubunit] ←
Cmd.Authority
RETURN OK
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.9.8. MALD Get Subunit Authority

Description (Informative):

The ALD responds with the authority off the specified setup target subunit for the specified setup target control port (that is, for the primary connected to that port).

Message format (Normative):

```
PrimaryCommand MALDGetSubunitAuthorityCommand {
    CommandCode_t      Command ← 0x0016
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 5
    Subunit_t          ConfTargetSubunit
    uint16_t           ConfTargetPortNumber
    SettingSourceType_t SettingSourceType
}

ALDResponse MALDGetSubunitAuthorityResponse {
    CommandCode_t      Command ← 0x0016
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        AuthorityType_t Authority
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    TransactionNotInProgress
    InvalidSubunitNumber
    InvalidSettingSource
    IncorrectState
    InvalidConfTargetSubunitNumber
    InvalidConfTargetPortNumber
    NotControlCapablePort
}
```



Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF Cmd.Subunit ≠ 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF «Cmd.ConfTargetSubunit is not one of 1..NrOfSubunits» THEN
    RETURN InvalidConfTargetSubunitNumber
    EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
    EXIT
ENDIFUNLESS PortProperties[Cmd.ConfTargetPortNumber] = RS485ControlPort
OR PortProperties[Cmd.ConfTargetPortNumber] = RFControlPort THEN
    RETURN NotControlCapablePort
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

CASE Cmd.SettingSourceType IS
    WHEN Volatile:
        IF ConnectionState[CurrentPort] ≠ MALDSetupState THEN
            RETURN TransactionNotInProgress
        ENDIF
        RETURN OK «and» VolatileAuth[Cmd.PortNumber].Authority[Cmd.Subunit]
    WHEN Active:
        RETURN OK «and» ActiveAuth[Cmd.PortNumber].Authority[Cmd.Subunit]
    OTHERWISE
        RETURN InvalidSettingSource
ENDCASE

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




12.9.9. MALD Set Security Setting

Description (Informative):

The ALD modifies the specified MALD security setting of the specified control port (that is for the connected primary) in the volatile setup copy.

Message format (Normative):

```
PrimaryCommand MALDSetSecuritySettingCommand {
    CommandCode_t      Command ← 0x001B
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 4
    uint16_t           PortNumber
    SecurityType_t     SecurityType
    SecuritySetting_t  SecuritySetting
}

ALDResponse MALDSetSecuritySettingResponse {
    CommandCode_t      Command ← 0x001B
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    OutOfRange
    IncorrectState
    InvalidSubunitNumber
    InvalidPortNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
EXIT
ENDIF
```



```
IF «Cmd.SecuritySetting is not one of SecuritySetting» THEN
    RETURN OutOfRange
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

CASE Cmd.SecurityType IS
    WHEN MALDSetup:
        VolatileAuth[Cmd.PortNumber].SetupPermission ← Cmd.SecuritySetting
    WHEN SWDownload:
        VolatileAuth[Cmd.PortNumber].SWDownloadPermission ← Cmd.SecuritySetting
    OTHERWISE
        RETURN UnsupportedSecuritySetting
ENDCASE

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

12.9.10. MALD Get Security Setting

Description (Informative):

The ALD responds with the specified MALD security setting of the specified control port (that is for the connected primary).

Message format (Normative):

```
PrimaryCommand MALDGetSecuritySettingCommand {
    CommandCode_t      Command ← 0x001C
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 3
    uint16_t           PortNumber
    SettingSource_t    SettingSourceType
}
```

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```
ALDResponse MALDGetSecuritySettingResponse {
    CommandCode_t      Command ← 0x001C
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        SecuritySetting_t  MALDSetupSecuritySetting
        SecuritySetting_t  SWDownloadSecuritySetting
    }
    else {
        ALDState_t         ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    InvalidSettingSource
    InvalidPortNumber
    InvalidSubunitNumber
    IncorrectState
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF
```

```
IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
EXIT
ENDIF
```

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

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

```
CASE SettingSourceType IS
    WHEN Volatile:
        Response.SetupPermission ← VolatileAuth[Cmd.PortNumber].SetupPermission
        Response.SWDownloadPermission ←
            VolatileAuth[Cmd.PortNumber].SWDownloadPermission
    RETURN OK
```



```
WHEN Active:
    Response.SetupPermission ← ActiveAuth[Cmd.PortNumber].SetupPermission
    Response.SWDownloadPermission ←
        ActiveAuth[Cmd.PortNumber].SWDownloadPermission
    RETURN OK
OTHERWISE
    RETURN InvalidSettingSource
ENDCASE
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.10. Site mapping commands

12.10.1. Get Number Of Ports

Description (Informative):

The ALD responds with its total number of ports regardless of their functionality (RF, AISG control, power supply ...).

Message format (Normative):

```
PrimaryCommand GetNumberOfPortsCommand {
    CommandCode_t      Command ← 0x001E
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse GetNumberOfPortsResponse {
    CommandCode_t      Command ← 0x001E
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t        NrOfPorts ← MaxPort
    }
    else if {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK «and number of ALD's ports»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.10.2. Get Port Info

Description (Informative):

The ALD provides, for the specified port, its properties, direction and the subunits associated with the port regardless authority setting.

Message format (Normative):

Port Property	Description
Direction	The direction of the port is indicated by the value: 0 means the port connects towards the antenna, 1 means the port connects towards the base station.
RS-485	The port is an RS-485 port.
RF	The port is an RF port.
Control	A layer 2 link can be established to this ALD through this port.
Ping	The port is able to send or receive a Ping message.
OOK	The port is an OOK port.
DC-IN	The ALD can be supplied with DC through this port.
DC-OUT	The port is able to supply DC.

Table 12.10.2-1: Description of Port Properties

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Port Properties Type	Direction Towards	RF	Ping	DC OUT	DC IN	RS 485	OOK	Control
RFAntPort	Antenna	✓						
RFAntPingPort	Antenna	✓	✓					
RFAntOOKPort	Antenna	✓		✓			✓	
RS485OutPort	Antenna			✓		✓		
RFBTSPort	Base station	✓						
RFBTSPingPort	Base station	✓	✓					
RFBTSOOKPort	Base station	✓			✓		✓	
RS485InPort	Base station				✓	✓		
RS485ControlPort	Base station				✓	✓		✓
RFCControlPort	Base station	✓			✓		✓	✓

Table 12.10.2-2: List of allowed PortPropertiesType and their composition

NOTE: The RF port on an antenna has the direction value 1 (TowardsBasestation). The RF port of base station has the direction value 0 (TowardsAntenna).

```

Enumeration Provenance_t : uint8_t {
    NotSet      ← 0 // is not set
    Factory     ← 1 // is factory set
    File        ← 2 // is set by a configuration file
    Automatic   ← 3 // set by the ALD automatically
    Manual      ← 4 // manually set by the user
}

CONSTANT uint8_t TowardsAntenna      ← 0
CONSTANT uint8_t TowardsBasestation ← 1

Enumeration PortPropertyMasks_t : uint8_t {
    Direction ← 00000001B // 1
    RF         ← 00000010B // 2
    Ping       ← 00000100B // 4
    DC_OUT     ← 00001000B // 8
    DC_IN      ← 00010000B // 16
    RS_485     ← 00100000B // 32
    OOK        ← 01000000B // 64
    Control    ← 10000000B // 128
}

Enumeration PortPropertiesType_t : uint8_t {
    RFAntPort      ← TowardsAntenna + RF // 00000010B (2)
    RFAntPingPort  ← TowardsAntenna + RF + Ping // 00000110B (6)
    RFAntOOKPort   ← TowardsAntenna + DC_OUT + RF + OOK // 01001010B (74)
    RS485OutPort   ← TowardsAntenna + DC_OUT + RS_485 // 00101000B (40)
    RFBTSPort      ← TowardsBaseStation + RF // 00000011B (3)
    RFBTSPingPort  ← TowardsBaseStation + RF + Ping // 00000111B // (7)
    RFBTSOOKPort   ← TowardsBaseStation + DC_IN + RF + OOK // 01010011B (83)
    RS485InPort    ← TowardsBaseStation + DC_IN + RS_485 // 00110001B (49)
    RS485ControlPort ← Control + TowardsBaseStation + DC_IN + RS_485 // 10110001B (177)
    RFCControlPort ← Control + TowardsBaseStation + DC_IN + RF + OOK // 11010011B (211)
}

PortPropertiesType_t PortProperties[MaxPort]
    
```



```
PrimaryCommand GetPortInfoCommand {
    CommandCode_t      Command ← 0x001F
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           PortNumber
}

ALDResponse GetPortInfoResponse {
    CommandCode_t      Command ← 0x001F
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        PortPropertiesType_t PortProperties
        Provenance_t         PortPropertiesProvenance
        uint16_t             NrOfAssociatedSubunits
        uint16_t             AssociatedSubunits[NrOfAssociatedSubunits]
    }
    Provenance_t         AssociatedSubunitProvenance
}
else {
    ALDState_t          ALDState
    ConnectionState_t   ConnectionState
}
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidPortNumber
    InvalidSubunitNumber
}
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
EXIT
ENDIF

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



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

```
RETURN OK, «PortProperties[Cmd.PortNumber] with the corresponding provenances, the
list of subunit numbers associated with the port with the corresponding provenances»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.10.3. Get RF Port Frequency Info

Description (Informative):

The ALD provides the frequency information for the specified RF port.

Message format (Normative):

```
PrimaryCommand GetRFPortFrequencyInfoCommand {
    CommandCode_t      Command ← 0x0025
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           PortNumber
}

ALDResponse GetRFPortFrequencyInfoResponse {
    CommandCode_t      Command ← 0x0025
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    uint16_t           PortNumber
    if (ReturnCode == OK) {
        Frequencies_t   PortFrequencies           // See Section 13. "BINARY BASED
                                                    // FREQUENCY CODING"
        Provenance_t    PortFrequenciesProvenance
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidPortNumber
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» OR
    PortProperties of Cmd.PortNumber ≠ RF THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

RETURN OK, «the port frequency information and the corresponding provenances»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.10.4. Get Port Interconnections

Description (Informative):

The ALD provides information about interconnections between ports within an ALD.

NOTE: The interconnection must be reported symmetrically i.e. by both endpoint ports of the interconnection.

Message format (Normative):



Interconnection Type	Description
AISGCom	AISG communication is connected between two RS-485 ports or between an OOK port and an RS-485 port within an ALD.
OOKBypass	OOK signal is connected between two RF ports within an ALD, bypassing a functionality that does not support OOK transmission. If an ALD supports the ping process, the OOKBypass is deactivated during the ping process.
RF	RF signal is connected between two RF ports within an ALD. This interconnection may contain devices such as amplifiers or filters.
DC	DC is connected between two DC ports within an ALD.

Table 12.10.4-1: Description of Interconnection Types

```

Bitfield InterconnectionType_t : uint8_t {
    InterAISGCom      : Bit 0
    InterOOKBypass   : Bit 1
    InterRF           : Bit 2
    InterDC           : Bit 3
}

PrimaryCommand GetPortInterconnectionsCommand {
    CommandCode_t      Command ← 0x0020
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           PortNumber
}

ALDResponse GetPortInterconnectionsResponse {
    CommandCode_t      Command ← 0x0020
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t        NrOfConnectedPorts
        uint16_t        ConnectedPortNumber[NrOfConnectedPorts]
        InterconnectionType_t PortConnections[NrOfConnectedPorts]
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    InvalidPortNumber
}
    
```

Primary pseudocode (Normative):

(This section is intentionally left blank)



ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

IF Cmd.PortNumber «has at least one interconnected Port» THEN
    RETURN OK, «the requested PortNumber, number of interconnected ports, the
    currently interconnected ports and the type of interconnection with corresponding
    interconnection type»
ELSE
    RETURN OK, «the number of interconnected ports»
ENDIF

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

12.10.5. Set RF Path IDs

Description (Informative):

The ALD stores the list of RF Path IDs to the specified port. The ALD has a separate RF Path IDs list on each port for each primary.

Message format (Normative):

NOTE: After any antenna line configuration change, the mapping of the RF Path ID Alias must be revalidated and possibly regenerated.

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```
PrimaryCommand SetRFPATHIDsCommand {
    CommandCode_t      Command ← 0x0021
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength
    uint16_t           PortNumber
    uint8_t            NrOfRFPATHIDs
    uint16_t           RFPATHIDs[NrOfRFPATHIDs]
    Provenance_t       RFPATHIDsProvenance // Provenance manual indicates
                                           // that the RFPATHID has been
                                           // supplied by the user.
                                           // Automatic indicates that
                                           // primary has assigned it with
                                           // an automated algorithm.
}

ALDResponse SetRFPATHIDsResponse {
    CommandCode_t      Command ← 0x0021
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      State
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    InvalidPortNumber
    TooManyArguments
    IncorrectPortType
    InvalidProvenance
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
EXIT
ENDIF
```



```
IF (InterconnectionType[Cmd.PortNumber] bitwise AND InterRF) ≠ InterRF THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

IF Cmd. NrOfRFPathIDs > 6 THEN
    RETURN TooManyArguments
    EXIT
ELSEIF (PortProperties[Cmd.PortNumber] bitwise AND RF) ≠ RF THEN
    RETURN IncorrectPortType
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

// Factory provenance is reserved to be used by
// production equipment and is never allowed
// in the field commanded by the primary

IF RFPathIDsProvenance = (Factory OR File) THEN
    RETURN InvalidProvenance
    EXIT
ENDIF

«Store the RF Path IDs for the supplied PortNumber and Cmd.PortNumber to non-volatile
memory and provenances supplied by the primary »
// I.e Auto or Manual
IF «the ALD detects a hardware error» THEN
    // Replace "Hardware error" with a text describing the problem
    RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
    RETURN GeneralError
ELSE
    RETURN OK
ENDIF

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

12.10.6. Set RF Path ID Alias

Description (Informative):

The ALD stores the list of RF Path ID Alias to the specified port. The ALD has a separate RF Path ID Alias list on each port for each primary. This alias may be used to give a user-friendly description of the RF path identified by RFPathID.



Message format (Normative):

```
PrimaryCommand SetRFPathIDAliasCommand {
    CommandCode_t      Command ← 0x0022
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength
    uint16_t           RFPathID
    uint8_t            LengthOftheRFPathAlias
    UTF8String_t       RFPathIDAlias // max 32 octets
    Provenance_t       RFPathIDsAliasProvenance // Provenance manual indicates
                                                    // that the RFPathID has been
                                                    // supplied by the user.
                                                    // Automatic indicates that
                                                    // primary has assigned it with
                                                    // an automated algorithm.
}

ALDResponse SetRFPathIDAliasResponse {
    CommandCode_t      Command ← 0x0022
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t     ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    OutOfRange
    InvalidRFPathID
    InvalidProvenance
    GeneralError
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.RFPathID is out of range» THEN
    RETURN InvalidRFPathID
EXIT
ENDIF
```



```
IF Cmd.LengthOftheRFPathIDAlias > 32 THEN
    RETURN OutOfRange
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

// Factory provenance is reserved to be used by
// production equipment and is never to allowed
// in the field commanded by the primary

IF RFPathIDAliasProvenance = (Factory OR File) THEN
    RETURN InvalidProvenance
    EXIT
ENDIF

«Store the RF Path ID Alias for the supplied RFPathID and Cmd.PortNumber to non-volatile
memory and provenances supplied by the primary»
// I.e Auto or Manual

IF «the ALD detects a hardware error» THEN
    // Replace "Hardware error" with a text describing the problem
    RAISE AlarmGeneralError SEVERITY Major ON ALD, "Hardware error"
    RETURN GeneralError
ELSE
    RETURN OK
ENDIF

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

12.10.7. Get RF Path IDs

Description (Informative):

The ALD provides the RFPathID list for the requested port number. The ALD has a separate RF Path ID list on each port for each primary.

Message format (Normative):

```
PrimaryCommand GetRFPathIDsCommand {
    CommandCode_t      Command ← 0x0023
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           PortNumber
}
```



```
ALDResponse GetRFPathIDsResponse {
    CommandCode_t      Command ← 0x0023
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint16_t        NrOfRFPathIDs
        uint16_t        RFPathIDs[NrOfRFPathIDs]
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    InvalidPortNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
EXIT
ENDIF

RETURN OK, «number of stored RF Path IDs and the list of RF Path IDs of requested port
and Cmd.PortNumber»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```




12.10.8. Get RF Path ID Alias

Description (Informative):

The ALD provides the RFPATHIDAlias for the RFPATHID. The ALD has a separate RF Path ID Alias list on each port for each primary.

Message format (Normative):

```
PrimaryCommand GetRFPATHIDAliasCommand {
    CommandCode_t      Command ← 0x0024
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 2
    uint16_t           RFPATHID
}

ALDResponse GetRFPATHIDAliasResponse {
    CommandCode_t      Command ← 0x0024
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint8_t         LengthOftheRFPATHIDAlias
        UTF8String_t    RFPATHIDAlias // max 32 octets
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    IncorrectState
    InvalidSubunitNumber
    InvalidRFPATHID
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
EXIT
ENDIF

IF «Cmd.RFPATHID is out of range» THEN
    RETURN InvalidRFPATHID
EXIT
ENDIF
```



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

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

```
RETURN OK, «the length of the RF Path ID Alias and the RFPATHIDAlias of the requested  
RFPATHID and Cmd.PortNumber»  
CommandExit(Cmd.Command, CurrentPort)  
EXIT
```

12.10.9. Get Connector Plate Marking Info

Description (Informative):

On the receipt of this command the ALD returns connector plate marking information for the indicated port. This information contains a group of strings that describe marking of the RF ports on the connector plate(s) of the device. If no data is provided for a particular field, an empty string shall be returned.

Message format (Normative):

```
PrimaryCommand GetConnectorPlateMarkingInfo {  
    CommandCode_t    Command ← 0x0029  
    CommandSequence_t PrimaryCommandSequence  
    Subunit_t        Subunit  
    DataLength_t     DataLength ← 2  
    uint16_t         PortNumber  
}  
  
ALDResponse GetConnectorPlateMarkingInfo {  
    CommandCode_t    Command ← 0x0029  
    CommandSequence_t PrimaryCommandSequence  
    ReturnCode_t     ReturnCode  
    DataLength_t     DataLength  
    if (ReturnCode == OK) {  
        uint8_t      LengthOfPortNumberString  
        TextString_t PortNumberString  
        Provenance_t PortNumberStringProvenance  
        uint8_t      LengthOfPortLabelString  
        TextString_t PortLabelString  
        Provenance_t PortLabelStringProvenance  
        uint8_t      LengthOfArrayIDString  
        TextString_t ArrayIDString  
        Provenance_t ArrayIDStringProvenance  
        uint8_t      LengthOfPolarizationMarkingString  
        TextString_t PolarizationMarkingString  
        Provenance_t PolarizationMarkingStringProvenance  
        uint8_t      LengthOfFrequencyMarkingString  
        TextString_t FrequencyMarkingString  
        Provenance_t FrequencyMarkingStringProvenance  
        uint8_t      LengthOfArrayPositionInfoString  
        TextString_t ArrayPositionInfoString  
        Provenance_t ArrayPositionInfoStringProvenance  
    }
```



```
uint8_t      LengthOfPortColourString
TextString_t PortColourString
Provenance_t PortColourStringProvenance
uint8_t      LengthOfAdditionalMarkingString
TextString_t AdditionalMarkingString
Provenance_t AdditionalMarkingStringProvenance
}
else {
    ALDState_t      ALDState
    ConnectionState_t  ConnectionState
}
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    IncorrectState
    InvalidPortNumber
    InvalidSubunitNumber
    InvalidSubunitType
    NotAntennaPort
    NotAuthorised
}
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
IF «Cmd.PortNumber is not one of 1...MaxPort» THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

IF ALDType = MALD
    AND ActiveAuth[CurrentPort].Authority[Cmd.Subunit] = NoAccess THEN
    RETURN NotAuthorised
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
RETURN OK, «PortNumberString, PortLabelString, ArrayIDString,
PolarizationMarkingString, FrequencyMarkingString, ArrayPositionInfoString,
PortColourString, AdditionalMarkingString and corresponding string lengths and
provenances»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```



12.11. Ping commands

12.11.1. Send Ping

Description (Informative):

This command makes the pinger enter PingerBroadcastWaitState.

If the ALD receives the layer 2 command TriggerPing within the next 10 seconds, it sends a layer 2 Ping message on the requested port.

If the 10 seconds expires, the ALD raises AlarmPingerTimeoutExpired.

See Section 8.4. “Pinging” for details.

Message format (Normative):

```
PrimaryCommand SendPingCommand {
    CommandCode_t      Command ← 0x0026
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 6
    uint16_t           PortNumber
    uint32_t           PrimaryID
}

ALDResponse SendPingResponse {
    CommandCode_t      Command ← 0x0026
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    PortInUse
    IncorrectState
    InvalidPortNumber
    InvalidSubunitNumber
    IncorrectPortType
    IncorrectDirection
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

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ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

UNLESS (PortProperties[Cmd.PortNumber] bitwise AND Direction) = TowardsBaseStation
THEN
    RETURN IncorrectDirection
    EXIT
ENDIF

UNLESS (PortProperties[Cmd.PortNumber] bitwise AND Ping) = Ping THEN
    RETURN IncorrectPortType
    EXIT
ENDIF

IF ALDType = MALD
    AND Cmd.PortNumber ≠ CurrentPort
    AND LinkState[Cmd.PortNumber] = Connected THEN
    RETURN PortInUse
    EXIT
ENDIF

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

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

PrimaryID ← Cmd.PrimaryID
RETURN OK

FOREACH PORT FROM 1 to MaxPort DO
    NEXT IF PORT = CurrentPort
    SWITCH ConnectionState[Port] TO RestrictedConnectionState
ENDFOR

SWITCH ConnectionState[CurrentPort] TO PingerConnectionState
SWITCH ALDState TO PingerBroadcastWaitState
PendingConnectionStateChange ← false
UNLOCK StateLock
«Initiate PingTimer at 10 seconds»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

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12.11.2. Monitor Ping

Description (Informative):

This command makes the listener enter the ListenerBroadcastWaitState.

If the ALD receives the layer 2 command TriggerPing within 10 seconds, it monitors the requested port for a Ping message.

If the 10 seconds expires, the ALD raises AlarmListenerTimeoutExpired.

See Section 8.4. “Pinging” for details.

Message format (Normative):

```
Enumeration MonitorPhase_t : uint8_t {
    Start      ← 0
    Middle     ← 1
    End        ← 2
}

PrimaryCommand MonitorPingCommand {
    CommandCode_t      Command ← 0x0027
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 3
    MonitorPhase_t     Phase
    uint16_t           PortNumber
}

ALDResponse MonitorPingResponse {
    CommandCode_t      Command ← 0x0027
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
        uint32_t       PrimaryID
    }
    else {
        ALDState_t     ALDState
        ConnectionState_t  ConnectionState
    }
}

Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    PortInUse
    IncorrectState
    IncorrectPortType
    InvalidPortNumber
    InvalidSubunitNumber
    InvalidMonitorPhase
    IncorrectDirection
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

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ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

IF «Cmd.PortNumber is not one of 1..MaxPort» THEN
    RETURN InvalidPortNumber
    EXIT
ENDIF

IF «Cmd.Phase is not one of (Start, Middle, End)» THEN
    RETURN InvalidMonitorPhase
    EXIT
ENDIF

IF (PortProperties[Cmd.PortNumber] bitwise AND Direction) ≠ TowardsAntenna THEN
    RETURN IncorrectDirection
    EXIT
ENDIF

UNLESS (PortProperties[Cmd.PortNumber] bitwise AND Ping) = Ping THEN
    RETURN IncorrectPortType
    EXIT
ENDIF

IF ALDType = MALD AND «Cmd.PortNumber port has an enabled OOK bypass to a port
with an active connection to another primary» THEN
    RETURN PortInUse
    EXIT
ENDIF

IF «Cmd.Phase is one of (Start, Middle)» THEN
    result ← IsStateChangeAllowed( LIST{ OperatingConnectionState},
                                   Cmd.Command, CurrentPort)

    UNLESS result.allowed THEN
        RETURN result.code
        EXIT
    ENDIF

    FOREACH PORT FROM 1 to MaxPort DO
        NEXT IF PORT = CurrentPort
        SWITCH ConnectionState[Port] TO RestrictedConnectionState
    ENDFOR

    SWITCH ConnectionState[CurrentPort] TO ListenerConnectionState
    SWITCH ALDState TO ListenerBroadcastWaitState
    PendingConnectionStateChange ← false
    UNLOCK StateLock
    PingMonitorRFPort ← Cmd.PortNumber
    «Initiate PingTimer at 10 seconds»
```



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

    UNLESS result.allowed THEN
        RETURN result.code
        CommandExit(Cmd.Command, CurrentPort)
        EXIT
    ENDIF
ENDIF

RETURN OK, «PingReceivedFlag and PrimaryID»
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

NOTE: If a Ping message was received, the returned PingReceivedFlag will be 1 and the PrimaryID is the ID received in the Ping message.

NOTE: If the monitoring timed out (Ping message not received), the PingReceivedFlag will be 0 and the returned PrimaryID is whatever was previously set.

NOTE: If the Monitoring phase is Start, the PingReceivedFlag will be 0 and the returned PrimaryID is whatever was previously set.

12.11.3. Abort Ping

Description (Informative):

If the ALD is in the ListenerBroadcastWaitState or in the PingerBroadcastWaitState, it shall return to the OperatingState.

See Section 8.4. “Pinging” for details.

Message format (Normative):

```
PrimaryCommand AbortPingCommand {
    CommandCode_t      Command ← 0x0028
    CommandSequence_t  PrimaryCommandSequence
    Subunit_t          Subunit ← 0
    DataLength_t       DataLength ← 0
}

ALDResponse AbortPingResponse {
    CommandCode_t      Command ← 0x0028
    CommandSequence_t  PrimaryCommandSequence
    ReturnCode_t       ReturnCode
    DataLength_t       DataLength
    if (ReturnCode == OK) {
    }
    else {
        ALDState_t      ALDState
        ConnectionState_t  ConnectionState
    }
}
```




```
Enumeration ReturnCode_t {
    OK
    FormatError
    Busy
    UnknownCommand
    IncorrectState
    InvalidSubunitNumber
}
```

Primary pseudocode (Normative):

(This section is intentionally left blank)

ALD pseudocode (Normative):

```
UNLESS Cmd.Subunit = 0 THEN
    RETURN InvalidSubunitNumber
    EXIT
ENDIF

result ← IsStateChangeAllowed( LIST{ ListenerConnectionState,
                                      PingerConnectionState},
                               Cmd.Command, CurrentPort)

UNLESS result.allowed THEN
    RETURN result.code
    EXIT
ENDIF

SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
SWITCH ALDState TO OperatingState
PendingConnectionStateChange ← false
UNLOCK StateLock
RETURN OK
CommandExit(Cmd.Command, CurrentPort)
EXIT
```

12.12. Timers

12.12.1. Ping Timer

Description (Informative):

This timer is used to synchronise the ping process.

See 8.4. “Pinging” for details.

Message format (Normative)

Upon PingTimer expiration:

```
IF ALDState = ListenerBroadcastWaitState THEN
    RAISE AlarmListenerTimeoutExpired SEVERITY Warning ON ALL, ""
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
```

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```
ELSEIF ALDState = PingerBroadcastWaitState THEN
    RAISE AlarmPingerTimeoutExpired SEVERITY Warning ON ALL, ""
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
ELSEIF ALDState = ListenerRestrictedPreparationState THEN
    PingReceivedFlag ← 0
    «Clear the receive buffer»
    SWITCH ALDState TO ListenerRestrictedMonitorState
    «Initiate PingTimer at 40 ms»
ELSEIF ALDState = PingerRestrictedState THEN
    «Queue Ping message for transmission»
    SWITCH ALDState TO PingerRestrictedTransmitState
ELSEIF ALDState = ListenerRestrictedMonitorState THEN
    «Select the initiating AISG port»
    SWITCH ALDState TO OperatingState
    SWITCH ConnectionState[1..MaxPort] TO OperatingConnectionState
ENDIF
EXIT
```



13. STRUCTURED FREQUENCY CODING

All frequency information shall be coded using the structure FrequencyRange_t below.

For each defined frequency range, the first position in the table contains the number of frequency ranges to be defined. This is followed by one or more frequency ranges containing a link descriptor and tuples of lower and upper frequency limits. These are listed in ascending order of lower, secondarily upper, frequency limit. The frequencies are always stated in kHz (rounded to the nearest integer).

If a device covers non-contiguous frequency bands they shall be separately specified.

If the characteristics of a device are not frequency-dependent, the number of frequency ranges shall be 0.

The Link Descriptor Bidirectional shall be used for devices that cover a frequency range which is for Uplink and Downlink. The descriptors Uplink and Downlink shall be used in all cases where a frequency range supports only one of these functions.

```
Enumeration LinkDescriptor_t: uint8_t {
    Uplink           ← 1
    Downlink         ← 2
    Bidirectional    ← 3
}

struct FrequencyRange_t {
    LinkDescriptor_t  Link
    uint32_t          MinFrequency // in kHz
    uint32_t          MaxFrequency // in kHz
}
```

Number of frequency ranges	Link Descriptor, range 1	Fmin, range 1	Fmax, range 1	Link Descriptor, range n	Fmin, range n	Fmax, range n
----------------------------	--------------------------	---------------	---------------	-------	--------------------------	---------------	---------------

Table 13-1: Frequency information



14. VERSION MANAGEMENT

The version numbering of this standard and the subunit type standards uses the following scheme.

14.1. Base standard versions

Base standard version va.b.c.d

- a is used to identify AISG release. This document is release 3
- b is used for feature introductions. Incremented every time a new feature is introduced into the standard.
- c is for technical updates. Incremented every time a technical change is introduced into the standard. Once under change control, such changes shall only occur when AISG approves one or more change requests. Set to zero every time b is incremented. Major changes require an update of b.
- d is for editorial updates. Clarifications of missing or ambiguous definitions shall be considered as editorial updates. Incremented every time a purely editorial change is introduced into the standard. Set to zero every time c is incremented or set to zero. d shall not be used in version negotiation.
- Document version v3.b.c.d defines base standard version v3.b.c, which is used for version negotiation (PI=22).

14.2. Subunit type standard versions

Subunit type standard version vXXXa.b.c.d (XXX is the subunit type acronym)

- a is used to identify AISG release. This document is release 3.
- b is used for feature introductions. Incremented every time a new feature is introduced into the standard.
- c is for technical updates. Incremented every time a technical change is introduced into the standard. Once under change control, such changes shall only occur when AISG approves one or more change requests. Set to zero every time b is incremented. Major changes require an update of b.
- d is for editorial updates. Clarifications of missing or ambiguous definitions shall be considered as editorial updates. Incremented every time a purely editorial change is introduced into the standard. Set to zero every time c is incremented or set to zero. d shall not be used in version negotiation.
- Document version vXXXa.b.c.d defines subunit type standard version vXXXa.b.c. Numbers a, b and c are used version negotiation on layer 7.

Each subunit type standard lists the base standard versions with which it is compatible.



Annex A: Examples of structure frequency coding (Informative):

This annex shows the structured frequency coding of various devices as examples.

Dec	0
Hex	0x00

Table A-1: Device (for example a sensor) with no frequency range, coded as having no frequency ranges

Dec	1	3	790000	960000
Hex	0x01	0x03	0x000C0DF0	0x000EA600

Table A-2: Logical antenna array with 790-960 MHz frequency range

Dec	2	1	832000	862000	2	791000	821000
Hex	0x02	0x01	0x000CB200	0x000D2730	0x02	0x000C11D8	0x000C8708

Table A-3: Dual TMA with 832-862 MHz RX and 791-821 MHz TX frequency ranges

Coded as two frequency ranges, defining transmit and receive direction of signals

Dec	4	1	1710000	1785000	1	1920000	1980000	...
Hex	0x04	0x01	0x001A17B0	0x001B3CA8	0x01	0x001D4C00	0x001E3660	...

...	2	1805000	1880000	2	2110000	2170000
...	0x02	0x001B8AC8	0x001CAFC0	0x02	0x00203230	0x00211C90

Table A-4: Twin TMA with 1710-1785 MHz and 1920-1980 MHz RX frequency ranges and 1805-1880 MHz and 2110-2170 MHz TX frequency ranges

NOTE: Coded as four frequency ranges, defining transmit and receive direction of signals



Annex B: Version management example (Informative):

The green digits are used for version negotiation at layer 2, the red digits are configured for each subunit type standard at layer 7.

Release history	Base document version	Subunit type standard ST-TMA document version	Subunit type standard ST-RET document version
Next AISG release	v3.0.0.0	-	-
Technical update of base doc	v3.0.1.0	-	-
Editorial update of base doc	v3.0.1.1	-	-
First version of ST-TMA subunit type standard	v3.0.1.1	vTMA3.0.0.0	-
Change of substance of subunit type standard ST-TMA	v3.0.1.1	vTMA3.0.1.0	-
Editorial update of subunit type standard ST-TMA	v3.0.1.1	vTMA3.0.1.1	-
Major change to base document that does not affect ST-TMA	v3.1.0.0	vTMA3.0.1.2	-
Major change to base document that affects ST-TMA	v3.2.0.0	vTMA3.1.0.0	-
First version of ST-RET subunit type standard	v3.2.0.0	vTMA3.1.0.0	vRET3.0.0.0

Table B-1: Version management example



Annex C: Ping process timing (Informative):

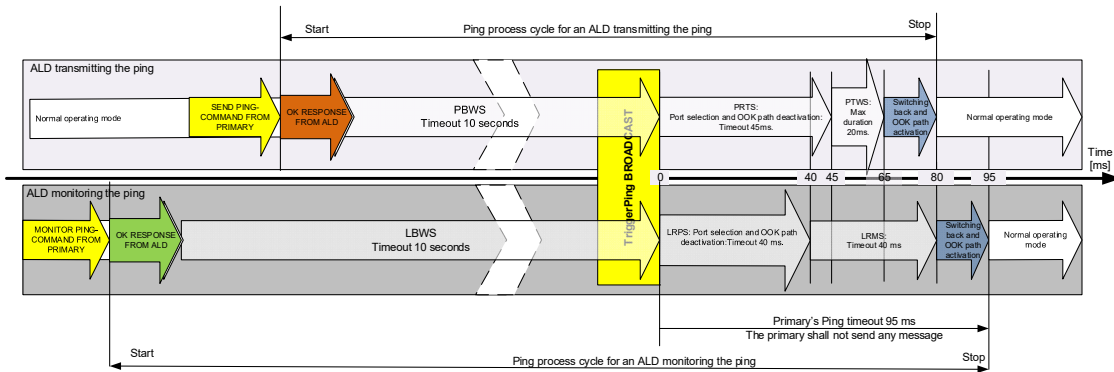


Figure C-1: Ping process with maximum state timeouts and durations

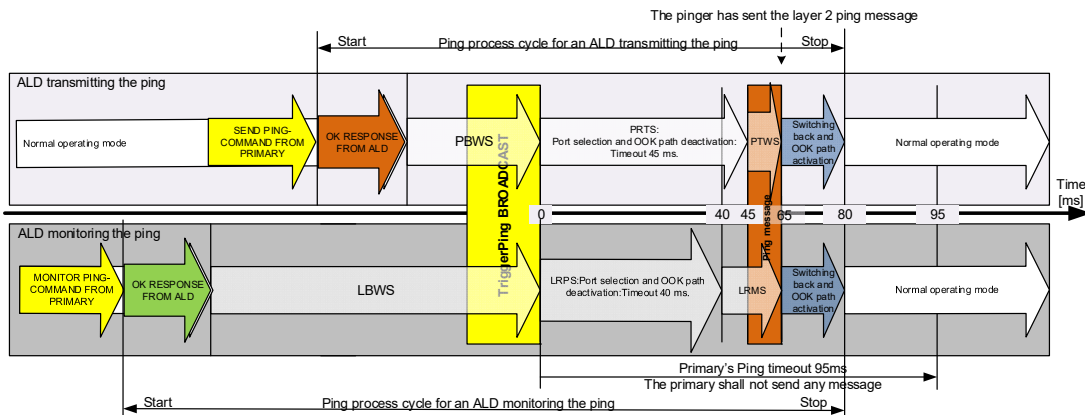


Figure C-2: Ping process timings in typical case

Ping State Abbreviations	Ping State Names
LBWS	ListenerBroadcastWaitState
LRMS	ListenerRestrictedMonitorState
LRPS	ListenerRestrictedPreparationState
PBWS	PingerBroadcastWaitState
PRTS	PingerRestrictedTransmitState
PTWS	PingerTransmitWaitState

Table C-1: Ping state abbreviations



Annex D: Examples of ALDs with different power mode values (Informative):

This annex shows various devices as examples. ATS is a temperature sensor and GLS is a geographic location sensor.

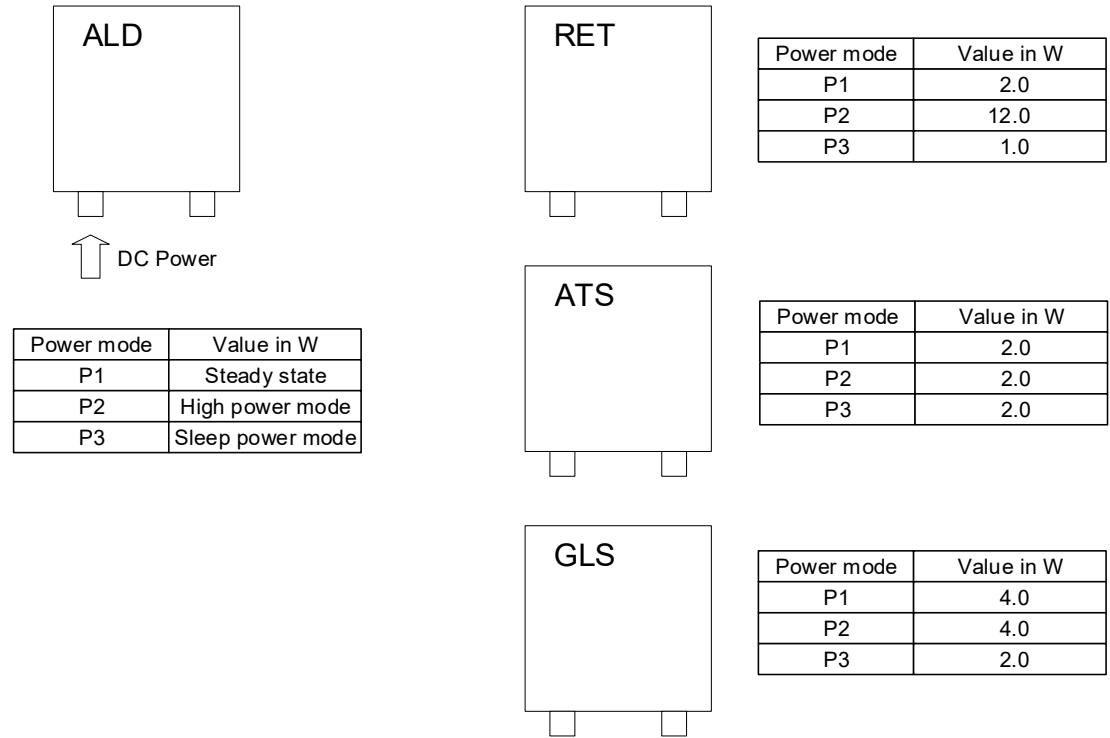


Figure D-1: An example for stand alone ALDs each with single subunit

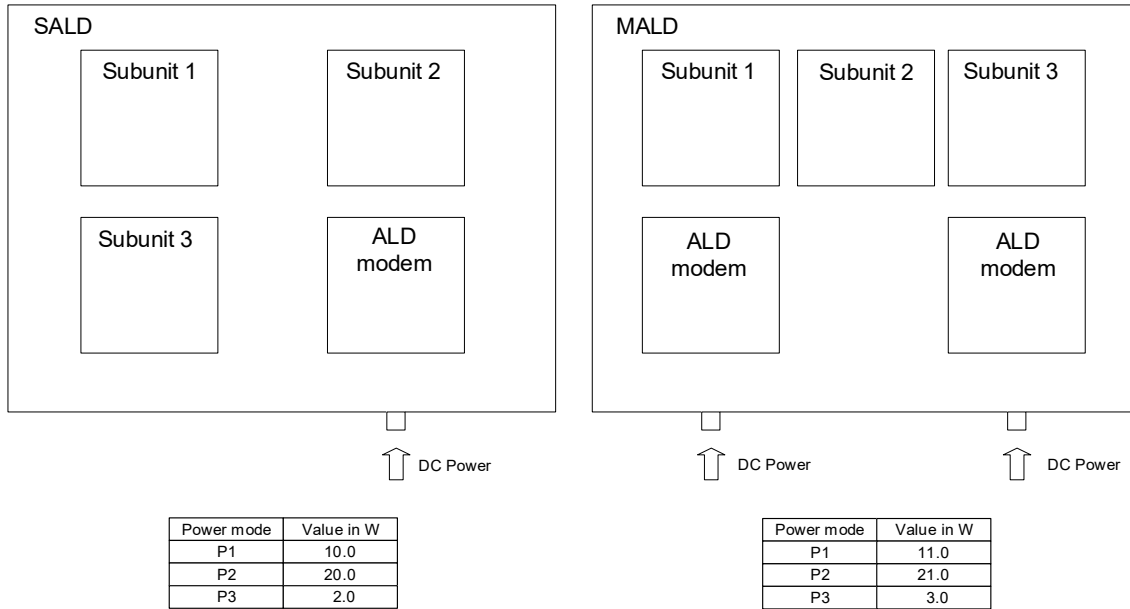


Figure D-2: An example for SALD and MALD