

BGAN XL Radio Module

Integrators manual



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BGAN XL Radio Module

Integrators Manual

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About this manual

1.1 Purpose

This document is the Integrators Manual for the TT-3750 BGAN XL Radio Module from Cobham SATCOM.

The manual describes the general principles for integrating the BGAN XL Radio Module (RM) in a product to provide access to the Inmarsat BGAN network. The manual is also intended as a reference manual for looking up details regarding protocols, parameters, commands, troubleshooting etc.

This manual covers software version 1.07 or higher.

1.2 Chapter overview

Chapter 2, *Introduction to BGAN*, describes the BGAN network, IAI-2 layering, the physical layer and user terminal classes.

Chapter 3, *Product overview*, lists the key features, applications, overview over interfaces available and some specifications.

Chapter 4, *System description*, provides an overall description of the BGAN XL Radio Module and introduces terms and functional behaviour of special importance for integrators.

Chapter 5, *Product specifications*, provides all physical specifications related to the BGAN XL Radio Module, e.g. mechanical outline, environmental specifications and electrical specifications of all interfaces.

Chapter 6, *Startup & configuration*, provides a complete and consistent description of the start-up procedure and the associated configuration parameters that the integrator meets to bring a BGAN XL Radio Module into an operational mode.

Chapter 7, *Data interfaces*, presents the services provided and the protocols used on the Data interface. The data interface applies standard protocols wherever possible and feasible. Furthermore the protocols applicable for the TSI interface used for ISDN data are described.

Chapter 8, *Control interface*, specifies the protocols applicable for the control-interface protocol. This protocol is a proprietary protocol specially designed to control and configure the BGAN XL Radio Module.

Chapter 9, *RF & RF control interface*, describes the behaviour of the RF interfaces and specifies the associated RF control interface which specially design to provide the integrator with the required information of the RF interfaces.

Chapter 10, *Test & diagnostics*, provides information about available tests and monitoring capabilities.

Chapter 11, *Terminal support*, describes the available functions to support integration, operation and troubleshooting of a complete terminal with a BGAN XL Radio Module.

Chapter 12, *Use cases*, presents use cases which can provide inspiration when integrating the BGAN XL Radio Module into a product.

Chapter 13, *Applications*, shows some applications.

Chapter 14, *Type approval*, introduces and describes the various parts of an Inmarsat type approval, i.e. a general introduction to an Inmarsat type approval procedure and an introduction of the generic type approval hold by the BGAN XL Radio Module.

1.3 Manual variants (FOR INTERNAL USE)

The manual is prepared to be published in two variants:

- An extended variant with more detailed information intended for internal use only.
- A variant intended to be distributed to external partner (under NDA)

To clearly identify which parts of the documents that will be omitted in the variant intended for distribution to external partners, these sections/parts are marked **FOR INTERNAL USE**.

The manual released to external partners will differ on the following points:

- Sections and text parts marked **FOR INTERNAL USE** will be hidden.
- The document will have a different order number.
- The footer will change from **Confidential – For internal use** to **Confidential**.



WARNING! Information marked as **FOR INTERNAL USE** covers all employees in the Cobham SATCOM SBU and should not be passed on to external partners!

1.4 Recommended terminology (FOR INTERNAL USE)

The purpose of the following writing guidelines is to ensure consistency in the naming of the different terms through out the entire manual.

Term to use	Other terms used for the same thing
Terminal	A terminal may in other documents be called UE (User equipment) or UT (User Terminal).
Board processor	Control processor or master processor
Application processor	Data processor
Reference clock	Master oscillator, reference oscillator or ref. clock
Data interface	USB interface
Control interface	Board processor interface
User	Used to address the end-user of the terminal.
Integrator	Used to address the integrator of the BGAN XL Radio Module i.e the terminal vendor.
BGAN air interface	air interface
B2B Connector	User Connector, Data Connector or Multi pin Connector

Table 1-1: Recommended terminology

1.5 Intended readers

The intended readers of this manual should understand the basics of satellite communications, systems, software, hardware, RF and mechanical engineering. The document is targeted towards the systems engineering and integrator team who has overall responsibility that the system described in this specification meets the implementation requirements of the Inmarsat BGAN system.

1.6 Typography (FOR INTERNAL USE)

In this manual, typography is used as indicated below:

Bold is used for the following purposes:

To emphasize words or parameter names.

Example: Example: “The **sys.status.mode** parameter reflects ...Do **not** touch the antenna”.

Italic is used to emphasize the paragraph title in cross-references.

Example: “For further information, see *Connecting Cables* on page...”.

Make cross-references according to the following guidelines:

Cross-references **to a table or figure within the same section** are referred to with table or figure number and either ‘above’ or ‘below’. This also applies if the item referred to is on another page.

Example: “Figure 5-7 below shows...”

Cross-references **to a table or figure in another section** should be referred to with table or figure number **and** page number.

Example: “In Figure 4-1 on page 4-4 is shown...”

Cross-references **to other sections** are referred to with section number **and** page number. This also applies if the item referred to is on another page.

Example: “... see section 8.2 on page 8-2.”

1.7 Precautions

1.7.1 Warnings, Cautions and Notes

Text marked with “Warning”, “Caution”, “Note” or “Important” show the following type of data:

- **Warning:** A Warning is an operation or maintenance procedure that, if not obeyed, can cause injury or death, or jeopardize the safety.
- **Caution:** A Caution is an operation or maintenance procedure that, if not obeyed, can cause damage to the equipment.
- **Note:** A Note gives information to help the reader.
- **Important:** A text marked Important gives information that is important to the user, e.g. to make the system work properly. This text does **not** concern damage on equipment nor personal safety.

1.7.2 General precautions

All personnel who operate equipment or do maintenance as specified in this manual must know and follow the safety precautions. The warnings and cautions that follow apply to all parts of this manual.



WARNING! Before using any material, refer to the manufacturers' material safety data sheets for safety information. Some materials can be dangerous.



CAUTION! Do not use materials that are not equivalent to materials specified by Cobham SATCOM. Materials that are not equivalent can cause damage to the equipment.



CAUTION! The system contains items that are electrostatic discharge sensitive. Use approved industry precautions to keep the risk of damage to a minimum when you touch, remove or insert parts or assemblies.

Introduction to BGAN

This chapter has the following sections:

2.1	About the BGAN network	2-2
2.1.1	IAI-2 Layering	2-3
2.1.2	Physical layer	2-4
2.2	User terminal classes	2-6

2.1 About the BGAN network

The BGAN system was developed to provide 3GPP (3rd Generation Partnership Project) services to portable mobile terminals via the Inmarsat-4 (I-4) satellites, offering up to 858 kbps to the highest capability mobile terminals. BGAN delivers 'always-on' Internet Protocol (IP) services, telephony and ISDN. Using the I-4 satellites and a new generation of small, light user equipment, BGAN delivers higher data rates at lower costs than any previous Inmarsat system.

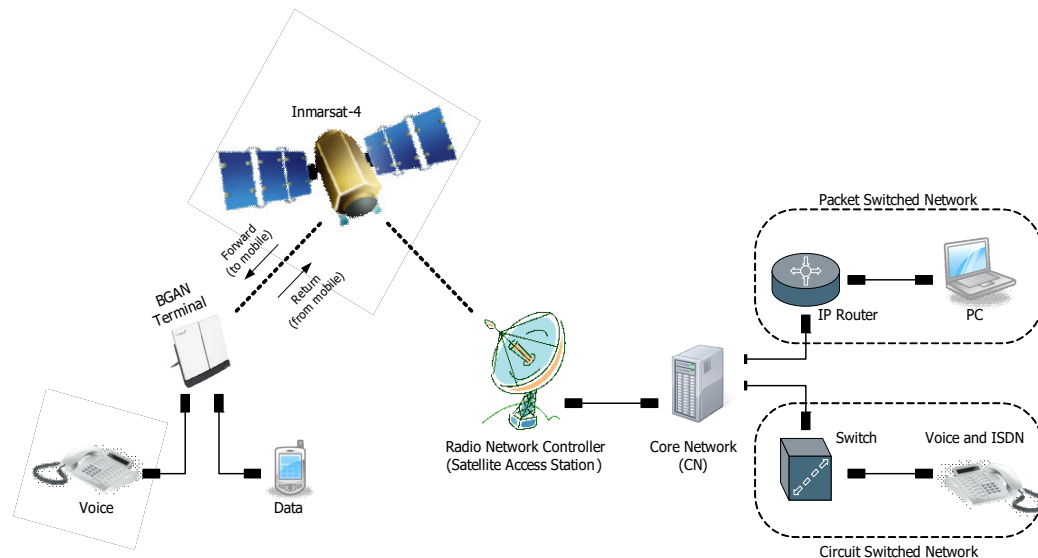


Figure 2-1: BGAN satellite network

The I-4 satellites are some of the largest geostationary satellites in service. The dry mass of the spacecraft is estimated at around 3400 kg, with a separation mass in the region of 6000 kg. They are based on Astrium's Eurostar 3000 platform and contain a 9 m unfurlable reflector that provides a global beam, 19 regional beams, and approximately 228 spot beams. Each is 60 times more powerful than an Inmarsat-3 satellite. The BGAN system maximizes the use of this satellite capacity by reallocating it dynamically to meet demand, to ensure that bandwidth is always available when and where users need it.

The first two I-4 satellites were launched on 11 March and 8 November 2005. The third I-4 was launched on 18 August 2008, enabling Inmarsat to provide BGAN services worldwide.

BGAN supports Circuit Switched (CS) and Packet Switched (PS) services. CS services include dial-on-demand digitized 4 kbps voice and 64 kbps ISDN. PS services include standard (or background) IP, which is charged by volume, and streaming mode IP, which provides guaranteed Quality of Service (QoS) and is charged by time. In addition Short Message Service (SMS) is supported. The user can access CS and PS services simultaneously, and can have up to 11 Packet Data Protocol (PDP) contexts established.

The BGAN system uses rate adaptive technology to maximise user data throughput. Rather than fixing the data rates for all terminals, link adaptation gives higher data rates to those with a better radio link. Thus larger terminals and those with good

pointing, or located in the centre of a beam, can take advantage of favourable link conditions to send or receive at a higher data rate. Depending on the reported link quality, the system will dynamically assign the highest possible modulation (QPSK, 16-QAM, 32-QAM or 64-QAM) and FEC coding rate combination. Similarly streaming data rates can be used up to the maximum limit, based on the available link budget.

Traffic is currently routed via two BGAN Satellite Access Stations (SASs) - one at Burum in the Netherlands and the one in Paumalu in Hawaii. Each SAS maintains a separate Radio Network Controller (RNC) for access to each satellite, and Core Network (CN) switching elements. The RNC manages the radio traffic to and from the satellite, whereas the CN provides the terrestrial telecommunications infrastructure and switching. A backup site in Fucino provides full site redundancy over Europe. All sites are fully redundant internally.

2.1.1 IAI-2 Layering

The Air Interface is carried over a satellite link. As such there are a number of requirements on the protocol to ensure that the attributes of the satellite link (high delay, variable error rate, aperiodic disruption) are countered. The satellite communication protocol is considered as a number of communication layers, as follows:

- Adaptation Layer
- Bearer Connection Layer
- Bearer Control Layer
- Physical Layer

Each layer communicates with its peer, the layer above and the layer below. For each layer there are a set of protocol unit definitions, which are used to communicate with the peer. In addition between each layer there are a set of interface definitions that provide the mechanisms for control and transfer of information.

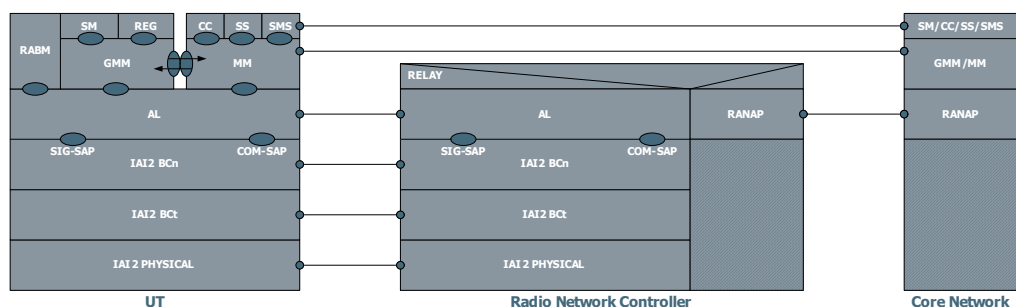


Figure 2-2: BGAN protocol stack layering.

2.1.2 Physical layer

The physical layer in the BGAN system is considered to be the layer that transfers an information bit stream over the satellite link, and includes the following:

Transmitter:

- Scrambling, encoding and interleaving blocks of data and conversion to a serial symbol stream
- Modulation and filtering of a carrier at a specified frequency using the symbol stream
- Transmission of the modulated and filtered carrier at the appropriate time and power level

Receiver:

- Reception of a modulated carrier and measurement of carrier parameters
- Filtering and demodulation of the carrier into a received symbol stream
- Decoding, de-interleaving and de-scrambling of the symbol stream into a received block of data
- Channel equalisation (Aeronautical Class terminal only)

IAI-2 operates with multiple physical bearer configurations in both the forward and return direction, offering a choice of different modulation schemes as well as symbol and coding rates. The choice of the optimum bearer configuration is determined by the Bearer Control Layer based on various parameters, such as terminal capabilities, satellite beam selection, required bit rate etc.

Forward (to terminal) and Return Bearers (from terminal) are configurable as follows:

- Bandwidth efficient 64-QAM, 32-QAM, 16-QAM and power efficient QPSK (forward) and $\pi/4$ QPSK (return) modulation schemes
- A choice of symbol rates in the forward direction: 8.4, 33.6, 84, 151.2 and 168 kSym/s
- A choice of symbol rates in the return direction: 16.8, 33.6, 67.2, 84, 151.2 and 168 kSym/s
- Variable coding rate allowing nominal 1 dB steps of change in required C/No.

Different unique words (known patterns) are used to allow the receiver to decode transmissions without a prior knowledge of the coding rate that the transmitter is applying to a specific burst or frame.

There is, in addition, a set of bearers for which modulation rate is variable on an FEC-block basis between QPSK and 16-QAM. These bearers are defined as X4/16 rather than QPSK to highlight the distinction between these and normal QPSK bearers.

2.1.2.1 Bearer type identification

To identify the large number of permutations of bearer symbol rate, modulation type, frame/burst duration and coding rate, the format (similar to the SDM format) is explained in the figure below.

Naming Convention	Syntax	Description
Direction	F R FR	Forward (continuous transmission) Return (burst transmission) Forward & Return (continuous transmission)
Burst duration	5 20 80	5 ms burst (only return direction) 20 ms burst (only return direction) 80 ms frame/burst (forward and return direction)
Type	T	Type
Symbolrate	0.25 0.5 1 2 2.5 4.5 5	Symbol rate specified in 33600 symbols per second: Forward: 0.25 (8400), 1 (33600), 2.5 (84000), 4.5 (151200), 5 (168000) Return: 0.5 (16800), 1 (33600), 2 (67200), 2.5 (84000), 4.5 (151200), 5 (168000)
Modulation	Q X X4 X16 X32 X64	Return: Q ($\pi/4$ QPSK), X/X16 (16QAM), X4 (QPSK), X32 (32QAM), X64 (64QAM) Forward: Q/X4 (QPSK), X/X16 (16QAM), X32 (32QAM), X64 (64QAM)
FEC blocks per frame	1 2 4 5 6 7 8 9 11 13	1 and 2 are used for 5 ms and 20 ms burst transmission 1, 4 and 8 are used for continuous transmission without interleaver 1, 6, 7, 9, 11 and 13 are used for continuous transmission with interleaver

Figure 2-3: BGAN bearer type identification

- Example:** The bearer type F80T1Q4B identifies a continuous forward bearer with a 80 ms frame structure that holds 4 FEC blocks per frame. This bearer has a symbol rate of 33600 symbols per second and is modulated with QPSK.
- Example:** The bearer type R5T2X1B identifies a return bearer with a 5 ms burst structure that holds a single FEC block. This bearer has a symbol rate of 67200 symbols per second and is modulated with 16-QAM.
- Example:** The bearer type FR80T5X64-13B identifies a continuous return bearer with a 80 ms frame structure that holds 13 FEC blocks per frame. This bearer has a symbol rate of 168000 symbols per second and is modulated with 64-QAM.

2.2 User terminal classes

The BGAN system supports a number of different terminal classes in order to serve differing communication needs and thus enable a variety of terminals available to the end-user. The various terminal classes are grouped in families having similar specification targeted for a given market segment. *Table 3-4 on page 3-7* shows an overview of the different classes and how they are mapped into groups.

Product overview

This chapter has the following sections:

3.1	Key features	3-2
3.2	Functional description	3-2
3.3	Interfaces	3-4
3.4	Mechanical outline	3-4
3.5	Environmental Specifications	3-5
3.6	Power consumption	3-6
3.7	Protocols	3-7
3.8	TT-3752A Integrators Kit	3-10
3.9	Approvals and certifications	3-11
3.10	Ordering information	3-11

3.1 Key features

- Modem compatible L-band radio.
- Flexible design based on software-defined radio principles.
- Compact form factor and low weight for portable and tracking devices.
- Low power consumption and power-saving mode for battery-powered operation.
- Single input supply and power-cycle resilient on all interfaces
- Easy to type-approve with all currently defined Inmarsat BGAN and BGAN-XL services including LDR/HDR and BGAN classes.

3.2 Functional description

The BGAN XL Radio Module implements the complete BGAN(-X) Protocol Stack and Physical Layer as defined by the Inmarsat System Definition Manual. All currently defined terminal classes will be supported incl. LDR & HDR.

The BGAN XL Radio Module is based on a flexible SDR architecture enabling support of future BGAN waveforms/services or for alternative waveforms with similar performance requirements.

Designed for operation in harsh environments with a compact form factor the BGAN XL Radio Module will be the logical part of all future Inmarsat BGAN terminals regardless of end-user segment.



Figure 3-1: BGAN XL Radio Module segments

3.2.1 Integration options

The architecture of the BGAN XL Radio Module has been designed with flexibility in mind to enable easy integration into all different kind of terminal architectures. Apart from the various user interfaces defining a given terminal the integrator will only have to implement an antenna system (incl. HPA/LNA) and a SIM card interface.

To speed up the development process Cobham Satcom offers a development platform for the BGAN XL Radio Module and different kind of integration services e.g.:

- Support of BGAN XL Radio Module integration with 3rd party antenna system.
- Support/integration of complete Inmarsat type approved BGAN XL Radio Module solution incl. antenna system into customers application.

3.2.2 Typical application

A typical terminal based on the BGAN XL Radio Module contains a board processor and an application processor in addition to the BGAN XL Radio Module itself.

To ensure correct operation of the terminal the board processor shall provide the BGAN XL Radio Module with configuration parameters like e.g. terminal class and output power and control information like e.g. SIM card information. The board processor functions can, if desired, be integrated into the application processor.

The application processor handles user interfaces like e.g. Ethernet LAN including DHCP and NAT, USB, Analog 2-Wire (POTS) and ISDN and the associated protocol stacks. It also implements GUIs and PABX functions.

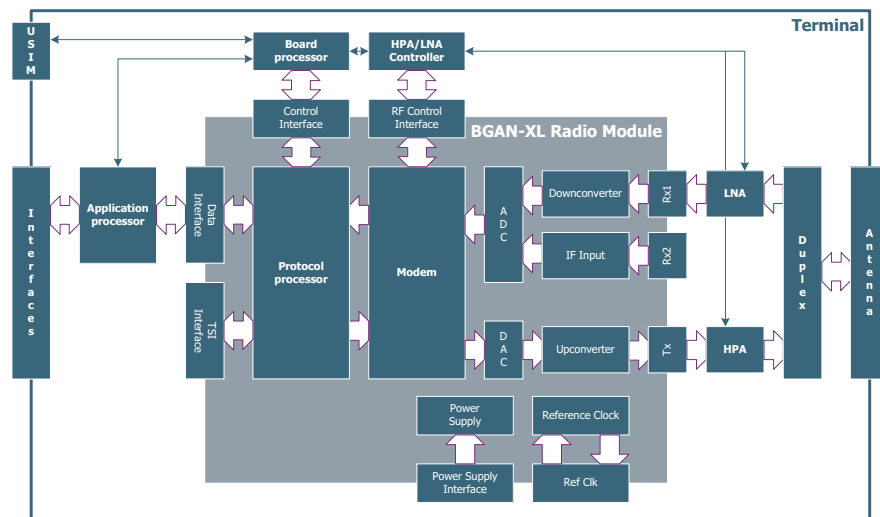


Figure 3-2: Typical application

3.3 Interfaces

The BGAN XL Radio Module provides a number of interfaces for integration into a terminal. The various interfaces are listed below with a short description of the functionality:

Name	Description
Data Interfaces	
Data IF	Used for payload data, management, event detection, software upload etc.
TSI IF	Used for ISDN data (optional).
Control Interfaces	
Control IF	Used for configuration and control of the BGAN XL Radio Module.
RF Control IF	Timing-critical information of the physical layer operation of the BGAN air-interface.
RF Interfaces	
Rx1	1518-1559 MHz high dynamic range receiver input.
Rx2	130-140 MHz secondary receiver input for diversity or aeronautical use.
Tx	1626.5-1675.0 MHz transmitter output.
Ref Clk	Precision reference clock input/output.

Table 3-1: Interface overview

3.4 Mechanical outline

The following figure shows the outline drawings and dimensions of the BGAN XL Radio Module.

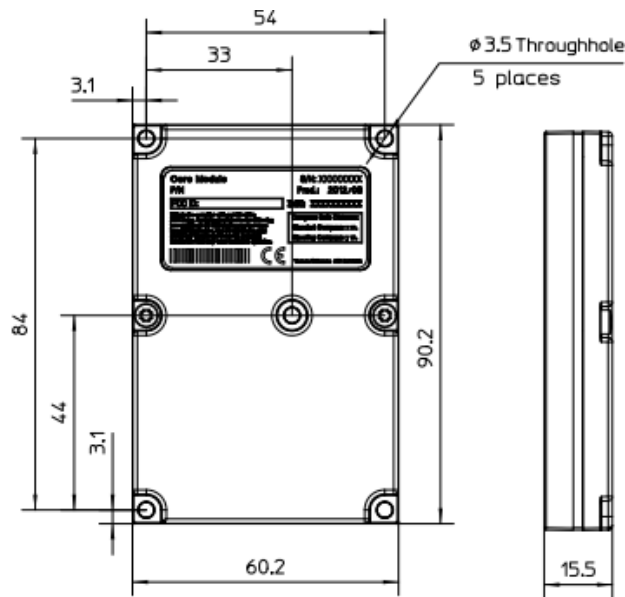


Figure 3-3: Mechanical outline

3.5 Environmental Specifications

The BGAN XL Radio Module is designed and tested for use in harsh environments found in e.g. maritime and aeronautical segments. The following sections state the extreme values which the BGAN XL Radio Module meets with regards to temperature, humidity, shock and vibration.

3.5.1 Temperature and humidity

The BGAN XL Radio Module is designed and tested to meet the temperature and humidity specifications listed in the table below.

Property	Value	Unit
Case temperature - operational		
T_{min}	-40	°C
$T_{max_sustained}$	+70	°C
T_{max}^a	+75	°C
$T_{max_short_time}^b$	+80	°C
Case temperature - survival (Powered but reset)		
T_{min}	-55	°C
T_{max}	+80	°C
Humidity - operational		
Relative humidity (40°C Non-condensing)	95	%

Table 3-2: Temperature and humidity

a. Max. 25% duty cycle / 10 years

b. Max. 30 minutes

3.5.2 Vibration and shock

The BGAN XL Radio Module is designed and tested to the specifications listed in the following table using the on-board reference clock on the BGAN XL Radio Module.

Property	Value
Vibration ^a 5 to 20 Hz	0.02 g ² /Hz
Vibration ^a 20 to 150 Hz	-3 dB/octave
Vehicle/Vessel Motions: Shock (Survival)	20 g
Vehicle/Vessel Motions: Induced acceleration	0.5 g

Table 3-3: Technical data for vibration and shock

- a. Random vibration of 1.05 g rms in each of three mutually perpendicular axes.

Using a dedicated external reference clock the specifications can be extended to meet more demanding requirements as put up by e.g. aeronautical or military applications.

3.6 Power consumption

The following figure presents the typical power consumption in different operating states of the BGAN XL Radio Module with the internal ATC circuit deactivated.



Figure 3-4: Power consumption

Note | Activation of the internal ATC circuit will increase the power consumption with approximately 430 mW.

3.7 Protocols

Three of the interfaces illustrated in Figure 3-2 on page 3-3 support higher layer protocols:

- *BGAN air interface*
- *BGAN XL Radio Module control interface*
- *BGAN XL Radio Module data interface*

Note

No higher layer protocols are implemented on the TSI (Time Slot Interchange) interface which implements a standard PCM bus protocol. The TSI interface can connect to standard PCM equipment (like ISDN or 2W) and is dedicated for ISDN user plane data (Circuit Switched - User Plane)

3.7.1 BGAN air interface

The air interface is compliant with the current Inmarsat BGAN SDM. The BGAN class is defined by configuration at power-up. The following BGAN (User Terminal) classes will be supported:

Market segment	BGAN class	Terminal type	Maximum data bit rates (published by Inmarsat) [Download/Upload]
Land portable	Class 1 HDR	Briefcase (A3) Size with HDR capabilities	858 kbps / 858 kbps
	Class 2	Laptop (A4) size	464 kbps / 448 kbps
Aeronautical	Class 4	Enhanced Low Gain Antenna (ELGA) with LDR capabilities	576 kbps / 492 kbps (TBC)
	Class 6 HDR	High Gain Antenna with HDR capabilities.	858 kbps / 858 kbps (TBC)
	Class 7 HDR	Intermediate Gain Antenna with HDR capabilities.	858 kbps / 858 kbps (TBC)

Table 3-4: Supported BGAN classes

Market segment	BGAN class	Terminal type	Maximum data bit rates (published by Inmarsat) [Download/Upload]
Maritime	Class 8	High Gain Antenna	432 kbps / 432 kbps
	Class 9	Intermediate Gain Antenna	284 kbps / 284 kbps
	Class 14 ^a	Low Gain Antenna	150 kbps / 150 kbps
Vehicular ^a	Class 10	High Gain Antenna	492 kbps / 492 kbps
	Class 11	Intermediate Gain Antenna	464 kbps / 448 kbps

Table 3-4: Supported BGAN classes (Continued)

a. Available in future firmware release.

3.7.2 BGAN XL Radio Module control interface

The BGAN XL Radio Module control interface is based on a standard serial interface (UART). The control interface is used for interfacing with devices such as USIM card readers and GPS/GNSS modules. The protocol layer is strictly proprietary and documented in the Integrators Manual which is available under NDA.

3.7.3 BGAN XL Radio Module data interface

The data interface is based on USB 2.0 OTG using the CDC EEM (Communication Device Class - Ethernet Emulation Model) and hence it behaves in most respects as an Ethernet interface. It supports a wide range of standard network protocols including but not limited to the following:

Protocol layer	Reference	Comments
Physical Layer + Data Link Layer	USB 2.0 [usb.org] USB CDC EEM [usb.org]	The electrical interface complies with the USB 2.0 standard with the exception of the mechanical properties of the connector. The link layer protocol is standard Ethernet frames carried over the USB link as specified by the CDC EEM protocol. (Communication Device Class - Ethernet Emulation Model).

Table 3-5: Supported standard network protocols

Protocol layer	Reference	Comments
Network Layer	IPv4 [IETF RFC-791]	The IP network layer provides access to local services and to the CS service, which is accessed via SIP.
Circuit Switched Services	SIP [IETF RFC-3261] RTP [IETF RFC-3550]	The CS services of the BGAN network are provided by the RM via the SIP and RTP protocols. SIP is used for call control (session control in SIP terminology) and RTP is used for user plane data.
Packet Switched Services	PPPoE [IETF RFC 2516] PPP [IETF RFC 1661]	The PS services of the BGAN network are provided by the RM via the PPPoE protocol. Each PPPoE sessions maps directly to a PDP context in the PDCP protocol.
Management Services	HTTP Syslog AT-shell Telnet	The management services are provided via three protocols. HTTP is the primary access path to the configuration system of the module. The syslog protocol is used for event reporting and data logging. The Telnet protocol is used for the AT command shell and as internal debug command shell.

Table 3-5: Supported standard network protocols

3.8 TT-3752A Integrators Kit

An Integrators Kit is available to assist smooth integration of the BGAN XL Radio Module in a new terminal. The kit is based on a carrier board specifically designed to hold a BGAN XL Radio Module and provide the basic functionality required to operate the BGAN XL Radio Module.

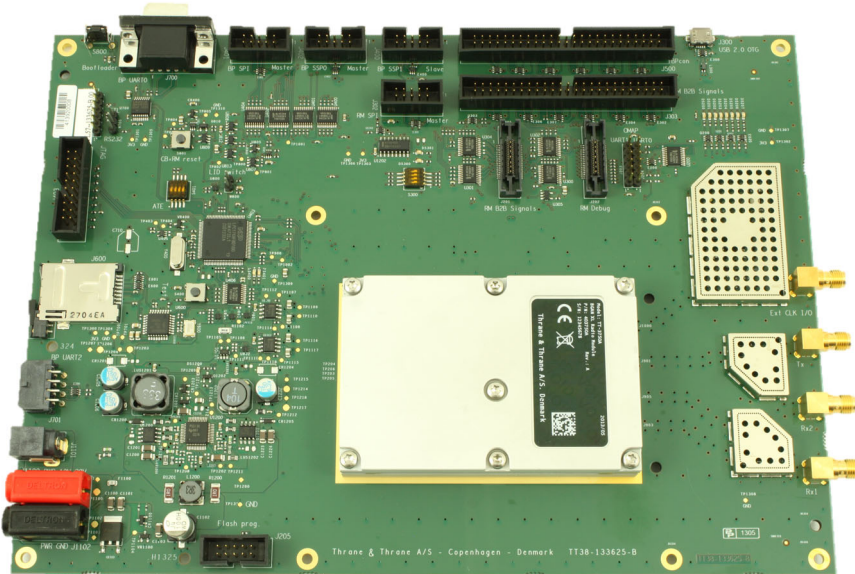


Figure 3-5: BGAN XL Radio Module carrier board

- Local power supply module for the carrier board and a BGAN XL Radio Module
- Board Processor with interfaces to:
 - Control Interface to BGAN XL Radio Module
 - USIM controller (incl. SIM card connector)
 - Temperature and voltage/current monitoring
 - Control of RF circuitry
- RF circuitry for:
 - Loopback of BGAN XL Radio Module TX to RX1 (with attenuation)
 - External Oscillator Circuitry

3.8.1 What's included

- Carrier Board with TT-3750A BGAN XL Radio Module, power supply and cables
- TT-3750A BGAN XL Radio Module Integrators Manual (printed copy)
- TT-3752 BGAN XL Radio Module Integrators Kit CD-ROM including:
 - Comprehensive documentation package (pdf format)
 - Python scripts examples supporting different BGAN XL Radio Module test scenarios
 - Basic Board Processor software including USIM and BGAN XL Radio Module drivers

3.9 Approvals and certifications

The BGAN-XL Radio Module is designed for application in CE and FCC approved products and fully complies with the RoHS and WEEE directives of the European Union.



Figure 3-6: Prepared for CE and FCC approval

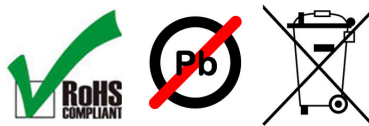


Figure 3-7: RoHS and WEEE compliant

3.9.1 Shortest way to a type approval

Mandatory test requirements (MTRs) for a BGAN UT are written and provided to the terminal manufacturers by Inmarsat. The entire suite of MTR documents consists of more than 30 documents and describe over 500 test cases which must be completed before a type approval is granted. An ordinary type approval period of a standard BGAN UT development project is therefore quite long due to the thorough testing.

To address this issue and reduce the time-to-market the BGAN XL Radio Module holds a pre-approval on a large number of the specified test cases (per agreement with Inmarsat). Integrators of the BGAN XL Radio Module should therefore anticipate a much shorter approval period and gain a significant advantage compared to other terminal manufacturers.

Note

The actual MTR documents are covered by an NDA and may not be reproduced here. They may on request be provided directly to the Integrator by Inmarsat.

3.10 Ordering information

Order number	Description
TT-3750A	BGAN XL Radio Module
TT-3750A-AER	BGAN XL Radio Module for aeronautical use
TT-3752A	BGAN XL Radio Module Integrators Kit

Table 3-6: Ordering information

System description

This chapter has the following sections:

4.1	Introduction to the BGAN XL Radio Module	4-2
4.2	BGAN XL Radio Module interface overview	4-3
4.3	Integrating the BGAN XL Radio Module	4-4
4.4	High-level terminal system design	4-8

4.1 Introduction to the BGAN XL Radio Module

The BGAN XL Radio Module is designed to be a versatile building block for easy integration of BGAN functionality into a variety of different terminal architectures targeting all applicable market segments.

Basically the module presents a data interface towards the user side and an L-band RF input/output towards the BGAN system.

All protocols and physical layers specified by the Inmarsat BGAN SDM as well as the necessary hardware required for up and down conversion to L-band are implemented on the BGAN XL Radio Module. This includes:

- UMTS protocols
- IAI-2 BGAN-X protocol
- AMBE+2TM Codec
- Cipherring
- Modulation and demodulation

In addition to the functionality defined in the BGAN SDM a number of functions are implemented to support and ease integration of the BGAN XL Radio Module into a terminal. Examples are:

- Functions to support antenna pointing.
- Extended POST functionality to enable thorough BITE test coverage at terminal level.
- Systems for event detection.
- Built-in spectrum analyser for test and debugging during terminal development and/or enhanced after-sales support.
- Test signal generation of all defined BGAN waveform for use in development and/or manufacturing.
- Support of various test modes required to verify terminal performance during type approval.

For a vast number of mandatory type approval tests the BGAN XL Radio Module has been pre-approved by Inmarsat. Hence, a terminal with the BGAN XL Radio Module will require only a subset of type approval tests to be conducted by the integrator at the terminal level (see chapter 14 on page 14-1).

4.2 BGAN XL Radio Module interface overview

The BGAN XL Radio Module provides a number of interfaces for integration into a terminal. The various interfaces are listed below with a short description of the functionality:

Name	Description	Type
Data Interfaces		
Data IF	Used for payload data, management, event detection, software upload etc.	USB 2.0 (OTG)
TSI IF	Used for ISDN data (optional).	TSI slave
Control Interfaces		
Control IF	Used for configuration and control of the BGAN XL Radio Module.	UART
RF Control IF	Provides timing-critical information of the physical layer operation of the BGAN air-interface.	SPI master + 4 discretes
RF Interfaces		
Rx1	1518-1559 MHz high dynamic range receiver input.	Coax
Rx2	130-140 MHz secondary receiver input for diversity use.	Coax
Tx	1626.5-1675.0 MHz transmitter output.	Coax
Ref Clk	Precision reference clock input/output. Used as either input for external reference clock or output to provide a low-phase noise precision clock for e.g. external RF circuitry.	Coax

Table 4-1: Interface overview

4.3 Integrating the BGAN XL Radio Module

The BGAN XL Radio Module is not designed for stand-alone operation. It requires to be controlled by an external processing unit. In all aspects the external processing unit will be the master. This applies during startup, configuration and operation of the BGAN XL Radio Module.

The following sections provides a basic description of various terms and functionality that the integrator must study and understand to ensure successful integration.

4.3.1 Modes of operation

The BGAN XL Radio Module always operates within a predefined set of modes, each supporting its own well-defined set of functions. The standard BGAN XL Radio Module start-up procedure is defined by the modes and is shown in Figure 4-1 below.

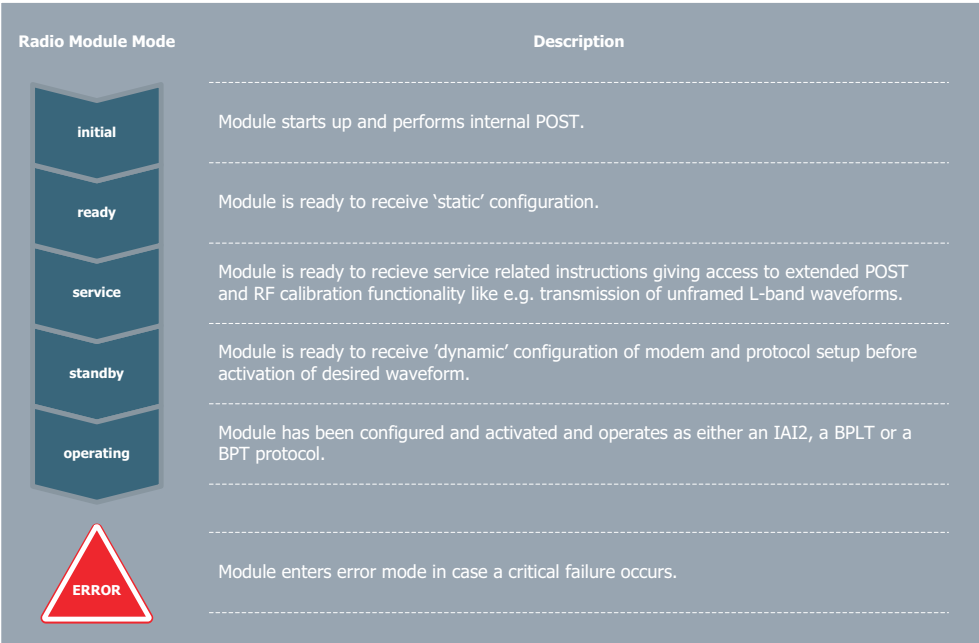


Figure 4-1: Modes of operation supported by the BGAN XL Radio Module

It is the responsibility of the integrator to respect the shown start-up sequence and provide the BGAN XL Radio Module with the configuration required in the different modes in order to obtain proper BGAN operation. A more detailed description of the start-up procedure and the properties of the various modes of operation can be found in section 6.1 on page 6-2.

4.3.2 Configuration system

The configuration system is a vital part of the BGAN XL Radio Module and is used to exchange configuration settings and system information between the surrounding platform and the BGAN XL Radio Module.

The integrator can access the configuration system via both the **control interface** and the **data interface** as illustrated in the figure below.

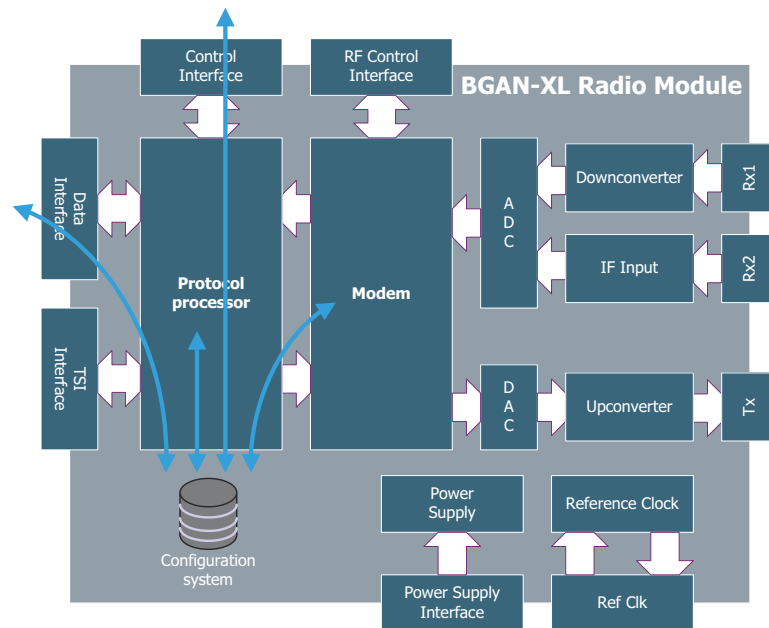


Figure 4-2: Access to the configuration system in the BGAN XL Radio Module

The configuration system offers a feature where the integrator can receive a notification when a certain parameter has been modified. Likewise certain parameters have an attached notification (call-back) function so that the BGAN XL Radio Module is informed on any changes of dynamic parameters.

For detailed information on the configuration system and the supported configuration parameters see chapter 6.

4.3.3 Power Management

When in **service** or **operating** mode the BGAN XL Radio Module operates with an autonomous power management scheme which is designed to save as much power as possible at all times. The various sub-modules in the BGAN XL Radio Module will be powered down whenever possible while respecting functional requirements given by the actual operational mode.

The BGAN XL Radio Module supports sleep mode operation¹ as defined by the SDM (see [18]). In order to avoid confusion to the operational modes defined in section 4.3.1

1. Not applicable to all terminal classes; see the SDM [18].

this state will be referred to as **SDM sleep** further on. If activated by the integrator in the configuration system the BGAN XL Radio Module will enter this power management state when it is in **operating iai2** mode and is registered to the BGAN network if no PS or CS connection is established. For further details on **SDM sleep** operation see section 11.5 on page 11-12.

In certain applications it may be convenient for the integrator to instrument the internal power management schemes to immediately save power while maintaining the ability to resume to normal operation as soon as possible. For this purpose the BGAN XL Radio Module supports a special message on the control interface which will bring the BGAN XL Radio Module into a low-power state designated **suspend**. See section 11.5.2 on page 11-13 for further information.

The autonomous behaviour described above implies that the actual power consumption in a given mode will depend on the currently active services and functionality. To give an indication of the expected power consumption a number of typical use case scenarios has been defined:

- **Suspend**
The BGAN XL Radio Module is in **operating iai2** mode but has been commanded into suspend by the integrator.
- **SDM sleep**
The BGAN XL Radio Module is in **operating iai2** mode and is registered to the BGAN network.
- **Receive only**
The BGAN XL Radio Module is in **operating iai2** mode and is registered to the BGAN network but no PS or CS connection is established and sleep operation is disabled.
- **128 kbit/s streaming**
The BGAN XL Radio Module is in **operating iai2** mode and is registered to the BGAN network and transmits 128 kbit/s data on a PS streaming connection.
- **768 kbit/s streaming**
The BGAN XL Radio Module is in **operating iai2** mode and is registered to the BGAN network and transmits 768 kbit/s data on a PS streaming connection.

The typical power consumption in each of the above use-case scenarios are stated in section 5.6.1 on page 5-14.

4.3.4 Antenna pointing assistance

The BGAN XL Radio Module implements a versatile interface enabling an integrator to direct the search for a global BGAN channel in a way suited to the actual antenna used. Pointing of the following types of antennas is supported:

- Fixed antennas.
- Manual pointed antennas.
- Mechanical pointed antennas with power detector.

- Mechanical pointed antennas without power detector.
- Phased array antennas.
- Omnidirectional antennas.

It is the responsibility of the integrator of the BGAN XL Radio Module to design an antenna pointing algorithm which matches the antenna and can accommodate requirements such as reliable pointing, fast channel acquisition and meaningful GUI information. See section 8.5.5 on page 8-36 for more information.

4.3.5 Software licensing (FOR INTERNAL USE)

The software running on the BGAN XL Radio Module is in general proprietary and not covered by commercial licenses. However, a few modules are implemented or used under license as shown in Table 4-2 below.

Software module	License owner	Cobham Satcom part number
AMBE+2 TM Voice Codec	DVSI	83-120828-100
M5T SIP client	media5	83-126100-100
Turbo Decoder	France Telecom	83-120827-100
USB driver	HCC embedded	99-145421-A

Table 4-2: Software licenses

Each license is subject to a fee to be paid to the license owner. These fees are not included in the BGAN XL Radio Module cost but must be put on the terminal BOM.

The BGAN XL Radio Module uses a non-modified version of eCosPro distributed by eCosCentric as operating system. The eCosPro licenses is governed by the eCosPro Distribution Software Licenses Agreement found on:

<http://www.ecoscentric.com>

4.4 High-level terminal system design

As mentioned earlier the BGAN XL Radio Module requires to be controlled by an external processing unit designed and implemented by the integrator. Also, all product specific software functionality related to a given terminal must be implemented outside the BGAN XL Radio Module. Typically these functions can be grouped in two; one for user/network application software and one for software related to control and maintenance of the terminal.

It is envisioned that the two groups of functionality can be implemented on two separate processors with advantage, however this is not a requirement put up by the BGAN XL Radio Module. This implementation strategy is assumed throughout the rest of this manual. References to the two processor units are made according to the following definitions:

- **Board Processor:** Used for the low-level control and maintenance tasks and interfaces to the BGAN XL Radio Module using the control interface.
- **Application Processor:** Implementing the high-level user/network applications and interfaces to the BGAN XL Radio Module using the data interface and optionally the TSI interface.

The following sections provide a short description of the Board Processor and the Application Processor respectively. In Figure 4-1 on page 4-4 a high-level block diagram of the overall system architecture, based on these three building blocks, is shown.

4.4.1 Board Processor

All terminals based on a BGAN XL Radio Module shall implement a Board Processor to handle control and maintenance tasks related to the specific terminal platform. The Board Processor is envisioned to be the master of the complete system having the responsibility for the overall system operation like e.g.:

- Mandatory:
 - BGAN XL Radio Module configuration
 - BGAN XL Radio Module control
 - Platform manager
 - System monitoring
 - Handling of POST and PAST
 - General power management
 - Antenna pointing algorithm
 - SIM interface
- Optional:
 - Cable loss calibration routines
 - Antenna control

- Software upload of ADU
- ARINC interface (aero only)

The size of the Board Processor can be chosen independently to meet the processing requirements put up by a given platform architecture. Hence, an integrated terminal should require a rather small and inexpensive Board Processor whereas a more complex terminal with automatically controlled antennas may require a larger variant.

4.4.2 Application Processor

The Application Processor is meant to be the flexible part of the architecture differentiating the various terminals towards the user. The BGAN XL Radio Module does not put up any constraints on the implementation of the Application Processor, hence its size and type can be chosen freely with respect to the user/network applications implemented for a given terminal.

The purpose of the Application Processor is to service the various user interfaces of a given terminal and host various applications like e.g.:

- PABX for voice call routing
- Echo Cancelling for 2W/POTS
- SIP server and additional voice codecs for user applications
- Firewall/NAT/DHCP
- Routing of IP data to and from the BGAN XL Radio Module
- HTTP / TCP / PEP Acceleration and compression
- SIP client for interfacing to BGAN XL Radio Module
- General terminal management
- Support for various user interfaces
- Web-based MMI
- Handling of continuous monitoring (CM)

Depending on the complexity of the terminal the Application Processor is envisioned being a bigger processor with adequate FLASH and RAM for running a bigger OS like e.g. Linux.

The term 'Application Processor' should not necessarily be seen as one processor only. Rather it should be interpreted as a digital processing complex providing the required processing capabilities for a given terminal.

All terminals are intended to implement an Application Processor in order to realize a minimum set of functions required for the complete BGAN terminal to work. This minimum set of functions is mainly basic management functionality like e.g.:

- Upload of software for the BGAN XL Radio Module.
- MMI for user configuration of the terminal.

- System error logging and reporting.
- PPPoE connections to the BGAN XL Radio Module.
- SIP client.

4.4.3 High-level System Architecture Block Diagram

The following figure shows a conceptual high-level block diagram of the BGAN XL Radio Module-based system architecture. For more block diagrams of various terminal types see chapter 13.

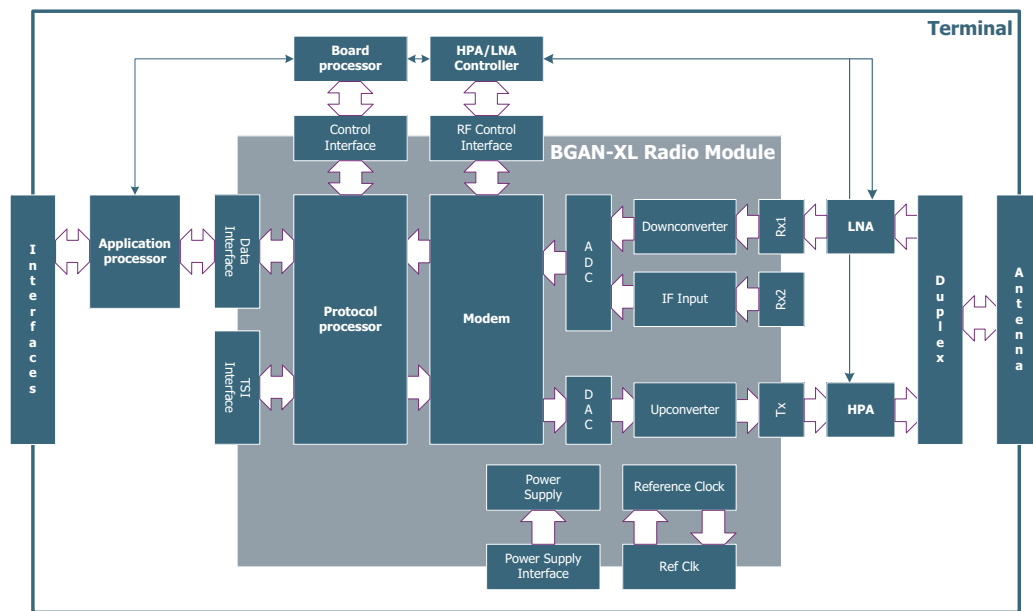


Figure 4-3: High-level System Architecture Block Diagram

Note Throughout this manual it is assumed that the system consists of an Application Processor and a Board Processor connected to the BGAN XL Radio Module as shown in the above figure. However, it is up to the system integrator to decide whether the envisaged functionality of these processors can be implemented on one or two processors.

Product specifications

This chapter has the following sections:

5.1	General precautions	5-2
5.2	Physical specifications	5-2
5.3	Mounting considerations	5-4
5.4	Environmental specifications	5-6
5.5	Connector specifications	5-9
5.6	Electrical characteristics	5-14
5.7	Interface descriptions	5-20

5.1 General precautions



CAUTION! The BGAN XL Radio Module is designed for mounting on a PCB, implementing appropriate external interfaces designed to meet overall regulatory specifications of the unit. The electrical interfaces of the RM are thus not designed to be directly accessible for the user of the end product. It is therefore important to handle the RM with care as it does not have ESD protection on all I/Os.



CAUTION! Assemble and repair the BGAN XL Radio Module-enabled product in an anti-static environment. When handling the RM you should wear anti-static wrist straps or similar.

5.2 Physical specifications

The following figure shows the BGAN XL Radio Module.



Figure 5-1: BGAN XL Radio Module

The dimensions and weight of the BGAN XL Radio Module is shown in Table 5-1 below.

Property	Dimension
Length	90.2 mm
Width	60.2 mm
Height	15.5 mm
Weight	120 g

Table 5-1: Physical dimensions

The following figure shows the outline drawings and dimensions of the BGAN XL Radio Module.

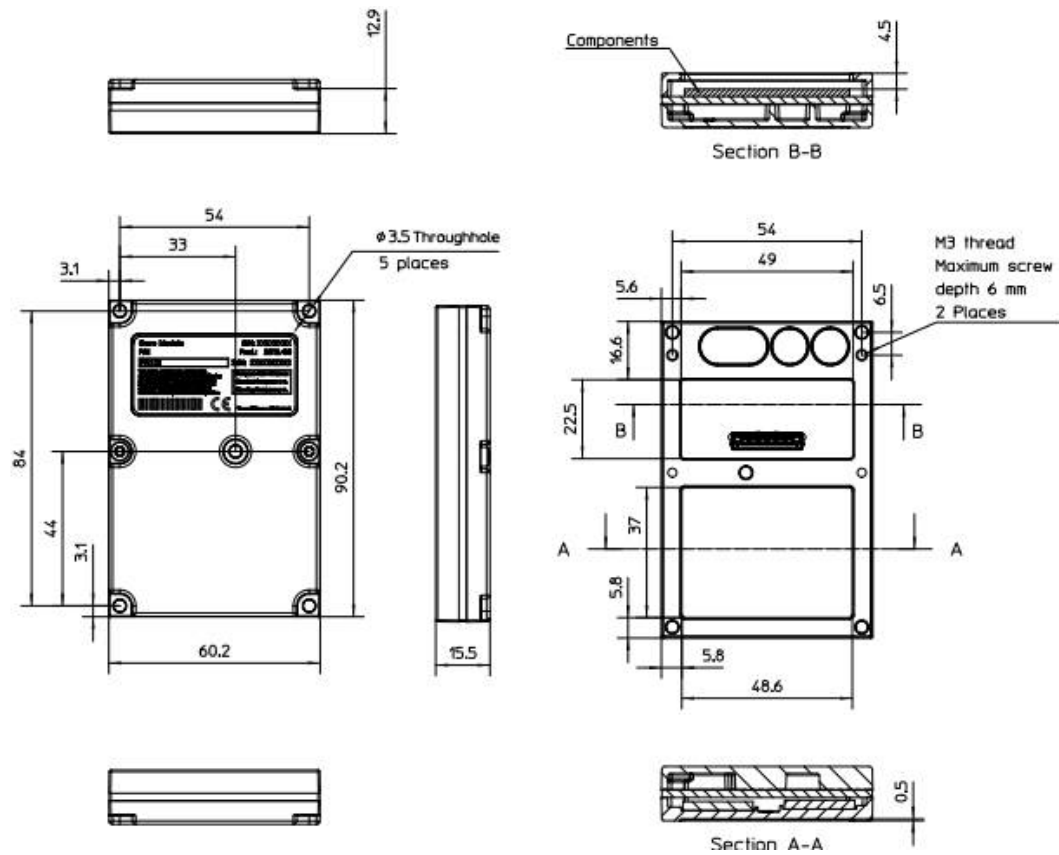


Figure 5-2: Outline drawing with dimensions in mm

Tolerances are in accordance with DS/ISO 2768-1 F.

5.3 Mounting considerations

The BGAN XL Radio Module shall be mounted to the carrier board and/or terminal mechanics using five non-threaded through-holes; for details see Figure 5-3 below. Optionally two threaded blind-holes in the bottom can be used as well if required by the application.

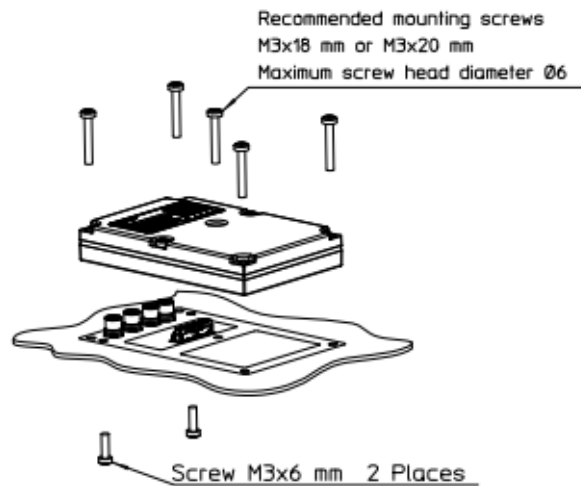


Figure 5-3: Mounting possibilities

Mount the BGAN XL Radio Module on a carrier board implementing appropriate external interfaces designed to meet overall regulatory specifications of the unit.

5.3.1 Recommended footprint

The following figure shows the recommended footprint for mounting of the BGAN XL Radio Module. Building height underneath the BGAN XL Radio Module is specified in Figure 5-2 on page 3.

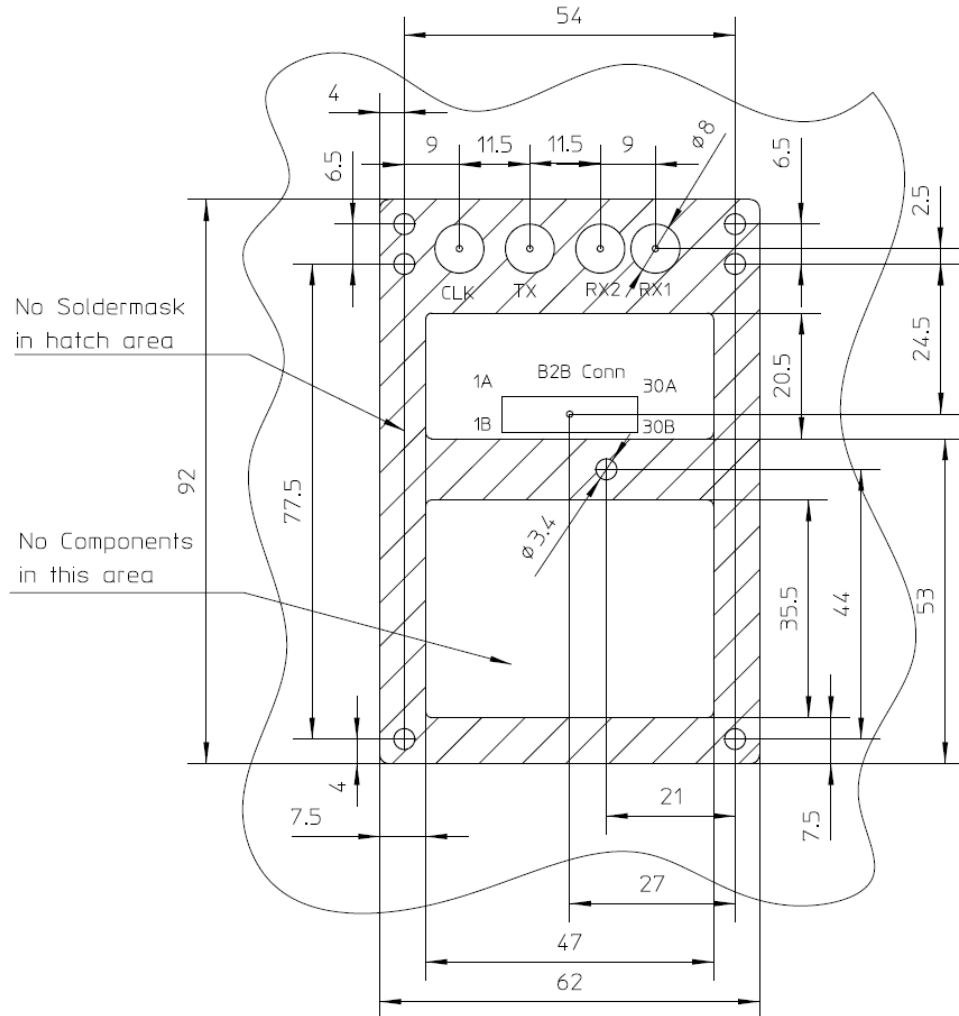


Figure 5-4: Recommended RM footprint

5.3.2 Cooling requirements

It is essential that the maximum allowed case temperature for the BGAN XL Radio Module is not exceeded. The maximum case temperature is shown in *Table 5-2 on page 5-6*.

If the recommended footprint shown in section 5.3.1 is used, the typical thermal resistance is 0.2°C/W hence the temperature difference will be less than 1°C between the BGAN XL Radio Module case and the board temperature of the board that the BGAN XL Radio Module is mounted on.

5.4 Environmental specifications

The following sections state the extreme values which the BGAN XL Radio Module meets with regards to temperature, humidity, shock and vibration.

5.4.1 Temperature and humidity

The BGAN XL Radio Module is designed and tested to meet the temperature and humidity specifications listed in the table below.

Property	Value	Unit
Case Temperature - Operational		
T _{min}	-40	°C
T _{max_sustained}	+70	°C
T _{max} ^a	+75	°C
T _{max_short_time} ^b	+80	°C
Case Temperature - Survival (Powered but reset)		
T _{min}	-55	°C
T _{max}	+80	°C
Humidity - Operational		
Relative humidity (40°C Non-condensing)	95	%
Heat Dissipation		
The dissipated power is dependent of use case.	See 5.6.1	W

Table 5-2: Temperature and humidity

- a. Max. 25% duty cycle / 10 years
- b. Max. 30 minutes

Operating the BGAN XL Radio Module above +70°C will have a negative impact on MTBF, hence the maximum case temperature should not exceed +70°C.

If operated at +75°C no more than 25% of the time of a 10 years period a MTBF better than 10 years can be expected.

The BGAN XL Radio Module will be operational up to +80°C, but operation at this temperature will seriously degrade the MTBF and is therefor not recommended nor covered by warranty. However, for certain types of terminals the integrator may want to exploit operation at this temperature in certain distress situations.

5.4.1.1 Temperature capabilities (FOR INTERNAL USE)

The BGAN XL Radio Module is designed for case temperatures from -40°C to +75°C but has been qualified from -55°C to +85°C with external reference clock. This means that operation outside -40°C to +75°C cannot be guaranteed by design and should thus be verified by the integrator at terminal level.



WARNING! Operation below -40°C requires an external master clock as the internal master oscillator will not work here.

5.4.2 Shock and vibration

The BGAN XL Radio Module has been designed and tested to the specifications listed in Table 5-3 below, using the on-board reference clock on the BGAN XL Radio Module.

Property	Value	Unit
Vibration^a		
5 to 20 Hz	0.02	g ² /Hz
20 to 150 Hz	-3	dB/octave
Vehicle/vessel motions		
Shock (Survival)	20	g
Induced Acceleration	0.5	g

Table 5-3: Specifications for shock and vibration

a. Random vibration of 1.05 g RMS in each of 3 mutually perpendicular axes.

5.4.2.1 Aeronautical shock and vibration

The aeronautical RTCA D0160F "Operational Shock and Crash Safety" category B and "Vibration category S curve B, L and M can be met by the BGAN XL Radio Module by use of an external reference clock.

5.4.2.2 Cobham Maritime Vibration Spectrum (FOR INTERNAL USE)

In addition to the Inmarsat standard vibration requirements stated above, the BGAN XL Radio Module meets the specifications of the T&T Maritime Vibration Spectrum shown in the following figure. The same spectrum applies to all three axes.

- Lower blue graph shows normal operation.

- Higher red graph shows survival operation.

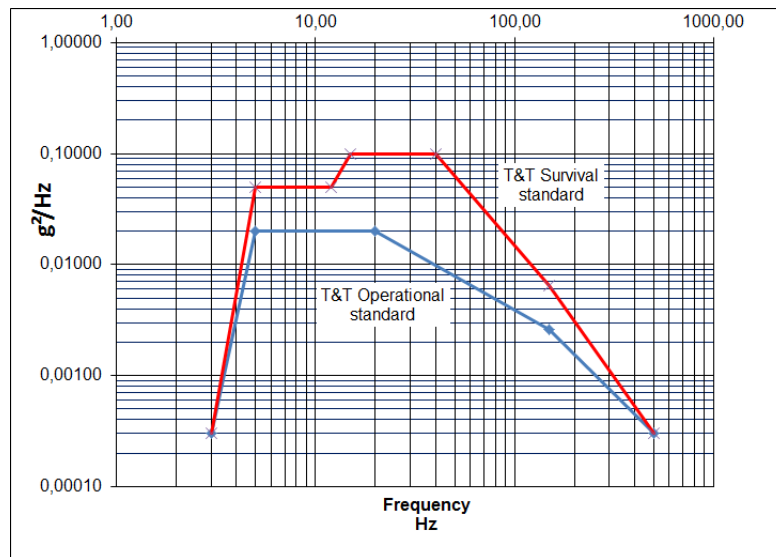


Figure 5-5: Cobham vibration spectrum

5.4.2.3 Vibration capabilities (FOR INTERNAL USE)

The BGAN XL Radio Module is designed for and tested with a vibration spectrum with twice the amplitudes stated in sections 5.4.2 and 5.4.2.2.

The BGAN XL Radio Module is designed for and tested with a vibration spectrum with three times the amplitudes stated in section 5.4.2.1

The following figure shows the direction of worst case G-sensitivity.

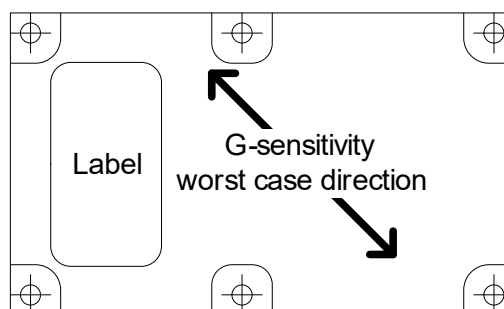


Figure 5-6: G-sensitivity - worst case direction (top view)

5.5 Connector specifications

This section specifies the various connectors on the BGAN XL Radio Module with respect to type, placement and pin allocation.

5.5.1 Connector overview

Figure 5-7 below shows the connectors of the BGAN XL Radio Module.

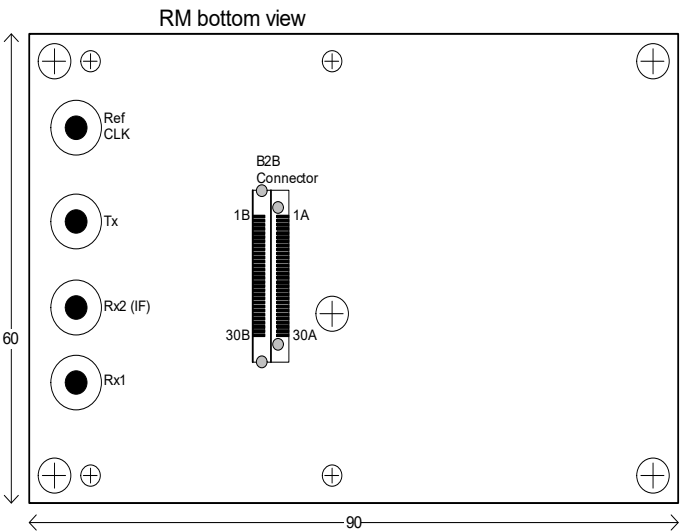


Figure 5-7: Connectors of the BGAN XL Radio Module

5.5.2 Connector types

To access the logical interfaces of the BGAN XL Radio Module the carrier board must use the following connectors:

Connector classification	Reference	Description
Mandatory connectors	B2B connector	One 60-pin Samtec LSHM series B2B connector Samtec part number: LSHM-130-04.0-x-DV-A-S
	Rx1 and Tx	Two Tyco spring-loaded B2B coaxial connectors Tyco part number: 619135-1

Table 5-4: Connector types and specifications

Connector classification	Reference	Description
Optional RF connectors	Rx2	One Tyco spring-loaded B2B coaxial connector Tyco part number: 619135-1
	Ref CLK	One Tyco spring-loaded B2B coaxial connector Tyco part number: 619135-1
Connector for BGAN XL Radio Module development only (for internal use)	Debug Connector	One 40-pin Samtec LSHM series B2B connector Samtec part number: LSHM-120-04.0-x-DV-A-N

Table 5-4: Connector types and specifications (Continued)

5.5.3 Board-to-Board connector

The pin numbers listed in the Table 5-5 below are defined by Figure 5-7. Electrical characteristics for the signal types are listed in Table 5-8 and Table 5-9.

There are multiple supply grounds. All supply and supply grounds must be connected.

Signal	Description	I/O	Electrical	Pin #
Control Interface				
UART_RxD	Received Serial Data	In	3.3V TTL	9B
UART_TxD	Transmitted Serial Data	Out	3.3V TTL	7B
UART_RTS	Request-to-send	Out	3.3V TTL	8B
UART_CTS	Clear-to-send	In	3.3V TTL	10B
Irq_In	Input Interrupt / Startup in boot loader	In	3.3V TTL	12B
Irq_Out	Output Interrupt	Out	3.3V TTL	11B
Rst_In	Reset	In	3.3V TTL ^a	15B
Digital Reference Clock Output for synchronization of ext. clock-domains				
Ref_CLK	Reference Clock, 57.85 MHz	Out	3.3V TTL	17B
RF Control Interface				
SPI_CLK	Clock	Out	3.3V TTL	27A
SPI_MOSI	Master Output, Slave Input	Out	3.3V TTL	28A
SPI_MISO	Master Input, Slave Output	In	3.3V TTL	29B
SPI_LE	Latch Enable/ Slave Select	Out	3.3V TTL	29A
Tx_Sync	Tx Burst Sync Pulse	Out	3.3V TTL	19B
Tx_Ack	Tx Acknowledge	In	3.3V TTL	21B

Table 5-5: B2B connector – pin allocation

Signal	Description	I/O	Electrical	Pin #
Rx_Ctrl	Rx Chain Active	Out	3.3V TTL	22B
Tx_Ctrl	Tx Chain Active	Out	3.3V TTL	20B
Power Supply Interface				
5V_In	4x DC input power	PWR	5.2 VDC	1A, 1B, 2A, 2B
GND	17x GND	PWR	GND	3A, 3B, 6A, 6B, 9A, 12A, 14A, 16B, 17A, 18B, 20A, 23A, 23B, 26A, 28B, 30A, 30B
Data Interface				
USB_DP	Serial Data +	I/O	USB2.0	4A
USB_DM	Serial Data -	I/O	USB2.0	5A
USB_ID	Host/device Identification	In	USB2.0	4B
USB_VBUS	USB Bus Voltage	PWR	USB2.0	5B
TSI Slave Bus				
TSI_CLK	TSI Bit Clk	In	3.3V TTL	24B
TSI_Fsync	TSI Frame Sync	In	3.3V TTL	25B
TSI_RxD	TSI Receive data	Out	3.3V open drain	27B
TSI_TxD	TSI Transmit data	In	3.3V TTL	26B
UART for debug (protocol)				
UART_TxD	Transmitted Serial Data	Out	3.3V TTL	13B
UART_RxD	Received Serial Data	In	3.3V TTL	14B
No Connects for future use – Do not connect!				
NC[1..13]	Not Connected	N/A	N/A	7A, 8A, 10A, 11A, 13A, 15A, 16A, 18A, 19A, 21A, 22A, 24A, 25A

Table 5-5: B2B connector – pin allocation (Continued)

- a. The BGAN XL Radio Module includes pull-up on this pin and must be driven by Open Drain output.

Note The signals available on the B2B connector are often referred to with a 'B2B_' prefix to emphasise that e.g. a specification of a given functionality is applicable at the connector boundary.

Note On the BGAN XL Radio Module for aeronautical use (TT3750A-AER), pins 7A, 8A, 10A, 11A, 13A, 15A, 16A, 18A, 22A, 24A and 25A are reserved for use with the Synchronous Serial Link. No further description is provided in this document.

5.5.4 Debug connector (FOR INTERNAL USE)

The pin numbers listed in the table below are defined by the figure below. Electrical characteristics for the signal types are listed in *Table 5-10 on page 5-15*.

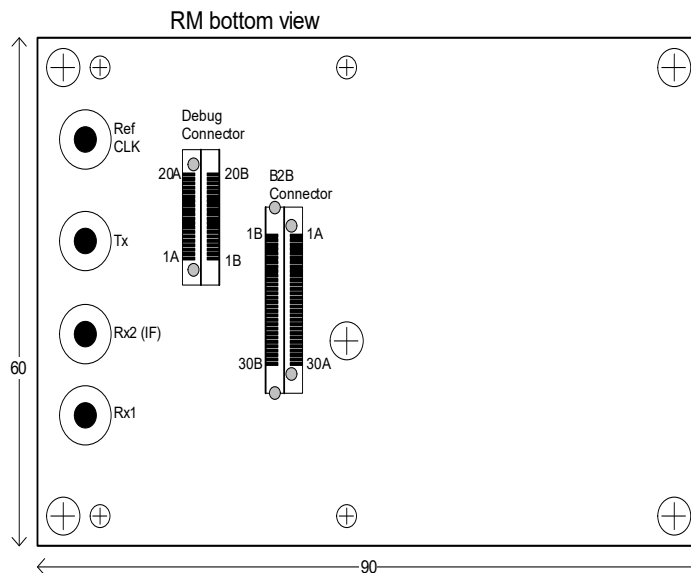


Figure 5-8: Pin allocation of debug connector

Signal	Description	I/O	Electrical	Pin #
FPGA Debug				
Debug_[1..20]	FPGA Debug	I/O	1.8V LVCMOS	[20B..1B]
Debug_0	FPGA Debug	I/O	1.8V LVCMOS	20A
UART for debug (modem)				
Debug_UART1_RxD	Received Serial Data	In	3.3V TTL	5A
Debug_UART1_TxD	Transmitted Serial Data	Out	3.3V TTL	6A
Power Interface				
3V3D	3.3V digital voltage for reference use	Out	3.3 VDC	3A, 8A
GND	Ground reference	PWR	GND	4A, 7A
NC for future use				
NC[1-13]	Not Connected	N/A	N/A	1A,2A, 9A..19A

Table 5-6: Debug connector – pin allocation

Note The debug connector is intended for development purposes only and is not mounted per default.

5.5.5 RF coaxial connectors

The product using the BGAN XL Radio Module can connect to the RM via four RF connection points using spring loaded coaxial connectors.

Signal	Description	I/O	Specification
RF Interface			
Rx1	Receiver input	In	Refer to 5.6.3 on page 5-16
Rx2	Secondary IF receiver input	In	Refer to 5.6.4 on page 5-17
Tx	Transmitter output	Out	Refer to 5.6.5 on page 5-18
Ref CLK	Reference Clock input/output	In/Out	Refer to 5.6.6 on page 5-19

Table 5-7: RF coaxial connectors

5.6 Electrical characteristics

This section specifies the electrical characteristics of the various interfaces to the BGAN XL Radio Module.

5.6.1 Power supply interface

Electrical characteristics for the supply pins in Table 5-5 are shown in the table below. Refer to section 4.3.3 on page 4-5 for a definition of the various use cases for which the power consumption is given.

Electrical characteristics	Min.	Typical	Max.	Unit
Power Supply Interface, 5.2 VDC				
V_{in}	4.95	5.2	5.45	V
$V_{in, ripple}^a$			50	mVpp
$V_{in, step}^b$			150	mVpp
$P_{in, Suspend}$ (see section 11.5.2)		0.433 ^c		W
$P_{in, SDM Sleep}$ (see section 11.5.1)		0.50 ^c	0.55	W
$P_{in, Receive Only}$		2.90		W
$P_{in, Active 128 kbit/s}$ (legacy)		3.50		W
$P_{in, Active 768 kbit/s}$ (HDR)		4.00		W
$P_{in, ATC mode extra power}$		0.43	0.49	W

Table 5-8: Electrical characteristics for the supply pins of the B2B connector

- a. Voltage Ripple @ maximum load, 20 MHz BW
- b. Step Load @ 100% load step, 20 MHz BW
- c. The power will be 50mW higher if the reference clock is configured to static operation, see Table 6-24 on page 6-24.

Note The integrator should assume that the power dissipated by the BGAN XL Radio Module equals the applied power stated in Table 5-8.

5.6.2 Digital interfaces

Electrical characteristics for the digital signals listed in Table 5-5 on page 5-10.

Electrical characteristics	Min.	Max.	Unit
3.3V TTL			
V_{IH}	2.0	3.6	V
V_{IL}	-0.3	0.8	V
V_{OH}	2.4	3.6	V
V_{OL}	-0.3	0.4	V

Table 5-9: Electrical characteristics for the signals of the B2B connector

Electrical characteristics	Min.	Max.	Unit
I_O		± 4	mA
3.3V Open Drain			
V_{OH}	Ext. VDD	Ext. VDD	V
V_{OL}	-0.3	0.4	V
I_O		4	mA
USB 2.0			
See USB 2.0 [16] and USB 2.0 OTG [17] for electrical specifications except for the following deviation: It is only permitted to use VBUS for signalling purposes, i.e. do not use VBUS to power external equipment.			

Table 5-9: Electrical characteristics for the signals of the B2B connector

Note The BGAN XL Radio Module is tolerant to the signal levels specified in table 5-9 also when powered off. Therefore the integrator can power cycle the RM without three-stating all connections to the RM.

Electrical characteristics for the signals in *Table 5-7 on page 5-13* (FOR INTERNAL USE).

Characteristic	Min	Max	Unit
1.8V LVCMOS			
V_{IH}	0.8	1.95	V
V_{IL}	-0.3	0.38	V
V_{OH}	1.2	1.95	V
V_{OL}	-0.3	0.45	V
I_O		± 4	mA
3.3V TTL			
V_{IH}	2.0	3.6	V
V_{IL}	-0.3	0.8	V
V_{OH}	2.4	3.6	V
V_{OL}	-0.3	0.4	V
I_O		± 4	mA

Table 5-10: Electrical characteristics for the signals of the Debug connector (FOR INTERNAL USE)

5.6.3 Rx1 coaxial interface

The electrical specifications related to the Rx1 coaxial interface are shown in the table below.

Property	Value	Unit
Receiver Specifications (Rx1)		
Tuning Range	1518.0 – 1559.0	MHz
Channel step size	1.25	kHz
Input Signal Level	-100 to -60	dBm
Noise Figure (see Figure 5-9 on page 17, normal mode).	<8	dB
Noise Figure (ATC mode)	<18	dB
IIP3	>-30	dBm
IIP3 (offset > 2 MHz, normal mode)	+5	dBm
IIP3 (offset > 2 MHz, normal mode, ATC mode)	+30	dBm
Recommended max input power (offset > 2 MHz, normal mode)	-40	dBm
Recommended max input power (offset > 2 MHz, normal mode, ATC mode)	-15	dBm
Recommended max input power Tx band (1626.5 - 1675 MHz, normal mode)	-30	dBm
Recommended max input power Tx band (1626.5 - 1675 MHz, ATC mode)	0	dBm
Recommended max input power image frequency (1250 - 1291 MHz, normal mode)	-30	dBm
Recommended max input power image frequency (1250 - 1291 MHz, ATC mode)	0	dBm
Group Delay Ripple, 200 kHz BW ^a	<400	ns
Input Impedance	50	Ohm
Input Return Loss (min)	12	dB

Table 5-11: Electrical characteristics of the Rx1 coaxial interface

- a. According to the SDM (see [18]) the recommended maximum total system group delay ripple is 500 nS.

The figure below shows the typical noise figure versus temperature.

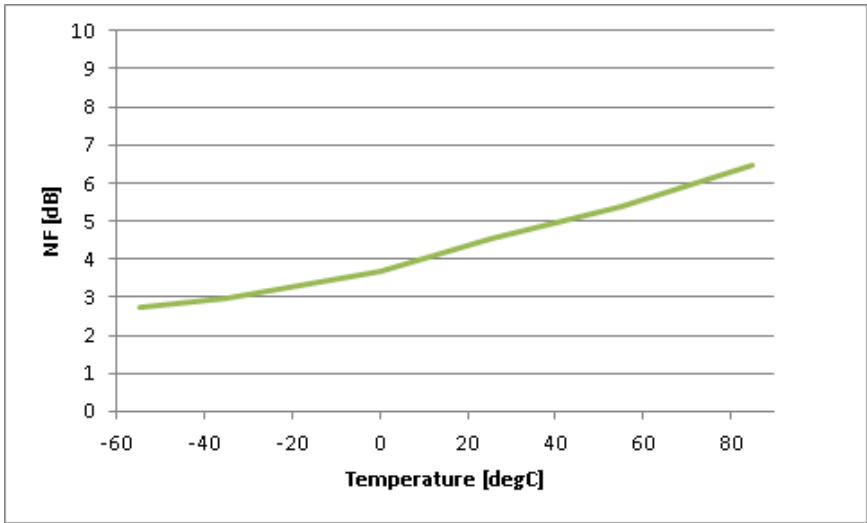


Figure 5-9: NF versus temperature (typical)

Note The BGAN XL Radio Module meets the requirements to Packet Error Rate (PER) stated in the SDM (see [18]) with a 0.2 dB degradation of C/N_0 compared to the C/N_0 points stated in the SDM in order to allow for implementation losses like e.g. HPA noise, in-band frequency ripple etc.

5.6.4 Rx2 coaxial IF interface

The electrical specifications related to the Rx2 coaxial interface are shown in the table below.

Property	Value	Unit
Receiver Specifications (Rx2)		
Frequency Range	134 – 140	MHz
Input Signal Level	-70 to -30	dBm
Noise Figure ^a	12 to 27	dB
IIP3 (inside signal bandwidth)	-10 to +5	dBm
Input Impedance	50	Ohm
Input Return Loss (min)	12	dB

Table 5-12: Electrical characteristics of the Rx2 coaxial interface

a. Varies dynamically with internal AGC setting.

5.6.5 Tx coaxial interface

The electrical specifications related to the Tx1 coaxial interface are shown in the table below.

Property	Value	Unit
Transmitter specifications (Tx)		
Tuning range ^a	1626.5 – 1660.5 1668.0 – 1675.0	MHz
Channel step size	1.25	kHz
Output signal level ^b	-10 to -40	dBm
Output signal level, absolute precision	+/-1	dB
Output signal level, relative precision	+/-0.25	dB
Output noise floor (max)	-150	dBm/Hz
LO leakage (max)	-10	dBm
LO frequency	Tx + 162	MHz
Spurious (in band) offset < 700kHz (modulated spurious)	-55	dBc
Spurious (in band) offset > 700kHz (modulated spurious)	-67	dBc
Spurious (in band) offset > 21MHz	-75	dBc
Phase noise (SDM spec) ^c / typ. 10 Hz	(-35) / -50	dBc/Hz
Phase noise (SDM spec) ^a / typ. 100 Hz	(-55) / -75	dBc/Hz
Phase noise (SDM spec) ^a / typ. 1 kHz	(-73) / -85	dBc/Hz
Phase noise (SDM spec) ^a / typ. 10 kHz	(-75) / -85	dBc/Hz
Phase noise (SDM spec) ^a / typ. 100 kHz	(-90) / -105	dBc/Hz
Transmit power spectral density margin to SDM and ETSI spec. ^{d e}	-6	dB
EVM, typical contribution ^f	$0.15 \cdot 10^{-3}$	EVM ²
Output impedance	50	Ohm
Output return loss (min)	12	dB
Group delay ripple	<10	ns

Table 5-13: Electrical characteristics of the Tx coaxial interface

- a. Tuning range for test purpose is 1518.0 - 1675.0 MHz.
- b. Maximum nominal power (EIRP back off = 0).
- c. As specified in SDM (see [18]).
- d. ETSI 301444 and 301473.
- e. The Transmit Power Spectral Density margin to SDM (see [18]) and ETSI 301473 for aeronautical T5 (HDR) masks are -5dB.
- f. Measured on Rohde & Schwarz FSQ analyzer with the BGAN XL Radio Module in service mode transmitting a continuous modulated signal.

5.6.6 Reference Clock I/O

The electrical specifications related to the Ref CLK coaxial interface are shown in the table below.

Property	Value	Unit
Reference Clock Specifications (Ref CLK)		
Frequency	57.85	MHz
Phase Noise (Internal clock) 10 Hz (worst case) / typical	(-71) / -83	dBc/Hz
Phase Noise (Internal clock) 100 Hz (worst case) / typical	(-96) / -108	dBc/Hz
Phase Noise (Internal clock) 1 kHz (worst case) / typical	(-112) / -125	dBc/Hz
Phase Noise (Internal clock) 10 kHz (worst case) / typical	(-114) / -130	dBc/Hz
Phase Noise (Internal clock) 100 kHz (worst case) / typical	(-126) / -135	dBc/Hz
Phase Noise (External Clock) 10 Hz	-71	dBc/Hz
Phase Noise (External Clock) 100 Hz	-96	dBc/Hz
Phase Noise (External Clock) 1 kHz	-112	dBc/Hz
Phase Noise (External Clock) 10 kHz	-114	dBc/Hz
Phase noise (external clock) 100 kHz	-126	dBc/Hz
Duty cycle	45 to 55	%
Output impedance	50	Ohm
Output level (internal clock)	+6 to +10	dBm
Frequency precision including aging ^a	+/- 2	ppm
Frequency drift slope	<0.5	Hz/s
Input level (external clock)	+1.0 to 3.0	Vpp
Input impedance	1	kOhm

Table 5-14: Electrical characteristics of the reference clock coaxial interface

a. For information about the frequency error compared to network see section 6.7.2.

5.7 Interface descriptions

The following sections describes the physical-layer behaviour for the various interfaces on the BGAN XL Radio Module.

5.7.1 Control interface

The control interface is used for low-level control of the BGAN XL Radio Module. It consists of a UART with hardware flow control, an outgoing and an incoming interrupt, and a reset signal.

Signal	Description
UART_RxD	Active high received serial data (to BGAN XL Radio Module)
UART_TxD	Active high transmitted serial data (from BGAN XL Radio Module)
UART_RTS	Request-to-send, active high flow control output
UART_CTS	Clear-to-send, active high flow control input RTS and CTS are used together to implement hardware flow control
Irq_In	Active high input interrupt (when high during power-on/reset, the BGAN XL Radio Module will stop in boot loader/safe mode)
Irq_Out	Active high output interrupt
Rst_In	Active low input used to reset BGAN XL Radio Module circuitry

Table 5-15: Control interface – signal description

The typical power up sequence is illustrated below:

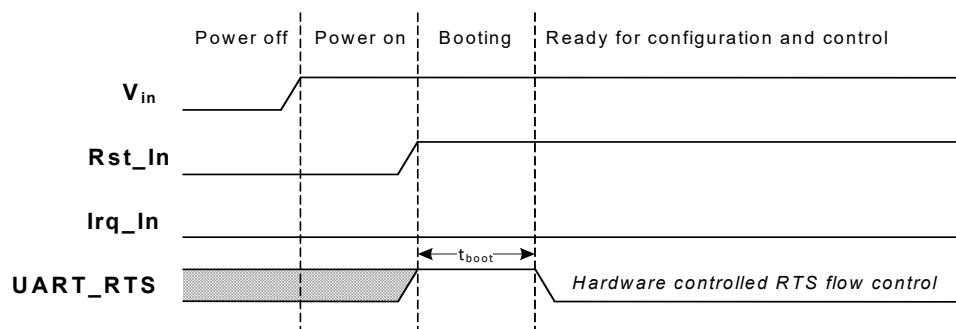


Figure 5-10: Control Interface startup

The boot time of the BGAN XL Radio Module includes the internal POST tests and is typically around 6 seconds.

For detailed description of the data flow and protocols supported by the control interface see chapter 8 on page 8-1.

5.7.2 Digital reference clock output

The 57.85 MHz reference clock of the BGAN XL Radio Module is output at 3.3V TTL levels and can be used for external synchronization.

See section 6.5.4 for information on how to enable the reference clock output.

Note The digital reference clock output will by default be disabled when the BGAN XL Radio Module enters sleep mode in order to save power. If the digital reference clock output is configured to static (always on) a higher power consumption must be expected.

5.7.3 RF control interface

The RF control interface consists of an SPI bus (Serial Peripheral Interface bus) and 4 control I/O. The BGAN XL Radio Module acts as the master for the SPI bus.

Signal	Description
SPI_CLK	Clock
SPI_MOSI	Master output, slave input
SPI_MISO	Master input, slave output
SPI_LE	Active low latch enable/ slave select
Tx_Sync	Active high signal synchronized to each Tx burst / Tx frame
Tx_Ack	Active high input to signal acknowledge of Tx transmission
Rx_Ctrl	Control of external Rx circuitry (low indicates power down)
Tx_Ctrl	Control of external Tx circuitry (low indicates power down)

Table 5-16: Signal description of the RF control interface

Note All signals defined as outputs in the table above are three-stated during boot and waveform load. The integrator should place appropriate pulls external to the BGAN XL Radio Module.

For a detailed description of the dataflow and protocols supported by the RF Control interface see section 9.2 on page 9-12.

5.7.3.1 RF Control SPI Configuration

The SPI configuration is summarised in the table below.

Mode	Clock polarity	Clock phase	Latch enable	Word size [bit]
4-wire	Rising edge	First valid clock	Active Low	40

Table 5-17: SPI configuration

5.7.3.2 RF Control SPI Timing

Timing of the SPI bus is shown in the figure below. The specifications are valid at the interface of the BGAN XL Radio Module (i.e. at the B2B connector).

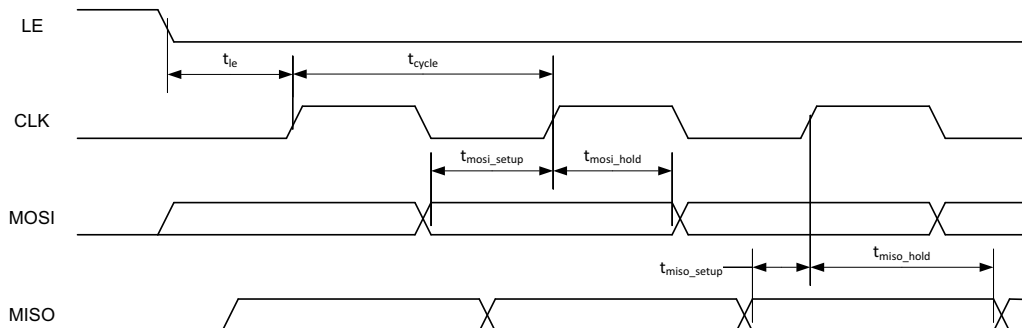


Figure 5-11: SPI timing diagram.

The timing parameters shown in the table below are specified with respect to the 50% edge of CLK/LE and the 10/90% edges of the data signals (MOSI/MISO).

Characteristic	Min.	Typ.	Max.	Unit
RF Control SPI signals				
t_{cycle}	68.4	71.4	74.4	ns
$t_{\text{mosi_setup}}$	15			ns
$t_{\text{mosi_hold}}$	15			ns
$t_{\text{miso_setup}}$	22			ns
$t_{\text{miso_hold}}$	6			ns
t_{le}	15			ns

Table 5-18: SPI timing parameters

5.7.4 TSI/PCM Interface

The TSI/PCM Interface consists of the 4 signals described in the table below.

Signal	Description
TSI_CLK	Active high bus clock input signal
TSI_Fsync	Active high frame synchronization input signal
TSI_RxD	Active high receive data output signal
TSI_TxD	Active high transmit data input signal

Table 5-19: TSI interface signal description

For a detailed description of the dataflow and protocols supported by the TSI/PCM interface see section 7.9 on page 7-42.

5.7.5 Data interface

The data interface of the BGAN XL Radio Module is electrically compliant to the USB 2.0 OTG standard.

Signal	Description
USB_DP	Serial Data +
USB_DM	Serial Data -
USB_ID	Host/device Identification
USB_VBUS	USB Bus Voltage

Table 5-20: USB interface signal description

The VBUS power output has a current-limiting function and is tolerant of short term short circuit. It is however not allowed to draw supply current from VBUS, as the PSU of the BGAN XL Radio Module is not designed for this. Use VBUS only for signalling purposes.

Startup & configuration

This chapter has the following sections:

6.1	Start-up	6-2
6.2	General use	6-7
6.3	Parameter overview	6-11
6.4	System	6-12
6.5	Interface	6-21
6.6	Functionality	6-28
6.7	Status	6-37
6.8	Control	6-46
6.9	Connection types	6-55
6.10	Support	6-58
6.11	Factory (FOR INTERNAL USE)	6-66
6.12	Settings (FOR INTERNAL USE)	6-72

6.1 Start-up

This section describes in detail the various modes of operation supported by the BGAN XL Radio Module and describes the procedure for bringing the BGAN XL Radio Module into operational mode.

6.1.1 Overview

As introduced in section 4.3.1 on page 4-4 the BGAN XL Radio Module always operates within a predefined set of modes, each supporting its own well-defined set of functions.

To assist the integrator in starting the BGAN XL Radio Module correctly the overall mode of the BGAN XL Radio Module is reflected by the configuration parameter **sys.status.mode** described in section 6.4.1 on page 6-12.

The **sys.status.mode** parameter reflects the current mode of the BGAN XL Radio Module using only a few simple modes designated **initial**, **ready**, **service**, **standby**, **operating** or **error**.

The BGAN XL Radio Module consists of two processing units; one implementing the higher level protocols and one implementing the modem. These units are designated unit.0 and unit.1 respectively in the configuration system.

The **operating mode** supports one of three sub-modes defined by the mode of the protocol processor namely **IAI-2** for standard on-air operation using the IAI-2 protocols or two test modes designated as **BPT** and **BPLT** mode.

The correlation of the unit modes to the overall system modes are shown in the figure below, together with a short description of the actions that the integrator is supposed to do. A detailed step-by-step start-up procedure is given in section 6.1.2.

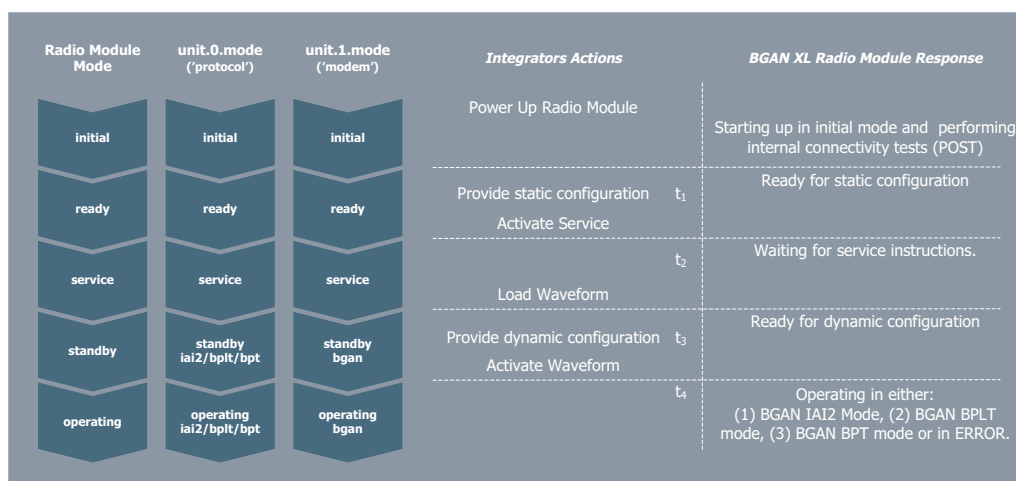


Figure 6-1: BGAN XL Radio Module modes.

Each configuration parameter has its own constraint with regards to when it must be set in order to obtain correct operation of the BGAN XL Radio Module. These points in

the start-up sequence are designated with $t_1..t_4$ in Figure 6-1 above and are described in detail in section 6.2.4 on page 6-8.

6.1.1.1 BGAN XL Radio Module actions (FOR INTERNAL USE)

The following figure is only for internal use and summarises the actions done by the BGAN XL Radio Module during the start up procedure.

Radio Module Mode	Integrators Actions	BGAN XL Radio Module Response
initial	Power Up Radio Module	1) Boots CPU application and DSP/FPGA service.
		2) CPU and DSP performs POST
ready	Static configuration t_1	3) POST done (failed or passed), idle mode
	Activate Service	4) Receiving configuration data from Control interface
service	t_2	5) START_REQ CPU->DSP
		6) Receiving service related commands from Control Interface (extended post...)
standby	Load Waveform	7) CPU loads DSP and FPGA waveform
	Dynamic configuration t_3	8) CPU finished loading DSP and FPGA, and has received "DSP READY" from DSP
operating	Activate Waveform	9) Receiving configuration data from Control interface
	t_4	10) START_REQ CPU->DSP
		11) CPU executes initcalls depending on the loaded waveform (see initcallReport shell command)
		12) CPU has all software modules loaded related to the loaded waveform.

Figure 6-2: BGAN XL Radio Module states for internal use.

6.1.2 Start-up Procedure (step by step)

The following paragraphs provides step-by-step descriptions of the start-up sequence illustrated in the figure below. At each step the actions required by the integrator to bring the BGAN XL Radio Module into an operational state are described.

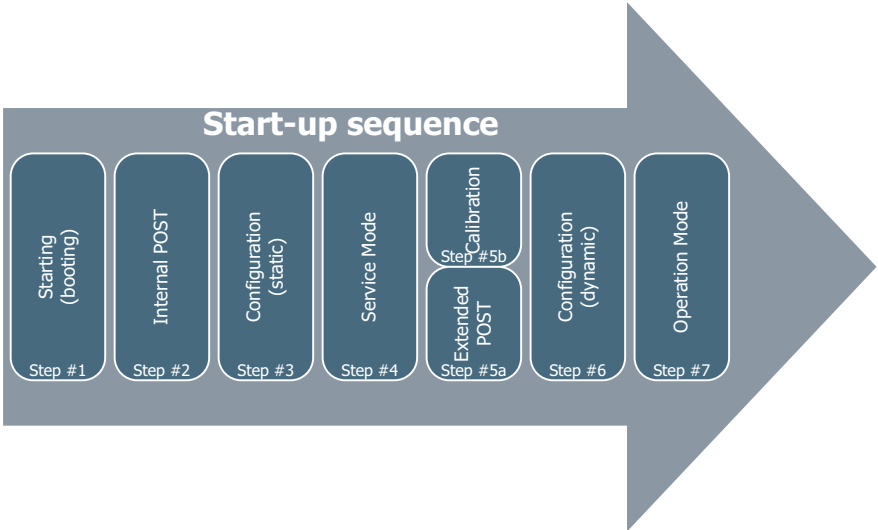


Figure 6-3: Start-up sequence of the BGAN XL Radio Module.

6.1.2.1 Step #1 - Starting (booting)

Each time the BGAN XL Radio Module is started (see 5.7.1 on page 5-20) it will enter the **initial mode**. In this mode the software modules and service functionality for the physical layer will be loaded.

The state of the BGAN XL Radio Module is reflected by the **sys.status.mode** parameter which is located in the configuration system (see section 6.4.1 on page 6-12 for more information).

6.1.2.2 Step #2 - Internal POST

As soon as the BGAN XL Radio Module is brought into the **initial mode** and the software has been initialized it performs a set of tests to validate the internal connectivity to its sub-components and to verify that the module is still operational. These tests are referred to as internal Power On Self-Test (internal POST) and require 100% conformity (see details in section 10.1 on page 10-2). If any of these mandatory tests fail the BGAN XL Radio Module will be non-operational.

The test results are logged as simple pass/fail entries and are stored in the configuration system. If the POST is passed the BGAN XL Radio Module enters the **ready mode**, which makes the control interface operational and ready to receive commands.

In the **ready mode** the BGAN XL Radio Module is waiting for instructions from the integrator.

Note | At this point any requests for establishment of Internet connections and voice calls will be rejected as no waveform is loaded/activated yet.

6.1.2.3 Step #3 - Configuration (static)

The integrator is responsible for bringing the BGAN XL Radio Module into the different operating modes and to configure it accordingly. The integrator must ensure that surrounding hardware, modules or other functions that have influence on the BGAN XL Radio Module (LNA(off), HPA(off), RF Ctrl(on) etc.) are correctly configured before the RM is activated.

Static configuration must be provided to specify which application (class, antenna etc.) the BGAN XL Radio Module is a part of. This configuration is used by the BGAN XL Radio Module to decide how the software must be initialized and how it must be executed (see details in section 6.5 on page 6-21 and 6.8 on page 6-46).

When the configuration has been completed the service related functionality must be activated by sending the message (see section 8.5.2.4.1 on page 8-11):

MSG_WAVEFORM(activate,service)

Note | Certain applications may not utilize the service mode functionality (Step #4, #5a and 5b) and thus skip these steps and go directly to Step #6.

6.1.2.4 Step #4 - Service mode

When the BGAN XL Radio Module is ready to receive service related instructions on the control interface an acknowledge message is returned (see section 8.5.2.9.1 on page 8-26):

MSG_ACK

Now the BGAN XL Radio Module has entered **service mode** and the integrator has access to a special designed service API which among other things offers the capability to:

- Execute additional connectivity tests (see step #5a in section 6.1.2.5).
- Perform calibration of the Rx and Tx chains (see step #5b in section 6.1.2.6).
- Transmit an unframed L-band carrier (modulated or CW).
- Perform measurements on a specified L-band Rx channel (spectrum analyzer).

6.1.2.5 Step #5a - Extended POST

In **service mode** the integrator can choose to perform some additional connectivity tests to validate that the connections to the BGAN XL Radio Module are functional and ready to operate. These tests are referred to as extended POST and are controlled by the integrator who must perform the pass/fail validation. The following functionality is available in this mode:

- Loop-back on the TSI interface.
- Read/write via the RF Control interface.
- Read/write and loop-back via the RF interfaces.
- Bit Error Rate testing using Rx and Tx signals.

To support this kind of interaction between the integrator and the BGAN XL Radio Module, a subset of test functions specially designed for this purpose are accessible. The API subset is described in further details in section 11.3 on page 11-6.

6.1.2.6 Step #5b - Calibration

Service mode also offers an API subset designed to assist the integrator with external calibration of the Rx and Tx chains (e.g. Tx levels and frequency variations).

The API includes the following capabilities (and is described in further detail in chapter 11):

- Transmit an unframed L-band carrier (modulated or CW).
- Perform measurements on a specified L-band Rx channel (spectrum analyzer).

6.1.2.7 Step #6 -Configuration (dynamic)

Finally the integrator must provide more configurations to specify dynamic information (such as Tx power level(s), reference clock, ATC activation etc.) that is needed by the BGAN modem to operate properly depending on the specific configuration.

After dynamic configuration has been completed the BGAN XL Radio Module can be put into **operating mode**, requesting load of a specific waveform, by sending the following message (see section 8.5.2.4.1 on page 8-11):

MSG_WAVEFORM (load, IA12) which is acknowledge with **MSG_ACK**.

On request for a specific waveform the BGAN XL Radio Module loads the physical layer with a waveform-specific modulator/demodulator and starts the associated protocol processes. The mode is now switched to **standby IA12** waiting for further waveform specific configuration and/or to be activated.

When configuration has been completed the integrator must activate the BGAN XL Radio Module by sending the message:

MSG_WAVEFORM (activate, IA12) which is acknowledged with **MSG_ACK**.

6.1.2.8 Step #7 -BGAN Waveform mode

Now the BGAN XL Radio Module is in the **operating IA12 mode** where it will begin to act as a modem (with access to the Inmarsat BGAN network) that is ready to accept requests for establishing Internet data connections using PPPoE and/or calls using SIP.

From this point on the integrator has access to a new API explicitly designed for waveform operation which among other things offers the capability to:

- Acquire and evaluate a BGAN carrier (for antenna pointing and satellite search).
- Perform power measurements on a specified L-band Rx channel.
- Establish PS and CS connections.
- SDM sleep operation (power save).
- AMBE+2TM encoding/decoding (using SIP)
- Access the management interface.

6.2 General use

6.2.1 Introduction to the configuration system

The BGAN XL Radio Module has a configuration system which is used for sharing configuration information. All public parameters in the database are accessible from all tasks in both the protocol processor and the modem and for the integrator as well using the control and data interface.

The configuration system supports 3 different storage types:

1. Volatile memory (RAM),
2. Non-volatile (Flash file-system)
3. Cached (RAM parameters saved to flash at power down or every 30mins)

The parameters in the configuration system are organized in a tree-based hierarchy identified by text strings. The text strings are composed of the names of the nodes in the tree, e.g. **protocols.bgan.interface.rf.gain.tx.nominal_power**.

6.2.2 Mutual exclusiveness

To ensure mutual exclusiveness the integrator must respect a simple protocol when modifying inter-related parameters.

- **Lock** before modifications and **unlock** after modifications.

A padlock on the following configuration trees symbolizes that the parameters are inter-related and that this mutual exclusion protocol must be respected.

During startup of the BGAN XL Radio Module all the mutual exclusiveness parameters are initialised to **unlocked**. The BGAN XL Radio Module sees the locked parameters as read-only during normal operation. They are thereby entirely owned by integrator which holds the responsibility of keeping them unlocked when the inter-related data isn't modified.



WARNING! Ignoring this protocol will potentially harm the operation of the BGAN XL Radio Module such that the overall system requirements are violated.

See chapter 12, *Use cases* for detailed examples on writing to inter-related parameters.

6.2.3 Notification on parameter changes

The system has a feature where the integrator can receive a notification when a certain parameter has been modified. Some of the parameters will have an attached notification (call-back) function so that the BGAN XL Radio Module is informed on any changes of dynamic parameters.

6.2.4 Syntax description for parameters

All parameters described in this section are presented in a table similar to the one illustrated below.

Parameter name	External access	Type / Domain	Values	Comment
.param.name	[r|w|r/w] [t1|t2|t3|t4] [\$1|\$2|\$3|\$4|\$5]	[int|string|bytearray] [ram|flash| cached|factory]	[min..max]	A description

Table 6-1: Tx and rx delay configuration parameters

A short descriptions of the categories are listed below:

- **Parameter name** specifies the parameter name with a complete directory hierarchy where dots '.' are used as delimiter. This exact parameter name must be used during every access of the parameter by all possible users of the configuration system.
- **External access** specifies which privileges the integrator has in terms of accessing the parameter. The parameter can be either read ('r'), write ('w') or read_write ('r/w'). It also holds a time indication which specifies the latest time in the startup sequence the parameter must be written defined as follows:
 - t1=before service activation
 - t2=during service
 - t3=before waveform activation
 - t4=during waveform operation

The parameter restriction (§1.5) is described in details in section 6.2.4.1.

- **Type** specifies the attribute type of the parameter which can either be an 32-bit integer ('int'), a character string ('string') or a byte array ('byte array').
- **Domain** specifies in which domain the parameter is stored (ram or flash) and thereby if the parameter is persistent or not (volatile/non-volatile memory).
 - ram = the parameter is stored in volatile memory and will be cleared during reset of the BGAN XL Radio Module (dyndata).
 - flash = the parameter is stored in non-volatile memory and is thus persistent during reset of the BGAN XL Radio Module.
 - cached= the parameter is stored in volatile memory but written to non-volatile memory every 30 min. or at power down.
 - 'factory' is used for parameters stored during production that cannot be changed, e.g. MAC address, internal calibration values etc..

- **Value** specifies the minimum and maximum value of the parameter.

Comment contains a short description of the parameter and how it can be used.

Note

The configuration is written to a file system and not a single sector in the non-volatile memory. Using multiple sectors extends the flash wear-out time significantly.

6.2.4.1 Parameter restrictions

The parameters in the configuration system are classified into the following five restriction groups:

- §1 **Mandatory** parameters which must be specified by the integrator. These parameters are only read once during activation and **cannot be modified** later in the startup process. If these parameters are not specified when activated the BGAN XL Radio Module will enter its ERROR state and **cannot proceed** to normal operation before the errors are corrected.
- §2 **Mandatory** parameters which must be specified by the integrator. These parameters are read during activation but **can be modified** anytime later in the startup process. If these parameters are not specified when activated the BGAN XL Radio Module will enter its **error mode** and **cannot proceed** to normal operation before the errors are corrected.
- §3 Parameters which **should be specified** if the associated functionality/interface is activated. These parameters are only read once during activation and **cannot be modified later** in the startup process. If the associated functionality/interface is activated and the parameters are not specified the BGAN XL Radio Module will enter its **error mode** and proceed with a harmless configuration.
- §4 **Optional** parameters (if **transient** located in RAM and cleared during reboot) and are per default deactivated. Optional parameters specified for **t1 or t3** are only read once during activation and **cannot be modified later** in the startup process. Parameters for **t2 and t4** **can be altered anytime**.
- §5 **Optional persistent** parameters are located in FLASH (survives a reboot) and includes a default value. These parameters can be altered anytime but **requires a reboot** to be effected.

Note

When the BGAN XL Radio Module enters its **error mode** one or more of the mode parameters (described in section 6.4.1 on page 6-12) will include the string 'error'. Details about why the BGAN XL Radio Module enters the **error mode** can be captured via the syslog interface described in section 10.2 on page 10-6.

The table below illustrates the severity (or impact) of an unconfigured parameter versus the different restrictions. As an example if a §2 parameter is missing the BGAN XL Radio Module will not operate properly whereas a missing §4 parameter is acceptable.

Restrictions	The RM will not operate (error mode)	The RM will operate (but in error mode)	The RM will operate
§1	x		
§2	x		
§3		x	

Table 6-2: Severity of unconfigured parameters.

Restrictions	The RM will not operate (error mode)	The RM will operate (but in error mode)	The RM will operate
§4			x
§5			x

Table 6-2: Severity of unconfigured parameters. (Continued)

Note

To ease configuration and assist the integrator during initial troubleshooting the BGAN XL Radio Module generates syslog entries (severity level 5) about missing configuration parameters which are mandatory (§1, §2 and §3).

Examples:

```
Sys log entries (severity level 5):  
0: Err. 'protocols.bgan.class' (0)  
1: Err. 'protocols.bgan.interface.rf.delay.tx.external' (0)
```

6.3 Parameter overview

6.3.1 Configuration tree (Top-level)

The parameters in the configuration system are organized in a hierarchical structure as shown in below table.

Root level	Description
sys	System parameters like serial number, software version etc.
post	POST test definitions and results
protocols	Protocol specific parameters. Subdivision based on the software module structure, e.g. protocols.bgan, protocols.sip and protocols.umts
services	Service specific parameters, e.g. spectrum analyzer and transmission time plan configuration parameters.
platform	Platform/terminal specific parameters, e.g. usim, serial numbers and revision history. These parameters can be created by the Board Processor using the Control Interface and can be accessed by the Application Processor.

Table 6-3: Parameter organization in the configuration system

A complete list of all parameters available is shown later in this chapter.

6.3.2 Static configuration parameters

Static configuration parameters can only be specified once and are mandatory parameters that must be configured before either service or waveform activation. These parameters are organized in hierarchies and described in detail in section 6.5 and 6.8.

6.3.3 Dynamic configuration parameters

Dynamic configuration parameters are parameters which can be altered during operation by either the modem itself or by the integrator. The dynamic parameters are organized in hierarchies and are described in detail in section 6.6, 6.7 and 6.9.

6.4 System

The sections below describe the parameters that are related to the overall system.

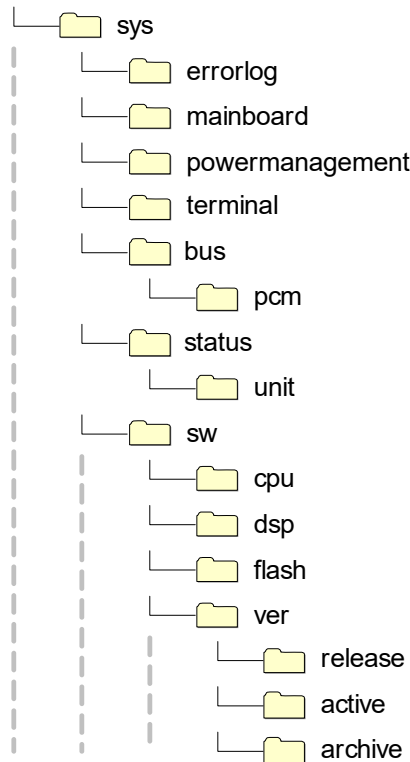


Figure 6-4: Parameter hierarchy for system parameters.

6.4.1 BGAN XL Radio Module status

The status of the BGAN XL Radio Module is reflected by the **sys.status.mode** parameter listed in the table below. Furthermore the current state of each sub-unit is exposed in the parameters **sys.status.unit.<n>.mode**.

Parameter name sys.status	External access	Type / Domain	Values [min;max]	Comment
.mode	r	string / ram	n.a.	initial, ready, service, standby, operating or error
.unit.0.mode	r	string / ram	n.a.	initial, ready, service, standby iai2/bplt/bpt, operating iai2/bplt/bpt or error
.unit.0.name	r	string / ram	n.a.	Name: protocol
.unit.1.mode	r	string / ram	n.a.	initial, ready, service, standby bgan, operating bgan or error

Table 6-4: Configuration parameter: BGAN XL Radio Module status

Parameter name sys.status	External access	Type / Domain	Values [min;max]	Comment
.unit.l.name	r	string / ram	n.a.	Name: modem
.unit.cnt	r	int / ram	n.a.	Number of units who report status
.uptime	r	int / ram	n.a.	BGAN XL Radio Module uptime specified in seconds

Table 6-4: Configuration parameter: BGAN XL Radio Module status (Continued)

6.4.1.1 BGAN-XL User Terminal Test Setup (BUTTS) status (FOR INTERNAL USE)

The BGAN XL Radio Module BUTTS functionality can be enabled or disabled.

Parameter name sys.status	External access	Type / Domain	Values [min;max]	Comment
.butts.unit	r/w	string / ram	n.a.	Unit name: rx, tx
.butts.unit_en	r/w	int / ram	[0, 1]	0: Disable (default) 1: Enable

Table 6-5: Configuration parameter: BUTTS status

6.4.2 Software versions

6.4.2.1 Software release version

The BGAN XL Radio Module discloses the following software release information.

Parameter name sys.sw.flash.release	External access	Type / Domain	Values [min;max]	Comment
.version	r	string / ram	n.a.	Release version number
.buildid	r	string / ram	n.a.	Build ID of the release
.buildnr	r	int / ram	n.a.	Build number of the release
.builddate	r	string / ram	n.a.	Build date of the release

Table 6-6: Configuration parameter: Software release information

6.4.2.2 Versions of active software units (FOR INTERNAL USE)

The BGAN XL Radio Module discloses the following information about the active units:

Parameter name sys.sw.	External access	Type / Domain	Values [min;max]	Comment
.cpu.version	r	string / ram	n.a.	Version number of the active cpu build
.cpu.buildid	r	string / ram	n.a.	Build ID of the active cpu build (format "<build name>--<build number>")
.cpu.builddate	r	string / ram	n.a.	Build date of the active cpu build
.dsp.version	r	string / ram	n.a.	Version number of the active dsp build
.dsp.buildid	r	string / ram	n.a.	Build ID of the active dsp build
.dsp.buildnr	r	int / ram	n.a.	Build number of the active dsp build.
.dsp.builddate	r	string / ram	n.a.	Build date of the active dsp build.

Table 6-7: Configuration parameter: Active software units

6.4.2.3 Versions of archive software units (FOR INTERNAL USE)

The BGAN XL Radio Module discloses the following information about the archive units. At this stage the archive includes; one cpu image, two dsp images and two FPGA images.

Parameter name sys.sw.flash	External access	Type / Domain	Values [min;max]	Comment
.unitversion.<n>.version	r	string / ram	n.a.	Version number of unit n.
.unitversion.<n>.buildid	r	string / ram	n.a.	Build ID of unit n.
.unitversion.<n>.buildnr	r	int / ram	n.a.	Build number of unit n.
.unitversion.<n>.name	r	string / ram	n.a.	Name of unit n
.unitversion.cnt	r	int / ram	n.a.	Number of units.

Table 6-8: Active software units

6.4.3 BGAN XL Radio Module temperature

The internal temperature of the BGAN XL Radio Module is stored in the configuration system. The parameter is updated every time the temperature changes 1°C.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.mainboard.temperature	r	int / ram	[-55.. +125]	Temperature in degrees Celsius (°C). Values correspond to the working area of the sensor.
.overheat_protection.reboot	r/w t4 §4	int / ram	[0..1]	Determines if the BGAN XL Radio Module shall reboot if the temperature gets critically high. 1: Reboot is performed (default) 0: Reboot is disabled
.overheat_protection.alarm	r/w t4 §4	int / ram	[0..1]	Determines if a message is sent (see 8.5.6.1) if the temperature gets critically high. 1: Message is enabled (default) 0: Message is disabled

Table 6-9: Configuration parameter: BGAN XL Radio Module temperature

Less than 3°C temperature difference to case temperature can be expected by the on-board temperature sensor. Temperature monitoring is described in 10.3.3 on page 10-12.

6.4.4 Software updated

The BGAN XL Radio Module sets this parameter to '1' when the software has been updated using the procedure described in section 11.2 on page 11-3.

Parameter name sys.sw	External access	Type / Domain	Values [min;max]	Comment
.updated	r	int / ram	[0..1]	0: Not updated 1: Software has been updated

Table 6-10: Software updated parameter

6.4.5 Power management / SDM sleep

The BGAN XL Radio Module SDM sleep mode can be enabled and disabled. For more information on SDM sleep see 11.5 on page 11-12 and 11.5.2 on page 11-13 for limitations in using SDM sleep and suspend mode together.

Parameter name sys.powermanagement	External access	Type / Domain	Values [min;max]	Comment
.enabled	r/w t4 §4	int / ram	[0..1]	0: Disable (default) 1: Enable

Table 6-11: Enable / disable BGAN XL Radio Module power management

6.4.6 TSI/PCM bus configuration

The following parameters are used to configure which rx and tx slots on the TSI/PCM bus that shall be active.

Parameter name sys.bus.pcm	External access	Type / Domain	Values [min;max]	Comment
.enabled	r/w t3 §4	int / ram	[0..1]	0=disable(default) 1=enable
.rxslots	r/w t3 §4	int / ram	[0.. 2 ³² -1]	Bit mask slot.
.txslots	r/w t3 §4	int / ram	[0..2 ³² -1]	Bit mask slot
.rxdatadly	r/w t3 §4	int / ram	[0..3]	Delay in PCM clock cycles for the beginning of actual data reception with respect to the start of the frame
.txdatadly	r/w t3 §4	int / ram	[0..3]	Delay in PCM clock cycles for transmission with respect to the start of the frame
.testmode	r/w t3 §4	int / ram	[0..1]	This test mode parameter is not used and should be left untouched. 0=disable(default) 1=enable.
.loopback.enable	r/w t3 §4	int / ram	[0..1]	Enable loop back of data in slot 0 0=disable (default) 1=enable

Table 6-12: TSI/PCM slot configuration.

Note

Note that the parameters **.rxslots**, **.txslots**, **.rxdatdly**, **.txdatdly**, must be configured before the parameter **.enabled** is activated as they are only read once.

6.4.7 Terminal serial number (FOR INTERNAL USE)

The integrator must, upon startup, write the serial number of the terminal into the configuration parameter **sys.terminal.serial**

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.terminal.serial	r/w t1 §1	string/ ram	n.a.	Max. 200 characters

Table 6-13: Terminal serial number

Important

This is for internal use only and only intended to be used for E710 units that have not been produced with SIM Lock code. For new products the SIM Lock code must be written during production. Otherwise the SIM Lock feature will not be secure.

6.4.8 RM serial numbers

The serial number of the RM is the last ten digits of the 20-digit PCB ID. The PCB ID can be found in the configuration parameter **sys.pcbid**, and is stored as an ASCII string.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.pcbaid	r	byte array/ factory	n.a.	A 20 character ASCII string representing the serial number (or pcb id) of the unit .

Table 6-14: Radio Module serial number

6.4.9 MAC address

The MAC address which is pre-programmed during manufacturing of the BGAN XL Radio Module can be read in the following parameter.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.macaddr	r	byte array/ factory	n.a.	A 6 character ASCII string.

Table 6-15: Radio Module MAC address

6.4.10 BOM versions

The BOM versions which are pre-programmed during manufacturing of the BGAN XL Radio Module can be read in the following parameters.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.bom_version	r	byte array/ factory	n.a.	A 4 character ASCII string representing the BOM (or part list) of the board . Examples: 0B02 or 0C02
.unit_bom_version	r	byte array/ factory	n.a.	A 4 character ASCII string representing the BOM (or unit part list) of the unit . Examples: 0A01 or 0A15

Table 6-16: Radio Module BOM version

6.4.11 Errorlog entries (FOR INTERNAL USE)

The total amount of errorlog entries in the internal errorlog can be read from the **sys.errorlog.count** parameter.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.errorlog.count	r	int/ ram	[0..100]	Total number of internal errorlog entries, both from current and previous power cycles.

Table 6-17: Errorlog entries

6.4.12 Platform type (FOR INTERNAL USE)

This parameter holds the value corresponding to the product id described on the internal wiki (<http://wiki.ttnet/bin/view/Products/CoreSwPlatformProductId>)

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.platform_type	r	byte array / factory	[0x0d, 0x15]	Product ID for BGAN XL Radio Module (TT3750A) is 0x0d. Product ID for the BGAN XL Radio Module for Aero (TT3750A-AER) is 0x15.

Table 6-18: Value for platform_type parameter

6.4.13 Limitation on the background data rate

This parameter enforces a limitation on the transmission data rate (to 64 kbit/s) for a background connection. Temperature monitoring and use of this parameter is described in more details in 10.3.3 on page 10-12.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comments
.reduce_background_datarate	r/w t4 §4	int / ram	[0..1]	0: No limit for data rate is enforced (default). 1: A limit of 64 kbit/s for background connections is enforced.

Table 6-19: Value used to limit data transmission rate on background connections

Note | This does not affect streaming connections.

6.4.14 HTTP Interface

The following parameters are used to control the HTTP interface to the BGAN XL Radio Module. The HTTP interface is described in 7.7.1 on page 7-28.

Parameter name sys.sw.http	External access	Type / Domain	Values [min;max]	Comment
.keepalive	r/w t4 §4	int / ram	[60..3600]	Default: 120 seconds
.port	r	int	n.a.	Default: 8080

Table 6-20: HTTP settings

Parameter name sys.sw.http	External access	Type / Domain	Values [min;max]	Comment
.update_port	r/w	int / ram	n.a	Writing to this parameter will change the port used for software update (overriding the default 8080 port). Subsequent updates to the parameter (without restarting the BGAN XL Radio Module) are ignored.
.notification.keepalive	r/w t4 \$4	int / ram	[60..3600]	Default: 120 seconds, This setting will override .keepalive .

Table 6-20: HTTP settings

6.5 Interface

The sections below describe the parameters that are related to the USIM, RF and RF control interfaces.

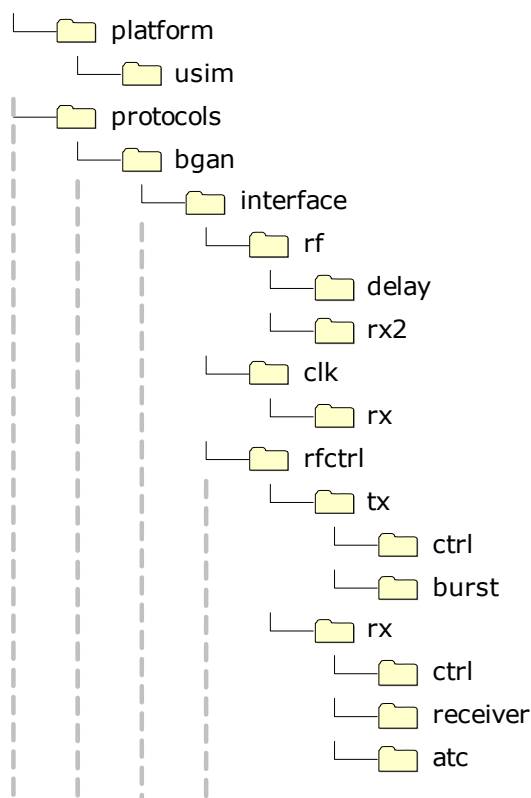


Figure 6-5: Parameter hierarchy for interface parameters.

6.5.1 USIM

The following parameters are related to the BGAN XL Radio Module USIM configuration.

Parameter name platform.usim	External access	Type / Domain	Values [min;max]	Comment
.status	r/w	int / ram	[0..1]	Indicates if there is a USIM card present or not. 0: Removed / Not present 1: Inserted / present
.apn	r	string / ram	n.a.	EF _{APN}

Table 6-21: USIM related parameters

Parameter name platform.usim	External access	Type / Domain	Values [min;max]	Comment
.airtime_provider	r	string / ram	n.a.	EF _{DP_NAME}
.iccid	r	string / ram	n.a.	EF _{ICCID}
.imsi	r	string / ram	n.a.	EF _{IMSI}
.pin.status	r	string / ram	Absent, Invalid, Needed, Blocked, PUK Blocked, SIM Lock Blocked, Valid	USIM PIN status
.m2m	r	int / ram	[0..1]	0: Not an M2M USIM card 1: M2M USIM card

Table 6-21: USIM related parameters (Continued)

The Board Processor must inform the BGAN XL Radio Module if there is a USIM card present and ready to receive commands. When the Board Processor has powered up and initialized the USIM card, the setting **platform.usim.status** must be set to 1. If the card is disconnected or removed the Board Processor must write 0 to **platform.usim.status**.

When the USIM is ready for commands, the BGAN XL Radio Module performs a automatic read of the EF_{APN}, EF_{ICCID}, EF_{IMSI}(defined in TS 31.102 [21]) and EF_{DP_NAME} (defined by Inmarsat),

If the RM fails to perform any operations in the USIM, the **platform.usim.pin.status** will be set to 'Invalid'. If a operation is timed out (no response on a command) the **platform.usim.pin.status** will be set to 'Absent'.

The USIM protocol between the Board Processor and the RM is described section 8.5.2.11 on page 8-29. The Application Processors (data interface) interface to the USIM card is described in section 7.7.6 on page 7-39.

If the **sys.product** value described in section 6.8.2 on page 6-47 has been set to indicate an M2M terminal, the terminal may function with both an M2M USIM card and a Land USIM card. If the USIM card is successfully recognized as an M2M USIM, the **platform.usim.m2m** value will be set to 1, otherwise 0.



sys.product_type must be written to the BGAN XL Radio Module before **platform.usim.status** is set to 1.

6.5.2 Tx and rx delay

The table below shows the parameters related to the RF signal timing. The following delay parameters are at disposal for the external platform to achieve correct burst timing (see 9.1.1).

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.delay.tx.external	r/w t1 \$1	int / ram	[0..4095]	Specified in 57.85 MHz clock cycles.
.rf.delay.rx1.external	r/w t1 \$2	int / ram	[0..4095]	Specified in 57.85 MHz clock cycles.
.rf.delay.rx2.external	r/w t1 \$1	int / ram	[0..4095]	Specified in 57.85 MHz clock cycles.

Table 6-22: Tx and rx delay configuration

6.5.3 Secondary receiver chain

The BGAN XL Radio Module has a secondary receiver input which can be activated via the **.rf.rx2.chain.enable** parameter as specified in the table below. The Rx2 input can operate as a secondary input in a diversity configuration or as the primary receiver input where external down conversion is required. In the latter case the primary chain (related to Rx1 operation) will be suspended.

The secondary receiver input is per default deactivated.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.rx2.chain.enable	r/w t1 \$4	int / ram	[0..2]	0=disable(default) 1=enable as secondary input 2=enable as primary input
.rf.rx2.if_centre_frequency	r/w t1 \$4	int / ram	[134000000.. 140000000]	IF frequency of Rx2 in Hz (default = 138MHz).

Table 6-23: Configuration parameter for secondary receiver chain configuration

6.5.4 Reference clock

The source of the reference clock must be specified via the **.clk.rx.ref_clk_sel** parameter specified in the table below.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;m ax]	Comment
.clk.rx.ref_clk_sel	r/w t1 §5	int / flash	[0..1]	0=internal (factory default) 1=external
.clk.rx.ref_clk_coax_out	r/w t1 §4	int / ram	[0..1]	0=off (default) 1=on Only allowed to be enabled when ref_clk_sel is set to internal
.clk.rx.ref_clk_b2b_out	r/w t1 §4	int / ram	[0..2]	Specifies if the reference clock is present on B2B_REF_CLK pin 0=off 1=dynamic (follows SDM sleep mode operation) 2=always on, which results in a higher power consumption in sleep mode (see 5.6.1)

Table 6-24: Configuration parameters for reference clock

When the parameter **.clk.rx.ref_clk_sel** is configured to external clock the estimated aging frequency will be exposed by the parameter **.clk.aging_frequency** presented in section 6.7.2.

Note Note when the parameter for the reference clock (**.clk.rx.ref_clk_sel**) is modified, a reboot of the BGAN XL Radio Module is required. This parameter is only read once prior to physical layer activation and are not allowed to change during operation.

6.5.5 RF control interface

The different interfaces included in the RF control interface are controlled via the parameters described in the following table. For a detailed description of the RF control interface see 9.2. The values in brackets in the following tables are used in section 9.2 for illustrative purposes.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rfctrl.tx.ctrl.spi_en	r/w t1 §4	int / ram	[0..1]	SPI Tx messages 0=disable(default) 1=enable
.rfctrl.tx.pin.tx_ctrl_en	r/w t1 §4	int / ram	[0..1]	Tx control (B2B_Tx_Ctrl) 0=disable(default) 1=enable
.rfctrl.tx.ctrl.tx_ack_en	r/w t1 §3	int / ram	[0..1]	Tx acknowledgement (B2B_Tx_Ack) 0=disable 1=enable(default)
.rfctrl.rx.pin.rx_ctrl_en	r/w t1 §4	int / ram	[0..1]	Rx control (B2B_Rx_Ctrl) 0=disable(default) 1=enable
.rfctrl.rx.ctrl.spi_en	r/w t1 §4	int / ram	[0..1]	SPI Rx messages 0=disable(default) 1=enable

Table 6-25: RF control interface

6.5.5.1 Transmitter timing

The tables below show the timing parameters related to the RF control interface which can be modified via the standard configuration interface for the BGAN XL Radio Module. The parameters can theoretically represent any legal value in the parameter range. However, to get a successful result the following must apply:

up > info > init > start

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rfctrl.tx.burst.up	r/w t1 §3	int / ram	[28925..173550]	Specified in 57.85 MHz clock cycles. (144625)
.rfctrl.tx.burst.info	r/w t1 §3	int / ram	[28925..173550]	Specified in 57.85 MHz clock cycles. (113965)

Table 6-26: Transmitter timing

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rfctrl.tx.burst.init	r/w t1 §3	int / ram	[0..10413]	Specified in 57.85 MHz clock cycles.(10413)
.rfctrl.tx.burst.start	r/w t1 §3	int / ram	[0..10413]	Specified in 57.85 MHz clock cycles.(2582)
.rfctrl.tx.burst.down	r/w t1 §3	int / ram	[28925..57850]	Specified in 57.85 MHz clock cycles.(28925)

Table 6-26: Transmitter timing (Continued)

6.5.5.2 Receiver timing

The RF control interface includes a signal which is dedicated to activation and deactivation of the receiver (see section 9.2.2). The signal is included to satisfy the strict requirements from portable and battery driven terminal products.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rfctrl.rx.receiver.up	r/w t1 §3	int / ram	[347100..520650]	Specified in 57.85 MHz clock cycles. (520650)

Table 6-27: Receiver timing

6.5.5.3 Tx acknowledgement

The RF control interface includes a single signal which is dedicated to supervisory of the external part of the transmitter chain (i.e. HPA supervision).

The parameter **.rfctrl.tx.ack.guard** specifies the guard period, that can be allowed, in which it is ignored if B2B_Tx_Ack is active after a transmission (i.e. the BGAN XL Radio Module is not transmitting).

For a more detailed description of the behaviour of Tx Acknowledgement signal and the relation to the guard parameter see section 9.2.4 on page 9-14.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rfctrl.tx.ack.guard	r/w t1 §3	int / ram	[28925..289250]	Specified in 57.85 MHz clock cycles. (28925)

Table 6-28: Tx acknowledgement

6.5.6 Intermodulation test frequencies (aeronautical only)

These values contain the channel numbers to be used for testing the performance of the receive band intermodulation. The channel numbers are defined as described in the SDM v2c4 [18] where the most significant bit determines the offset and the remaining 15 bits are used to calculate the frequency.

These values are received from the RAN and require the BGAN XL Radio Module to operate in IAI2 mode, but they are reset on reboot. The Board Processor is therefore required to read and store these values internally before setting the BGAN XL Radio Module in service mode for conducting the intermodulation test.

The values are present on all BGAN XL Radio Modules with the default value. A value of 0 means that the channel numbers have not been received from the RAN.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.intermod_test.tx_1	r t4 §4	int / ram	[0..65535]	Default: 0.
.intermod_test.tx_2	r t4 §4	int / ram	[0..65535]	Default: 0.
.intermod_test.rx_1	r t4 §4	int / ram	[0..65535]	Default: 0.

Table 6-29: Intermodulation test channels configuration records

6.6 Functionality

The sections below describe the parameters that are related to different functionality offered by the BGAN XL Radio Module.

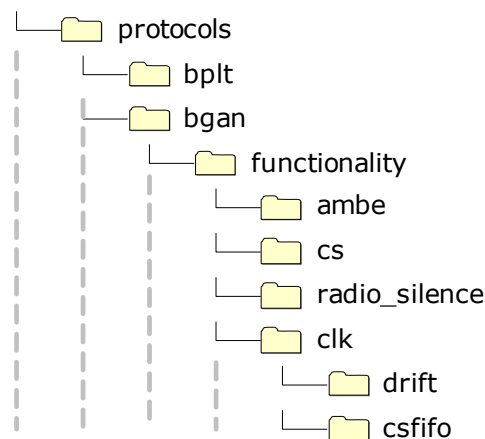


Figure 6-6: Parameter hierarchy for functionality parameters

6.6.1 Radio silence

During normal run time operation the BGAN XL Radio Module offers the possibility to achieve radio silence. When it operates in radio silence mode all burst transmissions are discarded. This service is controlled via the parameter **.radio_silence** and is per default deactivated.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.radio_silence	r/w t4 \$4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-30: Radio silence

6.6.2 Satellite selection

The parameter **.satellite_selection** can be used to control which satellite the BGAN XL Radio Module selects. This feature can be used in products with e.g. mechanically pointed antennas. It should not be used in products with fixed antennas or manually pointed antennas.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.satellite_selection	r/w t4 §4	string / flash	n.a.	APAC, EMEA, AMER, MEAS, AUTO (Default is AUTO)

Table 6-31: Satellite selection

If set to e.g. APAC the satellite search algorithm will only search for the APAC (Asia-Pacific) satellite.

Note If antenna pointing (see 8.5.5 on page 8-36) is running the integrator must first stop it, before changing **.satellite_selection**.
To stop the antenna pointing the integrator will have to wait for response to any outstanding **MSG_BGAN_CHECK_POWER** or **MSG_BGAN_CHECK_WAVEFORM** and then send **MSG_BGAN_SKYSCAN_RESULT(Result=Not tracking)** to the RM.

6.6.3 Doppler correction

Terminals mounted on vehicles, trains or aeroplanes moving at a velocity of more than 200 km/h must use Doppler correction to compensate for the Doppler effect (relevant for BGAN class 4, 6, 7, 10, 11 and 15).

The parameter **.doppler_correction** is used to activate frequency doppler correction.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.doppler_correction	r/w t3 §4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-32: Special service: Doppler correction

6.6.4 Fast signal-to-noise reports

During normal run time operation the BGAN XL Radio Module can deliver fast signal-to-noise reports at an interval of 10 ms. This service is controlled via the parameter **.fast_snr_reporting** and is per default deactivated.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.fast_snr_reporting	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-33: Special service: fast signal-to-noise reports

6.6.5 Drift distribution

During normal run time operation the BGAN XL Radio Module offers the possibility to distribute the estimated drift of the clock and the FIFO buffer used for circuit switched data. Refer to section 11.4 on page 11-10 for details on the drift estimation.

The reporting of the drift estimates is per default deactivated but can be enabled via the parameters **.clk.drift.distribution** and **.clk.csfifo.distribution**.

The drift is distributed to the integrator via a slot on the TSI bus configured by **.clk.drift.slot_no**.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.clk.drift.distribution	r/w t3 §4	int / ram	[0..1]	0=disable (default), 1=enable
.clk.csfifo.distribution	r/w t3 §4	int / ram	[0..1]	0=disable (default), 1=enable
.clk.drift.slot_no	r/w t3 §4	int / ram	[0..31]	TSI slot number used for distribution of drift estimates.

Table 6-34: Configuration of drift estimates

6.6.6 AMBE encoding

The **.ambe.enable** parameter specifies if the internal AMBE+2™ encoder shall be enabled.

The **.ambe.cni** parameter specifies if the internal comfort noise handling shall be enabled. Changes to that parameter takes effect for new CS calls.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.ambe.enable	r/w t3 §4	int / ram	[0..1]	0=disable, 1=enable (default)
.ambe.cni	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-35: Configuration parameters for AMBE encoding.

6.6.7 Call waiting

The **.cs.call_waiting.enable** parameter specifies if the BGAN XL Radio Module should accept and forward a second (or third) mobile-terminated call while having one or two active call(s). If disabled the BGAN XL Radio Module will reject the incoming call with cause User Busy.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.cs.call_waiting.enable	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-36: Configuration parameters for Call waiting.

6.6.8 FEC decoding

The **.bypass_fec** parameter specifies if the BGAN XL Radio Module should deactivate the internally FEC decoding of the received forward channel. The functionality is primarily included to support measurements of raw bit error rate.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.bypass_fec	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable

Table 6-37: Special service: FEC decoding.

6.6.9 BPLT parameters

The configuration parameters below are only used when the BPLT waveform is operational on the BGAN XL Radio Module. Some scripts require special handling which can be controlled through the values below.

Usually there is no need to use values beside 0 or 1. Any other values specifies the amount of FEC blocks to average CNo calculations over. A maximum of 1700 is defined.

Parameter name protocols.bplt	External access	Type / Domain	Values [min;max]	Comment
.frame_avg	r/w t4 §4	int / ram	[0..1700]	0=Averaging CNo measurement over 10 seconds, 1=disabled ("averaging" measurement over 1 FEC block) (default), Other = usually no other values are needed. Determines the amount of FEC blocks to average CNo over. Largest needed value for averaging over 10 seconds is with forward bearer F80T5X64 which has 13 FEC blocks/80 ms: $(10 \cdot 1000 \cdot 13) / 80 = 1625$.

Table 6-38: Configuration parameters specific for BPLT waveform

6.6.10 AAGW timestamp

AAGW timestamp determines if the BGAN XL Radio Module will continuously transmit an updated AAGW timestamp as described in section 8.5.2.10.1 on page 8-28.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.aagw_timestamp.enable	r/w t3 §4	int / ram	[0..1]	0=disable (default) 1=enable

Table 6-39: AAGW timestamp configuration

6.6.11 Suspend mode

In some cases it may be desired to put the BGAN XL Radio Module in a low-power operating state (suspend mode) and to detach it from the UMTS core network. For example if making a terminal with additional on-air interfaces.

Three configuration parameters are used to detach/attach and control the suspend mode. They are shown in the table below.

Parameter name	External access	Type / Domain	Values [min;max]	Comment
protocols.umts.cs.attach	w t4 §4	int / ram	[0..1]	0=CS detach 1=CS attach
protocols.umts.ps.attach	w t4 §4	int / ram	[0..1]	0=PS detach 1=PS attach
sys.suspend.enable	w t4 §4	int / ram	[0..1]	0=leave Suspend Mode 1=enter Suspend Mode

Table 6-40: Suspend mode configuration.

Actual CS/PS attach status can be read with the parameters in section 6.7.7 on page 6-42. See also section 11.5.2 on page 11-13 for further description of suspend mode and limitations when using it with **SDM sleep**.

6.6.12 Buffering on streaming connections

The IAI-2 stack in the BGAN XL Radio Module contains logic for buffering data until it can be sent on-air. For end customers using a terminal for video streaming it may give better performance (less jitter) if data is discarded instead of being buffered.

The **.reduced_buffering** parameter can be used to reduce the buffering.

Multi-Voice has special requirements and this can be controlled as described in 7.6.3.2 on page 7-21.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.reduced_buffering	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable.

Table 6-41: Buffering on streaming connections

6.6.13 HDR bit rate ramp up

When a PDP context using an HDR service (e.g. HDR Full Symmetric) is started it may take up to 15 seconds before the BGAN RAN allocates the full bit rate in the return direction. The initial bit rate will start at a lower level and first be increased as the terminal sends user data in the return direction.

If the terminal is used by broadcasters for streaming video, it may work better with the customer's video codec if the bit rate ramp up is faster. The faster bit rate ramp up can be enabled with **.hdr.rate_ramp_up**.

The disadvantage of using the faster bit rate ramp up is a higher power consumption, especially if the HDR connection is primarily used in the forward direction. This must be taken into consideration by integrators when making a battery-powered product.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.hdr.rate_ramp_up	r/w t4 §4	int / ram	[0..1]	0=disable (default), 1=enable.

Table 6-42: HDR bit rate ramp up

6.6.14 SMS

The BGAN XL Radio Module contains an SMS (Short Message Service) manager that stores Short Messages and Status Reports in persistent storage. Interface to the SMS manager is described in 7.5.12 on page 7-13.

When a Status Report is received it will per default only be stored if the matching sent SMS has been deleted.

The **.status_report.store_unknown** can be used to control how received Status Reports are handled. Can e.g. be useful if the Integrators chooses a solution based on Linux smsd daemon where SMS storage is in the smsd daemon..

Parameter name protocols.umts.sms	External access	Type / Domain	Values [min;max]	Comment
.status_report.store_unknown	r/w t4 §4	int / ram	[0..1]	0=Only store Status Reports that has matching sent SMS (default), 1=Store all Status Reports (also if sent SMS is deleted).

Table 6-43: SMS Status Report

6.6.15 Satellite table

For testing purposes it can be necessary to change the satellite table. For more info on satellite table refer to 6.7.3 on page 6-38 and 8.5.5.2 on page 8-38

Below can be used to change existing entries in the satellite table (identified by **.satellite_id**), or reset the satellite table to default.

It is not possible to delete or add new entries in the satellite table.

Changes in the satellite table is persistent, but can be overwritten by data received from the BGAN RAN.

Parameter name protocols.bgan.functionality. satellite_table	External access	Type / Domain	Values [min;max]	Comment
.change.locked	r/w t3 §4	int / ram	[0..1]	Lock mechanism
.change.satellite_id	r/w t3 §4	int / ram	[0..15]	Satellite ID
.change.position	r/w t3 §4	int / ram	[-1800..1800]	Longitude of satellite in 1/10th degrees. Positive values for East.
.change.channel.primary	r/w t3 §4	int / ram	[0..65535]	Primary identifying channel index for the satellite.
.change.channel.alternate	r/w t3 §4	int / ram	[0..65535]	Alternate identifying channel index for the satellite.
.change.default	r/w t3 §4	int / ram	[0..1]	0: Do not reset. 1: Reset satellite table to default.

Table 6-44: Change satellite table

See also 12.6.4 on page 12-15.

6.6.16 Static route

In the typical use case, the applications made by the integrator will all communicate with the BGAN XL Radio Module from the same IP address. In some very specific cases there may be a necessity to use multiple IP addresses.

To support this, below can be used to add static routes.

Parameter name protocols.net.static_route	External access	Type / Domain	Values [min;max]	Comment
.locked	r/w t4 §4	int / ram	[0..1]	Lock mechanism
.<x>.network	r/w t4 §4	string / ram		Target IP address

Table 6-45: Static route

Parameter name protocols.net.static_route	External access	Type / Domain	Values [min;max]	Comment
.<x>.netmask	r/w t4 §4	string / ram		Netmask
.<x>.gateway	r/w t4 §4	string / ram		Gateway IP address.

Table 6-45: Static route

.<**x**> is in the range [0..4]

6.7 Status

The following subsections describe the parameters that are entirely controlled by the BGAN XL Radio Module and are seen as 'read-only' from external integrators.

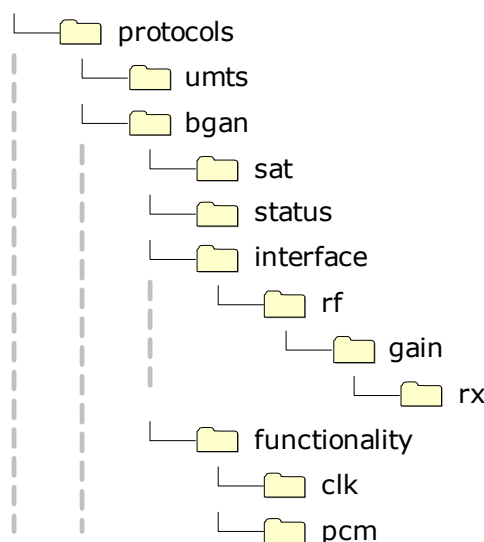


Figure 6-7: Parameter hierarchy for status parameters.

6.7.1 Receiver AGC level

The receiver AGC level is stored in non-volatile flash memory. The parameter is used during initial acquisition as a 'best guess' and is immediately overruled when a new BGAN signal has been validated.

Parameter name	External access	Type / Domain	Values [min;max]	Comment
protocols.bgan.interface				
.rf.gain.rx.agc_gain	r	int / flash	[-10000..0]	Rx AGC Gain in dBm x100

Table 6-46: Receiver AGC level

6.7.2 Reference clock

The BGAN XL Radio Module offers an aging-offset parameter that can be used to re-adjust an externally connected oscillator. This parameter represents the estimated oscillator aging in Hz (seen at L-band).

Likewise the BGAN XL Radio Module exposes the **.clk.drift** parameter which represents the actual clock offset (in parts-per-million) in relation to the received BGAN signal. If the reference clock is less than the nominal value the parameter **.clk.drift** will be positive otherwise it will be negative if the clock is above nominal value.

The **.clk.mode** parameter shows the condition (invalid, coarse or fine) of the clock offset estimate. The clock offset estimate is only safe to use when the condition is fine. Coarse condition indicates that the estimation is ongoing but has not been settled yet.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.clk.aging_frequency	r t4	int / ram	[-10000..10000]	Frequency offset (Hz) related to a clock offset compared to 1538.5 MHz
.clk.drift	r t4	int / ram	[-20000..20000]	Clock drift (in ppm x100)
.clk.mode	r t4	int / ram	[0..2]	0=invalid 1=coarse 2=fine

Table 6-47: Reference clock

Note | Note that the parameters **.clk.aging_frequency** and **.clk.drift** are updated regularly (several times per minute) when the modem is receiving a valid BGAN signal.

6.7.3 Satellite information

The fields described below contains information regarding the satellite currently in use.

Parameter name protocols.bgan.statu.sat	External access	Type / Domain	Values [min;max]	Comment
.name	r	string / ram	n.a.	Name of the satellite currently in use. None (default) Asia-Pacific EMEA Americas Middle East, Asia N/A
.position	r	int / ram	[-1800.. 1800]	Longitude of satellite in 1/10th degrees. Positive values for East.

Table 6-48: Satellite information

The fields described below contains information regarding the satellite table used by the IAI-2 stack.

Parameter name protocols.bgan.status.satellite_table	External access	Type / Domain	Values [min;max]	Comment
.count	r t4	int / ram	[0..8]	Number of entries in the satellite table. Only valid if waveform has been loaded. Will have the value 0 otherwise. 0: Satellite table is not valid (waveform has not been loaded) 1..8: Number of entries in the satellite table
.<x>.satellite_id	r t4	int / ram	[0..15]	Satellite ID as defined by Inmarsat.
.<x>.position	r t4	Int / ram	[-1800.. 1800]	Longitude of satellite in 1/10th degrees. Positive values for East.
.<x>.channel.primary	r t4	int / ram	[0..32767]	The primary identifying channel index for the satellite.
.<x>.channel.alternate	r t4	int / ram	[0..32767]	The alternate identifying channel index for the satellite.
.<x>.frequency.primary	r t4	int / ram	[1510000000 ..1591900000]	The primary identifying channel id converted to frequency [Hz]
.<x>.frequency.alternate	r t4	int / ram	[1510000000 ..1591900000]	The alternate identifying channel id converted to frequency [Hz]

Table 6-49: Satellite information

<x> is in the range 0..7

.count identifies the number of entries in the list. Entries with <x> >= .count has undefined values. The satellite table data above are only valid when the waveform is loaded. If not valid .count will be 0.

6.7.4 IAI-2 status information

Various information regarding the current status of the forward bearer currently in use by the IAI-2 stack.

Parameter name protocols.bgan.status	External access	Type / Domain	Values [min;max]	Comment
.state	r	string / ram	n.a.	Describes the overall state of the IAI-2 stack. N/A (initial) Satellite search Receive system information Registering Registered Deregistered
.channel	r	int / ram	[0..32767]	Identifies the forward channel index currently in use by IAI-2
.fwd_freq	r	int / ram	[1510000000 ..1591900000]	Identifies the forward frequency (in Hz) which the BGAN XL Radio Module is tuned to.
.beam_type	r	string / ram	n.a.	Current satellite beam type. N/A (initial) Global Regional Narrow None
.spot_id	r	int / ram	[0..255]	Spot-beam identifier.
.c_no	r	int / ram	[0..1000]	Carrier-to-noise ratio on forward link. Measured in 1/10dBHz. The CNo is theoretically infinite, however the measured value under normal operation is between 40dBHz (.c_no=400) and 100dBHz depending on various factors, among others is the BGAN class and bearer type.

Table 6-50: IAI-2 status information

6.7.5 Satellite coverage

The status field below can be used to detect if the terminal leaves the coverage area of the spot beams on the satellite.

Parameter name protocols.bgan.status	External access	Type / Domain	Values [min;max]	Comment
.out_of_coverage	r	int / ram	[0..1]	0: (Initial value). Either the spot beam coverage is undetermined (e.g. if protocols.bgan.status.state is 'Satellite search') or the terminal is within a spot beam. 1: Will be set to this value when the BGAN XL Radio Module has determined that the terminal has left coverage area of the spot beams announced by the RAN.

Table 6-51: Spot beam coverage

6.7.6 GPS policy

The table below contains information for the GPS policy. The GPS policy is received from RAN.

Parameter name protocols.bgan.status	External access	Type / Domain	Values [min;max]	Comment
.gps_policy.display	r	int / ram	[0..1]	This parameter reflects the gps-display-enable in GPSPolicyInfoParam (refer to SDM v2c4 [18]) 0: It is not permitted to make the GPS coordinates visible to the user (default). 1: It is permitted to make the GPS coordinates visible to the user in the current spot beam.

Table 6-52: GPS policy information

6.7.7 Connection status

The configuration parameters below contain information about the current state of the PLMN search and the status of the packet switched and circuit switched connections.

Parameter name protocols.umts	External access	Type / Domain	Values [min;max]	Comment
.cs.status	r	string / ram	n.a.	n/a (initial) Idle Attaching Attached Attached rejected Detaching Blocked
.ps.status	r	string / ram	n.a.	n/a (initial) Idle Attaching Attached Attached rejected Detaching Blocked
.plmn.status	r	string / ram	n.a.	n/a (initial) Scanning Searching Selecting Selected Not registered

Table 6-53: Connection status

The different status information determines the overall registration status and is suitable for presentation in a user interface.

The example below shows a possible interpretation:

Example:

```
.plmn.status = Scanning -> Scanning.
.plmn.status = Searching -> Searching
.plmn.status = Selecting -> Searching
.plmn.status = Selected:
  .cs.status = Attaching or .ps.status = Attaching -> Registering
  .cs.status = Attached or .ps.status = Attached -> Ready
  otherwise -> Not registered
.plmn.status = Not registered -> Not registered
```

6.7.7.1 PDP Context status

The configuration parameters below contain different status information for packet-switched connections (PDP contexts). For more information on PDP contexts see section 7.6 on page 7-19.

The RM has an array of 11 entries with PDP context information. '<x>' is 1..11.

Parameter name protocols.ums.ps	External access	Type / Domain	Values [min;max]	Comment
.pdp.<x>.cid	r	int / ram	[0..255]	CID (PDP Context Identifier) for the PDP context entry x. CID is used to define PDP context in AT+CGDCONT (3GPP TS27.007 [15]). If 0 there is no valid entry.
.pdp.<x>.pppoe_session	r	int / ram	[0..2 ¹⁶ -1]	PPPoE session id for the PPPoE session that created the PDP context. Only valid if .pdp.<x>.cid > 0, and PDP context is active.
.pdp.<x>.cause	r	int / ram	[0..2 ³² -1]	Cause code generated when activate is rejected or PDP context is deactivated. Either received from UMTS core network or generated by RM. Only valid if .pdp.<x>.cid > 0, and PDP context is closed.
.pdp.<x>.rx_kbytes	r	int / ram	n.a.	kBytes received on PDP context entry x
.pdp.<x>.tx_kbytes	r	int / ram	n.a.	kBytes sent on PDP context entry x
.pdp.<x>.rab	r	int / ram	[0, 1]	Normally not used. See below. 0: RAB not assigned. 1: RAB assigned.

Table 6-54: PDP context status and counters

If there is or has been a PDP context in a given entry **.pdp.<x>.cid** will be > 0.

Note | 'x' is a local index 1..11, it is not the cid value.

After a PDP context has been deactivated or the activation rejected **.pdp.<x>.cause** will hold the cause code.

.pdp.<x>.rx_kbytes and **.pdp.<x>.tx_kbytes** are traffic counters that can be used to show the amount of data sent/received on a connection.

The fields are still valid after a PDP context has been deactivated. They are first reset when a new PDP context activation request re-uses the same entry.

.pdp.<x>.rab should normally not be used. It is intended for aeronautical terminals with SwiftBroadband Oceanic Safety Service implemented. In this case it can be used to detect if radio resources on the PDP context are lost, and if so re-establish the PDP context.

6.7.8 Navigational information (aeronautical) (FOR INTERNAL USE)

The BGAN XL Radio Module supports an aeronautical receive path equalizer as defined in the SDM. For optimal performance, the equalizer requires information about the delay between the direct and the reflected signal. The delay is calculated by RM.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.nav.differential_delay	r t4 §4	int / ram	[0..100]	Delay between direct and reflected signal in microseconds. (default = 0)

Table 6-55: Navigational information

6.7.9 Data segregation (aeronautical) (FOR INTERNAL USE)

There is an ARINC-781 requirement for segregation of IP data from Aircraft Control Domain and Aircraft Information Services Domain.

The integrator can choose to design the aeronautical product with a BGAN XL Radio Module for each domain or a shared RM for the 2 domains. In the latter case the BGAN XL Radio Module offers data segregation.

Aircraft Control Domain and Aircraft Information Services Domain are using separate PDP contexts. Each PDP context has a separate data path through the RM, but there is a shared data pool in the IAI protocol.

The integrator can inform the RM to use a high priority pool for the Aircraft Control Domain when the PDP context is created (as described in 7.6.3.1 on page 7-21). The PDP context related to the Aircraft Control Domain will then be handled through a separate data pool (priority pool).

Furthermore the RM offers the integrator the option to read how much data is on queue in the priority pool (for Aircraft Control Domain) and the normal pool (for Aircraft Information Services Domain or other data). This information can be used by

segregation hardware / data arbitrator in front of the RM to ensure that data from Aircraft Information Services Domain does not flood the RM.

Parameter name protocols.bgan.status	External access	Type / Domain	Values [min;max]	Comment
.queue_size.high_prio	r	int / ram	[0..2 ³¹ -1]	Bytes in queue in the priority pool (specified as described above).
.queue_size.low_prio	r	int / ram	[0..2 ³¹ -1]	Bytes in queue in the normal data pool.

Table 6-56: Data segregation (IAI pool status).

6.7.10 S-Band, antenna mute detector (FOR INTERNAL USE)

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.ssr_muting.mean	r	int / ram	[0..1000]	Accumulated mean SSR muting time in ms per sec.
.ssr_muting.stdev	r	int / ram	[0..1000]	Accumulated standard deviation SSR muting time in ms per sec.

Table 6-57: Antenna Mute Detector.

6.8 Control

The following subsections describe the parameters that can be modified by the integrator to control behaviour of the BGAN XL Radio Module. The integrator must configure the control parameters before activation.

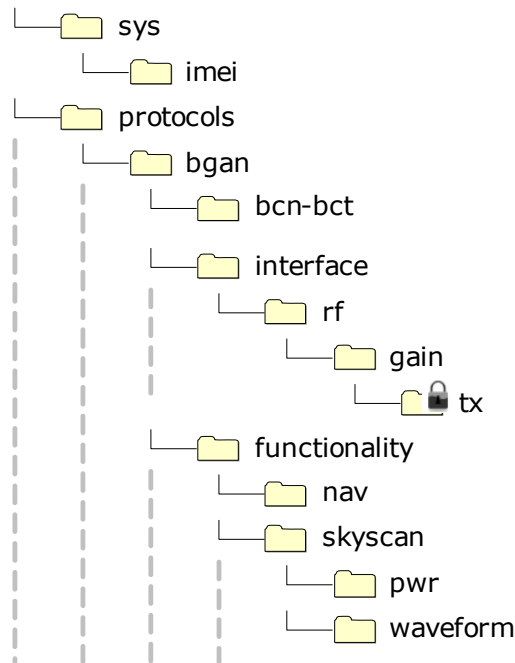


Figure 6-8: Parameter hierarchy for control parameters.

6.8.1 BGAN Class

The integrator of the BGAN XL Radio Module must configure the BGAN class. For supported classes see 3.7.1 on page 3-7.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.class	r/w t3 \$1	int / ram	[1..15]	BGAN Class configuration

Table 6-58: BGAN class configuration

6.8.2 Product Type

The integrator must configure the product type. This setting is used by the USIM driver of the BGAN XL Radio Module to enforce the Market Sector Restrictions described in the SDM v5c1 [18].

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.product_type	r/w t1 §3	int / ram	[0..5]	0: Land / Land-mobile. 1: Maritime 2: Aeronautical 3: M2M 4: Fleet One 5: S-Band

Table 6-59: Product type

Important

This setting must be written before **platform.usim.status** is set to 1 (see 6.5.1 on page 6-21).

6.8.3 BGAN IMEI Number

The integrator of the BGAN XL Radio Module must also configure the terminal IMEI number, which will be used as identification on the BGAN network.

Parameter name sys	External access	Type / Domain	Values [min;max]	Comment
.imei.type_allocation_code	r/w t3 §1	byte array / ram	8 bytes	Type allocation code assigned to terminal
.imei.serial_number	r/w t3 §1	byte array / ram	6 bytes	IMEI serial number part
.imei.check_digit	r/w t3 §1	int / ram	[0..15]	Checksum of complete IMEI calculated according to Luhn formula.
.imei.svn	r/w t3 §1	int / ram	[0..98]	Software version number of terminal software (not the RM software version)

Table 6-60: Terminal IMEI configuration

Note

The IMEI checksum (check_digit) is calculated as:

1. Starting from the right, double every 2nd digit (e.g. 5 -> 10).
2. Add the digits (e.g. 10 -> 1+0) and check if the sum is divisible by 10.
3. If not, the IMEI can be calculated by choosing the check digit that would give a sum divisible by 10.

Example:

IMEI: 35145120840121

1: (5x2, 4x2, 1x2, 0x2, 4x2, 1x2, 1x2) = (10, 8, 2, 0, 8, 2, 2)

2: (1+0+8+2+0+8+2+2) + (3+1+5+2+8+0+2) = 44

3: Luhn Digit = 6

IMEI: 351451-20-840121-6

6.8.4 BGAN capabilities

The integrator must configure the BGAN XL Radio Module with the capabilities of the terminal. The information is signalled to the BGAN network during registration and ensures that the appropriate radio resources are assigned to the terminal.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.hdr.enable	r/w t3 §4	int / ram	[0..3]	Support of high data rate bearers 0: Not supported (default) 1: Half (HDR in return) 2: Full 3: Half (HDR in forward)
.ldr.enable	r/w t3 §4	int / ram	[0..1]	Support of low data rate bearers 0: Not supported (default), 1: Supported
.xl	r/w t3 §4	int / ram	[0..1]	Support for eXtended L-band frequencies (forward 1518 .. 1525 MHz and return 1668 .. 1675 MHz) 0: Not supported 1: Supported (default)

Table 6-61: BGAN capabilities

The **.hdr.enable** parameter must be activated if the integrator wants a terminal that supports the use of high data rate (HDR) capabilities. The RM offers the option to

choose between full support (in both the forward and return direction) or half support in either the forward or the return direction.

The **.ldr.enable** parameter must be activated if the integrator wants a terminal that supports the use of low data rate (LDR) capabilities. If none of the capabilities are activated the RM will operate as a standard BGAN modem

A new product will normally have to support extended L-band to get Type Approval from Inmarsat. However, there can exceptionally be cases where the antenna does not support the extended frequencies. In such cases the **.xl** parameter can be used to disable this functionality.

See also description of PhysicalLayerCapabilityParam in SDM v2c2.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.aeronautical_safety	r/w t3 §4	int / ram	[0..1]	Aeronautical safety service. 0: Disable (default) 1: Enable
.enhanced_aeronautical_safety	r/w t3 §4	int / ram	[0..1]	Enhanced aeronautical safety service. 0: Disable (default) 1: Enable
.maritime_safety_voice	r/w t3 §4	int / ram	[0..1]	Maritime safety service 0: Disable (default), 1: Enable

Table 6-62: BGAN safety capabilities

The **.aeronautical_safety** parameter must be set if the integrator makes an aeronautical terminal with SwiftBroadband Oceanic Safety Service enabled. SwiftBroadband Oceanic Safety Service is defined in the SDM [18].

The **.enhanced_aeronautical_safety** parameter must be set if the integrator makes an aeronautical terminal with Enhanced SwiftBroadband Safety Service enabled. Enhanced SwiftBroadband Safety Service is defined in the SDM [18].

The 2 parameters will set bit 14 in access class (SDM v3c3 and v3c4) and aeronautical-safety-services-supported or (maritime-safety-voice-or-)enhanced-aeronautical-safety-service-supported bit in AdditionalUeCapabilityAVP (SDM v2c2).

The **.maritime_safety_voice** parameter must be set if the integrator makes a maritime terminal with Maritime Safety Voice enabled. Maritime Safety Voice is defined in the SDM [18].

Note It is the responsibility of the integrator of the RM to configure the capabilities so they are in agreement with the Inmarsat BGAN SDM and the BGAN class configured in section 6.8.1.

6.8.5 Receiver input power (FOR INTERNAL USE)

6.8.5.1 Gain variation

The BGAN XL Radio Module has a mechanism that can compensate for gain variations over the frequency range of the received signal. The RM uses pairs of frequencies and gain corrections together with an interpolation algorithm to compensate for variations. Only linear interpolation is supported.

The RM offers up to 15 pairs to cover the entire transmitter frequency range as indicated in the table below.

To get a successful result the following must apply:

$$f_{gaincor1} < f_{gaincor2} < \dots < f_{gaincor15}$$

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.gain.rx.locked	r/w t1 \$2	int / ram	[0..1]	Lock mechanism
.rf.gain.rx.gain_freq[1..15]	r/w t1 \$2	int / ram	[1500000000.. 1700000000]	L-band freq. [Hz]
.rf.gain.rx.gain_correction[1..15]	r/w t1 \$2	int / ram	[-750..750]	Gain corr. 0.01 dB
.rf.gain.rx.gain_pairs	r/w t1 \$2	int / ram	[0..15]	Number of gain pairs.

Table 6-63: Variation of receiver input gain

Note | Note that external gain variations over temperature must be handled by replacing the compensation parameters according to the drift of the temperature.

Note | These gain variation parameters are entirely for test purposes (e.g. BGAN UT Test Setup) where it is beneficial to adjust the RM RX gain without changing the actual RX gain calibration. In all other scenarios the gain corrections should be set to 0.

6.8.6 Transmitter output power

Nominal output power at the Tx connector of the BGAN XL Radio Module must be specified between -10 dBm and -40 dBm. The value can be adjusted via the parameter specified in the following table.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.gain.tx.nominal_power	r/w t1 \$2	int / ram	[-1000..-4000]	Nominal transmitter output power in dBm x100

Table 6-64: Nominal transmitter output level

Note The integrator must ensure that the combination of the nominal power and gain variations in any situation is within:

$$-40dBm \leq (P_{nom} + G_{comp}) \leq -10dBm$$

6.8.6.1 Gain variation

The BGAN XL Radio Module includes a mechanism that can compensate for gain variations over the frequency range of the transmitted signal. The RM uses pairs of frequencies and gain corrections together with an interpolation algorithm to compensate for variations. The interpolation type is specified via the parameter below which supports linear and 2nd order interpolation.

Parameter name protocols .bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.gain.tx.compensation_type	r/w t2 \$4	int / ram	[0..1]	0=linear (default), 1=2nd order

Table 6-65: Compensation type for gain variation

The RM offers up to 15 pairs to cover the entire transmitter frequency range as indicated in the table below.

To get a successful result the following must apply:

$$f_{pwr1} < f_{pwr2} < \dots < f_{pwr15}$$

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.rf.gain.tx.locked	r/w t1 \$2	int / ram	[0..1]	Lock mechanism
.rf.gain.tx.pwr_freq[1..15]	r/w t1 \$2	int / ram	[1500000000..1700000000]	L-band freq. [Hz]
.rf.gain.tx.pwr[1..15]	r/w t1 \$2	int / ram	[-750..750]	Power corr. 0.01 dB
.rf.gain.tx.pwr_pairs	r/w t1 \$2	int / ram	[0..15]	Number of Power pairs.

Table 6-66: Variation of transmitter output level

Note

Note that external gain variations over temperature must be handled by replacing the compensation parameters (or the nominal power) according to the drift of the temperature.

6.8.7 ATC activation

The parameter **.atc.activation** is used (by the integrator) to signal if an interferer is present or not. How this information is used by the RM is described in section 9.1.5.1 on page 9-9. The parameter is per default deactivated which indicates that no ATC interferers are present.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.atc.activation	r/w t4 §4	int / ram	[0..1]	0=off (default), 1=on

Table 6-67: ATC activation

6.8.8 Sky-scan (Check power)

The table below shows the parameters for channel power estimation for sky-scan operation (see section 8.5.5.9 on page 8-44).

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.skyscan.check.pwr.averages	r/w t4 §4	int / ram	[1..30]	Number of averages. (default = 30)
.skyscan.check.pwr.narrow_bw	r/w t4 §4	int / ram	[0..3]	0=10 kHz, 1=14 kHz (default), 2=18 kHz, 3=22 kHz
.skyscan.check.pwr.wide_bw	r/w t4 §4	int / ram	[0..3]	0=30 kHz, 1=36 kHz (default), 2=42 kHz, 3=48 kHz

Table 6-68: Sky-scan (Check power)

The number of averages (N_{avg}) determines the accuracy and processing delay according to the following equation:

$$t_{estimation} = t_{fixed} + N_{freq} \cdot (t_{tuning} + N_{avg} \cdot t_{measure})$$

where t_{tuning} is equal to 6 ms, t_{fixed} is equal to ~1 ms, $t_{measure}$ is equal to 7.25 ms and N_{freq} specifies the number channels where the power is estimated.

6.8.9 Sky-scan (Check waveform)

The following parameter specifies the time-out values for the waveform validation (see section 8.5.5.11 on page 8-48). This time-out value is only used during sky-scan operation.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.skyscan.check.waveform.timeout	r/w t3 §4	int / ram	[0..2]	0=360ms (default), 1=440ms, 2=520ms

Table 6-69: Sky-scan (Check waveform) time-out.

6.8.10 UMTS operation mode

The BGAN XL Radio Module supports both Circuit Switched (CS) and Packet Switched (PS) domains.

If making a terminal that only support CS or PS, the below parameter can be used to restrict operations to only one domain.

Parameter name protocols.ums	External access	Type / Domain	Values [min;max]	Comment
.operation_mode	r/w t3 §3	int / flash	[0..3]	0: CS and PS operation (default) 1: Do not use (reserved) 2: PS only operation 3: CS only operation

Table 6-70: UMTS operation mode.

Above setting will also change the auto-attach mode of the RM. In CS/PS mode and CS-only mode, the RM will auto-attach in CS. In PS-only mode, the RM will auto-attach in PS.

6.8.11 S-Band (FOR INTERNAL USE)

The BGAN XL Radio Module can also be used in Aeronautical S-Band class 7S terminal with external frequency conversion. The parameter below must be set accordingly.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.sband	r/w t3 §3	int / ram	[0..1]	0: L-Band (default) 1: S-Band

Table 6-71: S-Band setting.

The **.sband** parameter will internally in the DSP add 353.4 MHz and 651.86 MHz to the Tx and Rx target frequencies instructed by CPU to shift operation from L-band to S-band.

Parameter name protocols.bgan.interface.rf	External access	Type / Domain	Values [min;max]	Comment
.freq_offset.rx.external	r/w t3 §3	int / ram	[0..2 ³² -1]	Rx frequency conversion in kHz external to RM. default: 0
.freq_offset.tx.external	r/w t3 §3	int / ram	[0..2 ³² -1]	Tx frequency conversion in kHz external to RM. default: 0

Table 6-72: S-Band; external frequency conversion.

6.8.12 S-Band antenna mute detector (FOR INTERNAL USE)

On an Aeronautical S-band class 7S terminal the integrator must enable Antenna Mute Detector to improve decoder performance.

Parameter name protocols.bgan.functionality	External access	Type / Domain	Values [min;max]	Comment
.ssr_muting.enable	r/w t3 §3	int / ram	[0..1]	0: Disable (default) 1: Enable
.ssr_muting.threshold	r/w t3 §3	int / ram	[0..40]	Antenna Mute detector threshold in dB below noise floor. Default: 12

Table 6-73: Antenna Mute Detector.

6.8.13 Synchronous Serial Link (FOR INTERNAL USE)

On the BGAN XL Radio Module for aeronautical use (TT3750A-AER) pins on the B2B connector can be used for two Synchronous Serial Links. Activation of these links are

controlled with below configuration parameters. Further description of the Synchronous Serial Link is not provided in this document.

Parameter name protocols.bgan.interface	External access	Type / Domain	Values [min;max]	Comment
.serial_link.control	r/w t1 §3	int / ram	[0..1]	0: Disable (default) 1: Enable
.serial_link.data	r/w t1 §3	int / ram	[0..2]	0: Disable (default) 1: Enable for PPPoE 2: Enable for IP (only for test purpose)

Table 6-74: Synchronous Serial Link.

6.9 Connection types

The following subsections describe the parameters that can be modified by the integrator to control the behaviour of the different connection types.

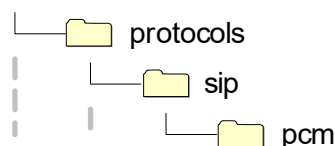


Figure 6-9: Parameter hierarchy for connection parameters.

6.9.1 Circuit switched parameters

The following parameters are defined for the circuit switched services described in section 7.5 on page 7-6:

Parameter name protocols.sip	External access	Type / Domain	Values [min;max]	Comment
.auth.enable	r/w t4 §5	int / flash	[0..1]	Enable/disable authentication. Requires reboot to take effect. 0: Disable 1: Enable (default)
.user-name	r/w t4 §4	string / flash	n.a.	Max length: 30 (default = 'sip1')
.password	r/w t4 §4	string / flash	n.a.	Max length: 9 (default = 'sip1')
.def-call-type	r/w t3 §4	int / flash	[0..3]	0: Speech (default) 1: 3.1 kHz 2: ISDN RDI 3: ISDN UDI
.codecs	r/w t4 §4	string / flash	n.a.	Comma separated prioritized list of preferred RTP audio codecs. Supported values are: 'pcma' and 'pcm16'. Note: Only the first item in the list is used. (default='pcma')
.pcm.enabled	r/w t3 §4	int / flash	[0..1]	Support for TSI/PCM bus data. 0: Disable (default) 1: Enable

Table 6-75: Circuit switched parameters

Parameter name protocols.sip	External access	Type / Domain	Values [min;max]	Comment
.pcm.slotrx	r/w t3 §4	int / flash	[0..31]	TSI/PCM Rx slot to use.
.pcm.slottx	r/w t3 §4	int / flash	[0..31]	TSI/PCM Tx slot to use.
.pcm.calltypes	r/w t3 §4	int / flash	[0..3]	Bit field specifying for which call types the TSI/PCM bus shall be used. Bit 0: ISDN UDI/RDI (default), Bit 1: 3.1 kHz

Table 6-75: Circuit switched parameters (Continued)

6.10 Support

The sections below describe the parameters that are related to the different services offered by the BGAN XL Radio Module.

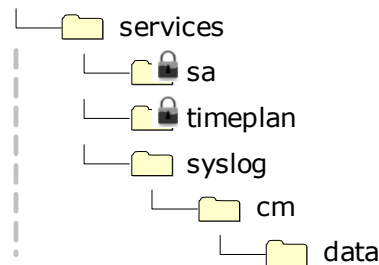


Figure 6-10: Parameter hierarchy for support parameters.

6.10.1 Configuration of the spectrum analyzer

The tables below show the parameters related to configuration of the internal spectrum analyzer which is available in service mode (see section 11.12 on page 11-32).

Parameter name services.intif	External access	Type / Domain	Values [min;max]	Comment
.sa.locked	r/w t2 §4	int / ram	[0..1]	Lock mechanism
.sa.centre_frequency	r/w t2 §4	int / ram	[1500000000 .. 1700000000]	Centre frequency in Hz
.sa.span	r/w t2 §4	int / ram	[0..3]	Bandwidth: 0=2 kHz, 1=20 kHz, 2=200 kHz 3=2 MHz
.sa.no_avg	r/w t2 §4	int / ram	[1..1000]	Number of averages
.sa.window_type	r/w t2 §4	int / ram	[0..3]	Window type: 0=none 1=Blackman 2=Hanning 3=Hamming
.sa.pn_offset	r/w t2 §4	int / ram	[-1000000 .. 1000000]	Phase noise offset in Hz
.sa.pn_bw	r/w t2 §4	int / ram	[1..999999]	Phase noise bandwidth in Hz

Table 6-76: Spectrum analyzer configuration

Parameter name services.intif	External access	Type / Domain	Values [min;max]	Comment
.sa.spur_bw	r/w t2 §4	int / ram	[1..999999]	Spurious search bandwidth in Hz
.sa.rx_auto_gain_adjus t	r/w t2 §4	int / ram	[-10000 .. 3200]	Receiver gain in 0.01 dB

Table 6-76: Spectrum analyzer configuration (Continued)

- Spectrum analyzer bandwidth (span): 4 different bandwidths are available in the range from 2 kHz to 2 MHz.
- Number of FFT block averages: Set # averages used (= number of FFT sample block used) before producing a result. The more averages, the less variance on the result. The standard deviation of the result is proportionate to:

$$\delta = \frac{1}{\sqrt{\text{averages}}}$$

- FFT window type: 4 different window types are available: Rectangular (i.e. no windowing), Blackman, Hamming or Hanning.
- Phase noise offset: The offset is relative to the frequency which gives the peak power.
- Phase noise bandwidth: Specifies the bandwidth (in Hz) in which the power will be measured.
- Spurious bandwidth: The spur search will produce frequency and power level in descending order for 4 power peaks (called spurs) ranging just below (in power) the primary peak (the one for which we calculate 'peak power'). The previous spur is eliminated from the power spectrum in the selected bandwidth before searching for the next spur is initiated.

6.10.2 Configuration of the transmitter time-plan

The following parameters implements the 'Tx time-plan' which is used to specify transmit patterns (for emulation of BGAN return schedules). The content of these parameters are used by the 'Tx burst' functionality when the time-plan option is activated (refer to section 11.10 on page 11-24 for a detailed description).

Parameter name services.intif	External access	Type / Domain	Values [min;max]	Comment
.timeplan.bt_[0..15]	r/w t4 \$4	string / ram	n.a.	R5T1X, R5T1XD, R5T2X, R5T2XD, R5T45X, R5T45XD, R20T1X, R20T1XD, R20T2X, R20T2XD, R20T45X, R20T45XD, R5T2Q, R5T2QD, R5T45Q, R5T45QD, R20T05Q, R20T05QD, R20T1Q, R20T1QD, R20T2Q, R20T2QD, R20T45Q, R20T45QD, R80T05Q, R80T1Q, FR80T25X4, FR80T25X16, FR80T25X32, FR80T25X64, FR80T5X4, FR80T5X16, FR80T5X32, FR80T5X64,NA
.timeplan.cr_[0..15]	r/w t4 \$4	string / ram	n.a.	L14, L13, L12, L11, L10, L9, L8, L7, L6, L5, L4, L3, L2, L1, R, H1, H2, H3, H4, H5, H6
.timeplan.fo_[0..15]	r/w t4 \$4	int / ram	[-100000.. 100000]	Frequency offset from centre in Hz
.timeplan.eirp_[0..15]	r/w t4 \$4	int / ram	[0..10]	EIRP backoff level: 0 = Max 10 = -10 dB from max
.timeplan.timing_[0..15]	r/w t4 \$4	int / ram	[-180..180]	Timing correction in microseconds

Table 6-77: Transmitter time-plan used with the Tx_BURST message.

6.10.3 Syslog

The syslog client can be configured using the following settings:

Parameter name services	External access	Type / Domain	Values [min;max]	Comment
.syslog.relay_ip	r/w t4 §4	string / flash	16 chars	IP of the Syslog collector (Application Processor) Default: "192.168.1.2"
.syslog.severity	r/w t4 §4	int / flash	[0..7]	Severity level 0: Emergency 1: Alert 2: Critical 3: Error 4: Warning 5: Notice 6: Informational (default) 7: Debug

Table 6-78: Syslog configuration settings

6.10.4 Continuous monitoring - data logging

The BGAN XL Radio Module offers a set of data logging points that provides detailed information about certain system variables internally in the Radio Module. The data logging tool is solely intended to assist the Integrator during system integration and other debugging scenarios and should not be used as input for e.g. an MMI.

Each logging point can be enabled individually via the configuration parameters listed below. For a detailed description of the information attached to each of these logging points refer to section 10.2.2 on page 10-8.

Parameter name services.syslog.cm	External access	Type / Domain	Values [min;max]	Comment
.data.snr	r/w t4 §4	int / ram	[0..1]	Enable/disable of signal-to-noise (EsNo) data logging of the forward bearer. 0: Disable (default) 1: Enable
.value.snr	r	int / ram	[0..10000]	The last reported signal-to-noise value in 0.01 dB.
.rate.snr	r/w t4 §4	int / ram	50	Reporting rate specified in 80ms units. Default: 50 (4 sec.)

Table 6-79: Data logging configuration settings

Parameter name services.syslog.cm	External access	Type / Domain	Values [min;max]	Comment
.data.evm	r/w t4 §4	int / ram	[0..1]	Enable/disable of squared Error Vector Magnitude data logging of the forward bearer. 0: Disable (default) 1: Enable
.value.evm	r	int / ram	[0..1000000]	The last reported Error Vector Magnitude value in parts-per-million.
.rate.evm	r/w t4 §4	int / ram	50	Reporting rate specified in 80 ms units. Default: 50 (4 sec.)
.data.clk_drift	r/w t4 §4	int / ram	[0..1]	Enable/disable of clock drift data logging of the forward bearer. 0: Disable (default) 1: Enable
.data.freq_drift	r/w t4 §4	int / ram	[0..1]	Enable/disable of frequency drift data logging of the forward bearer. 0: Disable (default) 1: Enable
.value.freq_drift	r	int / ram	[-20000..20000]	The last reported frequency drift value in Hz.
.rate.freq_drift	r/w t4 §4	int / ram	50	Reporting rate specified in 80ms units. Default: 50 (4 sec.)
.data.power_drift	r/w t4 §4	int/ram	[0..1]	Enable/disable of channel power data logging of the forward bearer. 0: Disable (default) 1: Enable
.value.power_drift	r	int / ram	[-2000..20000]	The last reported channel power value in 0.01 dBm.
.rate.power_drift	r/w t4 §4	int / ram	50	Reporting rate specified in 80 ms units. Default: 50 (4 sec.)
.data.multipath_delay	r/w t4 §4	int/ram	[0..1]	Enable/disable of multipath delay data logging. 0: Disable (default) 1: Enable
.value.multipath_delay	r	int/ram	[0..10000]	The last reported multipath delay in μ s.

Table 6-79: Data logging configuration settings (Continued)

Parameter name services.syslog.cm	External access	Type / Domain	Values [min;max]	Comment
.rate.multipath_delay	r	int/ram	50	Reporting rate specified in 80 ms units. Default: 50 (4 sec.)
.data.demod	r/w t4 \$4	int/ram	[0..1]	Enable/disable of demodulator related data logging. 0: Disable (default) 1: Enable
.value.demod_state	r	int/ram	[0..4]	The last reported state of the demodulator (0: idle, 1: tune, 2: search, 3: track, 4: blocking).
.value.demod_reacq	r	int/ram	[0..1]	The last reported re-acquisition status of the demodulator (0: none, 1: reacquisition performed).
.value.demod_frm_err	r	int/ram	[0..1000000]	The last reported number of errored frames during demodulation (since last re-tune).
.value.demod_uw_err	r	int/ram	[0..80]	The last reported number of UW bit errors within a single demodulated frame.
.value.demod_pilot_err	r	int/ram	[0..186]	The last reported number of pilot bit errors within a single demodulated frame.
.value.demod_inp_dist	r	int/ram	[0..32767]	The last reported input distance of the demodulator.
.value.demod_gain_adj	r	int/ram	[-10000..10000]	The last reported AGC gain adjustment in 0.01 dB.
.value.demod_code_rate	r	int/ram	[0..14]	The last reported code rate (found from UW) of the demodulator.
.value.demod_inst_rel_freq_off	r	int/ram	[-1800..1800]	The last reported instantaneous frequency offset - relative to the previous frame.
.value.demod_bt	r	int/ram	[0..14]	The last reported bearer type used by the demodulator.
.rate.demod	r/w t4 \$4	int/ram	[0..100]	Reporting rate specified in 80 ms units. Default 1 (80 ms).

Table 6-79: Data logging configuration settings (Continued)

Parameter name services.syslog.cm	External access	Type / Domain	Values [min;max]	Comment
.data.per	r/w t4 §4	int/ram	[0..1]	Enable/disable of packet error rate data logging. 0: Disable (default) 1: Enable
.value.per	r	int/ram	[0..1000000]	The last reported packet error rate of the turbo decoder (in 10E-06 units). Packet error rate is measured on all packets on the received bearer possibly including packets for other terminals.
.rate.per	r/w t4 §4	int/ram	[0..100]	Reporting rate specified in 80 ms units. Default: 50 (4 sec.).
.data.cm	r/w t4 §4	int/ram	[0..1]	Enable/disable of Carrier to Multipath data logging. 0: Disable (default) 1: Enable
.value.cm	r	int/ram	[0..10000]	The last reported carrier-to-multipath level in 0.01 dB.
.rate.cm	r/w t4 §4	int/ram	[10..100]	Reporting rate specified in 80 ms units. Default: 50 (4 sec.).
.data.dec_err	r/w t4 §4	int/ram	[0..1]	Enable/disable of decoder related data logging (logged on error). 0: Disable (default) 1: Enable
.value.bt_on_dec_err	r	int/ram	[-1..12]	The last reported bearer type on error. Default -1 (no decoding error).
.value.cr_on_dec_err	r	int/ram	[-1..14]	The last reported code rate on error (found from UW or AVP). Default -1 (no decoding error).
.value.delay_on_dec_err	r	int/ram	[-1.. 10000]	The last reported multipath delay on error. Default -1 (no decoding error).

Table 6-79: Data logging configuration settings (Continued)

Parameter name services.syslog.cm	External access	Type / Domain	Values [min;max]	Comment
.value.fec_on_dec_err	r	int/ram	[-1..12]	The last reported FEC number (within frame) on error. Default -1 (no decoding error).
.value.seq_on_dec_err	r	int/ram	[-1..4095]	The last reported sequence number on error. Default -1 (no decoding error).

Table 6-79: Data logging configuration settings (Continued)

6.11 Factory (FOR INTERNAL USE)

The sections below describe the factory parameters that are specified during BGAN XL Radio Module manufacturing and related to the modem. These calibration parameters are all stored in the configuration system and are organized in the hierarchy shown in the figure below.

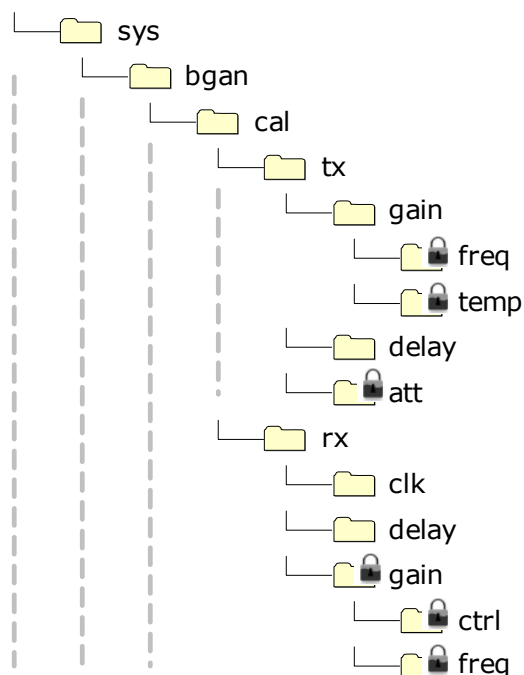


Figure 6-11: Parameter hierarchy for factory parameters.

6.11.1 Tx gain calibration

The following subsection presents the parameters related to Tx gain calibration

6.11.1.1 Tx absolute gain

The following parameter holds the calibrated value of the absolute Tx gain.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.tx.gain.absolute_gain	r/w t1 §1	int / factory	[-1000..500]	Absolute Gain in dBm x100

Table 6-80: Configuration parameter: transmitter gain

6.11.1.2 Tx gain versus temperature

The following shows the parameters used for Tx gain calibration versus temperature.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.tx.gain.temp.locked	r/w t1 \$1	int / ram	[0..1]	Lock mechanism
.tx.gain.temp.thres[1..10]	r/w t1 \$1	int / factory	[-100..150]	Temp [°C] threshold
.tx.gain.temp.pwr_correction[1..10]	r/w t1 \$1	int / factory	[-500..500]	Power corr. 0.01 dB
.tx.gain.temp.pwr_pairs	r/w t1 \$1	int / factory	[0..10]	Number of temperature pairs.

Table 6-81: Gain versus temperature, can be configured

To get a successful result the following must apply:

$$temp_{thres1} < temp_{thres2} < \dots < temp_{thres10}$$

6.11.1.3 Tx gain versus frequency

The following shows the parameters used for Tx gain calibration versus frequency.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.tx.gain.freq.locked	r/w t1 \$1	int / ram	[0, 1]	Lock mechanism
.tx.gain.freq.thres[1..10]	r/w t1 \$1	int / factory	[1500000000.. 1700000000] GHz	L-band freq. [Hz]
.tx.gain.freq.pwr_correction[1..10]	r/w t1 \$1	int / factory	[-500..500]	Power corr. 0.01 dB
.tx.gain.freq.pwr_pairs	r/w t1 \$1	int / factory	[0..10]	Number of Power pairs.

Table 6-82: Configuration parameters: Tx gain versus frequency

To get a successful result the following must apply:

$$freq_{thres1} < freq_{thres2} < \dots < freq_{thres10}$$

6.11.1.4 Tx step attenuator

The following shows the parameters used for calibration of the Tx step attenuator.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.tx.att.locked	r/w t1 \$1	int / ram	[0..1]	Lock mechanism
.tx.att.step_[00..31]	r/w t1 \$1	int / factory	[100..-3500]	Att. setting in dB x100

Table 6-83: Tx attenuator step calibrations

To get a successful result the following must apply:

$$step_{31} < step_{30} < \dots < step_0$$

6.11.2 Rx gain calibration

The following shows the parameters used for Rx gain calibration.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.rx.gain.ctrl.locked	r/w t1 \$1	int / ram	[0..1]	Lock mechanism
.rx.gain.ctrl.lna_max	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.lna_min	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.vga1_max	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.vga1_min	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.vga2_max_set	r/w t1 \$1	int / factory	[0..127]	Discrete steps.
.rx.gain.ctrl.vga2_min_set	r/w t1 \$1	int / factory	[0..127]	Discrete steps.
.rx.gain.ctrl.rx1_max	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.rx2_max	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.atc_max	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.atc_min	r/w t1 \$1	int / factory	[0..10000]	Gain 0.01 dB
.rx.gain.ctrl.lna_ref	r/w t1 \$1	int / flash	[0..1]	Temporary, used for manufacturing
.rx.gain.ctrl.vga1_ref	r/w t1 \$1	int / flash	[0..1]	Temporary, used for manufacturing

Table 6-84: Reference point for the Rx1 and Rx2 gain calibration

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.rx.gain.ctrl.vga2_ref	r/w t1 §1	int / flash	[0..127]	Temporary, used for manufacturing
.rx.gain.ctrl.atc_ref	r/w t1 §1	int / flash	[0..1]	Temporary, used for manufacturing
.rx.gain.ctrl.freq_ref	r/w t1 §1	int / flash	[1500000000..1700000000]	Temporary, used for manufacturing [Hz]
.rx.gain.ctrl.rx1_ref	r/w t1 §1	int / flash	[0..10000]	Temporary, used for manufacturing
.rx.gain.ctrl.rx2_ref	r/w t1 §1	int / flash	[0..10000]	Temporary, used for manufacturing

Table 6-84: Reference point for the Rx1 and Rx2 gain calibration (Continued)

6.11.2.1 Rx gain versus frequency

The following shows the parameters used for Rx gain calibration versus frequency.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.rx.gain.freq.locked	r/w t1 §1	int / ram	[0..1]	Lock mechanism
.rx.gain.freq.thres[1..10]	r/w t1 §1	int / factory	[1400000000..1700000000]	L-band freq. [Hz]
.rx.gain.freq.gain_correction[1..10]	r/w t1 §1	int / factory	[-500..500]	Power corr. 0.01 dB
.rx.gain.freq.gain_pairs	r/w t1 §1	int / factory	[0..10]	Number of gain pairs.

Table 6-85: Gain versus frequency configuration

6.11.3 Reference oscillator calibration

The following parameters are used for the calibration of the reference oscillator:

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.rx.clk.dac_setting	r/w t1 §1	int / factory	[0..4095]	Clk DAC setting
.rx.clk.dac_offset	r/w t1 §1	int / cached	[-4095..4095]	Clk offset from factory setting (i.e. aging offset).
.rx.clk.dac_slope	r/w t1 §1	int / factory	[-10000..10000]	Slope of the Clk DAC in 1000xHz/bit referred to 57.85 MHz (mHz per bit)

Table 6-86: Initial reference oscillator calibration

The internal reference oscillator will undergo a slow gradual change of frequency with time, which is referred to as aging. Although the aging will decrease logarithmically it must be tracked and compensated for internally by the modem.

To prevent a situation where an incorrect 'aging' configuration can harm the modem (in form of deafness) a very cautious strategy is adopted. A considerable inertia has been incorporated in the algorithm in a way that only a fraction of the estimated aging offset is included.

Example:

```
S = sys.bgan.cal.rx.clk.dac_slope
O = sys.bgan.cal.rx.clk.dac_offset
I = sys.bgan.cal.rx.clk.dac_setting
T = protocols.bgan.set.functionality.clk.drift_abs_threshold
```

The reference oscillator is initialized with the values: $I + O$ when the BGAN XL Radio Module is activated. During run time operation the modem will continuously monitor the symbol drift and evaluate the clock aging according to the following algorithms:

$$\Delta_1 = \text{floor} \left((57.85 \times 10 \times T / (2 \times S)) + 0.5 \right)$$

```
IF (drift < -T) THEN
    Δ2 = - Δ1
ELSE IF (drift > T) THEN
    Δ2 = + Δ1
ELSE
    Δ2 = 0
END
```

When the RM enters the system shut-down sequence it stores a new value of O in the configuration system using the equation: $O_{\text{new}} = O_{\text{old}} + \Delta_2$. To deal with scenarios where the power is removed immediately (i.e. the system shut-down sequence is bypassed) a new value is stored every 30 minutes.

6.11.4 RF signal delay

The following parameters hold the BGAN XL Radio Module's internal RF delays which are used in combination with the external reported delays to achieve correct Tx timing as explained in 9.1.1 on page 9-2.

Parameter name sys.bgan.cal	External access	Type / Domain	Values [min;max]	Comment
.tx.delay.tx.internal	r/w t1 §1	int / factory	[0..4095]	Specified in 57.85 MHz clock cycles
.rx.delay.rx1.internal	r/w t1 §1	int / factory	[0..4095]	Specified in 57.85 MHz clock cycles
.rx.delay.rx2.internal	r/w t1 §1	int / factory	[0..4095]	Specified in 57.85 MHz clock cycles

Table 6-87: Tx and Rx delay – calibration parameter

6.12 Settings (FOR INTERNAL USE)

6.12.1 Flash parameters related to modem operation

The sections below describe the flash parameters that are specified during BGAN XL Radio Module development and related to modem operation. These settings are all stored in the configuration system and are organized in the hierarchy shown in the figure below.

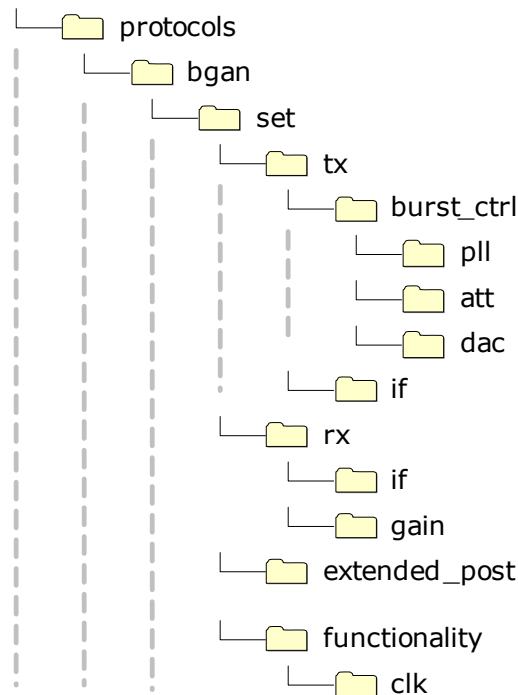


Figure 6-12: Parameter hierarchy for flash parameters.

6.12.1.1 Tx burst control

The BGAN XL Radio Module includes the following settings which are related to the various control mechanisms that are involved in burst transmissions. A detailed

description of each of these parameters can be found in the internal design documentation.

Parameter name protocols.bgan.set.tx	External access	Type / Domain	Values [min;max]	Comment
.burst_ctrl.seq_len_ch0	r	int / ram	[28925..433875]	Sequence length of channel 0 ('Setup 1') (default=404950)
.burst_ctrl.seq_len_ch1	r	int / ram	[28925..173550]	Sequence length of channel 1 ('Setup 2').(default=173550)
.burst_ctrl.seq_len_ch2	r	int / ram	[28925..173550]	Sequence length of channel 2 ('Reset').(default=173550)
.burst_ctrl.seq_len_ch3	r	int / ram	[28925..173550]	Sequence length of channel 3 ('Adjust').(default=173550)
.burst_ctrl.seq_len_ch4	r	int / ram	[28925..57850]	Sequence length of channel 4 ('End').(default=57850)
.burst_ctrl.pll.rcnt	r	int / ram	[0..433875]	Time to write R Count Register.(default=404950)
.burst_ctrl.pll.ncnt	r	int / ram	[0..433875]	Time to write N Count register.(default=115700)
.burst_ctrl.dac.on	r	int / ram	[28925..173550]	Time to turn DAC on.(default=115700)
.burst_ctrl.dac.off	r	int / ram	[0.. 57850]	Time to turn DAC off.(default=20826)
.burst_ctrl.att.setup	r	int / ram	[0..144625]	Time to write Attenuator during a 'Setup' sequence.(default=115700)
.burst_ctrl.att.reset	r	int / ram	[0..144625]	Time to write Attenuator during a 'Reset' sequence.(default=10331)
.burst_ctrl.att.adjust	r	int / ram	[0..144625]	Time to write Attenuator during a 'Adjust' sequence. (default=59)

Table 6-88: Settings related to burst control

6.12.1.2 Intermediate receiver frequency

The table below shows the parameter for the intermediate frequency in the receiver chain.

Parameter name protocols.bgan.set.rx	External access	Type / Domain	Values [min;max]	Comment
.if.freq	r	int / flash	[100000000.. 200000000]	[Hz]. (default=130400000)

Table 6-89: Configuration parameter: intermediate Rx frequency in the receiver chain

6.12.1.3 Intermediate transmitter frequency

The table below shows the parameter related to the intermediate frequency in the transmitter chain.

Parameter name protocols.bgan.set.tx	External access	Type / Domain	Values [min;max]	Comment
.if.freq	r	int / flash	[100000000.. 200000000]	[Hz]. (default=162000000)

Table 6-90: Configuration parameter: intermediate Tx transmitter frequency

6.12.1.4 Internal power saving

The **.sleep.wakeup.time** parameter specifies time in ms before the modem is fully active after being asleep.

Parameter name protocols.bgan.set.functionality	External access	Type / Domain	Values [min;max]	Comment
.sleep.wakeup.time	r	int / flash	[320..480]	Specifies the wake-up time in ms before the modem can be fully active. (default=409)

Table 6-91: Configuration parameters for special service: internal power saving

6.12.1.5 Modem state

This parameter specifies the mode of operation for the modem and is solely used during debugging of the physical layer.

Parameter name protocols.bgan.set.modem	External access	Type / Domain	Values [min;max]	Comment
.mode	r/w t4 §4	int / ram	[0..3]	0=normal (default) 1=manufacturing 2=debug 3=BPLT

Table 6-92: Modem mode

- **Normal** mode is default.
- In **manufacturing** mode, alive surveillance is deactivated.
- In **debug** mode, alive surveillance and internal power save are deactivated.

Note 3=BPLT is a status parameter that is set when BPLT waveform is loaded. It can not be used to load the BPLT waveform.

6.12.1.6 Rx gain control

The BGAN XL Radio Module includes the following settings which are related to the various control mechanisms that are involved in forward channel reception. A detailed description of each of these parameters can be found in the internal design documentation.

Parameter name protocols.bgan.set.rx.gain	External access	Type / Domain	Values [min;max]	Comment
.backoff.f80t025q1b	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-3595)
.backoff.f80t1q4b	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2993)
.backoff.f80t1x4b	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-3248)
.backoff.f80t45x8b	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2646)
.backoff.f80t1q1b	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2993)
.backoff.f80t2.5x4	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2595)

Table 6-93: Configuration parameter: RX gain control

Parameter name protocols.bgan.set.rx.gain	External access	Type / Domain	Values [min;max]	Comment
.backoff.f80t2.5x16	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2850)
.backoff.f80t2.5x16m	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2850)
.backoff.f80t2.5x32	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2950)
.backoff.f80t2.5x64	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-3126)
.backoff.f80t5x4	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2295)
.backoff.f80t5x16	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2550)
.backoff.f80t5x16m	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2550)
.backoff.f80t5x32	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2650)
.backoff.f80t5x64	r/w t3 §4	int / flash	[-8700..0]	Backoff from full scale in 0.01 dB.(default=-2826)
window_threshold.lower	r/w t3 §4	int / flash	[0..2000]	Lower limit for AGC adjustment (adjust when at least "threshold" below operating point). Specified in 0.01 dB. (default=300)
.window_threshold.upper	r/w t3 §4	int / flash	[0..2000]	Upper limit for AGC adjustment (adjust when at least "threshold" above operating point). Specified in 0.01 dB. (default=300)
.step_size	r/w t3 §4	int / flash	[0..100]	Resolution for AGC adjustments in 0.01 dB A value of 0 disables the AGC. (default=40)

Table 6-93: Configuration parameter: RX gain control (Continued)

6.12.1.7 Reference clock

The table below shows the parameters related to the clock offset estimation (see 6.7.2). The **.mov_avg_nframe** parameter indicates how many frames (80 ms) needed before a clock offset estimate is calculated. If the receiver is in tracking mode a value of 50 gives an update rate of 4 seconds. The **.mov_avg_m** parameter tells how many "nframe values" are used to estimate the clock offset.

Parameter name protocols.bgan.set.functionality	External access	Type / Domain	Values [min;max]	Comment
.clk.mov_avg_nframe	r	int / flash	[10..300]	None.(default=50)
.clk.mov_avg_m	r	int / flash	[10..200]	None.(default=30)
.clk.drift_abs_threshold	r	int / flash	[5..100]	Clock drift threshold in ppm x 100 used to adjust .rx.clk.dac_offset value at power down. (default=10)

Table 6-94: Configuration parameter: Reference clock settings

Note

Note that the value of **.rx.clk.dac_offset** is only used to initialise the reference oscillator once per life cycle (i.e. boot). The new value is calculated as;
.rx.clk.dac_offset := **.rx.clk.dac_offset** + Δ where the definition of Δ can be found in the design documentation (see section 6.11.3).

6.12.1.8 Early termination of the turbo decoder

The table below shows the parameters related to the early termination threshold in the turbo decoder.

Parameter name protocols.bgan.set.rx	External access	Type / Domain	Values [min;max]	Comment
.td.early_termination	r/w t3 §4	int / flash	[0..32]	0=disable, N=threshold, (default=16)

Table 6-95: Configuration parameter: early termination of the turbo decoder

6.12.1.9 FPGA debug mux

The table below shows the parameters for setting of the platform specific signal routing used for internal debugging in the modem.

Parameter name protocols.bgan.set	External access	Type / Domain	Values [min;max]	Comment
.fpga.debug_mux	r/w t4 \$4	int / ram	[0..15]	0=disable (default), 15=TDP, 14=Extended-POST, 13=BUTTS

Table 6-96: Configuration parameter: FPGA debug mux

6.12.1.10 BUTTS setting

The table below shows the parameters for configuration of the BGAN XL Radio Module when operating as a BUTTS.



These functionalities are only supported in the special BUTTS version of the RM software.

Parameter name protocols.bgan.set	External access	Type / Domain	Values [min;max]	Comment
.butts.awgn.enable	r/w t4 \$4	int / ram	[0, 1]	0=disable (default) 1=enable
.butts.awgn.level	r/w t4 \$4	int / ram	[-12000..0]	Noise gain in 0.01 dB (-12000)
.butts.fading.enable	r/w t4 \$4	int / ram	[0, 1]	0 = disable (default) 1 = enable
.butts.fading.bw	r/w t4 \$4	int / ram	[0..200]	Fading bandwidth in Hz (0)
.butts.fading.cm	r/w t4 \$4	int / ram	[0..6000]	Fading carrier-to-multipath in 0.01 dB (6000)
.butts.fading.delay	r/w t4 \$4	int / ram	[0..700]	Fading delay in 0.1 μs (0)

Table 6-97: Configuration parameter: BUTTS settings

Parameter name protocols.bgan.set	External access	Type / Domain	Values [min;max]	Comment
.butts.ref_clk.cal_request	r/w t4 §4	int / ram	[0, 1]	0=ready/finished 1=ongoing calibration
.butts.ref_clk.cal_status	r	int / ram	[0..2]	0=ready/finished 1=ongoing 2=timeout

Table 6-97: Configuration parameter: BUTTS settings

Note

If **.butts.ref_clk.cal_status** returns the value **timeout**, it is usually a consequence of either a wrong setting of **fpga.debug_mux** (must be set to 13=BUTTS), or that no proper 10 MHz external reference clock signal has been applied to the RM.

6.12.1.11 S-Band SSR Generator

Below parameter can be used to simulate 2. harmonic SSR reply interference detected and muted by S-Band antenna.

Parameter name protocols.bgan.set.ssr_generator	External access	Type / Domain	Values [min;max]	Comment
.profile	r/w t3 §4	int / ram	[0..4]	Number of exponential distributed SSR replies per second: 0: Off (default) 1: 200 Mode-AC, 50 Mode-S (short), 16 Mode-S (long). 2: 700 Mode-AC, 110 Mode-S (short), 54 Mode-S (long) 3: 1200 Mode-AC, 50 Mode-S (short), 16 Mode-S (long) 4: 353 Mode-AC, 41 Mode-S (short), 20 Mode-S (long)

Table 6-98: S-Band SSR generator configuration

6.12.2 Parameters related to extended POST (FOR INTERNAL USE)

6.12.2.1 RF control interface

The table below shows the parameters related to perform extended POST for the RF control interface. The SPI clock and SPI word length can be configured on the RF control interface. This feature is only available during extended POST.

Parameter name protocols.bgan.set.extended_post	External access	Type / Domain	Values [min;max]	Comment
.rf_ctrl_spi_clock_div	r/w t2 §4	int / ram	[4,8,16,32, 64,128,256,512]	Bit rate: 56 MHz/spi_clock_div (default=4)
.rf_ctrl_spi_word_size	r/w t2 §4	int / ram	[2..64]	Legal word size (default=40)

Table 6-99: Configuration parameter: RF control interface, extended POST

Data interfaces

This chapter has the following sections:

7.1	Protocol overview for the data interface	7-2
7.2	Physical layer	7-4
7.3	Network layer	7-5
7.4	IP addressing scheme	7-5
7.5	Circuit switched services	7-6
7.6	Packet switched services	7-19
7.7	Management services	7-28
7.8	Test-specific protocols	7-40
7.9	TSI/PCM interface	7-42

7.1 Protocol overview for the data interface

The data interface of the BGAN XL Radio Module provides access to a wide range of services. First and foremost it provides access to the services of the BGAN network - both the Circuit Switched (CS) and Packet Switched (PS) services. Secondly, it provides access to a number of local services for management and test of the RM itself. The figure below illustrates how access to the BGAN services is provided on the data interface and the protocols involved

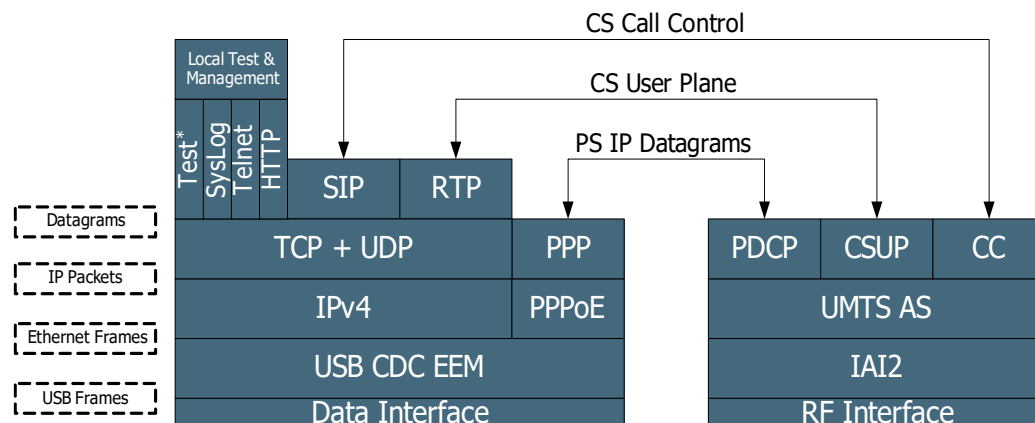


Figure 7-1: Data interface access

The table below explains the behaviour of the different layers in context of the RM and gives references to the sections of the manual where more information can be found.

Protocol layer	Reference	Comments
Physical Layer + Data Link Layer	USB 2.0 [usb.org] USB CDC EEM [usb.org] [Section 7.2]	The electrical interface complies with the USB 2.0 standard with the exception of the mechanical properties of the connector. The link layer protocol is standard Ethernet frames carried over the USB link as specified by the CDC EEM protocol. (Communication Device Class - Ethernet Emulation Model).
Network Layer	IPv4 [IETF RFC-791] [Sections 7.3 and 7.4]	The IP network layer provides access to local services and to the CS service, which is accessed via SIP.
Circuit Switched Services	SIP [IETF RFC-3261] RTP [IETF RFC-3550] [Section 7.5]	The CS services of the BGAN network are provided by the RM via the SIP and RTP protocols. SIP is used for call control (session control in SIP terminology) and RTP is used for user plane data.

Table 7-1: Overview of data interface protocols

Protocol layer	Reference	Comments
Packet Switched Services	PPPoE [IETF RFC 2516] PPP [IETF RFC 1661] [Section 7.6]	The PS services of the BGAN network are provided by the RM via the PPPoE protocol. Each PPPoE sessions maps directly to a PDP context in the PDCP protocol.
Management Services	HTTP [Section 7.7.1] Syslog [Section 7.7.2] AT-shell [Section 7.7.3] Telnet [Section 7.7.4] Data Tunnel [Section 7.7.5]	The management services are provided via three protocols. HTTP is the primary access path to the configuration system of the module. The syslog protocol is used for event reporting and data logging. The Telnet protocol is used for the AT command shell and as internal debug command shell.
Test Services	BPLT [Section 7.8.1] BPT [Section 7.8.2] VCTS [Section 7.8.3]	The test services are provided for type approval purpose and designed to operate with the BPLT, BPT and VCTS test equipment provided by Inmarsat.

Table 7-1: Overview of data interface protocols

7.2 Physical layer

The connection between the Application Processor and the BGAN XL Radio Module is done by using a USB 2.0 interface in device mode, so that the RM acts as a USB device, and the Application Processor acts as a USB host. The RM can run USB 2.0, and will do so if the Application Processor side also offers this, but will fall back to 1.1 if needed.

The RM presents itself with the following USB numbers:

Parameter	USB number	Explanation
Vendor ID	0x10fe	Cobham SATCOM
Device ID	0x000c	403750 BGAN XL Radio Module

Table 7-2: USB numbers of the RM

To provide Ethernet connectivity, the RM implements Communications Device Class - Ethernet Emulation Model (CDC EEM), and expects the Application Processor to do the same. The standard Linux kernel includes a CDC EEM driver whereas a number of commercial drivers are available for purchase for MS Windows.

Per the CDC-EEM specification, the RM presents itself with the following characteristics:

Parameter	Code	Explanation
USB Communication Device Class Code	0x02	Communication Device Class
USB Communication Device Subclass Code	0x0c	Communication Device Subclass/EEM
USB Class Protocol Code	0x07	EEM

Table 7-3: Communication device class codes for USB

Once a CDC-EEM link has been successfully established, a small two-node ethernet network exists. The RM CDC-EEM interface has a fixed MAC address in the Thrane & Thrane range (00:11:cf prefix). The application processor can pick a random MAC address with the "locally administered" bit set to 1 and the multicast bit set to 0, or it can use a real, assigned MAC address.

Important

It is the responsibility of the application processor to ensure that it picks a different MAC address than the RM in order to avoid duplicate MAC addresses on the CDC-EEM Ethernet network.

The RM will present its 10-digit serial number in the serial number field of the USB descriptor. If halted in the boot loader, the serial number will be the string "boot loader."

The RM supports USB suspend. USB suspend is controlled by the host, so it is the responsibility of the host to suspend the link. If not suspended, the RM, as a whole, can not suspend completely and will have increased power consumption. To resume the link, either end can perform a resume.

7.3 Network layer

An IPv4 network runs on top of the Ethernet network. This network is used for a number of things, among those:

- Circuit Switched services such as SIP, RTP and PCM.
- Telnet access to the RM debug shell.
- Configuration system read/write access.

7.4 IP addressing scheme

The IP addresses and netmask for the two-node network between the AP and the BGAN XL Radio Module are determined as follows:

The network mask must be a 255.255.255.252 (a /30 network). This network contains, by virtue of its network mask, four IP addresses; a network address (the first IP address), a broadcast address (the last IP address) and two node addresses (the middle ones.)

The AP must select one of the node IP addresses. The RM will then automatically configure itself to have the other one. These two assignments are static for the duration of the RM life cycle. The RM discovers the IP configuration based on the first ARP request it sees. The AP needs to ensure that an ARP request is transmitted and IP connectivity will not work until this has happened

The AP should select an IP network that resides inside one of the three private IP address ranges, 10.0.0.0/8, 172.16.0.0/12 or 192.168.0.0/16, as specified in RFC 5735. However, the following networks are reserved for internal use by the RM and cannot be used:

192.168.2.0/24

Example: Valid network configuration

The following shows a valid network configuration based on the IP network 10.0.0.0/30 (network mask is 255.255.255.252):

10.0.0.0: Network address, not used for anything in practice.

10.0.0.1: AP.

10.0.0.2: RM, configured automatically as a response to the AP picking 10.0.0.1.

10.0.0.3: Broadcast address, also somewhat redundant on a two-node network.

The standard setup is to assign 192.168.1.1 to the RM and 192.168.1.2 to the AP.

7.5 Circuit switched services

This section describes the interfaces for accessing the Circuit Switched (CS) BGAN services including:

- Voice calls (Speech and 3.1 kHz Audio)
- CS data calls (ISDN UDI/RDI)
- Supplementary Services (SS)
- Short Message Service (SMS)

The Session Initiating Protocol (SIP) is used for call control of voice and ISDN calls. User plane data (i.e. voice frames or ISDN data frames) are supported via the Real Time Protocol (RTP). For ISDN UDI/RDI data calls a PCM bus interface is also provided for user-plane data. The following sections describes how specific SIP and RTP protocol features are used by the RM and how they map to BGAN specific services.

Supplementary services and SMS are controlled via AT commands provided by the AT command shell. Section 7.5.11 lists the supported AT commands for supplementary services while section 7.5.12 lists the supported AT commands for SMS.

7.5.1 Voice and CS data calls

The Session Initiation Protocol (SIP) provides an interface to the BGAN Circuit Switched (CS) call services of the BGAN XL Radio Module. SIP is used for call signalling while RTP is used for voice user data. For ISDN RDI/UDI data calls, user data may either be exchanged via RTP or via the PCM bus.

The RM acts as a gateway between SIP on one side and the BGAN network on the other side. The following sections describe how various SIP and RTP protocol settings and features are used to invoke the CS call features provided by the BGAN network. This includes selecting the BGAN call type and priority, invoking in call supplementary services etc.

7.5.2 SIP registering and authentication

To register with the SIP server of the RM the following parameters must be used:

SIP server parameter	Default value
Server address	<RM ip>
Port	5060
User name (protocols.sip.user-name)	sip1
Password (protocols.sip.password)	sip1

Table 7-4: Default SIP server parameters

Registering is mandatory. If authentication is enabled all transactions with the SIP server will require HTTP Digest authentication as described in RFC 2617 [3] using the specified user name and password.

User name, password and whether or not to use authentication may be configured via the configuration parameters presented in section 6.9.1.

7.5.3 BGAN call type signalling

The BGAN network supports the following four call types:

- Speech (AMBE+2)
- 3.1 kHz audio
- UDI
- RDI

Selecting the call type for Mobile Originated (MO) calls is done by including the proprietary SIP header X-Call-Type and assigning it one of the values defined in the table below. If this header field is not included in the INVITE the RM will assign the call a default call type taken from the configuration parameter **protocols.sip.def-call-type** (see section 6.9.1 on page 6-56).

Call type	X-Call-Type value
Speech	BGAN-Speech
3.1 kHz	BGAN-3.1KHz
UDI	BGAN-ISDN-UDI
RDI	BGAN-ISDN-RDI

Table 7-5: Values for header field for call types

Example: MO speech

Invite Peer -> BGAN XL Radio Module

```
INVITE sip:4512345678@radio-module.local SIP/2.0
X-Call-Type: BGAN-Speech
To: 004512345678 <sip:4512345678@radio-module.local>
```

The call type of Mobile Terminated (MT) calls is signalled by the RM using the same header field.

Example: MT 3.1 KHz

Invite BGAN XL Radio Module -> Peer

```
INVITE sip:sip1@peer.local SIP/2.0
X-Call-Type: BGAN-3.1KHz
From: 4512345678 <sip:4512345678@radio-module.local>
```

7.5.4 BGAN call priority signalling

The BGAN network supports the following call priorities:

- Normal / no priority
- 3GPP eMLPP priority 0-4,A,B¹
- Emergency call

If none of the header fields described below are included in the INVITE a normal/no priority call is established.

If the BGAN XL Radio Module receives an INVITE having both header fields present, it will treat the call as a 3GPP eMLPP priority call.

7.5.4.1 3GPP eMLPP priority calls

3GPP eMLPP priority calls are used by the BGAN maritime safety service. Calls having an eMLPP priority shall include the Resource-Priority header field as defined by RFC 4412 [4]. RFC 4412 defines different priority namespaces for various purposes. The BGAN XL Radio Module supports the namespace q735 defining the priorities 4-0 (0 being highest priority).

For BGAN distress calls (eMLPP level 0) the following header field shall be included in the SIP INVITE:

```
Resource-Priority: q735.0
```

Example: MO distress

```
INVITE sip:500@radio-module.local SIP/2.0
To: 500 <sip:500@radio-module.local>
Resource-Priority: q735.0
```

Example: MT distress

```
INVITE sip:sip1@peer.local SIP/2.0
From: 500 <sip:500@radio-module.local>
Resource-Priority: q735.0
```

For BGAN mobile originated urgency calls (eMLPP level 1) the following header field must be included:

```
Resource-Priority: q735.1
```

Example: MO urgency

```
INVITE sip:517@radio-module.local SIP/2.0
To: 517 <sip:517@radio-module.local>
Resource-Priority: q735.1
```

1. Priority A and B are reserved for internal network use and therefore not used over the air.

7.5.4.2 Emergency calls

For emergency calls (defined by emergency destination numbers such as 112 or 911 configured in the BGAN XL Radio Module and on the USIM) the header field *Priority* is used (RFC3261 [5]). To setup a mobile originated emergency call the following header field must be present:

```
Priority: emergency
```

Example: Emergency

```
INVITE sip:112@radio-module.local SIP/2.0
To: 112 <sip:112@radio-module.local>
Priority: emergency
```

7.5.5 Network and BGAN XL Radio Module cause codes

The BGAN XL Radio Module supports the header field *Reason* (RFC 3326 [6]) for detailed network and RM cause code signalling to the SIP peer. The header field *Reason* contains a protocol, a protocol cause and a reason text. The protocols used by the RM are Q.850 for network cause codes and a proprietary X-BGAN protocol defined for RM status cause codes.

Example: Cause codes

```
Reason: Q.850 ;cause=19 ;text="User alerting,
no answer"
Reason: X-BGAN ;cause=105 ;text="No satellite signal"
```

The SIP peer may include a Q.850 reason cause when rejecting an MT call or terminating an established call. This cause will then be relayed to the BGAN network.

It is recommended to log the RM status cause codes for diagnostic purposes.

7.5.6 Supplementary services

7.5.6.1 Call Hold/Retrieve

If the SIP peer wishes to place an on-air call on hold it must send a re-invite having the SDP session attribute *a=sendonly*. To retrieve the call it must send a re-invite having the SDP session attribute *a=sendrecv*.

7.5.6.2 Multiple simultaneous on-air calls

The RM supports two simultaneous on-air calls of which one must be placed on hold. I.e. to dial a second on-air call the SIP peer must place the first call on hold before sending the invite for the second call. When the second call is established it is possible to toggle between the two calls by placing the active call on hold and then retrieving the other call.

7.5.6.3 Calling Line Identification Restriction

Calling Line Identification Restriction (CLIR) may be suppressed or invoked on a per call basis. This is signalled to the RM by using the header field Privacy defined in RFC 3323 [7]. If the SIP peer wishes to invoke CLIR for a single call it must include the following header in the SIP INVITE:

```
Privacy: header
```

If the SIP peer wishes to suppress CLIR for a single call it must include the following header in the SIP INVITE:

```
Privacy: none
```

If the Privacy header is omitted the default subscription setting for CLIR will be used.

7.5.7 RTP payloads

The BGAN XL Radio Module supports three payload formats for voice via RTP and one for ISDN data:

- PCM A-law (G.711)
- L16 (with a sampling rate of 8000 in 1 channel)
- AMBE+2
- Clearmode (64 kbps data)

The table below lists the payload formats supported for each of the BGAN call types.

BGAN Call type	Supported payload format	Reference
Speech	PCMA	RFC3551 [8]
	L16	RFC3551
	AMBE+2	N/A
3.1KHz	PCMA	RFC3551
	L16	RFC3551
UDI	CLEARMODE	RFC4040 [9]
RDI	CLEARMODE	RFC4040

Table 7-6: Payload formats for BGAN call types

For Speech and 3.1KHz calls the accepted/offered payload format is determined by the configuration parameter **protocols.sip.codecs** (see 6.9.1 on page 6-56).

The BGAN XL Radio Module will reject the call if the requested call type and the payload formats offered by the SIP peer do not match.

7.5.7.1 DTMF

For BGAN speech calls transcoded to PCM A-law or L16 the RM supports in-band DTMF detection and generation.

7.5.7.2 AMBE+2 RTP definitions

AMBE+2 has not been assigned an official encoding name and static payload type by IANA so a proprietary name has been defined that may be used with dynamic payload type number assignment.

Media type	Subtype (name)	Clock rate	Channels
Audio	X-AMBEp2	8000	1

Table 7-7: Proprietary AMBE+2 RTP definitions

Example: SDP example offering the AMBE+2 codec:

```
...
m=audio 49170 RTP/AVP 120
a=rtpmap:120 X-AMBEp2/8000
```

Note | The BGAN XL Radio Module only supports RTP packets with a ptime of 20 ms.

7.5.8 ISDN Q.931 bearer capabilities

In the MO direction the BGAN XL Radio Module supports the proprietary header field X-Q931-Bearer-Capabilities in the SIP INVITE request for signalling bearer capabilities to the network. The RM will translate Q.931 bearer capabilities provided in this header field to corresponding 3GPP bearer capabilities.

The format of the value for this header field must be a string representing a hexadecimal dump of the Q.931 bearer capability information element. Each octet shall be divided by a SPACE character.

Example: ISDN Q.931

```
INVITE sip:4512345678@radio-module.local SIP/2.0
...
X-Call-Type: BGAN-ISDN-UDI
X-Q931-Bearer-Capabilities: 02 3f 12 04 11 87 11 00
```

7.5.9 ISDN data via the PCM bus

For BGAN ISDN UDI/RDI calls user data may be exchanged using the PCM bus. Whether or not to use the PCM bus is determined by the configuration parameter **protocols.sip.pcm.enabled** (see section 6.9.1 on page 6-56).

Even though RTP is not used when exchanging user data via the PCM bus, the RM will require valid SDP RTP session parameters from the SIP peer, indicating CLEARMODE as payload. The RM shall also send SDP session parameters indicating CLEARMODE as payload. See section 7.5.10 for an SDP ISDN example.

The RX and Tx PCM slot numbers to use are determined by the configuration parameters **protocols.sip.pcm.slotrx** and **protocols.sip.pcm.slottx** (see section 6.9.1 on page 6-56).

7.5.10 ISDN data via RTP

If configured to use RTP for ISDN RDI/UDI calls (**protocols.sip.pcm.enabled** set to 0) the RM will send and accept for these call types the SDP session parameters shown in the example below. Only payload CLEARMODE is supported for ISDN RDI/UDI calls.

Example: SDP Session parameters for ISDN RDI/UDI via RTP

```
...
m=audio 49170 RTP/AVP 97
a=rtpmap:97 CLEARMODE/8000
```

7.5.11 Supplementary services interrogation, registration and invocation

Through the use of 3GPP defined AT commands, supplementary services such as Call Forwarding, Call Waiting and Call Barring can be registered, interrogated and invoked. The table below lists the AT commands supported by the RM for the supplementary services supported by the BGAN network. The sections in the column **Reference** refer to the technical specification 3GPP TS 27.007 [1].

AT command	Description	Reference [1]
+CLCK	Facility Lock Supported <fac>: "AO","OI","OX","AI","IR","AB","AG","AC"	Section 7.4
+CPWD	Change Password Supported <fac>: "AO","OI","OX","AI","IR","AB","AG","AC"	Section 7.5
+CLIP	Calling Line Identification Presentation	Section 7.6
+CLIR	Calling Line Identification Restriction	Section 7.7
+COLP	Connected Line Identification Presentation	Section 7.8
+CCUG	Closed User Group	Section 7.10
+CCFC	Call Forwarding	Section 7.11
+CCWA	Call Waiting	Section 7.12
+CUSD	Unstructured Supplementary Service Data	Section 7.15
+CAEMLPP	eMLPP priority registration and interrogation	Section 7.22

Table 7-8: AT commands for supplementary service control

Refer also to section 11.14 on page 11-48 for alternative ways of setting eMLPP on a terminal supporting Multi-Voice or Safety service.

7.5.12 Short Message Service (SMS)

AT commands provide the interface for handling Short Messages. The table below lists the supported AT commands for configuring the service, sending, receiving and storing messages. The sections in the column **Reference** refer the technical specification 3GPP TS 27.005 [2].

AT command	Description	Reference [2]
+CSMS	Select Message Service	Section 3.2.1
+CPMS	Preferred Message Storage	Section 3.2.2
+CMGF	Message format	Section 3.2.3
+CSCA	Service Centre Address	Section 3.3.1
+CSMP	Set Text Mode Parameters	Section 3.3.2
+CSDH	Show Text Mode Parameters Only <show>: 1 supported	Section 3.3.3
+CSAS	Save Settings	Section 3.3.5
+CRES	Restore Settings	Section 3.3.6
+CNMI	New Message Indications Supported values: <mode>: 1 <mt>: 0,1 <bm>: 0 <ds>: 0,2 <bfr>: 0	Section 3.4.1
+CMGL	List messages	Section 3.4.2/4.1
+CMGR	Read Message	Section 3.4.3/4.2
+CMGS	Send Message	Section 3.5.1/4.3
+CMSS	Send Message from Storage	Section 3.5.2/4.7
+CMGW	Write Message to Memory	Section 3.5.3/4.4
+CMGD	Delete Message	Section 3.5.4
+CMGC	Send Command	Section 3.5.5/4.5

Table 7-9: AT commands for SMS handling

7.5.13 Supported SIP RFCs

The BGAN XL Radio Module SIP implementation supports the functionality defined by the RFCs listed in Table 7-10 below.

RFC	Description
2617	HTTP Auth Basic and Digest
3261	Core SIP functionality
3262	Making 1xx responses reliable; defines the PRACK method
3264	An Offer-Answer model with SDP
3323	A Privacy Mechanism for SIP
3326	The Reason header field for SIP.
3550	Defines RTP/RTCP: a Transport Protocol for real-time applications
3551	A RTP profile for audio and video conferences: RTP/AVP
4040	RTP Payload format for a 64 kbps Transparent Call
4412	Communications Resource Priority for SIP
4566	Defines the Session Description Protocol (SDP)

Table 7-10: Supported SIP RFCs

7.5.14 List of circuit-switched cause codes

The tables below list possible cause codes related to circuit-switched services together with a short description. The description could be shown in a call log.

Cause code	Description
0	Disconnect, not specified
1	Unassigned number
3	Network failure, no route
6	Network failure, channel error
8	Operator barring
16	Normal call clearing
17	User busy

Table 7-11: List of circuit-switched cause codes (UMTS Call Control)

Cause code	Description
18	No user responding
19	User alerting, no answer
21	Call rejected
22	Number changed
25	Pre-emption
26	Core Network failure
27	Core Network failure
28	Invalid number
31	Normal, unspecified
34	Call Rejected, no channel/circuit
44	Call Rejected, requested channel/circuit not available
102	Network timeout (no answer)

Table 7-11: List of circuit-switched cause codes (UMTS Call Control) (Continued)

For other cause codes < 256 refer to 'UMTS Specific cause values for call control' in 3GPP TS24.008.

Cause code	Description
0x00134166	Call Rejected, no channel"
0x00134366	Call Rejected, no response from network
0x00134a66	Call disconnect, no response from network
0x00134d66	Call Release, no response from network
0x00034100	Reject, normal
0x00034101	Reject, unspecified
0x00034102	Connection timeout
0x00034103	Reject, no IMSI
0x00034104	Reject, limited Service
0x00034105	Reject, access class not allowed
0x00034106	Reject, connection not idle

Table 7-12: List of circuit-switched cause codes (Internal cause codes from the RM)

Cause code	Description
0x00034107	Reject, no cell or Radio Network
0x00034108	Reject, authentication failure active conn.
0x00034109	Reject, authentication failure

Table 7-12: List of circuit-switched cause codes (Internal cause codes from the RM) (Continued)

Cause code	Description
0x00086400	Establish Reject, normal
0x00086401	Establish Reject, Radio Network failure
0x00086402	Establish Reject, congestion
0x00086403	Establish Reject, unsupported IAI version
0x00086404	Establish Reject, unsupported UE class
0x00086405	Establish Reject, USIM required
0x00086406	Establish Reject, physical channel failure
0x00086407	Establish Reject, access Class not allowed
0x00086408	Establish Reject, unspecified
0x00086409	Conn. release, normal
0x0008640a	Conn. release, Radio Network security failure
0x0008640b	Conn. release, physical channel failure
0x0008640c	Conn. release, PLMN Search
0x0008640d	Conn. release, security command failure
0x0008641e	Deregister, unknown cause
0x00086414	Deregister, register with no complete
0x00086415	Deregister, service area BARRED
0x00086416	Deregister, position required
0x00086417	Deregister, Core Network reset
0x00086418	Deregister, inactivity
0x00086419	Deregister, position response not received
0x0008641a	Deregister, position age expired

Table 7-13: Cause codes received from RAN (SDM cause codes added with 0x00086400)

Cause code	Description
0x0008641b	Deregister, decryption error
0x0008641c	Deregister, user specified position not permitted
0x0008641d	Deregister, Radio Network initiated Deregistration
0x0008641f	Deregister, tracked SAT below minimum
0x00086420	Deregister, Lease Group not available
0x00086421	Deregister, Lease Mode handover failed
0x00086422	Deregister, Radio Failure
0x00086423	Deregister, Unsupported UE subclass
0x00086424	Deregister, Elevation too low
0x00086425	Deregister, Protocol Failure
0x00086426	Deregister, Invalid UE capabilities

Table 7-13: Cause codes received from RAN (SDM cause codes added with 0x00086400)

Cause code	Description
0x00034002	Network failure IMSI unknown (HLR)
0x00034003	Network failure, Mobile Station illegal
0x00034004	Network failure IMSI unknown (VLR)
0x00034006	Network failure, Mobile Equipment illegal
0x0003400b	Network failure, PLMN not allowed
0x0003400c	Network failure, Location area not allowed
0x0003400d	Network failure, roaming not allowed at location
0x0003400f	Network failure, no service at location
0x00034011	Network failure, PLMN failure
0x00034014	Authentication reject, MAC failure
0x00034015	Authentication reject, sync failure
0x00034016	Network failure, congestion
0x00034017	Authentication reject, GSM unacceptable

Table 7-14: Cause codes from 'UMTS specific cause values for mobility management' in 3GPP TS24.008 section 10.5.3.6 added with 0x00034000

Cause code	Description
0x00034020	Service option rejected, not supported
0x00034022	Service option rejected, temporarily out of order
0x00034026	Network failure, call cannot be identified
0x00034030	Network failure, retry upon entry to new cell
0x0003405f	Network error, detached
0x00034060	Network error, invalid mandatory info
0x00034061	Network error, message invalid
0x00034062	Network error, protocol state error
0x00034064	Network error, invalid conditional info
0x00034065	Network error, not compatible with protocol state
0x0003406f	Network error, unspecified protocol error

Table 7-14: Cause codes from 'UMTS specific cause values for mobility management' in 3GPP TS24.008 section 10.5.3.6 added with 0x00034000 (Continued)

Cause code	Description
0x00051001	Attach reject, detaching
0x00051002	Attach reject, powerdown
0x00051003	Attach reject, domain blocked
0x00051004	Reject, missing pin
0x00051005	Reject, no selected PLMN
0x00051006	Reject, PLMN forbidden
0x00051007	Reject, PLMN/GPRS not allowed

Table 7-15: Cause codes from the RM, also used for packet-switched

7.6 Packet switched services

The following subsections introduces the packet switched services supported by the BGAN XL Radio Module and describes how they are controlled.

7.6.1 Brief introduction to PDP contexts and Traffic Flow Templates

A PDP context is a data pipe towards the Internet through the BGAN network. PDP contexts come in two types; primary and secondary, and are grouped in families. A PDP family consists of exactly one primary PDP context and zero or more secondary PDP contexts. The total number of PDP contexts (primary as well as secondary) in all families must not exceed 11. The primary PDP context in a PDP family holds the IP address and APN name assigned from the Core Network.

Inside a given PDP family, PDP contexts are equipped with Traffic Flow Templates (TFTs), which control what data flows in which PDP context, based on source/destination IP address and/or port. The TFTs are transmitted across the BGAN air interface so the core network knows what data goes where, in the direction of core-network-to-terminal. Maximum one PDP context in a PDP family can be without a TFT, and a maximum of eight TFTs per PDP context are supported. TFTs can be configured by AT commands (see section 7.6.5 on page 7-22).

7.6.2 The PPPoE-to-PDP-family mapping

To initiate a primary PDP context (and thereby a PDP family) a PPPoE connection into the RM is established. This can be done multiple times, for multiple PDP context families. The PPPoE connection can either start in the AP or outside the AP, at an end user computer, with the AP just passing the PPPoE connection through. The case with the PPPoE connection starting in the AP is illustrated in Figure 7-2 on page 7-20. Both cases appear identical from a RM point of view.

7.6.3 PPPoE service names

The PPPoE Service Name indicates which connection type is established, with regard to QoS. They are meant as a shorthand version for commonly used connection types. The service names and their parameters are described in Table 7-16. A connection can be made using a service name and used as is, or this can be the starting point for a connection which is then later manipulated via AT commands.

Alternatively, if more fine grained control is desired, the service name can be a string of AT commands that specifies the connection parameters.

Example:

```
XBB:AT+CGDCONT=2,ip,bgan.inmarsat.com;+CGEQREQ=2,3
```

The first establishes a PDP context with cid (Connection ID) 2, then requests a Quality of Service for cid 2 with traffic class 3, which is a background connection. (This particular example is, in result, identical to the “XBB:BACKGROUND” service name string.)

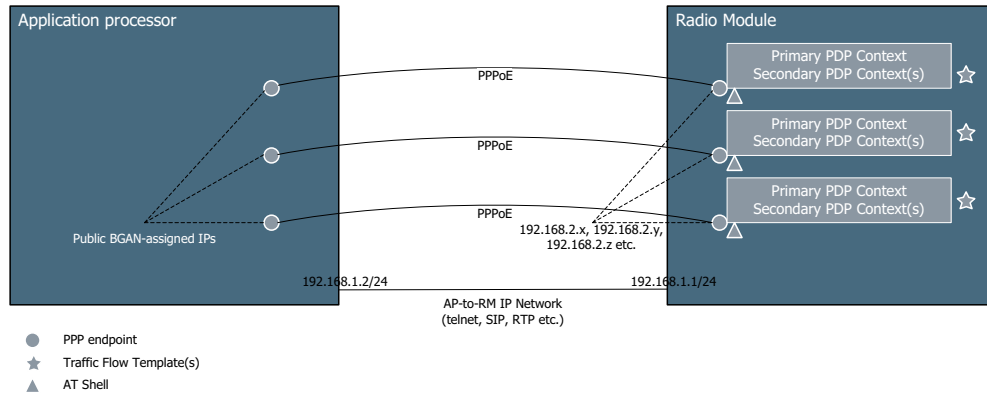


Figure 7-2: PDP contexts

Service Name	Connection Type	Guaranteed QoS (kbit/s)
XBB:BACKGROUND	Best effort	None, maximum 492 (best case)
XBB:STREAM8K	Symmetric streaming	8
XBB:STREAM16K	Symmetric streaming	16
XBB:STREAM32K	Symmetric streaming	32
XBB:STREAM64K	Symmetric streaming	64
XBB:STREAM128K	Symmetric streaming	128
XBB:STREAM176K	Symmetric streaming	176
XBB:STREAM256K	Symmetric streaming	256
XBB:X-STREAM	Symmetric streaming	Minimum 384, max 450
XBB:HDR_STREAM416K	Symmetric streaming	Minimum 290, maximum 416
XBB:HDR_STREAM896K	Symmetric streaming	Minimum 580, maximum 896
XBB:HDR_STREAM416K_64K	Asymmetric streaming	64 in forward direction, 290-416 in return direction
XBB:HDR_STREAM896K_64K	Asymmetric streaming	64 in forward direction, 580-896 in return direction

Table 7-16: PPPoE Service Names

7.6.3.1 Service parameter for data segregation (aeronautical) (FOR INTERNAL USE)

ARINC-781 requires that IP data from Aircraft Control Domain and Aircraft Information Services Domain is segregated. This is described in detail in 6.7.9 on page 6-44.

The separation of the data pools can be achieved by appending a proprietary AT command to the PPPoE service command string. The “+HPP” (High Priority Pool) command will instruct the BGAN XL Radio Module to use a high priority pool inside IAI2 for the family of PDP contexts created with the PPPoE Service command string.

Note that “+HPP” can only be used in conjunction with the PPPoE Service command string when establishing a PDP context, not as a standalone AT command at any point after PDP context activation.

Example:

```
XBB:AT+CGDCONT=2,ip,bgan.inmarsat.com;+CGEQREQ=2,3;+hpp
```

7.6.3.2 Service parameter for Multi-Voice

For terminals implementing Multi-Voice (SDM v3c2) the RM must be instructed that a given PPPoE connection is used for Multi-Voice. This is needed to optimise the way the RM interacts with the BGAN RAN and to minimize the risk of packet loss on the streaming connection used for RTP packets.

The information can be relayed to the RM by appending a proprietary AT command to the PPPoE service command string: “+MVS”.

Note that “+MVS” can only be used in conjunction with the PPPoE Service command string when establishing a PDP context, not as a standalone AT command at any point after PDP context activation.

Example:

```
XBB:AT+CGDCONT=2,ip,bgan.inmarsat.com;+CGEQREQ=2,3;+mvs
```

7.6.4 Manipulating secondary PDP contexts and QoS parameters

Once a PPPoE connection has been established, a PPP connection exists on top of it. This has two endpoints, with each having an IP address assigned to it. The IP address on the AP side is the IP assigned from the BGAN core network (often public), and on the BGAN XL Radio Module side the IP address is of the form 192.168.2.n.

To manipulate Quality of Service (QoS) parameters, an AT-shell exists on the RM side of a given PPP link. If a telnet connection to this IP is established, an AT-Shell for the corresponding PDP family presents itself, and a number of AT commands can be issued. These are identical to the commands allowed in the service name, but the AT shell allows for changing parameters at a later time, instead of initialization of the PPPoE connection.

7.6.5 List of AT commands for manipulating PDP family QoS

This subsection lists the subset of 3GPP AT commands used to manipulate QoS and other parameters for a given PDP context.

- AT+CGDCONT - defines a PDP context.
- AT+CGDSCONT - defines a secondary PDP context.
- AT+CGEQREQ - requests a QoS for a given PDP context.
- AT+CGEQMIN - requests a minimum QoS for a given PDP context.
- AT+CGTFT - defines (TFTs) Traffic Flow Templates for given PDP context family.
- AT+CGACT - activates a PDP context

Example:

```
AT+CGDCONT=2,ip,bgan.inmarsat.com
AT+CGEQREQ=2,3
AT+CGDSCONT=5,2
AT+CGEQREQ=5,1,32,32,32,32
AT+CGTFT=5,1,1,,1
AT+CGACT=1,2
```

This sequence makes the following happen:

1. A primary PDP context with cid 2 is created.
2. A PDP context with cid 2 is configured as a background connection.
3. A secondary PDP context with cid 5 is created, with primary PDP context with cid 2 as its “parent”.
4. This secondary PDP context (cid 5) is configured as a Streaming 32 connection with a QoS of 32 Kbit/s constant bit rate.
5. A TFT is set up for PDP context with cid 5 with identifier 1, evaluation precedence 1, sending everything with IP protocol number 1 (ICMP traffic) across this PDP context.
6. Finally the PDP contexts are activated.

For more detailed documentation of the AT commands, see the relevant 3GPP specification in ‘3GPP TS 27.007, AT Command set for User Equipment (UE)’ [1].

7.6.6 Link metrics monitoring via PPPoE PADQ message

RFC 2516 [19], the original description of PPPoE, has been extended by RFC 4938 [20] with extension for credit flow and link metrics. From this RFC the RM implements the PPPoE Active Discovery Quality (PADQ) message.

This means that the RM client can send a PADQ query message and in return it will get a PADQ message containing the current Tx data rate and the maximum Tx data rate. The RM internally updates these values every 80 milliseconds.

The figures for data rates exclude the data rate used for voice or ISDN. The maximum data rate depends on the current air link quality and current voice or ISDN connections (these will reduce the maximum data rate).

7.6.7 List of packet-switched cause codes

The tables below list possible cause codes related to packet-switched services together with a short description. The description could be shown in a call log.

Cause code	Description
8	Operator Determined Barring
25	LLC or SMDCP failure
26	Insufficient resources
27	Missing or unknown APN
28	Unknown PDP address or PDP type
29	User authentication failed
30	Activation rejected by GGSN
31	Activation rejected, unspecified
32	Service option not supported
33	Requested service option not subscribed
34	Service option temporarily out of order
35	NSAPI already used
36	Normal deactivation
37	QoS not accepted
38	Activation rejected, Network failure
39	Reactivation required
40	Feature not supported
41	Semantic error in the TFT operation
42	Syntactical error in the TFT operation
43	Unknown PDP context
44	Semantic errors in packet filter(s)

Table 7-17: List of packet-switched cause codes (GPRS specific)

Cause code	Description
45	Syntactical errors in packet filter(s)
46	PDP context without TFT already activated

Table 7-17: List of packet-switched cause codes (GPRS specific) (Continued)

For other cause codes < 256 refer to 'GPRS specific cause values for session management' in 3GPP TS24.008

Cause code	Description
0x00040001	Reject, detaching
0x00040002	Timeout
0x00040003	PS attach rejected
0x00040004	Activation error, invalid
0x00040005	Re-activation timeout
0x00040008	Attach reject, timeout
0x00040101	Normal deactivation (from Core Network)
0x00040102	Normal deactivation (power down or reboot)
0x00040103	Normal deactivation (PDP context removed)
0x00040107	Normal deactivation (AT command)
0x0004010b	Normal deactivation
0x00024100	Reject, unspecified
0x00024101	Reject, reattach required
0x00024102	Connection timeout
0x00024103	Reject, authentication failure
0x00024104	Reject, network invalid
0x00024105	Attach Reject, not allowed
0x00024106	Reject, normal detach
0x00024107	Attach reject, no IMSI
0x00024108	Attach reject, Service request denied
0x00024109	Attach reject, searching for PLMN

Table 7-18: Internal cause codes from the RM

Cause code	Description
0x00086300	Establish Reject, normal
0x00086301	Establish Reject, Radio Network failure
0x00086302	Establish Reject, congestion
0x00086303	Establish Reject, unsupported IAI version
0x00086304	Establish Reject, unsupported UE class
0x00086305	Establish Reject, USIM required
0x00086306	Establish Reject, physical channel failure
0x00086307	Establish Reject, access Class not allowed
0x00086308	Establish Reject, unspecified
0x00086309	Conn. release, normal
0x0008630a	Conn. release, Radio Network security failure
0x0008630b	Conn. release, physical channel failure
0x0008630c	Conn. release, PLMN Search
0x0008630d	Conn. release, security command failure
0x0008631e	Deregister, unknown cause
0x00086314	Deregister, register with no complete
0x00086315	Deregister, service area BARRED
0x00086316	Deregister, position required
0x00086317	Deregister, Core Network reset
0x00086318	Deregister, inactivity
0x00086319	Deregister, position response not received
0x0008631a	Deregister, position age expired
0x0008631b	Deregister, decryption error
0x0008631c	Deregister, user specified position not permitted
0x0008631d	Deregister, Radio Network initiated Deregistration
0x0008631f	Deregister, tracked SAT below minimum
0x00086320	Deregister, Lease Group not available

Table 7-19: Cause codes received from RAN (SDM cause codes added with 0x00086300)

Cause code	Description
0x00086321	Deregister, Lease Mode handover failed
0x00086322	Deregister, Radio Failure
0x00086323	Deregister, Unsupported UE subclass
0x00086324	Deregister, Elevation too low
0x00086325	Deregister, Protocol Failure
0x00086326	Deregister, Invalid UE capabilities

Table 7-19: Cause codes received from RAN (SDM cause codes added with 0x00086300) (Continued)

Cause code	Description
0x00024002	Network failure IMSI unknown (HLR)
0x00024003	Network failure, Mobile Station illegal
0x00024006	Network failure, Mobile Equipment illegal
0x00024007	Attach reject, GPRS not allowed
0x00024008	Attach reject, services not allowed
0x00024009	Network failure, Mobile station id unknown
0x0002400a	Network failure, implicitly detached
0x0002400b	Network failure, PLMN not allowed
0x0002400c	Network failure, Location area not allowed
0x0002400d	Network failure, roaming not allowed at location
0x0002400e	Network failure, no GPRS service allowed
0x0002400f	Network failure, no service at location
0x00024010	Network failure, service temporarily unreachable

Table 7-20: Cause codes from 'UMTS specific cause values for mobility management' in 3GPP TS24.008 section 10.5.5.14 added with 0x00024000

Cause code	Description
0x00051001	Attach reject, detaching
0x00051002	Attach reject, powerdown
0x00051003	Attach reject, domain blocked

Table 7-21: Cause codes from the RM, also used for circuit-switched

Cause code	Description
0x00051004	Reject, missing pin
0x00051005	Reject, no selected PLMN
0x00051006	Reject, PLMN forbidden
0x00051007	Reject, PLMN/GPRS not allowed

Table 7-21: Cause codes from the RM, also used for circuit-switched

7.7 Management services

The following subsections describes the management services supported by the BGAN XL Radio Module.

7.7.1 HTTP interface

This subsection contains all the services available via the HTTP protocol. The HTTP services are available using the HTTP 1.1 protocol (RFC 2616 [13]) to the IP address assigned in section 7.4 on page 7-5 at the port number defined in **sys.sw.http.port** (see 6.4.14 on page 6-19).

7.7.1.1 Software upload

The BGAN XL Radio Module supports software upload using the HTTP PUT method. The software update procedure is described in section 11.2 on page 11-3.

7.7.1.2 Diagnostic report

The BGAN XL Radio Module can provide a diagnostic report using the HTTP GET method. The diagnostic report interface is described in section 10.5 on page 10-17.

7.7.1.3 RM configuration, status and notification subscription

This subsection describes the access to the configuration system using HTTP based methods. The HTTP interface returns codes in accordance with the REST principles, stating whether the desired operation has been successful or not.

The currently implemented HTTP return codes are:

Return code	Reason	Meaning
200	OK	The request was handled successfully
400	Bad Request	The BGAN XL Radio Module was unable to perform the request
404	Not found	The requested resource was not found
409	Conflict	The request could not be handled due to lack of available resources. For example if there are too many open connections.
500	Internal Server Error	An internal error occurred while handling the request

Table 7-22: Currently implemented HTTP return codes

If the BGAN XL Radio Module gets a reboot request (MSG_REBOOT, section 8.5.2.8.4 on page 8-25) it will close all HTTP connections and reject new connections.

In both cases the RM will return HTTP response code 200 with an additional HTTP header: "X-Reboot: OpReboot\r\n":

```
HTTP/1.1 200 OK
X-Reboot: OpReboot
Content-Length: 0
```

7.7.1.3.1 Reading all parameters

Reading all parameters is done by invoking the HTTP GET method for the URL config.xml. The response body is of MIME type "text/xml" and consists of the entire collection of settings encoded as an XML document. The XML document contains a number of <param> elements contained in a <configuration> element that is a child of a <settings> element. The root node of the XML document is an <xml> element.

The value of a parameter is expressed as the child nodes of the param element. String and integer values are represented as ascii strings. Name, type and storage domain information is represented as attributes of the param element:

```
<xml><configuration> <settings>
<param name="Name of the parameter" domain="Storage domain" type="Datatype">
Value of the parameter
</param></settings></configuration></xml>
```

Parameter	Value
Storage domains	• persistent: Parameter is saved to persistent storage (non-volatile memory) • transient: Parameter is saved in volatile memory and its value is lost (or restored to default) after a boot cycle. • dyndata: Parameter is run-time generated. • cached: Parameter is cached from earlier processing. May be persisted from an earlier boot cycle. • factory: Parameter is read-only and cannot be changed.
Data types	• string: String values. 8 bit alphanumeric characters. Max length of string value is 256 characters. • integer: Integer values represented as a string value. E.g. "10042" • byte array: Array of bytes. Max length of byte_array type is 256 bytes.

Table 7-23: Parameters for storage domains and data types

7.7.1.3.2 Writing a set of parameters

Writing a set parameters is done by invoking the HTTP PUT method for the URL config.xml. The request body is a XML document containing the parameters to write to the configuration store.

Important Writing a set of parameters will be supported in future releases.

7.7.1.3.3 Reading a parameter

Individual parameters are read by performing a HTTP GET for an URL that represents the parameter.

Parameters are mapped into a URL space prepended with "/setting/". All occurrences of "." in the setting name hierarchy are replaced with "/" in order to construct the URL.

Parameter name	URL
sys.mainboard.temperature	/setting/sys/mainboard/temperature

Table 7-24: Reading the contents of a parameter (example)

The response to a GET is a text string representing the referenced parameter. When reading a parameter the HTTP header field "ETag" is returned. The "ETag" is used for the notification mechanism described later in this document. The Content-type HTTP header field is set as below:

Setting type	Content-type
Integer	text/x-int
String	text/x-string
Byte array	text/x-bytearray

Table 7-25: Read setting HTTP header field Content types

7.7.1.3.4 Setting the value of a parameter

Setting an individual parameter is done with an HTTP PUT to the parameter URL. The value to write to the configuration store is passed as the HTTP request body, encoded as a text string.

7.7.1.3.5 Subscribing to notification on a single parameter

Notifications are reported through the use of HTTP GET. The BGAN XL Radio Module HTTP protocol will block until the value has changed and return the new value as done when reading parameters. The URL is constructed by prepending the parameter name with "/notification" - while changing "." to "/" as described in section 7.7.1.3.3. Byte array settings are not supported for notifications.

Note that the client side HTTP implementation may end the connection before the BGAN XL Radio Module sends back any data. Such a timeout should simply be handled by resending the request. A typical sequence when waiting for a long time then becomes:

1. Client sends notification request
2. Client timeout
3. Client re-sends notification request
4. Client timeout
5. Client re-sends notification request
6. BGAN XL Radio Module sends back a HTTP response
7. Client continues processing

To ensure that a write event is detected by the client, the RM HTTP interface employs an ETag mechanism defined in the HTTP protocol. When reading a parameter or when a notification event occurs, the RM HTTP protocol generates a tag value and transmits it along with the response to the client.

The value can be used in a notification request as a way for the client to communicate the last value (as expressed by the tag) that it has received. The ETag value is included in the notification request in a "If-None-Match" header field.

If no ETag value is included in the request the BGAN XL Radio Module will wait until the next write is performed.

The notification timeout can be configured using the **sys.sw.http.notification.keepalive parameter** (see 6.4.14 on page 6-19).

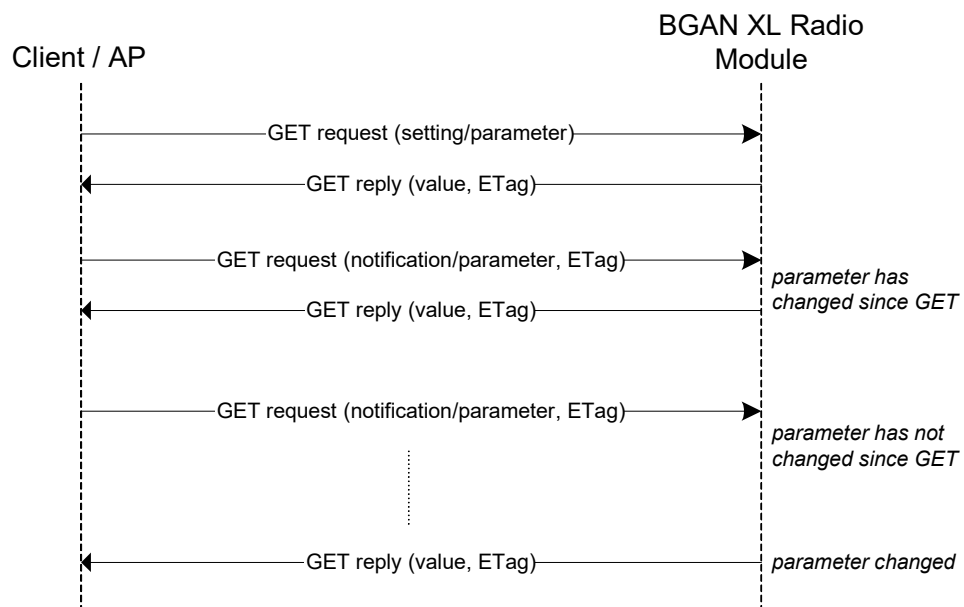


Figure 7-3: Notification sequence

7.7.1.3.6 Subscribing to notifications on multiple parameters

The BGAN XL Radio Module provides an interface to subscribe for changes on a set of parameters which minimizes overhead and minimizes the use of open socket connections. The set of parameters, which is to be subscribed for changes, must be specified in an XML file.

Example:

```
<notification>
  <param name="sys.sw.http.intif.sa_state"></param>
  <param name="sys.status.mode" etag="ready"></param>
</notification>
```

The XML file above contains two parameters, one without an ETag specified and one with an ETag specified. In order to subscribe the above parameters follow the steps below (also illustrated in Figure 7-4):

- Open TCP connection
- Send the above XML file using a PUT request to /notification
- The RM sends a PUT reply indicating if subscription was successful and stores the list of parameters for the lifetime of the TCP connection.
- Using the same TCP connection, send a GET request to /notificationwait.
- The RM will send a GET reply immediately, if the ETag check of one of the subscribed parameters indicates a change. If no ETag values are specified, or the ETag check does not indicate a change, the RM will send a GET response upon a change or close the connection if the keepalive time (6.4.14 on page 6-19) is reached.
- If the TCP connection is closed, all parameter subscriptions are discarded.

The GET response to /notificationwait contains an XML formatted list of the parameters that has changed. An example if the parameter **sys.status.mode** has changed to “service”, the response would be:

```
<notification>
  <param name="sys.status.mode">service type="string"</param>
</notification>
```

The type of the parameter (**string**, **int** or **bytearray**) is returned in the **type** attribute.

Note

The /notificationwait GET response does not contain ETag for the parameters. ETag can be used to ensure that no changes are lost after a timeout (TCP connection closed) and a new subscription is setup with the /notification request.

If setting **ETag=""** for all parameters in the XML file, then RM will respond immediately to the first /notificationwait with the values of all parameters.

If an error occurs during the notification subscription, an error message is logged in syslog and an HTTP response code 400 is returned. The file size of the XML file used for subscription of parameters, must not exceed 65536 bytes. The RM supports up to 512 parameter subscriptions in total.

7.7.2 Syslog interface

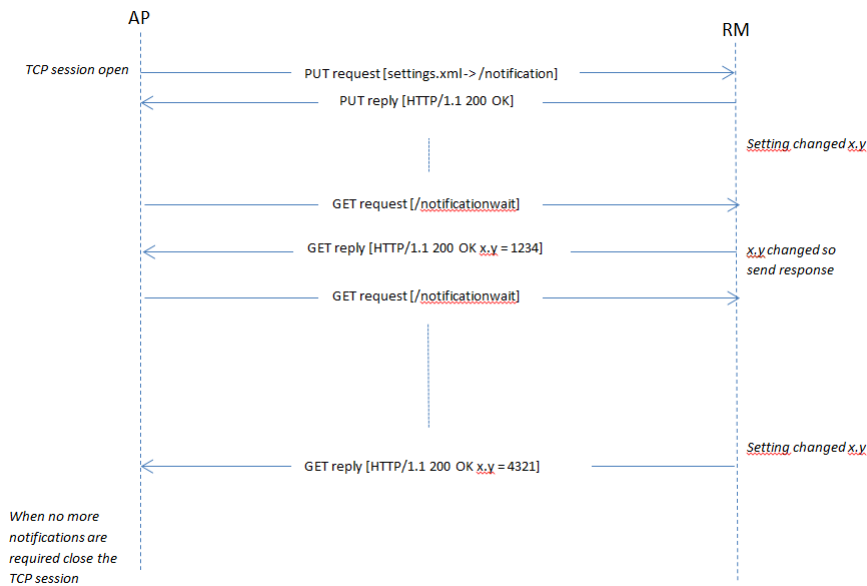


Figure 7-4: Notification sequence with multiple parameters

The BGAN XL Radio Module supports a subset of the syslog protocol described in RFC 5424 [10] and RFC 5426 [11] and operates as a syslog originator whereas the application processor operates as a syslog collector or relay. As allowed in the RFC, the RM will use its IP address in the HOSTNAME field of the syslog protocol.

As a syslog originator the RM will transmit events originating from either internal (the protocol processor or the modem) or external sources submitted via the control interface (see section 8.5.2.6 on page 8-19). Internal events use RM as the APP-NAME whereas external sources will have to use another unique APP-NAME. All generated entries will get a timestamp at the time it is issued from the RM. The timestamp will contain the system time of the RM in UTC time, if known. If the RM does not have time information from a GPS fix, the time since boot of the RM will be used (a time in 1970).

The application processor may operate as a syslog relay, relaying syslog entries to an application on an external unit, or as a syslog collector, storing the syslog entries in RAM or flash locally.

All syslog entries will be tagged with the local0 message facility. Each entry is assigned a message severity by the issuer on the scale shown in the following table:

Value	Severity
0	Emergency: system is unusable
1	Alert: action must be taken immediately
2	Critical: critical conditions

Table 7-26: Syslog entries – severity levels

Value	Severity
3	Error: error conditions
4	Warning: warning conditions
5	Notice: normal but significant condition
6	Informational: informational messages
7	Debug: debug-level messages

Table 7-26: Syslog entries – severity levels

The **services.syslog.relay_ip** contains the IP of the syslog collector (application processor).

By default only events with a severity level of 6 or lower will be transmitted to the application processor. This behaviour can be controlled by the parameter **services.syslog.severity** in the RM configuration system.

Note Up to 99 syslog entries are cached until an IP has been assigned to the RM. If more than 99 entries are made, the additional entries will be lost and entry 100 will contain information about the overflow situation. When an IP has been assigned to the RM, the cached content will be transmitted to the syslog collector.

7.7.2.1 User events

The BGAN XL Radio Module notifies about important events detected by the software by means of so called user events. The user events supported by the BGAN XL Radio Module are made available to the application processor by the syslog protocol (RFC 5424 [10] and RFC 5426 [11]) and are summarized in Table 7-28 below.

A user event is uniquely identified by an event id. In addition a sub-id is provided to further detail the cause of the event. Event ids and sub ids have integer values.

User events can be stateless or with states on/off and they have an information level which can be one of the following: Informational, Warning, Error and Fatal. In addition there is a help text associated to each User Event.

Below shows an example of a user event Syslog message.

```
<134>1.1970-01-01T23:05:52Z.192.168.1.1 RM - 32855 [3750@cobham SubID="0"
State="on" Info="0"] USIM missing
```

In the scope of the syslog protocol it is seen, that the facility is 'local0' and priority 'Informational'. The MSGID is 32855 = 8057hex which is 'USIM missing'.

Details of the user event is formatted as STRUCTURED-DATA, which contains SD-PARAMs with SubID, State and Info fields. The legal PARAM-VALUE range for 'State' is {"on", "off", "none"}, while the legal range for 'SubID' and 'Info' are integers. The help text 'USIM missing' follows the SD-ELEMENT.

All RM-specific user events use - as shown in the example - APP-NAME 'RM', facility 'local0' and SD-ID '3750@cobham'.

The mapping between the four information levels of the RM user events and the syslog message severities is shown in the table below:

RM information levels	Syslog message severity
Fatal (3)	Emergency (0): system is unusable
Error (2)	Error (3): error conditions
Warning (1)	Warning (4): warning conditions
Informational (0)	Informational (6): information messages

Table 7-27: Mapping between information levels of RM User Events and syslog message severities

A full list of all the BGAN XL Radio Module user events is presented in the following table.

Event id	Information level	Event Text	Explanation
0x1000	Informational	Low temperature warning	First notice that the temperature is below nominal level.
0x1010	Warning	Temperature too low (critical)	Low ambient temperature is causing the performance of the terminal to be degraded or halted.
0x1020	Warning	Too low temperature warning	Low ambient temperature is causing the performance of the terminal to be degraded or halted.
0x1100	Informational	High temperature warning	First notice that the temperature is above nominal level.
0x1110	Warning	Temperature too high (critical)	Critically high temperature is causing the terminal to shut down.
0x1120	Warning	Too high temperature warning	High ambient temperature is causing the performance of the terminal to be degraded or halted.
0x1400	Warning	Satellite signal lost	The terminal no longer receives a signal from the satellite.
0x1600	Warning	SOS calls only	The SIM card is not accepted by the network. Only emergency calls are allowed.
0x1700	Warning	Registration for voice failed	The terminal has not yet been allowed to register for voice services (Circuit Switched).

Table 7-28: User events of the BGAN XL Radio Module

Event id	Information level	Event Text	Explanation
0x1800	Warning	Registration for data failed	The terminal has not yet been allowed to register for data services (Packet Switched).
0x2000	Informational	Satellite signal weak	The signal from the satellite is weak.
0x2900	Warning	Network failed authentication	The terminal does not accept the network as a valid BGAN network. SubID = 1 if the event is generated by UMTS Mobility Management stack (CS domain), SubID = 2 if alarm is generated by UMTS GPRS Mobility Management (PS domain).
0x3900	Error	Air link error	Too many errors have been detected on the air link and the terminal will silently deregister.
0x4000	Informational	Air link bad	The quality of the air link is bad.
0x4100	Informational	Doppler change too big	The calculated doppler change exceeds the limits.
0x8021	Informational	IAI-2 Adaptation Layer: Idle	The IAI-2 Adaptation Layer is in the state group: Idle
0x8022	Informational	IAI-2 Adaptation Layer: Searching for network	The IAI-2 Adaptation Layer is in the state group: Searching for Network
0x8023	Informational	IAI-2 Adaptation Layer: Network found	The IAI-2 Adaptation Layer is in state group: Network Found
0x8024	Informational	IAI-2 Adaptation Layer: Registering	The IAI-2 Adaptation Layer is in the state group: Registering
0x8025	Informational	IAI-2 Adaptation Layer: Registered	The IAI-2 Adaptation Layer is in the state group: Registered
0x8026	Informational	IAI-2 Adaptation Layer: Releasing	The IAI-2 Adaptation Layer is in the state group: Releasing
0x8027	Informational	IAI-2 Adaptation Layer: Handover	The IAI-2 Adaptation Layer is in the state group: Handover
0x8028	Informational	IAI-2 Adaptation Layer: Terminal camped on PSAB, ready for registration procedure	The terminal is camped on PSAB, ready for registration procedure.

Table 7-28: User events of the BGAN XL Radio Module (Continued)

Event id	Information level	Event Text	Explanation
0x8029	Informational	IAI-2 Adaptation Layer: Silent deregistration, satellite connection temporarily lost	The IAI-2 adaptation layer reports silent de-registration causing temporary loss of the satellite connection. SubID = 0 means a "true" silent de-registration from the BCt layer, while sub id = 1 is used for a number of other cases, such as security command failure or integrity command failure.
0x8037	Informational	IAI-2 Adaptation Layer: Register reject, satellite connection temporarily lost	The IAI-2 adaptation layer received register reject causing temporary loss of the satellite connection.
0x8038	Informational	IAI-2 Adaptation Layer: Deregistration, satellite connection temporarily lost	The IAI-2 adaptation layer received de-registration causing temporary loss of the satellite connection. 'Info' is the cause code from the network.
0x8039	Informational	IAI-2 Adaptation Layer: Deregistration, satellite connection temporarily lost	The IAI-2 adaptation layer received de registration causing temporary loss of the satellite connection. 'Info' is the cause code from the network.
0x8040	Warning	Excessive writes to the flash memory	An excessive amount of writes to flash memory has been detected.
0x8049	Warning	Data rate reduction due to high temperature	The bit rate of the data channel is reduced because the temperature is too high.
0x804C	Warning	The chosen satellite is not visible at current GPS position	The terminal is set up to use a satellite that is not visible at the current GPS position.
0x8055	Informational	USIM accepted	The USIM card has been accepted by the terminal.
0x8056	Warning	USIM rejected	The type of USIM card inserted in the terminal is not correct for the terminal.
0x8057	Informational	USIM missing	No USIM card inserted in the terminal.

Table 7-28: User events of the BGAN XL Radio Module (Continued)

7.7.3 AT shell

This section contains a brief overview of the services available using the AT command shell. The AT commands supported are implemented following 3GPP specifications, major release 4. The following three areas of the BGAN XL Radio Module are controlled using AT commands:

- PDP connection setup and control (TS 27.007, [1])

- Supplementary Services (TS 27.007 [1])
- SMS handling (TS 27.005, [2])

The AT shell is accessed using the telnet protocol (RFC 854, [15]) to the IP address setup in section 7.4 on page 7-5 at port number 5454 using USB EEM as connection to the BGAN XL Radio Module.

Only a subset of AT commands listed in [1] and [2] is released for use on the BGAN XL Radio Module. All other AT commands present in the AT shell are for future use only.

7.7.4 Telnet

This section contains an overview of the debug shells accessible using the telnet protocol (RFC 854, [15]). The telnet services are available using an USB EEM connection to the BGAN XL Radio Module. For the IP address of the BGAN XL Radio Module see section 7.4 on page 7-5. The BGAN XL Radio Module offers a telnet server at the following port numbers:

Port number	Shell
23	RM protocol processor debug shell (For internal use)
124	RM Modem debug shell (For internal use)
125	Control interface shell (port 4)
126	Control interface shell (port 126)
127	Control interface shell (port 127)
5454	AT shell

Table 7-29: Telnet – debug shells

7.7.5 Data tunnel

The BGAN XL Radio Module provides four data tunnels providing communication links between the data interface and the control interface. The RM listens on UDP port 130 and TCP port 131 and accepts only one session at a time on each port. The data received on the respective ports is forwarded to the control interface.

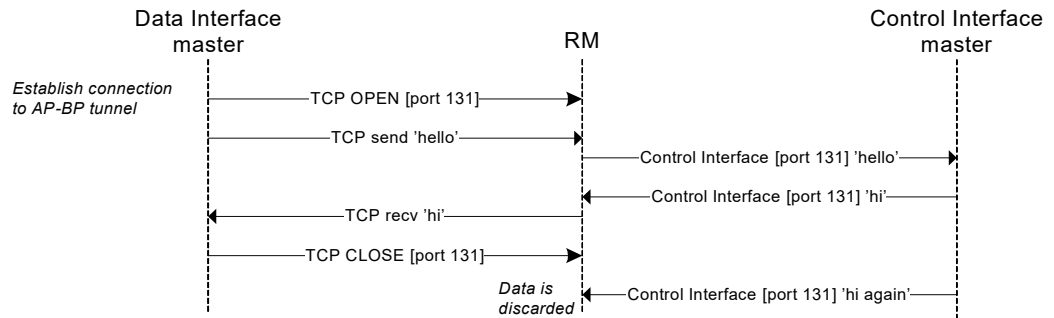


Figure 7-5: AP-BP tunnel, TCP example

The RM will discard any data received if the receiving end is not ready to receive/accept the data. For example if the board processor transmits data on a specific tunnel port which has not been opened by the application processor.

Important

The current release only supports one TCP and UDP tunnel. Four data tunnels will be supported in future releases.

7.7.6 USIM

The BGAN XL Radio Module supports the two AT commands AT+CPIN and AT+CRSM to interact with a USIM card available on the Control Interface (section 8.5.2.11 on page 8-29).

The AT+CPIN is used for entering a PIN/PUK code and is defined in TS 27.007 [1] section 8.3.

The AT+CRSM is used for restricted USIM commands (read/write/status) and returns the card response or an error. The AT+CRSM is defined in TS 27.007 [1] section 8.18.

The BGAN XL Radio Module provides a set of parameters related to USIM, see section 6.5.1 on page 6-21 for more information.

7.8 Test-specific protocols

The following subsections provides information on the protocols supported by the BGAN XL Radio Module to enable test required for type approval.

7.8.1 BPLT

The terminal communicates with the BGAN Physical Layer Tester (BPLT) by exchanging messages over TCP connections initiated by the BPLT. The BPLT issues messages to the terminal to request it to perform operations such as configuring its transmitter or receiver. The terminal sends acknowledgement messages to the BPLT in response to each message received. The terminal additionally issues messages to the BPLT to report received FEC blocks and to support transmission flow control. The BPLT does not acknowledge messages from the terminal.

Two separate TCP connections are used, one for control and acknowledgement messages and one for data traffic.

For aeronautical user terminals which require Doppler compensation, UDP datagrams carrying ARINC-429 messages must be sent to port 3001.

Port number	Connection	TCP	UDP
Port 2001	Control connection	X	
Port 2002	Data connection	X	
Port 3001	ARINC-429 interface		X

Table 7-30: TCP and UDP connections for physical layer tests

Do not change these port numbers in the BPLT configuration file.

For further details of the communication protocol between the BPLT and the BGAN XL Radio Module see the BPLT/UT Interface Specification document written by Square Peg Communications Inc¹.

For further details of the exchange of messages conforming to the ARINC Specification 429² between the BPLT and BGAN XL Radio Module, refer to the BPLT ARINC-429 Interface Specification written by Squarepeg Communication Inc.

See section 12.7.1 on page 12-17 for additional information on the physical BPLT setup. For a walkthrough of the physical layer scripts needed for validating the performance of the BGAN XL Radio Module as well as possible special handling of individual scripts with regards to correctly configuring the BGAN XL Radio Module, refer to 14.3.

1. See <http://www.squarepeg.ca> for further information.

2. See <http://www.arinc.com> for further information.

7.8.2 BPT

The BGAN Protocol Tester (BPT) provides a complete development and compliance environment for the Inmarsat Air Interface adaptation, bearer control and bearer connection layers for BGAN as well as 3GPP Non Access Stratum (NAS) and the ISDN sub-system. The BPT is based on the Test Case Manager (TCM) developed by Livewire Digital¹, a software suite that is used for the validation and type approval of user terminals by verifying that the terminal is compliant with the Mandatory Test Requirements (MTR) specified by Inmarsat.

By default the BPT uses port 1835 for control of the terminal but port numbers and IP addresses can be configured within the TCM, for additional information regarding the BGAN MTR test setup, see section 12.7.2 on page 12-21 and the documentation from Livewire Digital.

7.8.3 VCTS

The AMBE+2 voice codec is required to produce bit-exact output i.e. for a certain input sequence the output must be exactly as specified on bit-level. This is verified using test equipment called Voice Codec Test Set (VCTS) in conjunction with a PC software called Voice Codec Diagnostic Software (VCDS), both produced by DVSI Inc. The VCDS SW is the user interface. It is used to start and stop the tests, analyzing and presenting the test results and for controlling the VCTS. The VCTS is used to send data frames to and receive frames from the terminal.

The protocol between the terminal and VCTS runs over Ethernet using UDP port 4000. Byte order for data types is network order. It is a master-slave protocol where the VCTS is the master. For additional information on the VCTS test setup, see section 12.7.3 on page 12-23.

To run a bit-exact encoder test the Reset command is issued to initialize the voice encoder. The terminal should respond with an Ack. The test set then issues a Go command to signal the start of a test, and the terminal should also respond with an Ack. The test set then starts transmitting Encoder command packets to the terminal over Ethernet. The terminal reads the Encoder packets, encodes the voice data, and transmits Channel response packets to the test set over Ethernet. Testing stops when a Stop command is received and acknowledged by the terminal.

To enable the protocol the RM must be set to VCTS mode, it is done through the configuration system.

1. See <http://www.livewire.co.uk> for further information.

7.9 TSI/PCM interface

The TSI/PCM interface of the BGAN XL Radio Module may be used as data interface for ISDN RDI/UDI calls. If the integrator chooses to use the TSI/PCM interface he may in addition enable the reporting by the BGAN XL Radio Module of clock drift and buffer drift as described in section 11.4 on page 11-10.

7.9.1 Configuring the TSI/PCM interface for normal operation

Before using the TSI/PCM interface for normal operation the integrator must determine and configure the following parameters:

- Enabling of the TSI/PCM interface (**sys.bus.pcm.enabled**)
- All slot numbers used by the BGAN XL Radio Module for receiving data from the TSI/PCM bus (**sys.bus.pcm.rxslots**)
- All slot numbers used by the BGAN XL Radio Module for transmitting data on the TSI/PCM bus (**sys.bus.pcm.txslots**)
- BGAN XL Radio Module receive timing (**sys.bus.pcm.rxdadly**)
- BGAN XL Radio Module transmit timing (**sys.bus.pcm.txdadly**)
- Enabling of support for ISDN data via TSI/PCM interface (**protocols.sip.pcm.enabled**)
- Slot number used by BGAN XL Radio Module for receiving ISDN data from TSI/PCM bus (**protocols.sip.pcm.slotrx**)
- Slot number used by BGAN XL Radio Module for transmitting ISDN data on the TSI/PCM bus (**protocols.sip.pcm.slottx**)
- Enabling of clock drift reporting on the TSI/PCM interface (**protocols.bgan.functionality.clk.drift.distribution**)
- Enabling of buffer drift reporting on the TSI/PCM interface (**protocols.bgan.functionality.clk.csfifo.distribution**)
- Slot number used by the BGAN XL Radio Module for reporting clock and buffer drift on the TSI/PCM bus (**protocols.bgan.functionality.clk.drift.slot_no**)

Note

The integrator must ensure not to use the same TSI/PCM slot number for multiple purposes. E.g. the BGAN XL Radio Module must not be configured to use the same slot number for transmitting ISDN data and reporting clock/buffer drift onto the TSI/PCM bus.

The slot numbers used for receiving and transmitting ISDN data may be changed during normal operation on a per call basis prior to establishing the call. The integrator must ensure that any slot number used in the receive direction is included in the parameter **sys.bus.pcm.rxslots** and any slot number used in the transmit direction is included in the parameter **sys.bus.pcm.txslots** during the initial configuration on the BGAN XL Radio Module.

7.9.2 Data formats

The data format for ISDN data sent and received on the TSI/PCM interface is 8-bit PCM A-law.

The drift information is distributed via a dedicated TSI slot as specified in section 6.6.5 on page 6-30. The drift information is constructed by a 3 byte frame and is distributed to the integrator periodically every 4th second if distribution of at least one of the drift parameters has been enabled as per section 6.6.5 on page 6-30.

Byte 1		Byte 2	Byte 3
ID (7..4)	Check sum (3..0)	Clock drift	CS fifo drift

Table 7-31: Drift information format (3 bytes)

Data field	Type	Bits	Value	Comment
ID	U4	7..4	0..15	0x0 - not valid. 0x1 .. 0x4 reserved 0x5 - Clock adjust 0x6 .. 0xf reserved.
Check sum	U4	3..0	0..15	The result of an unsigned addition off all nibbles including checksum must give a 4bit result = 0. See example below.
Clock drift	S8	7..0	-128..127	Contains the clock drift information (if enabled, otherwise 0). Signed value x 0.0625 ppm
CS fifo drift	S8	7..0	-128..127	Contains the CS fifo drift information (if enabled, otherwise 0). Signed value x 0.0625 ppm

Table 7-32: Drift information frame content

Example: Check sum calculation

ID = 5, Clock drift (byte 2) = 0x45, CS fifo drift (byte 3) = 0xC4

Check Sum = 16 - ((5+4+5+12+4)%16) = 2

Byte 1 = 0x52, byte 2 = 0x45, byte 3= 0xC4

7.9.3 Configuring the TSI/PCM interface for test mode operation

The TSI/PCM interface may be configured for loopback test. This is described in detail in section 11.3.4 on page 11-9.

Control interface

This chapter has the following sections:

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8.1 Terminology

The control interface is the interface for controlling and configuring the BGAN XL Radio Module. The control interface implements a proprietary protocol for exchanging messages and data between a master and a slave. The BGAN XL Radio Module is the slave. The unit responsible for controlling and configuring the BGAN XL Radio Module is the master.

The messages transferred between the master and the RM are defined as Service Data Units (SDUs). In Open Systems Interconnection (OSI) terminology, an SDU is a unit of data that has been passed down from an OSI layer to a lower layer and that has not yet been encapsulated into a Protocol Data Unit (PDU) by the lower layer. It is a set of data that is sent by a user of the services of a given layer, and is transmitted semantically unchanged to a peer service user. It differs from a PDU in that the PDU specifies the data that will be sent to the peer protocol layer at the receiving end, as opposed to being sent to a lower layer. A port number, similar to TCP/IP, is used by the framing layer to identify the individual SDUs and their designated receiving service or application.

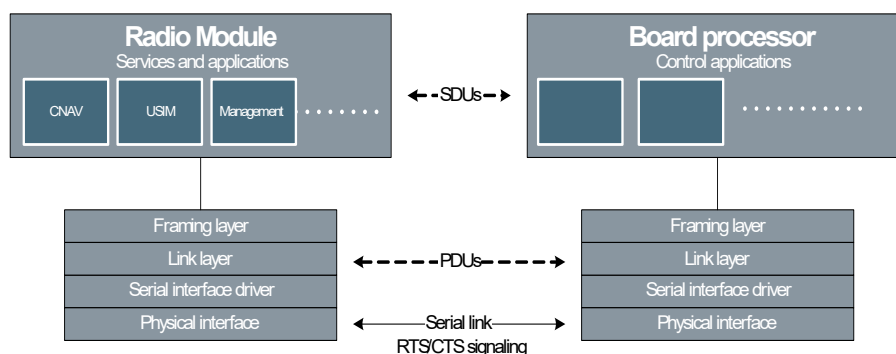


Figure 8-1: Control Interface between BGAN XL Radio Module and a board processor

8.2 Physical layer

The signals related to the physical layer of the Control Interface are listed in *Table 5-15 on page 5-20*. The UART configuration is listed below.

Setting	Value
Baud	115200
Parity	none
Data bits	8
Stop bits	1
Flow control	RTS/CTS

Table 8-1: Control interface UART configuration

8.3 Link layer

The following subsections define the link layer applicable for the control interface.

8.3.1 Format of the protocol data unit (PDU)

The control interface operates with a PDU format as illustrated below:

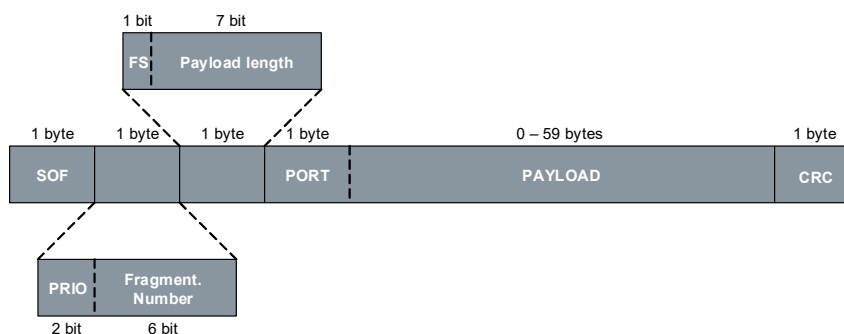


Figure 8-2: Format of the protocol data unit

- SOF: Start Of Frame identifier (0x7E)
- PRIO: Priority of the SDU message (0x0 is highest priority and 0x3 is lowest priority)
- FN: Fragment number used for fragmented transfer and indicates the number of remaining fragments (see section 8.4.3 on page 8-5)
- FS: Fragment Start bit indicates the first PDU in a fragmented transfer (see section 8.4.3 on page 8-5)
- Payload length: Length of remaining PDU data up until CRC field
- Payload: SDU data including the PORT number (see 8.4.1 on page 8-5)
- CRC: 8bit CRC of entire PDU after SOF (see next section for details))

8.3.2 CRC calculation

The 8bit CRC used in the control interface PDU frames are specified in the 3GPP specification TS 27.010 [22]. The CRC is generated from the polynomial $x^8 + x^2 + x^1 + 1$ and the reversed CRC table shown below:

```

static const8.5.6.1 U8 crc8_tab[256] = {
    0x00, 0x91, 0xe3, 0x72, 0x07, 0x96, 0xe4, 0x75,
    0x0e, 0x9f, 0xed, 0x7c, 0x09, 0x98, 0xea, 0x7b,
    0x1c, 0x8d, 0xff, 0x6e, 0x1b, 0x8a, 0xf8, 0x69,
    0x12, 0x83, 0xf1, 0x60, 0x15, 0x84, 0xf6, 0x67,
    0x38, 0xa9, 0xdb, 0x4a, 0x3f, 0xae, 0xdc, 0x4d,
    0x36, 0xa7, 0xd5, 0x44, 0x31, 0xa0, 0xd2, 0x43,
    0x24, 0xb5, 0xc7, 0x56, 0x23, 0xb2, 0xc0, 0x51,
    0x2a, 0xbb, 0xc9, 0x58, 0x2d, 0xbc, 0xce, 0x5f,
    0x70, 0xe1, 0x93, 0x02, 0x77, 0xe6, 0x94, 0x05,
    0x7e, 0xef, 0x9d, 0x0c, 0x79, 0xe8, 0x9a, 0x0b,
  
```

```
0x6c, 0xfd, 0x8f, 0x1e, 0x6b, 0xfa, 0x88, 0x19,  
0x62, 0xf3, 0x81, 0x10, 0x65, 0xf4, 0x86, 0x17,  
0x48, 0xd9, 0xab, 0x3a, 0x4f, 0xde, 0xac, 0x3d,  
0x46, 0xd7, 0xa5, 0x34, 0x41, 0xd0, 0xa2, 0x33,  
0x54, 0xc5, 0xb7, 0x26, 0x53, 0xc2, 0xb0, 0x21,  
0x5a, 0xcb, 0xb9, 0x28, 0x5d, 0xcc, 0xbe, 0x2f,  
0xe0, 0x71, 0x03, 0x92, 0xe7, 0x76, 0x04, 0x95,  
0xee, 0x7f, 0x0d, 0x9c, 0xe9, 0x78, 0x0a, 0x9b,  
0xfc, 0x6d, 0x1f, 0x8e, 0xfb, 0x6a, 0x18, 0x89,  
0xf2, 0x63, 0x11, 0x80, 0xf5, 0x64, 0x16, 0x87,  
0xd8, 0x49, 0x3b, 0xaa, 0xdf, 0x4e, 0x3c, 0xad,  
0xd6, 0x47, 0x35, 0xa4, 0xd1, 0x40, 0x32, 0xa3,  
0xc4, 0x55, 0x27, 0xb6, 0xc3, 0x52, 0x20, 0xb1,  
0xca, 0x5b, 0x29, 0xb8, 0xcd, 0x5c, 0x2e, 0xbf,  
0x90, 0x01, 0x73, 0xe2, 0x97, 0x06, 0x74, 0xe5,  
0x9e, 0x0f, 0x7d, 0xec, 0x99, 0x08, 0x7a, 0xeb,  
0x8c, 0x1d, 0x6f, 0xfe, 0x8b, 0x1a, 0x68, 0xf9,  
0x82, 0x13, 0x61, 0xf0, 0x85, 0x14, 0x66, 0xf7,  
0xa8, 0x39, 0x4b, 0xda, 0xaf, 0x3e, 0x4c, 0xdd,  
0xa6, 0x37, 0x45, 0xd4, 0xa1, 0x30, 0x42, 0xd3,  
0xb4, 0x25, 0x57, 0xc6, 0xb3, 0x22, 0x50, 0xc1,  
0xba, 0x2b, 0x59, 0xc8, 0xbd, 0x2c, 0x5e, 0xcf  
};
```

To calculate a new CRC given the current CRC and the new data:

```
U8 crc8(U8 crc, U8 * cp, int len)  
{  
    while (len--)  
        crc = crc8_tab[(crc ^ *cp++)];  
    return (crc);  
}
```

Example: The calculated CRC value of the array [1, 2, 3, 4] is 93 and the calculated CRC value of the array [1, 2, 3, 4, 93] is 0.

8.3.3 Error handling

The link layer validates the received PDUs using CRC, PDU fragmentation fields and the PDU length field. When an error is detected the entire PDU is discarded.

8.3.4 Link Bandwidth

With a serial link speed of 115200 bps, using 8-1-1, the link can effectively carry $115200[\text{bps}]/10[\text{bit}] = 11520 \text{ byte/s}$ in both directions.

8.4 Framing layer

The following subsections define the framing layer applicable for the control interface.

8.4.1 Format of the service data unit (SDU)

The SDU format is defined as below:



Figure 8-3: Format of the service data unit

- Port: Destination port number of the SDU data payload (see section 8.5.1 on page 8-7)
- SDU payload: SDU data.

Note | Data types in the SDU payload are transmitted in little endian order.

8.4.2 Priority transfer

The protocol supports four priority levels:

- 0 Critical
- 1 High
- 2 Normal
- 3 Low

The transmission rules are:

1. Higher priority SDUs will be selected before lower priority SDUs.
2. If two or more SDUs with the same priority are waiting for transmission, the framing layer selects the next SDU using the FIFO principle.
3. Transmission of lower priority fragmented SDUs will be suspended if higher priority SDUs are submitted for transmission.
4. A PDU transmission cannot be interrupted by another PDU, regardless of priority.

8.4.3 SDU fragmentation

When the length of an SDU is larger than the payload length of a PDU, the SDU will get fragmented in two or more PDUs. Figure 8-4 below shows three examples of the framing of different SDUs into PDUs.

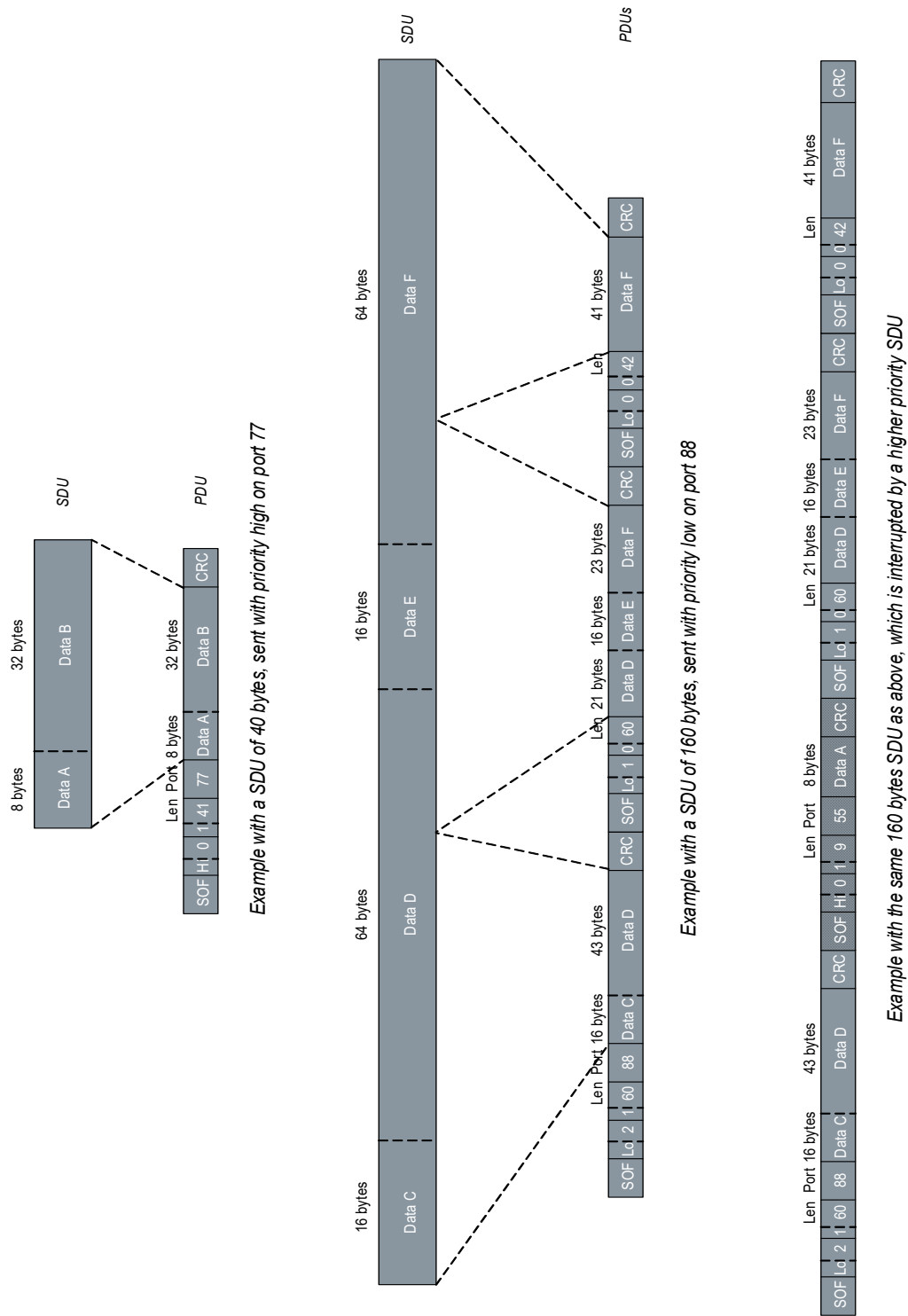


Figure 8-4: SDU to PDU framing examples

8.5 Application layers

8.5.1 Overview

The control interface of the BGAN XL Radio Module provides a set of application layer protocols which is used for configuring and controlling the RM. These protocols are also referred to as the control interface protocols.

The following application layer protocols must be implemented by the master:

Protocol	Description	Port(s)	Reference
Management	Operation management	1	8.5.2.4
	Configuration		8.5.2.5
	Event reporting		8.5.2.6
	File transfer from RM		8.5.2.7
	Power management		8.5.2.8
	General messages		8.5.2.9
	Aero-specific management		8.5.2.10
	Security management		8.5.2.11
	Bootloader security		8.5.2.12
USIM	USIM communication	2	8.5.2.11
Navigation	Satellite navigation (e.g. GPS)	3	8.5.4
Antenna Pointing	Global waveform search	5	8.5.5
	Satellite table (s)		
	Channel Power Estimation		
	Waveform validation		
Abnormality	Abnormality messages	6	8.5.6
Continuous Transmission	Start Continuous Wave (CW) transmission	5	8.5.10
	Stop Continuous Wave (CW) transmission		
	Fast signal-to-noise reports		
	Set in CW mode		

Table 8-2: Required application layer protocols for proper operation and control of the RM

A set of mandatory protocols are supported to provide extra functionality for integrating the RM in a product.

Protocol	Description	Port(s)	Reference
Tunnel	Direct communication between Data Interface and Control Interface master	130, 131	8.5.7
Debug shells	Debug shell interfaces	4, 126, 127	8.5.8
Extended POST	Functionality to help perform extended POST and validation	64	8.5.9

Table 8-3: Mandatory application layer protocols

8.5.2 Management protocol

The management protocol of the control interface implements the interface for controlling and configuring the BGAN XL Radio Module.

8.5.2.1 Overview

The management protocol messages are listed in the following table:

Message	Direction	Summary	Reference
MSG_WAVEFORM	In	Load and activation of BGAN XL Radio Module protocol and modem	8.5.2.4.1
MSG_CONFIG_READ_REQ	In	Requests a read from the RM configuration database	8.5.2.5.1
MSG_CONFIG_READ_RESP	Out	Response to a MSG_CONFIG_READ_REQ	8.5.2.5.2
MSG_CONFIG_WRITE_REQ	In	Request a write in the RM configuration database	8.5.2.5.3
MSG_CONFIG_NOTIFY_REQ	In	Register for parameter change notification in RM configuration	8.5.2.5.4
MSG_CONFIG_NOTIFY	Out	Sent when a registered parameter group is changed	8.5.2.5.5
MSG_CONFIG_NOTIFY_DATA	Out	Sent when a registered parameter is changed	8.5.2.5.6
MSG_USER_EVENT	In	Report a user event to RM	8.5.2.6.1
MSG_SYSLOG	In	Submit a syslog message	8.5.2.6.2

Table 8-4: Control Interface management messages

Message	Direction	Summary	Reference
MSG_TFTP_RRQ	In	Request a transfer of a file	8.5.2.7.1
MSG_TFTP_DATA	Out	Data packet for TFTP transfer	8.5.2.7.2
MSG_TFTP_ACK	In	TFTP acknowledgement message	8.5.2.7.3
MSG_SUSPEND_REQ	In	Set Radio Module in suspend (only available in IAI2 mode)	8.5.2.8.1
MSG_SUSPEND_ABORT	In	Exit from suspend mode	8.5.2.8.2
MSG_POWERDOWN	In	Power down RM	8.5.2.8.3
MSG_REBOOT	In	Reboot RM	8.5.2.8.4
MSG_RESET_REQ	Out	RM requests to be reset	8.5.2.8.5
MSG_ACK	Out	General acknowledgement message	8.5.2.9.1
MSG_NACK	Out	General not-acknowledged message	8.5.2.9.2
MSG_AAGW_TIME	Out	Calculated AAGW timestamp, for aero products only	8.5.2.10.1
MSG_SHELL_AUTHENTICATION	In	Enable shell authentication	8.5.2.11.1
MSG_DISABLE_SIM_LOCK	In	Disable SIM Lock	8.5.2.11.2
MSG_SHA256_HASH	Out	SHA256 hash	8.5.2.12.1

Table 8-4: Control Interface management messages

8.5.2.2 Message flow

The management protocol uses opcodes to identify the messages and transaction identifiers to identify the individual transactions. The management protocol message format is illustrated below:



Figure 8-5: Management protocol message format

The BGAN XL Radio Module will respond to messages with either an acknowledge or a not-acknowledge message indicating the result of the corresponding operation. This is illustrated in the figure below:

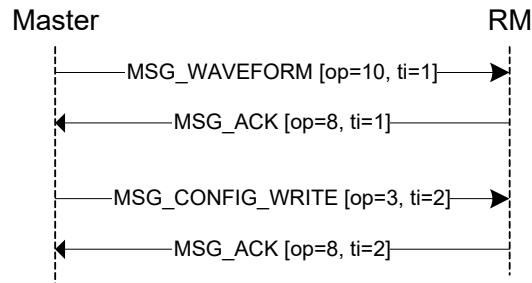


Figure 8-6: Management protocol message format

Each management protocol message received in the RM is executed in sequential order.

The transaction identifier field in the management protocol message can be used to increase the communication rate with the RM. This is illustrated in the figure below.

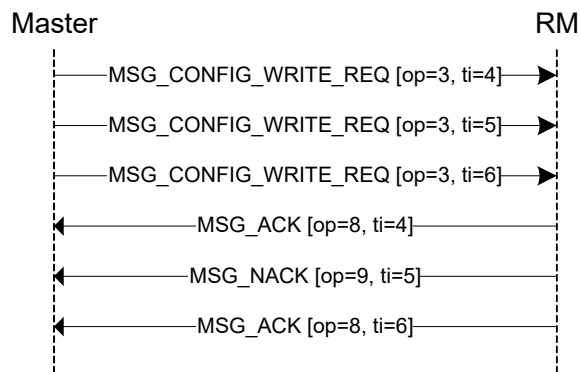


Figure 8-7: Transaction identifiers

In the example above, three `MSG_CONFIG_WRITE_REQ` message are transmitted before any acknowledge is received from the RM. It is up to the master to verify the result of each operation.

8.5.2.3 Error handling

The protocol master must handle both transmission time outs and not-acknowledge messages. If a not-acknowledge message is received, the BGAN XL Radio Module has failed to complete or does not allow the requested operation. The master must take appropriate action depending on the cause code of the not-acknowledge message. If an acknowledge or not-acknowledge is not received within a specified time, the

transmission has failed. In this case the master should try again, which is illustrated below.

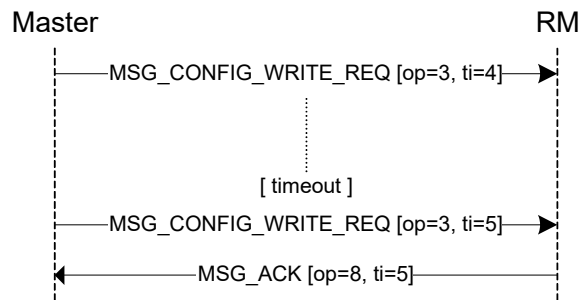


Figure 8-8: Message timeout handling

The timeout period depends on the individual messages and is specified in the message descriptions.

Note If the RM detects transmission errors (crc, framing errors...), it will output Syslog messages which informs of the detected error.

8.5.2.4 Operation management

8.5.2.4.1 MSG_WAVEFORM

Message to control the startup of the modem and waveform protocol as described in 6.1 on page 6-2.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Command	Waveform ID

Table 8-5: MSG_WAVEFORM data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	10	
Transaction ID	U8	1	1	0-255	
Command	U8	1	2	0: Load 1: Activate	
Waveform ID	U8	1	3	0: IAI2 1: BPLT 2: Service 3: BPT	

Table 8-6: MSG_WAVEFORM data fields

Cause code	Description
19	The requested operation is not supported. See Syslog output for further details.
25	The BGAN XL Radio Module could not activate the requested waveform ID. See Syslog output for further details.
28	The BGAN XL Radio Module could not load the requested waveform ID. See Syslog output for further details.

Table 8-7: MSG_WAVEFORM cause codes

Response timeout: 4000 ms.

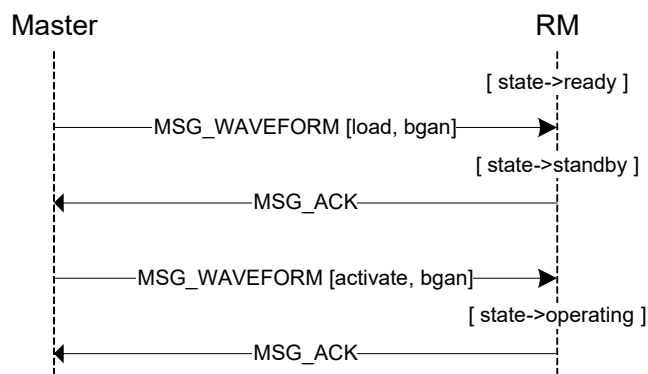


Figure 8-9: Example using MSG_WAVEFORM

See chapter 12 on page 12-1 for examples and general use of MSG_WAVEFORM.

8.5.2.5 Configuration access

8.5.2.5.1 MSG_CONFIG_READ_REQ

Message to read a configuration setting in the BGAN XL Radio Module configuration database.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Type	RecordIdLen
4	Record ID			
....				

Table 8-8: MSG_CONFIG_READ_REQ data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	1	
Transaction ID	U8	1	1	0-255	
Type	U8	1	2	0: Integer 1: String 2: Byte array	Type of record
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)

Table 8-9: MSG_CONFIG_READ_REQ data fields

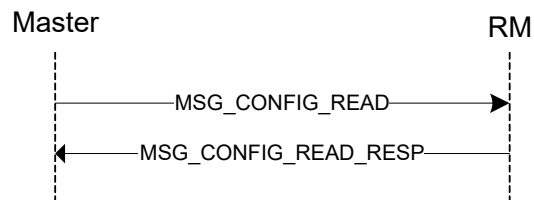


Figure 8-10: Example using MSG_CONFIG_READ

If the MSG_CONFIG_READ results in a successful read request from the configuration database of the BGAN XL Radio Module, the setting data is returned in the MSG_CONFIG_DATA message. The MSG_NACK message is returned if there was an error performing the read request. Cause codes related to MSG_CONFIG_READ are listed below:

Cause code	Description
2	Record not found
3	Wrong record type
23	General error. See Syslog output for details.

Table 8-10: MSG_NACK cause codes returned by a MSG_CONFIG_READ

Response timeout: 2000 ms.

8.5.2.5.2 MSG_CONFIG_READ_RESP

Response to MSG_CONFIG_READ_REQ containing the requested configuration setting.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Type	RecIdLen
4	Record ID			
....				
4+RecIdLen	ValueLen		.....	
....	Value			

Table 8-11: MSG_CONFIG_READ_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	2	
Transaction ID	U8	1	1	0-255	
Type	U8	1	2	0: Integer 1: String 2: Byte array	Type of record
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)
ValueLen	U16	2	4+RecIdLen	0-320	Length of the value field
Value	ARRAY	ValueLen	6+RecIdLen	N/A	Value of the record

Table 8-12: MSG_CONFIG_READ_RESP data fields

See 8.5.2.5.1 for further details.

8.5.2.5.3 MSG_CONFIG_WRITE_REQ

Message to request a write in the BGAN XL Radio Module configuration database.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Type	RecIdLen
4	Record ID			
....				

Table 8-13: MSG_CONFIG_WRITE_REQ data format

offset \ byte	0	1	2	3
4+RecIdLen	ValueLen		....	
....	Value			

Table 8-13: MSG_CONFIG_WRITE_REQ data format (Continued)

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	3	
Transaction ID	U8	1	1	0-255	
Type	U8	1	2	0: Integer 1: String 2: Byte array	Type of record
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)
ValueLen	U16	2	4+RecIdLen	0-320	Length of the value field
Value	ARRAY	ValueLen	6+RecIdLen	N/A	Value of the record

Table 8-14: MSG_CONFIG_WRITE_REQ data fields

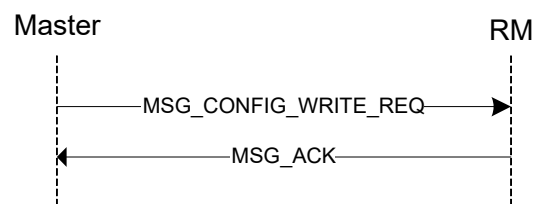


Figure 8-11: Example using MSG_CONFIG_WRITE_REQ

MSG_ACK is returned if the write request is successful, while MSG_NACK is returned if an error occurred.

Cause code	Description
2	Record not found
3	Wrong record type

Table 8-15: MSG_NACK cause codes returned by a MSG_CONFIG_WRITE_REQ

Cause code	Description
6	Write prohibited (read only record)
23	General error. See Syslog output for details.

Table 8-15: MSG_NACK cause codes returned by a MSG_CONFIG_WRITE_REQ

Response timeout: 2000 ms

8.5.2.5.4 MSG_CONFIG_NOTIFY_REQ

Message to request notifications for a given setting or setting group.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Reserved	RecordIdLen
4	Record ID			
....				

Table 8-16: MSG_CONFIG_NOTIFY_REQ data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	4	
Transaction ID	U8	1	1	0-255	
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)

Table 8-17: MSG_CONFIG_NOTIFY_REQ data fields

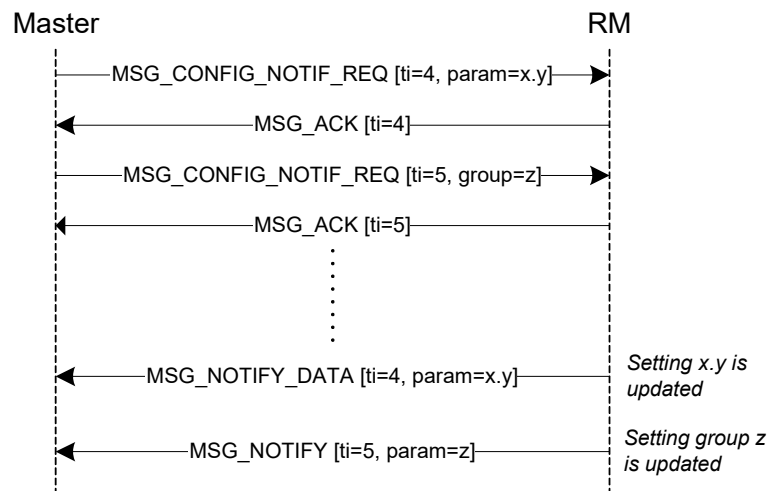


Figure 8-12: Example using MSG_CONFIG_NOTIF_REQ

The BGAN XL Radio Module responds with MSG_ACK when a MSG_CONFIG_NOTIF_REQ is accepted. If the notification request is not accepted the RM responds with MSG_NACK.

Cause code	Description
2	Record not found
23	General error. See Syslog output for details.

Table 8-18: MSG_NACK cause codes returned by a MSG_CONFIG_NOTIF_REQ

Response timeout: 2000ms

8.5.2.5.5 MSG_CONFIG_NOTIFY

Message sent when a record in a registered record group has been changed.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Reserved	RecordIdLen
4	Record ID			
....				

Table 8-19: MSG_CONFIG_NOTIFY data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	5	
Transaction ID	U8	1	1	0-255	
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)

Table 8-20: MSG_CONFIG_NOTIFY data fields

See 8.5.2.5.4 for further details.

8.5.2.5.6 MSG_CONFIG_NOTIFY_DATA

Message sent when a registered record is changed.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Type	RecIdLen
4	Record ID			
....				
4+RecIdLen	ValueLen		.....	
....	Value			

Table 8-21: MSG_CONFIG_NOTIFY_DATA data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	6	
Transaction ID	U8	1	1	0-255	
Type	U8	1	2	0: Integer 1: String	Type of record
RecIdLen	U8	1	3	0-128	Length of 'Record ID' field
Record ID	ARRAY	RecIdLen	4	N/A	Record identification in the format n.n.n.n (ASCII characters)
ValueLen	U16	2	4+RecIdLen	0-320	Length of the value field
Value	ARRAY	ValueLen	6+RecIdLen	N/A	Value of the record

Table 8-22: MSG_CONFIG_NOTIFY_DATA data fields

See 8.5.2.5.4 for further details.

8.5.2.6 Event reporting

8.5.2.6.1 MSG_USER_EVENT (FOR INTERNAL USE)

Message to report a user event to the BGAN XL Radio Module.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Event ID	
4	Unit ID		Sub ID	
8	Change		Info	

Table 8-23: MSG_USER_EVENT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	7	
Transaction ID	U8	1	1	0-255	
Event ID	U16	2	2	see 7.7.2.1 on page 7-34.	The id is a part of the event identification. The identifier must refer to an event definition previously registered in the event handler.
Unit ID	U16	2	4	see 7.7.2.1 on page 7-34.	Identifies which unit (HW) the event is sent from. e.g. ADU
Sub ID	U16	2	6	see 7.7.2.1 on page 7-34.	The Sub ID is a part of the event identification. The Sub ID must be used to separate multiple sources of the same event.
Change	U16	2	8	see 7.7.2.1 on page 7-34.	Specifies the event change as the current state value. Repeated state values (either EV_STATE_ON or EV_STATE_OFF) will be ignored.
Info	U16	2	10	N/A	The info parameter may be used to carry additional information about the event

Table 8-24: MSG_USER_EVENT data fields

MSG_USER_EVENT messages are acknowledged using MSG_ACK when accepted by the BGAN XL Radio Module.

Response timeout: 2000ms

8.5.2.6.2 MSG_SYSLOG

Message to report a Syslog message to the BGAN XL Radio Module which will get forwarded to the data interface.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Timestamp [s]	
4	.....		Timestamp [ms]	
8	Priority		Sequence	
12	DataLen		Data	
...				

Table 8-25: MSG_SYSLOG data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	15	
Transaction ID	U8	1	1	0-255	
Timestamp [s]	U32	4	2	any	Timestamp in seconds
Timestamp [ms]	U16	2	6	any	Milliseconds part of timestamp
Priority	U16	2	8	0: Emergency 1: Alert 2: Critical 3: Error 4: Warning 5: Notice 6: Info 7: Debug	Syslog priority levels System is unusable Action must be taken immediately Critical conditions Error conditions Warning conditions Normal but significant condition Information Debug-level messages
Sequence	U16	2	10	any	Sequence number
DataLen	U16	2	12	0-100	Length of the data field
Data	ARRAY	DataLen	14	N/A	Syslog data message

Table 8-26: MSG_SYSLOG data fields

MSG_SYSLOG messages are acknowledged with MSG_ACK when accepted by the BGAN XL Radio Module.

Cause code	Description
32	Syslog data length too large

Table 8-27: MSG_NACK cause code returned by a MSG_SYSLOG

Response timeout: 2000ms

8.5.2.7 File transfer (FOR INTERNAL USE)

The BGAN XL Radio Module can store product specific files uploaded via the data interface and provides a protocol for reading those files via the control interface. The protocol for reading files from the RM is similar to the standard TFTP protocol (RFC 1350 [12]).

The following properties are defined in the transfer protocol:

- Data block size of 500 bytes.
- File transfer is complete when a data block of less than 500 bytes is received. If the last block size equals 500 bytes, a block of size 0 will signal transfer complete.
- No timeout detection/handling in the RM.
- Only one transfer session at a time.
- A MSG_NACK is returned if the filename was not found in the RM.

The transfer message flow is illustrated below:

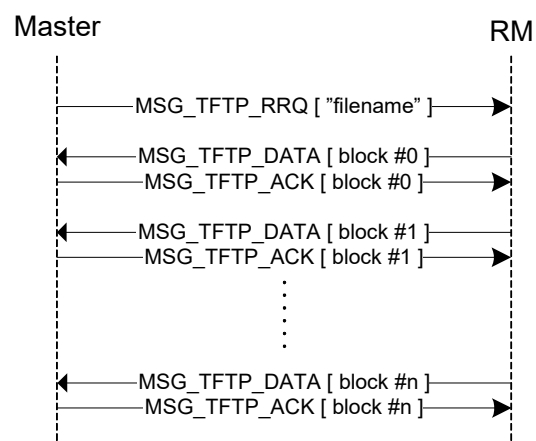


Figure 8-13: File read message flow

It is up to the integrator to implement timeout handling and block number verification.
A data block timeout scenario is illustrated below:

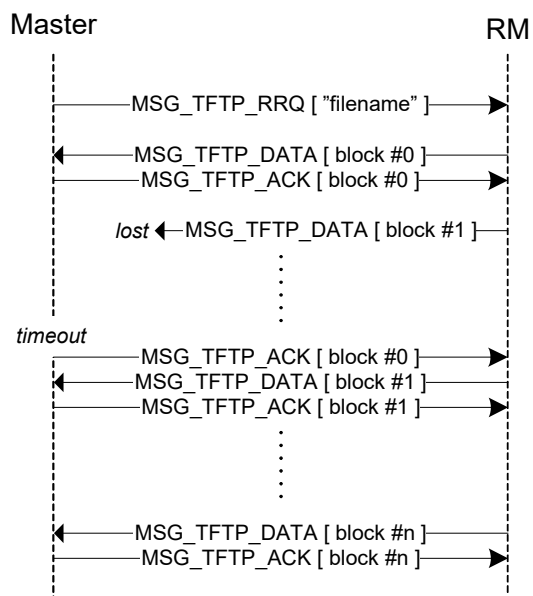


Figure 8-14: Data block timeout handling example

Response timeout: 2000 ms

The messages used for file transfer are defined in the coming subsections.

8.5.2.7.1 MSG_TFTP_RRQ (FOR INTERNAL USE)

Message used to request a file read from the BGAN XL Radio Module.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	FilenameLen	Filename
....				

Table 8-28: MSG_TFTP_RRQ data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	11	
Transaction ID	U8	1	1	0-255	
FilenameLen	U8	1	2	0-255	Length of the filename data field
Filename	ARRAY	FilenameLen	4	N/A	Name of the file to read

Table 8-29: MSG_TFTP_RRQ data fields

8.5.2.7.2 MSG_TFTP_DATA (FOR INTERNAL USE)

Message containing file data.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Block number	
4	Data			
....				

Table 8-30: MSG_TFTP_DATA data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	12	
Transaction ID	U8	1	1	0-255	
Block number	U16	2	2	any	Block number of the current data block
Data	ARRAY	0-500	4	N/A	Data block

Table 8-31: MSG_TFTP_DATA data fields

See 8.5.2.7 for more information.

8.5.2.7.3 MSG_TFTP_ACK (FOR INTERNAL USE)

Message to acknowledge a TFTP data block.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Block number	

Table 8-32: MSG_TFTP_ACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	13	
Transaction ID	U8	1	1	0-255	
Block number	U16	2	2	any	Block number of the acknowledged data block

Table 8-33: MSG_TFTP_ACK data fields

See 8.5.2.7 for more information.

Response timeout: 2000 ms

8.5.2.8 Power management

The following subsections define the messages used to control the power management of the BGAN XL Radio Module.

8.5.2.8.1 MSG_SUSPEND_REQ

Message to set the BGAN XL Radio Module in suspend mode.

See also section 11.5.2 on page 11-13 for further description of suspend mode and limitations when using it with **SDM sleep**.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Time [ms]	

Table 8-34: MSG_SUSPEND_REQ data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	17	
Transaction ID	U8	1	1	0-255	

Table 8-35: MSG_SUSPEND_REQ data fields

8.5.2.8.2 MSG_SUSPEND_ABORT

Message to exit suspend mode.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-36: MSG_SUSPEND_ABORT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	18	
Transaction ID	U8	1	1	0-255	

Table 8-37: MSG_SUSPEND_ABORT data fields

8.5.2.8.3 MSG_POWERDOWN

Message to inform the BGAN XL Radio Module that it will be powered down. When the system is going to be powered down the MSG_POWERDOWN must be sent to the RM. This allows the internal protocols and configuration system to shut down properly.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-38: MSG_POWERDOWN data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	16	
Transaction ID	U8	1	1	0-255	

Table 8-39: MSG_POWERDOWN data fields

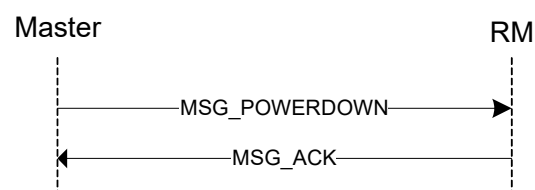


Figure 8-15: Power down message flow

Response timeout: 6000 ms.

8.5.2.8.4 MSG_REBOOT

Message to inform the BGAN XL Radio Module that it will be rebooted. When the system has decided to reboot/restart the RM the MSG_REBOOT must be sent. This allows the internal protocols and configuration system to shut down properly.

offset \ byte	0	1	2
0	Opcode	Transaction ID	Reboot Cause

Table 8-40: MSG_REBOOT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	19	
Transaction ID	U8	1	1	0-255	
Reboot Cause	U8	1	2	0: Normal 1: SW Download	Reboot Cause Code

Table 8-41: MSG_REBOOT data fields

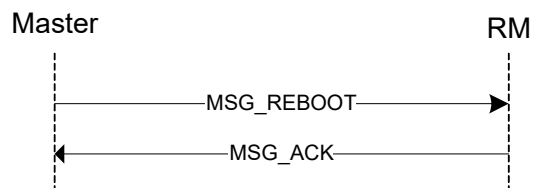


Figure 8-16: Prepare for reboot message flow

Response timeout: 6000 ms

8.5.2.8.5 MSG_RESET_REQ

Message to request the control interface master to reset the BGAN XL Radio Module. The RM can request the control interface master to reset/reboot the RM using this message. If the RM has not been rebooted within 4000 milliseconds, it will reboot itself.

offset \ byte	0	1	2
0	Opcode	Transaction ID	Reset Cause

Table 8-42: MSG_RESET data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	20	
Transaction ID	U8	1	1	0	Always value 0
Reset Cause	U8	1	2	0: Normal	Reset Cause Code

Table 8-43: MSG_RESET_REQ data fields

8.5.2.9 General messages

8.5.2.9.1 MSG_ACK

Message to acknowledge a received message in the BGAN XL Radio Module.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-44: MSG_ACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	8	

Table 8-45: MSG_ACK data fields

Data field	Type	Length	Offset	Value	Comment
Transaction ID	U8	1	1	0-255	

Table 8-45: MSG_ACK data fields

The transaction identifier has the same value as the message being acknowledged.

8.5.2.9.2 MSG_NACK

Message to indicate that a message received in the BGAN XL Radio Module could not be acknowledged due to some error.

offset \ byte	0	1	2
0	Opcode	Transaction ID	Cause Code

Table 8-46: MSG_NACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	9	
Transaction ID	U8	1	1	0-255	
Cause code	U8	1	2	See table below	Cause Code

Table 8-47: MSG_NACK data fields

Cause code	Description
2	Record not found
3	Wrong record type
6	Write prohibited
19	The request operation is not supported
23	General error (see syslog for further details)
25	The BGAN XL Radio Module could not activate the requested waveform ID
28	The BGAN XL Radio Module could not load the requested waveform ID
32	Syslog data length too large

Table 8-48: MSG_NACK cause codes

8.5.2.10 Aero-specific management

The following sections describe messages which are used only in aeronautical terminals (see Table 3-4 for an overview of aeronautical BGAN classes).

8.5.2.10.1 MSG_AAGW_TIME

The calculation of the AAGW timestamp is described in the SDM (v3c3) [18]. Every time the BGAN XL Radio Module receives UTC time or Leap Second from the RAN (provided that both UTC and Leap Second has been received at least once), it will calculate the precise AAGW timestamp and transmit this message.

Transmission of MSG_AAGW_TIME is disabled by default, see section 6.6.10 on page 6-32 for the configuration parameter that enables this feature.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Year	
4	Month	Day	Hour	Minute
8	Second	Millisecond		

Table 8-49: MSG_AAGW_TIME data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	23	
Transaction ID	U8	1	1	0-255	
Year	U16	2	2		Current year in the format yyyy
Month	U8	1	4	0-11	Months since January
Day	U8	1	5	1-31	Day of the month
Hour	U8	1	6	0-23	Hours since midnight
Minute	U8	1	7	0-59	Minutes after the hour
Second	U8	1	8	0-59	Seconds after the minute
Millisecond	U16	2	9	0-999	Milliseconds after the second

Table 8-50: MSG_AAGW_TIME data fields

8.5.2.11 Security management (FOR INTERNAL USE)

8.5.2.11.1 MSG_SHELL_AUTHENTICATION (FOR INTERNAL USE)

Message to request the BGAN XL Radio Module to enable authentication on the shell interfaces. When enabled, telnet access to DSP shell is denied and root login is required to login to CPU telnet shell.

Shell authentication can only be disabled by rebooting the RM.

When a production SIM card is inserted, shell authentication is automatically disabled until the card is removed.

offset \ byte	0	1	2
0	Opcode	Transaction ID	AuthEnable

Table 8-51: MSG_SHELL_AUTHENTICATION data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	24	
Transaction ID	U8	1	1	0-255	
AuthEnable	U8	1	2	1: Enable shell authentication	

Table 8-52: MSG_SHELL_AUTHENTICATION data fields

8.5.2.11.2 MSG_DISABLE_SIM_LOCK (FOR INTERNAL USE)

Message to request the BGAN XL Radio Module to disable SIM Lock and thereby ignoring the SIM Lock settings set in section 11.13.2 on page 11-43.

This message is only intended for one specific project and should generally not be used.

This message must be sent to RM before **platform.usim.status** is set to 1 the first time after boot.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-53: MSG_DISABLE_SIM_LOCK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	25	
Transaction ID	U8	1	1	0-255	

Table 8-54: MSG_DISABLE_SIM_LOCK data fields

8.5.2.12 Bootloader security

8.5.2.12.1 MSG_SHA256_HASH

RM bootloader v1.08 and newer will send a message control interface with a SHA256 hash of the application image before it loads the image.

offset \ byte	0	1		
0	Opcode	Transaction ID	Len	Hash
....				
....				
32	....			

Table 8-55: MSG_SHA256_HASH data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	32	
Transaction ID	U8	1	1	0-255	
Len	U8	1	2	32	Length of Hash
Hash	Array	32	3		32 hex digit SHA256 Hash

Table 8-56: MSG_SHA256_HASH data fields

8.5.3 USIM

The USIM protocol defines a generic interface using APDUs (Application Protocol Data Units) as specified in ISO 7816-4. The interface provides an abstraction layer such that the BGAN XL Radio Module does not require any knowledge of the USIM hardware setup.

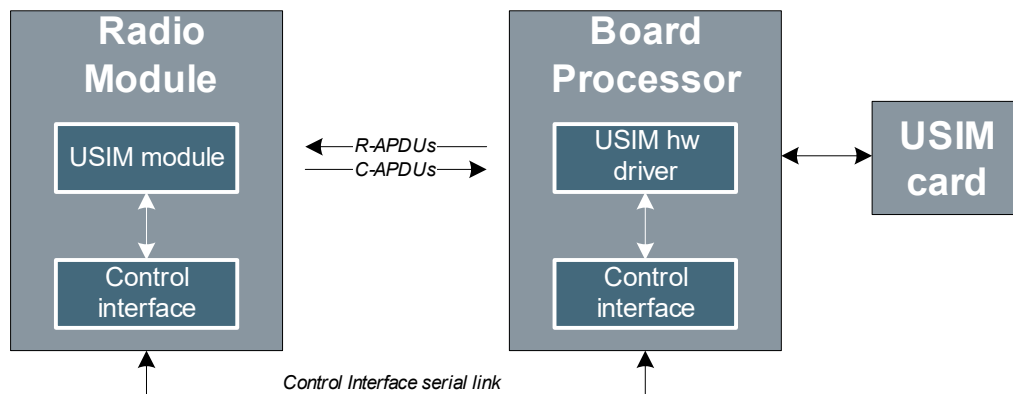


Figure 8-17: Typical USIM setup

The flow of messages between the USIM HW driver and the USIM module are ISO 7816 APDUs. The APDU is an application level protocol as specified in the ISO 7816-4, which takes place between the USIM card (connected to the BP) and a host application (implemented in the RM).

There are two categories of APDUs:

- C-APDU, Command APDU sent from the USIM module to the USIM card
- R-APDU, Response APDU sent from the USIM card to the USIM module in the RM as a response to a C-APDU.

The Board Processor must inform the RM when the USIM card is inserted and ready to receive C-APDUs, or when the USIM card is disconnected. This is done using the **platform.usim.status** parameter as illustrated below.

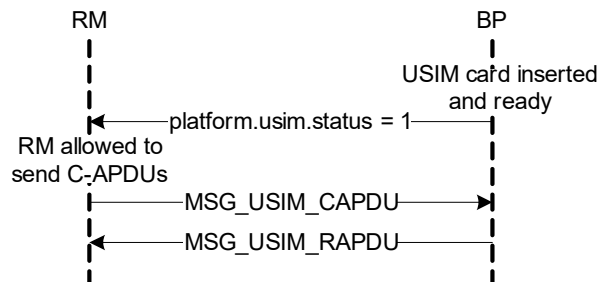


Figure 8-18: Typical USIM flow

8.5.3.1 MSG_USIM_CAPDU

Command Application Protocol Data Unit (ISO/IEC 7816-4 5.3). This packed structure covers the four cases of ISO/IEC 7816-4 C-APDU format. The C-APDU contains a mandatory header of 4 bytes (CLA, INS, P1, P2) and a body with variable length. The data length of the C-APDU body is coded into the body itself and depends on which of the four cases the C-APDU represents.

Message direction: RM->BP

offset \ byte	0	1	2	3
0	C-APDU (up to 512 bytes)			
....				
508	.....			

Table 8-57: MSG_USIM_CAPDU data format

Data field	Type	Length	Offset	Comment
C-APDU	ARRAY	0 - 512	0	ISO/IEC 7816-4 5.3

Table 8-58: MSG_USIM_CAPDU data fields

The Radio Module expects an R-APDU answer within 6000ms.

Note The BGAN XL Radio Module uses relative file access in the USIM card in order to optimise file access response time. So it is important to respect the flow of C-APDU and R-APDUs and make sure that the USIM card is properly reset when setting **platform.usim.status** to 1.

8.5.3.2 MSG_USIM_RAPDU

Response Application Protocol Data Unit (ISO/IEC 7816-4 5.3). This packet structure represents the response APDU. The R-APDU contains a conditional body with variable length and a mandatory header of 2 bytes (SW1, SW2). The data length of the R-APDU body is coded into the C-APDU body as specified in ISO/IEC 7816-4 5.3. The R-APDU is sent as a response to a C-APDU sent from the RM.

Message direction: BP->RM

offset \ byte	0	1	2	3
0	R-APDU (up to 512 bytes)			
....				
508	.....			

Table 8-59: MSG_USIM_RAPDU data format

Data field	Type	Length	Offset	Comment
R-APDU	ARRAY	0 - 512	0	ISO/IEC 7816-4 5.3

Table 8-60: MSG_USIM_RAPDU data fields

8.5.4 Navigation protocol

The navigation protocol specifies how to transfer positioning data to the BGAN XL Radio Module.

8.5.4.1 Overview

The navigation protocol is an acknowledgement base protocol which consists of the three messages listed below:

Message	Direction	Summary	Reference
MSG_NAV_REPORT	In	Positioning information message	8.5.4.2
MSG_NAV_ACK	Out	Acknowledgement of MSG_NAV_REPORT	8.5.4.4
MSG_NAV_NACK	Out	Not-acknowledgement of MSG_NAV_REPORT	8.5.4.3

Table 8-61: Control Interface debug shell protocol message

The navigation protocol uses opcodes to identify the messages and transaction identifiers to identify the individual transactions. The navigation protocol message format is illustrated below:



Figure 8-19: Navigation protocol message format

The message flow is illustrated below:

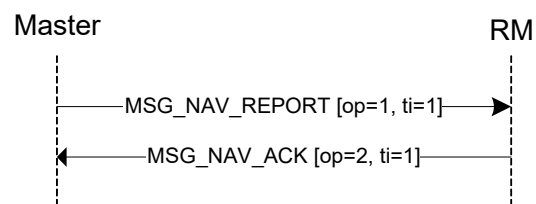


Figure 8-20: Navigation protocol message flow example

8.5.4.2 MSG_NAV_REPORT

Navigation report containing positioning data to the BGAN XL Radio Module. The navigation report must be sent as soon as possible to the BGAN XL Radio Module. The update frequency of the position information depends on the system (static or moving terminal).

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Fix type	Origin of fix
4	UTC time in seconds			
8	Latitude			
12	Longitude			
16	Altitude			
20	Velocity ECEF x			
24	Velocity ECEF y			
28	Velocity ECEF z			
32	Number of satellites			
36	HDOP			

Table 8-62: MSG_NAV_REPORT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	4	0	4	
Transaction ID	U8	1	1	0-255	
Fix type	U8	1	2	0-3	0: No fix 1: Dead reckoning 2: 2D fix 3: 3D fix
Origin of fix	U8	1	3	0-3	0: Manual 1: GPS 2: Glonass: 3: Galileo 4: BeiDou 5: Multi 6: IRS
UTC time (sec)	U32	4	4		Seconds since 01-01-1970 00:00:00
Latitude	S32	4	8		Latitude in degrees (1e7) (ie 551234567 specifies 55,1234567 degrees N)

Table 8-63: MSG_NAV_REPORT data fields

Data field	Type	Length	Offset	Value	Comment
Longitude	S32	4	12		Longitude in degrees (1e7) (ie 121234567 specifies 12,1234567 degrees E)
Altitude	S32	4	16		Altitude in mm
Velocity ECEF x	S32	4	20		Velocity in ECEF (Earth-Centered, Earth-Fixed) coordinate system. X direction in m/s
Velocity ECEF y	S32	4	24		Velocity in ECEF y direction in m/s
Velocity ECEF z	S32	4	28		Velocity in ECEF z direction in m/s
Satellites	S32	4	32		Number of satellites used in calculating position data
HDOP	U16	2	36		Horizontal dilution of precision scaling 0.01

Table 8-63: MSG_NAV_REPORT data fields (Continued)

Important

When used on a system with Doppler correction, the following rules apply:

- The velocity vector must be delivered to the RM at least once every second.
- If the velocity vector is more than approx. 100 ms old when delivered to the RM, the integrator must extrapolate the velocity vector to current time.

8.5.4.3 MSG_NAV_NACK

This is the not-acknowledge message in the navigation protocol and is sent as a response for the MSG_NAV_REPORT if an error occurred.

offset \ byte	0	1	2
0	Opcode	Transaction ID	Cause Code

Table 8-64: MSG_NAV_NACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	3	

Table 8-65: MSG_NAV_NACK data fields

Data field	Type	Length	Offset	Value	Comment
Transaction ID	U8	1	1	0-255	
Cause Code	U8	1	2	3-4	

Table 8-65: MSG_NAV_NACK data fields

Cause code	Description
3	Unknown opcode
4	Message length mismatch

Table 8-66: MSG_NAV_NACK cause codes

8.5.4.4 MSG_NAV_ACK

Message response when the BGAN XL Radio Module has accepted the MSG_NAV_REPORT.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-67: MSG_NAV_ACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	2	
Transaction ID	U8	1	1	0-255	

Table 8-68: MSG_NAV_ACK data fields

8.5.5 Antenna pointing protocol

The antenna pointing protocol implements an interface enabling an integrator to direct the search for a global BGAN channel in a way suited to the selected antenna type. The pointing flow offers great flexibility which enables support for the most commonly used antenna types:

- Fixed antennas
- Manual pointed antennas
- Mechanical pointed antennas (with or without power detector)
- Phased array antennas
- Omnidirectional antennas

It is the responsibility of the integrator of the BGAN XL Radio Module to design an antenna pointing algorithm which matches the antenna and can accommodate requirements such as reliable pointing, fast channel acquisition and meaningful GUI information.

A use case illustrating a simplified pointing procedure can be found in section 12.3.1 on page 12-6.

8.5.5.1 Message overview

The protocol messages related to antenna pointing are listed in the following table.

Message	Direction	Summary	Reference
MSG_BGAN_SKYSCAN_ALLOWED	In	Allowing sky-scan in the BGAN XL Radio Module.	8.5.5.4
MSG_BGAN_SKYSCAN_ALLOWED_RESP	Out	First response to MSG_BGAN_SKYSCAN_ALLOWED. Information about accept or reject of MSG_BGAN_SKYSCAN_ALLOWED	8.5.5.5
MSG_BGAN_START_SKYSCAN	Out	Response to a MSG_BGAN_SKYSCAN_ALLOWED or MSG_BGAN_SKYSCAN_RESTART. This second response is only received in case MSG_BGAN_SKYSCAN_ALLOWED or MSG_BGAN_SKYSCAN_RESTART was accepted. Also reissued later after a MSG_BGAN_SKYSCAN_RESULT is received	8.5.5.6
MSG_BGAN_SKYSCAN_RESULT	In	Information about the sky-scan results	8.5.5.7
MSG_BGAN_SKYSCAN_RESULT_RESP	Out	Information about accept or reject of MSG_BGAN_SKYSCAN_RESULT.	8.5.5.8
MSG_BGAN_CHECK_POWER	In	Request a channel power measurement	8.5.5.9
MSG_BGAN_CHECK_POWER_RESP	Out	Response to a MSG_BGAN_CHECK_POWER	8.5.5.10
MSG_BGAN_CHECK_WAVEFORM	In	Request a check of a potential BGAN channel	8.5.5.11
MSG_BGAN_CHECK_WAVEFORM_RESP	Out	Response to a MSG_BGAN_CHECK_WAVEFORM	8.5.5.12

Table 8-69: Control Interface global waveform search messages

Message	Direction	Summary	Reference
MSG_BGAN_SKYSCAN_RESTART	In	If the command is accepted then it will result in a restart of the satellite search with a new MSG_BGAN_START_SKYSCAN	8.5.5.13
MSG_BGAN_SKYSCAN_RESTART_RESP	Out	Information about accept or reject of MSG_BGAN_SKYSCAN_RESTART	8.5.5.14
MSG_BGAN_WAVEFORM_CNO	Out	Information about the signal quality.	8.5.5.15

Table 8-69: Control Interface global waveform search messages (Continued)

8.5.5.2 Satellite table

The master satellite table of a BGAN terminal is owned and maintained by the IAI2 software module which is located inside the BGAN XL Radio Module. The satellite table starts with a set of fixed default values (defined in the SDM) which are set during production and after reset to factory default. This table is then updated when new information is received from the BGAN network via the satellite earth station. The master satellite table contains information about satellite ID, satellite longitude, primary frequency and alternate frequency of the transmitted global beam.

The satellite search module in the RM will calculate which satellites are visible from the master satellite table information and the terminal position. A pointing elevation above the horizon will also be calculated for each satellite. The satellite table will be sorted after elevation and likelihood of success. The message **MSG_BGAN_START_SKYSCAN** will contain information about frequency (channel number) satellite longitude and calculated elevation for 1 to 16 frequencies.

For the first issue of the message the RM will return information on the best-choice satellite (typical 1 or 2 frequencies). On the next issue it will return information on all satellites with positive pointing elevation, whereas the complete table will be distributed the third time. The number of frequencies can be 0.

The figure below illustrates the message flow.

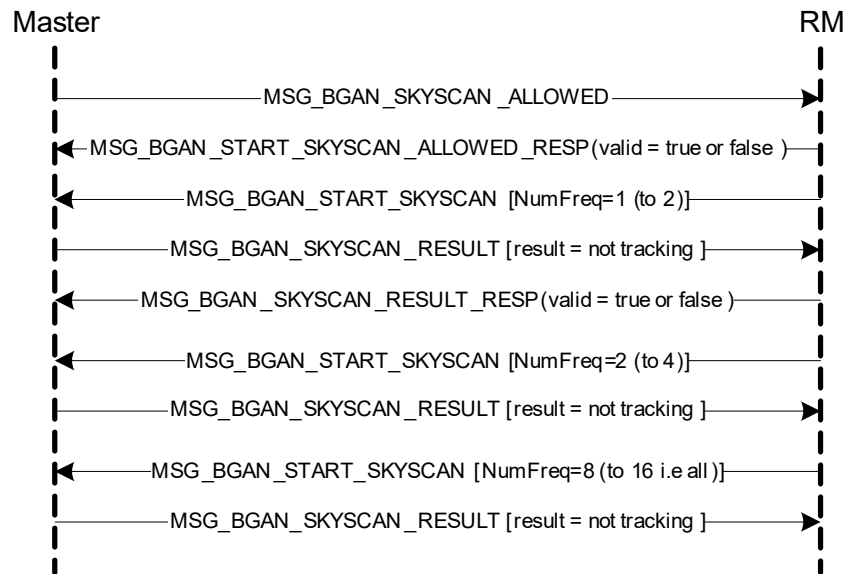


Figure 8-21: Fetching the satellite table

8.5.5.3 State transition machine

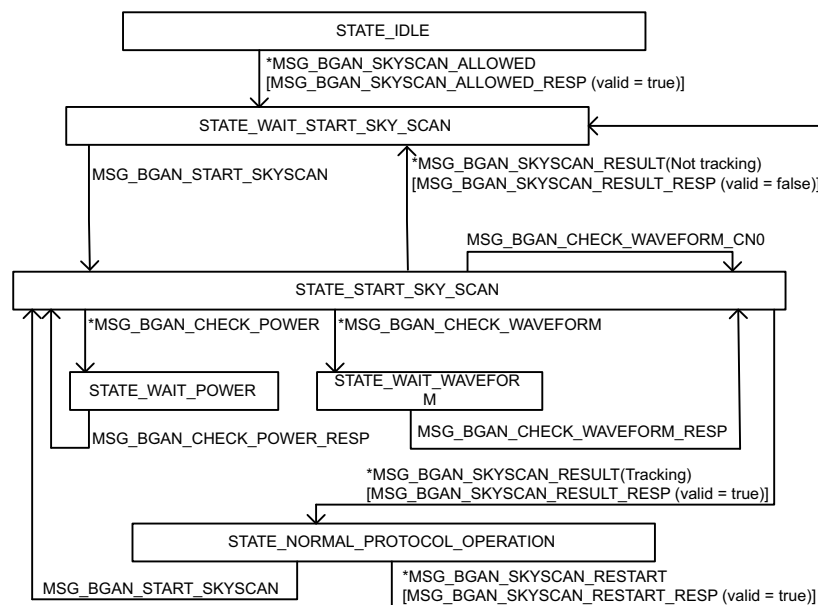


Figure 8-22: State transition machine

An * before a message indicates an input message to the RM.

[] around an output message indicates an accept response to the associated input message.

All input messages not received in the indicated states are rejected. Despite an input message is rejected the RM sends the expected response message, but valid field = false and the associated state shift is not executed. In case the response message contains measurement result fields, these fields are not valid.

8.5.5.3.1 State enumeration

Several response messages contain a state field. These fields have the following values:

0. STATE_IDLE
1. STATE_WAIT_START_SKYSCAN
2. START_SKY_SCAN
3. STATE_WAIT_POWER
4. STATE_WAIT_WAVEFORM
5. STATE_NORMAL_OPERATION

8.5.5.3.2 Reject cause enumeration

Several response messages contain a reject_cause field. These fields have the following values:

0. RM not ready
1. High power amplifier not ready
2. No signal found on RF link
3. State illegal. State field indicate the illegal state
4. Not rejected
5. CRC failed, signal found but signal strength too weak.

8.5.5.4 MSG_BGAN_SKYSCAN_ALLOWED

This message is sent to the BGAN XL Radio Module to inform that sky-scan is allowed.

offset \ byte	0
0	Opcode

Table 8-70: MSG_BGAN_SKYSCAN_ALLOWED data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	1	

Table 8-71: MSG_BGAN_SKYSCAN_ALLOWED data fields

8.5.5.5 MSG_BGAN_SKYSCAN_ALLOWED_RESP

The message is sent from the RM to inform about execution of the input message MSG_BGAN_SKYSCAN_ALLOWED.

offset \ byte	0	1	2	3
0	Opcode	Valid	State	Reject cause

Table 8-72: MSG_BGAN_SKYSCAN_ALLOWED_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	2	
Valid	U8	1	1	0-1	0: MSG_BGAN_SKYSCAN_ALLOWED not executed 1: MSG_BGAN_SKYSCAN_ALLOWED executed.
State	U8	1	2	See section 8.5.5.3.1 on page 8-40.	
Reject cause	U8	1	3	See section 8.5.5.3.2 on page 8-40.	

Table 8-73: MSG_BGAN_SKYSCAN_ALLOWED_RESP data fields

8.5.5.6 MSG_BGAN_START_SKYSCAN

This message is sent from the BGAN XL Radio Module to inform that the module is ready and that the sky-scan procedure shall be initiated. The message is used both for initial sky-scan and for situations where the signal is lost and a new sky-scan must be performed.

Note The BGAN XL Radio Module will not send this message until it has received a GPS position. See section 8.5.4.2 on page 8-33.

offset \ byte	0	1	2	3
0	Opcode	Scan Type	Cause Code	NumFreq
4	Satellite Frequencies (Channel numbers)		....	
....				

Table 8-74: MSG_BGAN_START_SKYSCAN data format

offset \ byte	0	1	2	3
36	Elevation		....	
....				
68	Longitude		....	
....				

Table 8-74: MSG_BGAN_START_SKYSCAN data format (Continued)

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	3	
Scan Type	U8	1	1	0-1	0: Full scan 1: Fixed scan
Cause Code	U8	1	2	0-4	Cause code for sky scan 0: Initial sky scan 1: Retry sky scan 2: Signal lost 3: Transmission failure 4: User action
NumFreq	U8	1	3	0-16	Number of slots used in each of the Satellite Frequencies, Elevation and Longitude arrays
Satellite Frequencies	ARRAY, U16	32	4		Array of frequencies (in SDM channel numbers) to scan. 16 entries.
Elevation	ARRAY, S16	32	36		Array of elevation to satellite in degrees. 16 entries.
Longitude	ARRAY, S16	32	68		Array of longitude of satellite in 0.1 degrees. 16 entries.

Table 8-75: MSG_BGAN_START_SKYSCAN data fields

8.5.5.7 MSG_BGAN_SKYSCAN_RESULT

This message informs the BGAN XL Radio Module about the sky-scan results. The result may be either successful (tracking) or unsuccessful (not tracking). In case of a **successful** result the BGAN XL Radio Module will leave sky-scan mode and initiate

normal protocol operation. An **unsuccessful** result will force a new MSG_BGAN_START_SKYSCAN message to be issued with more global frequencies than the last message (if possible).

offset \ byte	0	1	2	3
0	Opcode	Result	Frequency	

Table 8-76: MSG_BGAN_SKYSCAN_RESULT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	4	
Result	U8	1	1	0-1	0: Tracking 1: Not tracking
Frequency	U16	2	2		If the result is tracking this is the satellite frequency in SDM channel number.

Table 8-77: MSG_BGAN_SKYSCAN_RESULT data fields

8.5.5.8 MSG_BGAN_SKYSCAN_RESULT_RESP

This message is sent from the RM to inform about the execution of the input message MSG_BGAN_SKYSCAN_RESULT.

offset \ byte	0	1	2	3
0	Opcode	Valid	Reject cause	State

Table 8-78: MSG_BGAN_SKYSCAN_RESULT_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	5	
Valid	U8	1	1	0-1	0: MSG_BGAN_SKYSCAN_RESULT not executed 1: MSG_BGAN_SKYSCAN_RESULT executed
Reject cause	U8	1	2	See section 8.5.5.3.2 on page 8-40.	
State	U8	1	3	See section 8.5.5.3.1 on page 8-40.	

Table 8-79: MSG_BGAN_SKYSCAN_RESULT_RESP data fields

8.5.5.9 MSG_BGAN_CHECK_POWER

Message to request the BGAN XL Radio Module to start a power check (i.e. measure the channel power) on one or more frequencies.

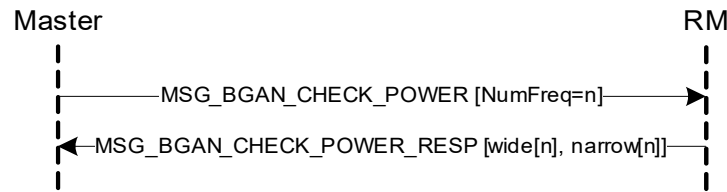


Figure 8-23: Check power message flow

offset \ byte	0	1	2	3
0	Opcode	NumFreq	Frequencies	
....				
32	....			

Table 8-80: MSG_BGAN_CHECK_POWER data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	11	
NumFreqs	U8	1	1	1-16	Number of slots used in Frequencies array.
Frequencies	ARRAY, U16	32	2		List of frequencies in SDM channel numbers. 16 entries.

Table 8-81: MSG_BGAN_CHECK_POWER data fields

When the RM is instructed to perform a **MSG_BGAN_CHECK_POWER**, the following procedure will be initiated:

1. First the receiver is tuned to the first specified SDM channel number. Legal channel numbers are received in **MSG_BGAN_START_SKYSCAN**.
2. After a settling period of 6 ms the RM initiates an estimation of the channel power. Two channel power estimates are calculated; the wide estimate is calculated in a 36 kHz bandwidth and the narrow estimate is calculated in a 14 kHz bandwidth.
3. After approximately 30 ms the RM will have estimated the channel power in a narrow and a wide bandwidth.
4. Steps 1 and 2 are repeated until the channel power of all the requested frequencies has been estimated.
5. When this request is carried out the power estimates are returned with the response: **MSG_BGAN_CHECK_POWER_RESP**.

The BGAN XL Radio Module both delivers a wide and a narrow power estimate in which the filter bandwidths can be configured independently (see more in section 6.8.8 on page 6-52). The wide power estimate is in general calculated in a 36 kHz bandwidth and the narrow power estimate is calculated in a 14 kHz bandwidth as illustrated in the right section of Figure 8-24.

The key parameters for determination of the narrow bandwidth are listed in the table below.

Parameters	Value
Global beam bearer type	F80T025Q1B
Symbol rate (f_{symb})	8400 symbols/sec
Roll-off factor	0.25
Maximum system frequency offset (f_{offset})	1400 Hz
Frequency doppler uncertainty (f_{doppler})	350 Hz
Minimum pass-band ($f_{\text{symb}} * 1.25/2 + f_{\text{offset}} + f_{\text{doppler}}$)	6125 Hz

Table 8-82: Narrow band filter specifications.

In a worst-case pointing scenario the long term stability of the built-in reference oscillator could mis-align the global bearer with up +/- 7 ppm. This is illustrated in the left part of the figure below. If the global bearer is misaligned a large percentage of the energy from the wanted bearer will be removed by the narrow band filter making the power estimate more or less useless and it complicates the pointing significantly. To accommodate for this problem another power estimate is calculated with a wider bandwidth. The key parameters for the wide bandwidth are:

Parameters	Value
Global beam bearer type	F80T025Q1B
Symbol rate (f_{symb})	8400 symbols/sec
Roll-off factor	0.25
Maximum system frequency offset (f_{offset})	1400 Hz
Frequency doppler uncertainty (f_{doppler})	350 Hz
Reference oscillator stability ~7ppm (f_{lts})	11000 Hz
Minimum pass-band ($f_{\text{symb}} * 1.25/2 + f_{\text{offset}} + f_{\text{doppler}} + f_{\text{lts}}$)	11625 Hz

Table 8-83: Wide band filter specifications.

The characteristics of the wide (36 kHz) and narrow (14 kHz) band filters are plotted in the figure below together.

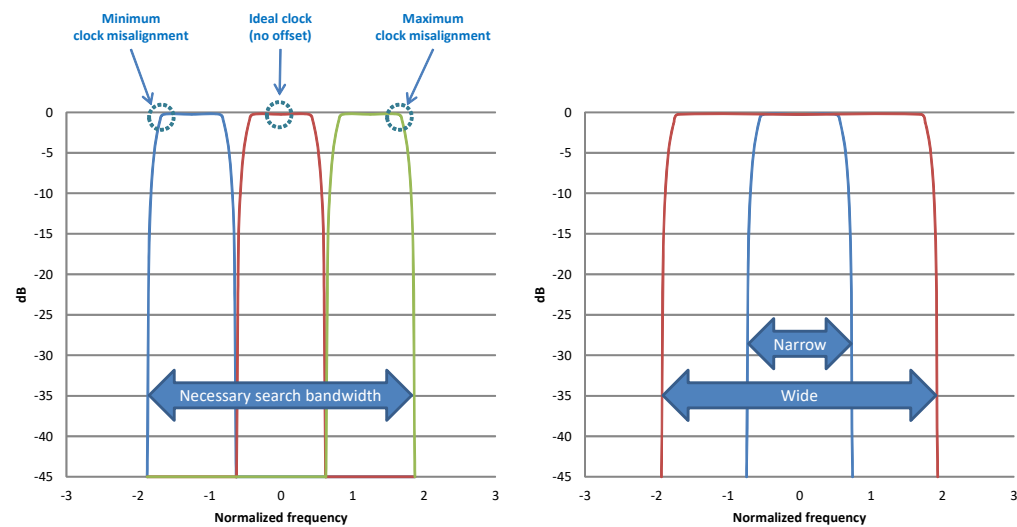


Figure 8-24: Wide and narrow filter characteristics.

8.5.5.10 MSG_BGAN_CHECK_POWER_RESP

Message from the BGAN XL Radio Module that contains the wide and narrow power measurement for each channel.

offset \ byte	0	1	2	3
0	Opcode	Number slots	valid	Reject cause
4	State	Reserved		
8	Power narrow			
....				
72	Power wide			
...				
136	Power 200			
...				
196	....			

Table 8-84: MSG_BGAN_CHECK_POWER_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	12	
Number slots	U8	1	1	1-16	Number of slots used in each of the power arrays
valid	U8	1	2	0-1	0: MSG_BGAN_CHECK_POWER_RESP is not executed 1: MSG_BGAN_CHECK_POWER_RESP is executed
Reject cause	U8	1	3	See section 8.5.5.3.2 on page 8-40.	
State	U8	1	4	See section 8.5.5.3.1 on page 8-40.	
Reserved	ARRAY , U8	3	5	0	Reserved for future use. Now initialized to 0.
Power narrow	ARRAY , S32	64	8		List of narrow power measurements. 16 entries.
Power wide	ARRAY , S32	64	72		List of wide power measurements. 16 entries.
Power 200	ARRAY , S32	64	136	0	List of 200 kHz power measurements. 16 entries reserved for future use. Now initialised to 0.

Table 8-85: MSG_BGAN_CHECK_POWER_RESP data fields

8.5.5.11 MSG_BGAN_CHECK_WAVEFORM

Message to request the BGAN XL Radio Module to start a waveform check for a global BGAN carrier on the specified channel number.

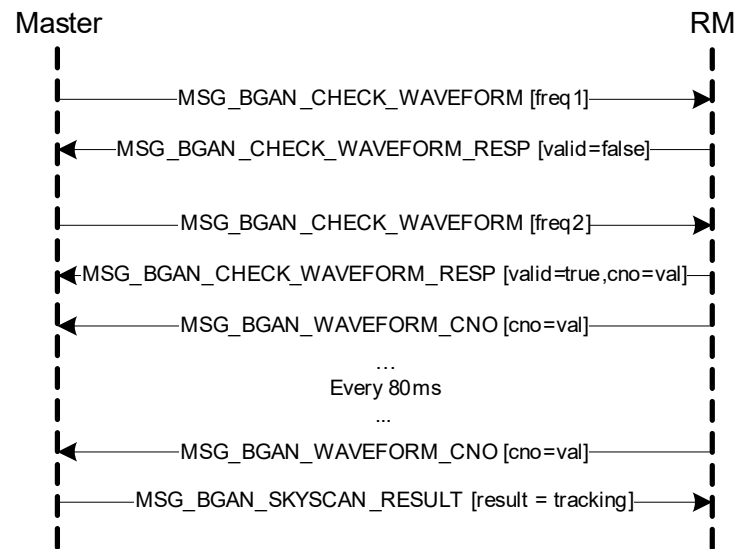


Figure 8-25: Check waveform message flow

offset \ byte	0	1	2
0	Opcode	Frequency	

Table 8-86: MSG_BGAN_CHECK_WAVEFORM data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	8	
Frequency	U16	2	1		Frequency in SDM channel number

Table 8-87: MSG_BGAN_CHECK_WAVEFORM data fields

When the BGAN XL Radio Module is instructed to perform a **MSG_BGAN_CHECK_WAVEFORM**, the following procedure will be initiated:

1. First the receiver is tuned to the specified L-band frequency.
2. After a settling period of 6 ms the BGAN XL Radio Module initiates an initial acquisition (due to the unknown frequency offset of the global channel).
3. The BGAN XL Radio Module now begins to estimate a coarse frequency offset using the assumption that a F80T025Q1B bearer is present.
4. After 122 ms a fairly good estimate of the coarse frequency offset will be available and the BGAN XL Radio Module begins the acquisition of the bearer (searching for known patterns).

5. The outcome of this acquisition is either unsuccessful or successful:

If the outcome is unsuccessful, the BGAN XL Radio Module cannot acquire the bearer within a specified time-out period. In this case the response

MSG_BGAN_CHECK_WAVEFORM_RESP will contain a carrier-to-noise ratio (CNo) equal to 0 dBHz and an estimate of the channel power (wide). An unsuccessful response will be delivered approximately 360ms (see 6.8.8 on page 6-52) after the reception of **MSG_BGAN_CHECK_WAVEFORM**.

If the outcome is successful, the BGAN XL Radio Module acquires the bearer within a specified time-out period. In this case the response

MSG_BGAN_CHECK_WAVEFORM_RESP will contain an estimate of the carrier-to-noise ratio (CNo) and an estimate of the channel power (wide). A successful response will be delivered in the range [335ms ..414ms] the reception of **MSG_BGAN_CHECK_WAVEFORM**.

In cases of low carrier-to-noise ratio it may take up to 1500ms-1900ms to get a response.

6. In case of a successful acquisition, subsequently CNo reports

(**MSG_BGAN_WAVEFORM_CNO**) will now be delivered every 80 ms until acquisition fails (e.g. due to poor signal quality) or the BGAN XL Radio Module is given new instructions.

Note

In a normal scenario the BGAN XL Radio Module will after a short period have a solid estimate of the coarse frequency, and so it will omit step number 3. This will result in a reduction of the response time by approximately 122 ms.

8.5.5.12 MSG_BGAN_CHECK_WAVEFORM_RESP

Message from the BGAN XL Radio Module that informs about the result of a **MSG_BGAN_CHECK_WAVEFORM**

offset \ byte	0	1	2	3
0	Opcode	CNO		Valid
4	Reject code	State		

Table 8-88: MSG_BGAN_CHECK_WAVEFORM_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	9	
CNO	U16	2	1		Carrier to noise ratio in 0.1 dBHz (F80T025Q1B)
Valid	U8	1	3		0: CNO not valid else CNO valid

Table 8-89: MSG_BGAN_CHECK_WAVEFORM_RESP data fields

Data field	Type	Length	Offset	Value	Comment
Reject cause	U8	1	4		See section 8.5.5.3.2 on page 8-40.
State	U8	1	5		See section 8.5.5.3.1 on page 8-40.

Table 8-89: MSG_BGAN_CHECK_WAVEFORM_RESP data fields

8.5.5.13 MSG_BGAN_SKYSCAN_RESTART

This message is sent to the BGAN XL Radio Module to signal a restart of the satellite search is needed. A typical reason for issue could be user action in a terminal GUI. If already pointed when received, the BGAN XL Radio Module will clear all connections and start a new satellite search.

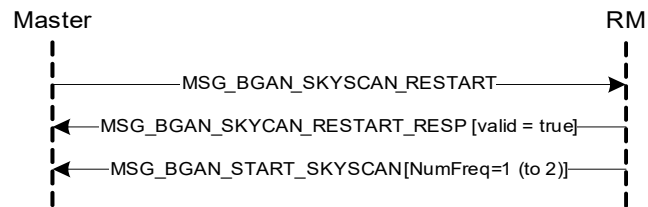


Figure 8-26: Restart of the satellite search

offset \ byte	0
0	Opcode

Table 8-90: MSG_BGAN_SKYSCAN_RESTART data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	6	

Table 8-91: MSG_BGAN_SKYSCAN_ALLOWED data fields

8.5.5.14 MSG_BGAN_SKYSCAN_RESTART_RESP

The message is sent from the RM to inform about the execution of the input message MSG_BGAN_SKYSCAN_RESTART.

offset \ byte	0	1	2	3
0	Opcode	valid	State	Reject cause

Table 8-92: MSG_BGAN_SKYSCAN_RESTART_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	7	
Valid	U8	1	1	0-1	0: MSG_BGAN_SKYSCAN_RESTART not executed 1: MSG_BGAN_SKYSCAN_RESTART executed.
State	U8	1	2	See section 8.5.5.3.1 on page 8-40.	
Reject cause	U8	1	3	See section 8.5.5.3.2 on page 8-40.	

Table 8-93: MSG_BGAN_SKYSCAN_RESTART_RESP data fields

8.5.5.15 MSG_BGAN_WAVEFORM_CNO

This message is sent from the BGAN XL Radio Module every 80 ms with information about the signal to noise level of the received BGAN waveform, but only while in sky-scan mode and when receiving a valid BGAN waveform. Transmission will also stop after a MSG_SKYSCAN_RESULT, MSG_BGAN_CHECK_WAVEFORM or MSG_BGAN_CHECK_POWER

offset \ byte	0	1	2
0	Opcode	CNO	

Table 8-94: MSG_BGAN_WAVEFORM_CNO data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	10	
CNO	U16	2	1		Carrier to noise ratio in 0.1 dBHz (F80T025Q1B).

Table 8-95: MSG_BGAN_WAVEFORM_CNO data fields

8.5.6 Abnormality

This section contains the messages used for abnormality signalling from the BGAN XL Radio Module to the Board Processor. Abnormality causes are described in more detail in section 10.3 on page 10-11.

8.5.6.1 MSG_ABNORMALITY

A message is sent from the BGAN XL Radio Module when an abnormality is observed. The cause code identifies the source of the abnormality and shall be taken into account when the Board Processor receives the message.

This message only identifies an abnormality and the source, The syslog contains further information.

offset \ byte	0	1
0	Opcode	Cause code

Table 8-96: MSG_ABNORMALITY

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	1	
Cause code	U8	1	1	0: Internal RF 1: External RF 2: Temperature Alert 3: Fatal Error 4: Position Needed 5: Doppler Velocity 6: Doppler Acceleration	Source of the abnormality

Table 8-97: MSG_ABNORMALITY data fields

Depending on the cause code, the board processor is expected to behave differently.

- Cause code 0 and 1: Leaves the RM in a state where it is inoperable, a reboot is necessary to get back to a working state. Determine the cause of the abnormality, correct the error and reboot the RM to return to operational state.
- Cause code 2: The temperature sensor has detected that the RM has reached a critically high temperature. Shut off power to the RM immediately, take the necessary precautions and turn on the power again when the temperature is within the operating range.
- Cause code 3: A fatal error has occurred. Only a reboot of the RM will allow it to return to operational state. Additional information on the specific cause of the error, is in the syslog. If the board processor does not reboot the RM, it will do so by itself 60 seconds after the fatal error has been reported.
- Cause code 4: The RM has not received a navigational report (position and velocity vector) within the last 4 seconds. When Doppler correction (see section 6.6.3 on page 6-29) is enabled the RM shall Doppler-compensate on-air data. Navigational reports (position and velocity vector) are necessary input data for this compensation. The RM will not send data on-air if this is the case. See section 10.3.5 on page 10-15 for further description of Navigational monitoring.
- Cause code 5: The RM has calculated an unrealistic Doppler velocity. Probably because the position and/or velocity is wrong. The RM will not send data on-air if this is case.

- Cause code 6: The RM has calculated an unrealistic change in Doppler velocity (doppler acceleration is unrealistic). The cause is probably that position and/or velocity is wrong. The RM will not send data on-air if this is case.

8.5.6.2 MSG_ABNORMALITY_OK

This message clears one or more abnormality situations.

offset \ byte	0	1
0	Opcode	Cause code

Table 8-98: MSG_ABNORMALITY_OK

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	2	
Cause code	U8	1	1	0: Doppler OK	Cause code for abnormality ok

Table 8-99: MSG_ABNORMALITY_OK data fields

- Cause code 0: This cause code is used to cancel all previous Doppler-related cause codes (cause 4, 5 and 6) received in the MSG_ABNORMALITY. The RM will again send data on-air.

8.5.7 Data tunnel

The BGAN XL Radio Module provides four data tunnels providing communication links between the data interface and the control interface. The RM listens on UDP port 130 and TCP port 131 and accepts only one session at a time on each port. The data received on the respective ports is forwarded to the control interface.

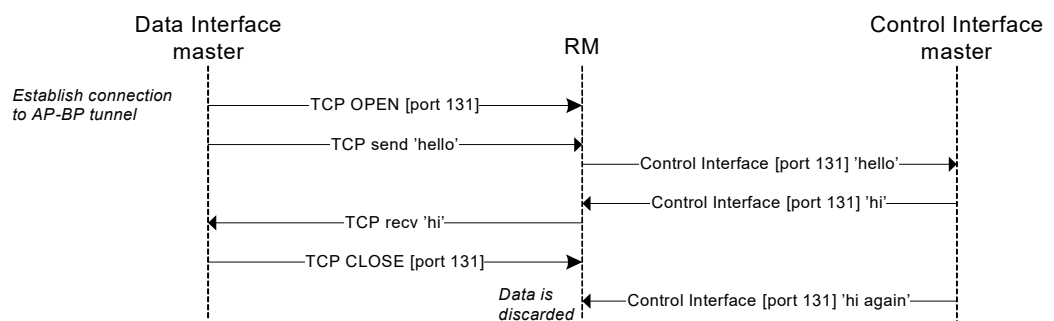


Figure 8-27: AP-BP tunnel, TCP example

The RM will discard any data received if the receiving end is not ready to receive/accept the data. For example if the board processor transmits data on a specific tunnel port which has not been opened by the application processor.

Important The current release only supports one TCP and UDP tunnel. Four data tunnels will be supported in future releases.

8.5.8 Debug shells

The BGAN XL Radio Module implements a simple character-based interface which enables a Telnet client on the data interface to communicate with a client shell (or other character based interface) in the control-interface master.

8.5.8.1 Overview

The Telnet server implementation in the BGAN XL Radio Module handles the Telnet session and forwards the Telnet data between the Telnet session and the debug shell ports of the control interface. This is illustrated below:

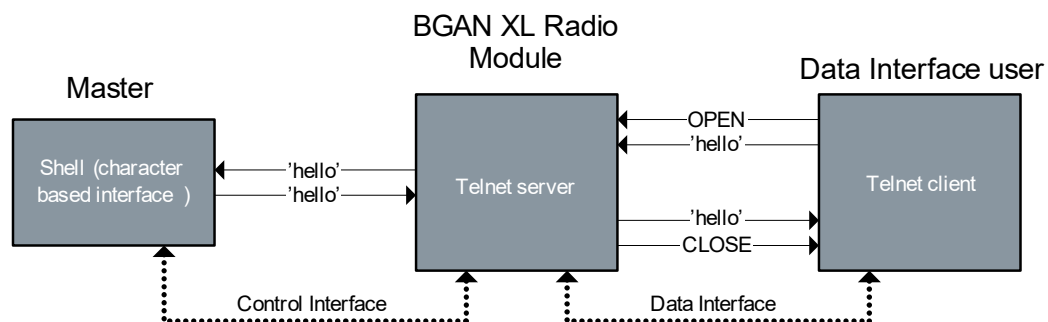


Figure 8-28: Message timeout handling

The mapping of the Telnet port to the control interface port is listed below:

Telnet port	Control Interface port
125	4
126	126
127	127

Table 8-100: Mapping of Telnet ports to control interface ports

Message	Direction	Summary	Reference
MSG_DBGSHELL_DATA	In / Out	Contains character data	8.5.8.2

Table 8-101: Debug shell protocol message of the control interface

8.5.8.2 MSG_DBGHELL_DATA

Message containing the debug shell character data.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Data ...	
4	...			

Table 8-102: MSG_DBGHELL_DATA data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	1	
Transaction ID	U8	1	1	0-255	
Data	Array	0-32	2		

Table 8-103: MSG_DBGHELL_DATA data fields

8.5.9 Extended POST

The extended POST protocol of the control interface contains functionality to assist the integrator to perform an extended set of POST of various BGAN XL Radio Module interfaces. This protocol and the associated functions are only accessible when the RM operates in **service** mode. For details on the extended POST functions refer to section 11.3 on page 11-6.

8.5.9.1 RF control interface

The protocol supporting extended POST of the RF Control Interface comprises three messages described in the following subsections. In a successful scenario the message flow depicted in Figure 8-29 below should be expected.

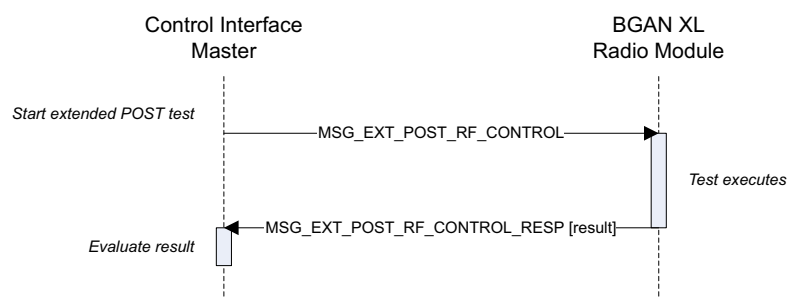


Figure 8-29: RF Control Interface Extended POST protocol example

For a detailed description on the extended POST functionality available for test of the RF Control Interface refer to section 11.3.1 on page 11-6.

8.5.9.1.1 MSG_EXT_POST_RF_CONTROL

Message to initiate RF control extended POST.

offset \ byte	0	1
0	Opcode	Transaction ID

Table 8-104: MSG_EXT_POST_RF_CONTROL data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	1	
Transaction ID	U8	1	1	0-255	

Table 8-105: MSG_EXT_POST_RF_CONTROL data fields

8.5.9.1.2 MSG_EXT_POST_RF_CONTROL_RESP

Response message to **MSG_EXT_POST_RF_CONTROL**.

offset \ byte	0	1	2	3
0	Opcode	Transaction ID	Tx acknowledge ...	
4	...		SPI lsw ...	
8	...		SPI msw ...	
12	...			

Table 8-106: MSG_EXT_POST_RF_CONTROL_RESP data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	2	
Transaction ID	U8	1	1	0-255	
Tx acknowledge	U32	4	2		
SPI lsw	U32	4	6		SPI least significant word
SPI msw	U32	4	10		SPI most significant word

Table 8-107: MSG_EXT_POST_RF_CONTROL_RESP data fields

8.5.9.1.3 MSG_EXT_POST_RF_CONTROL_NACK

Not-acknowledge message in the Extended POST protocol.

offset \ byte	0	1	2
0	Opcode	Transaction ID	Cause Code

Table 8-108: MSG_EXT_POST_RF_CONTROL_NACK data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	3	
Transaction ID	U8	1	1	0-255	
Cause Code	U8	1	2	1-4	

Table 8-109: MSG_EXT_POST_RF_CONTROL_NACK data fields

Cause code	Description
1	Internal error. See Syslog output for further details.
2	Operation not allowed. The BGAN XL Radio Module is not in Service mode. See Syslog output for further details.
3	Unknown opcode
4	Extended POST test failed

Table 8-110: MSG_EXT_POST_RF_CONTROL_NACK cause codes

8.5.10 Continuous Transmission

The BGAN XL Radio Module allows for a Continuous Wave (CW) to be set up on a specified frequency with a specified EIRP backoff level. The CW can amongst other things be used during the calibration procedure for antenna cable loss, as described in section 12.2.1.

Note that these messages are only applicable when the RM is operating in service mode (as described in section 12.1.1). In other operational modes these messages are discarded.

8.5.10.1 MSG_BGAN_START_CW

Message to request the RM to start transmission of a CW on the specified frequency. Expect a delay of approx. 55 ms from Tx start to the signal is present on the RF connector.

offset \ byte	0	1	2	3
0	Opcode	Frequency		
4		EIRP backoff		

Table 8-111: MSG_BGAN_START_CW data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	20	
Frequency	U32	4	1	1518000000-1700000000	Frequency in Hz.
EIRP backoff	U32	2	5	0-1000	In steps of 0.01 dB.

Table 8-112: MSG_BGAN_START_CW data fields

8.5.10.2 MSG_BGAN_STOP_CW

Message to request the RM to stop transmission of a CW previously started with message described in section 8.5.10.1.

Expect a delay of approx. 160 ms from Tx stop before the signal is removed from the RF connector.

offset \ byte	0
0	Opcode

Table 8-113: MSG_BGAN_STOP_CW data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	21	

Table 8-114: MSG_BGAN_STOP_CW data fields

8.5.10.3 MSG_BGAN_FAST_ESNO_REPORT

This message is sent by RM if fast signal-to-noise reports is enabled. See section 6.6.4 on page 6-30

The message is sent with an interval of 10 ms.

offset \ byte	0	1	2	3
0	Opcode	Valid	ESNO	

Table 8-115: MSG_BGAN_FAST_ESNO_REPORT data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	22	
Valid	U8	1	1		0: ESNO not valid else ESNO valid
ESNO	U16	2	2		Es/No in 0.1 dB

Table 8-116: MSG_BGAN_FAST_ESNO_REPORT data fields

8.5.10.4 MSG_SET_IN_CW_MODE

Used by RM to request L-Band return signal path to handle CW TX signal or BGAN burst TX signal.

Only used in BPLT mode.

offset \ byte	0	1
0	Opcode	Setting

Table 8-117: MSG_SET_IN_CW_MODE data format

Data field	Type	Length	Offset	Value	Comment
Opcode	U8	1	0	23	
Setting	U8	1	1	0-1	0: Signal path shall handle CW 1: Signal path shall handle BGAN burst

Table 8-118: MSG_SET_IN_CW_MODE data fields

RF & RF control interface

This chapter has the following sections:

9.1	RF interface	9-2
9.1.1	Transmission timing	9-2
9.1.2	Output power (Tx)	9-3
9.1.3	Receiver inputs (Rx1 & Rx2)	9-6
9.1.4	External reference oscillator (clk)	9-8
9.1.5	High level interference	9-9
9.2	RF control interface	9-12
9.2.1	Tx control signal (B2B_Tx_Ctrl)	9-12
9.2.2	Rx control signal (B2B_Rx_Ctrl)	9-13
9.2.3	Tx synchronization signal (B2B_Tx_Sync)	9-13
9.2.4	Tx acknowledge signal (B2B_Tx_Ack)	9-14
9.2.5	Definition of timing points t_0 and t_1	9-15
9.2.6	Timing corrections	9-20
9.2.7	Burst sequence example	9-22
9.2.8	SPI interface	9-22

9.1 RF interface

The BGAN XL Radio Module has a dedicated RF signal interface which consists of one output connection (Tx), two receive input connections (Rx1 and Rx2) and a precision reference clock input/output (Ref Clk). The Rx2 receiver input gives the integrator the opportunity to interface to the BGAN XL Radio Module at IF to implement an external downconverter as the primary input or as a part of an antenna-diversity solution.

The RF interface is used for L-band communication on the BGAN system and is designed to interact with an HPA/LNA which is located externally. The RM operates in adaptive power mode according to the SDM [18] and requires an externally connected HPA with fixed gain.

The following sections specify how the modem is controlled correctly to achieve correct BGAN behaviour.

9.1.1 Transmission timing

The timing of burst transmissions on the return channel is relative to the timing of the forward channel frames. For each forward frame a corresponding return frame is defined, which starts ($n \times 80\text{ms} + \text{SID}$) after the beginning of the first symbol of the unique word in the forward frame as observed at the antenna of the terminal (see the SDM [18] for detailed information). The value of n depends among other things on the interleaving used on the forward bearer (refer Return Schedule Description in the SDM v4c4 for details). The self-imposed delay (SID) depends among other things on the physical location of the terminal.

The BGAN system specifies that the overall adjustment accuracy of transmit burst timing must be $\leq 10 \text{ us}$ within a 3 sigma (99.8%) value. As this requirement includes all timing uncertainties in both receive and transmit chain, all delay contributions outside the BGAN XL Radio Module must be accumulated so the RM can compensate for the delays when transmitting (see also section 6.5.2 on page 6-23).

As a consequence of this dependency the integrator must carefully consider any additional delay contributions (indicated in the following figure) in the Rx and Tx paths and configure the BGAN XL Radio Module accordingly (see section 6.5.2 on page 6-23).

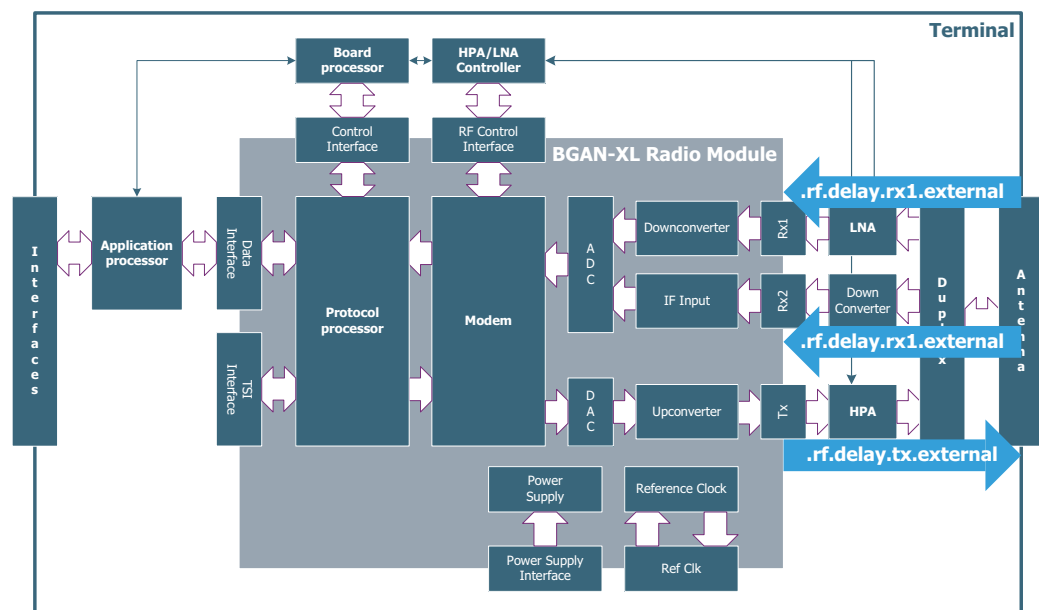


Figure 9-1: RF signals in the BGAN XL Radio Module

If any external ATC filtering can be switched in the delay, its contribution must be configured as the absolute delay introduced from the antenna to the input of Rx1 using the configuration parameter **.rf.delay.rx1.external** as described in section 9.1.5.1 on page 9-9.

9.1.2 Output power (Tx)

The output power, P_{out} , of the BGAN XL Radio Module is controlled by three factors:

- A reference level designated as the nominal output power.
- A gain compensation algorithm to account for gain variations versus frequency in e.g. the HPA.
- A back-off level defined by the BGAN air interface protocols.

The first two factors are to be configured by the integrator whereas the last is controlled by the BGAN XL Radio Module in accordance with the SDM (see [18]).

The following subsections describe each factor and the overall control mechanisms of the output power.

9.1.2.1 Nominal output power

The nominal output power, P_{nom} , is defined as the output power of the BGAN XL Radio Module corresponding to the maximum transmitted EIRP of the terminal¹ of which the BGAN XL Radio Module forms part.

1. Maximum EIRP depends on the terminal class; see the SDM [18].

The integrator must specify the nominal output power at the Tx connector of the BGAN XL Radio Module using the configuration parameter `.rf.gain.tx.nominal_power` which is specified in section 6.8.6 on page 6-50.

9.1.2.2 Gain compensation

The BGAN XL Radio Module includes an algorithm which can compensate for external gain variations in e.g. the HPA. The algorithm operates on pairs of frequencies and gain corrections and performs either:

1. Linear interpolation, where the gain at a certain frequency f is approximated by a straight line passing through the two data points f_j and f_{j+1} closest to f .
2. Second order interpolation, where the gain at a certain frequency f is approximated by a 2nd order polynomial passing through three data points f_j , f_{j+1} and f_{j+2} closest to f .

Up to 15 pairs can be specified to cover the entire transmitter frequency range using the configuration parameters described in section 6.8.6.1 on page 6-51.

A gain variation up to ± 7.5 dB can be accounted for by the algorithm and the resulting gain characteristic, G_{comp} , is added to the nominal output power.

Note

The integrator must ensure that the combination of the nominal power and gain variations in any situation is within:

$$-40\text{dBm} \leq (P_{nom} + G_{comp}) \leq -10\text{dBm}$$

The following figure shows an example (with linear interpolation) where the output level is compensated using 10 frequency pairs.

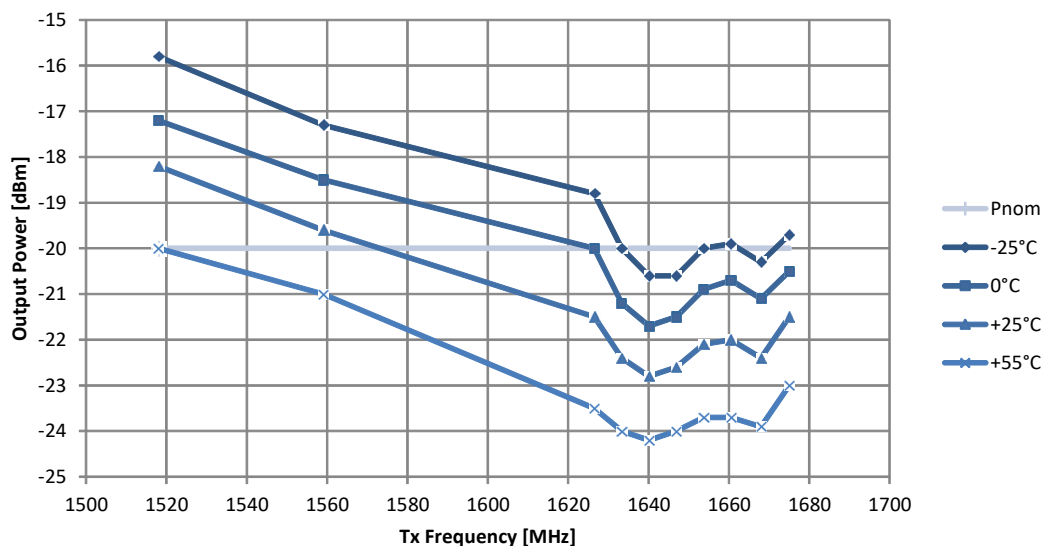


Figure 9-2: RF Output level versus Tx frequency

Note Gain variations over temperature must be handled externally by updating the compensation parameters (or the nominal power) according to the temperature drift.

9.1.2.3 Back-off level

During normal operation the BGAN XL Radio Module will continuously adapt the output power to get the optimum trade-off between the required data bandwidth and the link conditions on the air interface.

The adaptive power control is made by reducing the power level up to 10 dB in steps of 1 dB. The reduction is designated as the back-off level and may be changed from burst-to-burst.

The BGAN XL Radio Module offers output power stability for the first and subsequent bursts as indicated in the table below.

Back-off level	BGAN EIRP step size	Power setting accuracy
[0 ... -10] dB	1 dB	See section 5.6.5 on page 5-18

Table 9-1: Power setting, parameters to be configured

Note The power accuracy is measured from the median power (half way between upper and lower measured power) over 1000 subsequent bursts.

9.1.2.4 Output power control

Referring to the preceding subsections the output power of the BGAN XL Radio Module is defined as:

$$P_{out} = P_{nom} + G_{comp} + Backoff$$

The externally connected HPA must provide a fixed gain and be able to operate with an alternating input power in order have the back-off level reflected in the transmitted EIRP. Hence, the transmitted EIRP will be given by:

$$EIRP = P_{out} + G_{HPA}$$

The principles of integrating the RM with a fixed gain HPA is shown in the following figure.

It is the integrator's responsibility that the HPA operates with the BGAN XL Radio Module in a way that meets the overall system requirements specified in the SDM (see [18]).

Note

The BGAN XL Radio Module does not have a special feedback loop incorporated to control the output power. If higher precision is needed (see section 5.6.5) the integrator should incorporate his own feedback loop in the externally connected HPA and align it with the reported EIRP information provided via the RF control interface (see section 9.2).

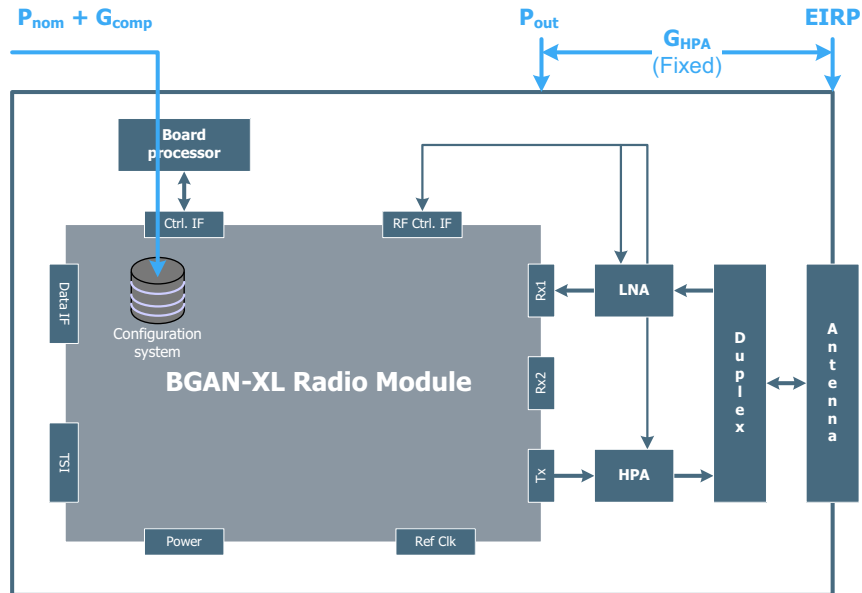


Figure 9-3: Configuration with fixed gain HPA (simplified)

9.1.3 Receiver inputs (Rx1 & Rx2)

The BGAN XL Radio Module has two receiver input connections (Rx1 and Rx2) and can operate as a single receiver input or with antenna diversity where both receiver inputs are used. Both Rx1 and Rx2 can be used in single receiver configuration. However, the latter requires external down conversion as shown in the following figure.

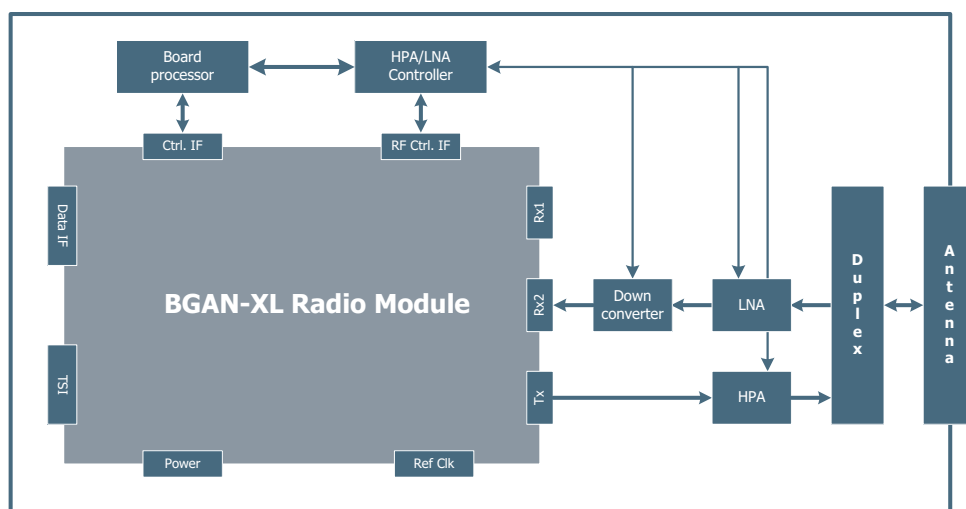


Figure 9-4: Configuration with Rx2 as primary input.

The following figure illustrates a simplified antenna diversity configuration where the externally connected down converter is controlled by an LNA controller module which uses the Rx frequency information communicated from the BGAN XL Radio Module through the RF control interface (see section 9.2 on page 9-12).

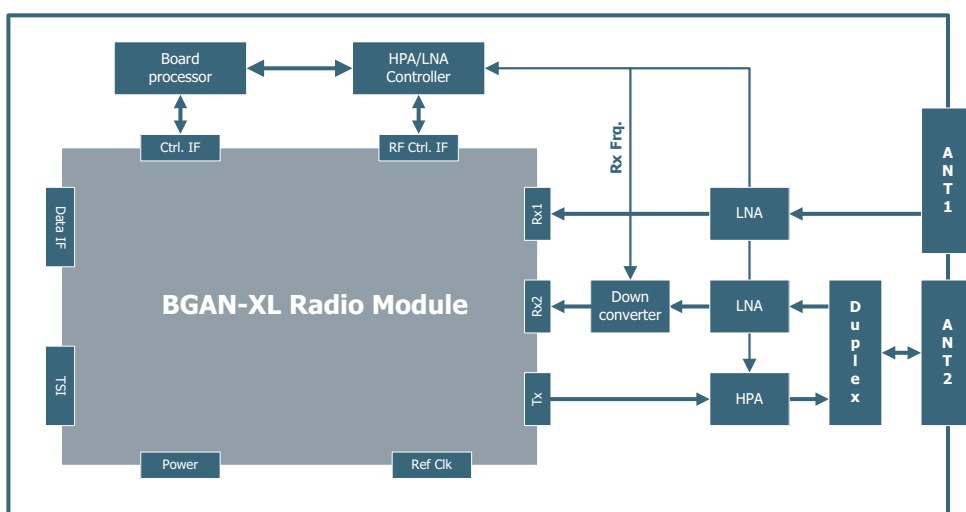


Figure 9-5: Configuration with antenna diversity (simplified)

The secondary receiver input can be activated via the `.rf.rx2.chain.enable` parameter specified in section 6.5.3 on page 6-23.

Use of the secondary receiver input dictates that the wanted channel is aligned to a specific IF which has been selected very carefully to ensure that no spurious products occur.

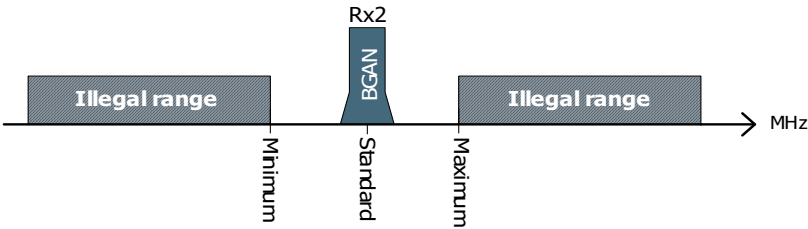


Figure 9-6: Rx2 IF spectrum range

The IF can be specified within the legal range shown in the table below using the configuration parameter `.rf.rx2.chain.enable` specified in section 6.5.3 on page 6-23.

Standard	Minimum	Maximum
138 MHz	134 MHz	140 MHz

Table 9-2: Rx2 IF range

9.1.4 External reference oscillator (clk)

The BGAN XL Radio Module has a connector for a reference clock for distribution of the reference clock to externally connected frequency synthesizers or for the option to connect an external clock signal to the BGAN XL Radio Module.

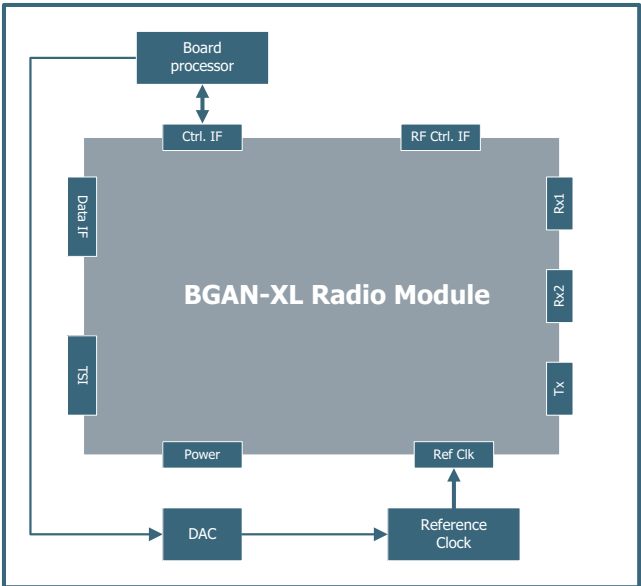


Figure 9-7: Configuration with an external reference oscillator VCTCXO (simplified)

The reference clock input can be configured using the `.clk.rx.ref_clk_sel` parameter specified in section 6.5.4 on page 6-24. Furthermore the RM has an aging offset

parameter which can be used to re-adjust an externally connected oscillator. This parameter is designated **.clk.drift** and is specified in section 6.7.2 on page 6-37.

The aging parameter represents the estimated oscillator aging in ppm and is updated regularly. It is the intention that the integrator must read this parameter once during start-up and adjust any externally connected oscillator accordingly.

9.1.5 High level interference

The BGAN terminal can experience interference from other ground originated systems like ATC and LTE.

9.1.5.1 ATC interference

The RM is designed to operate within terminals that requests full ATC compliance in both ATC phase 1A and phase 2 at the cost of intensified requirements to the external RX circuitry supplied by the Integrator.

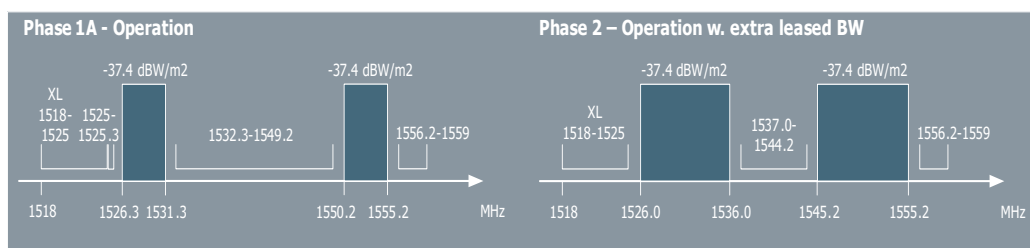


Figure 9-8: Frequency bands for ATC system (Phase 1A and 2)

9.1.5.2 Interference mitigation

The responsibility of detecting and removing an interference like ATC is entrusted to be performed externally by the Integrator. It is assumed that some kind of extended filter circuit (or ATC receiver) must be dynamically inserted to reduce the impact of an interferer when high level interference is detected. Such a setup is illustrated in the figure below.

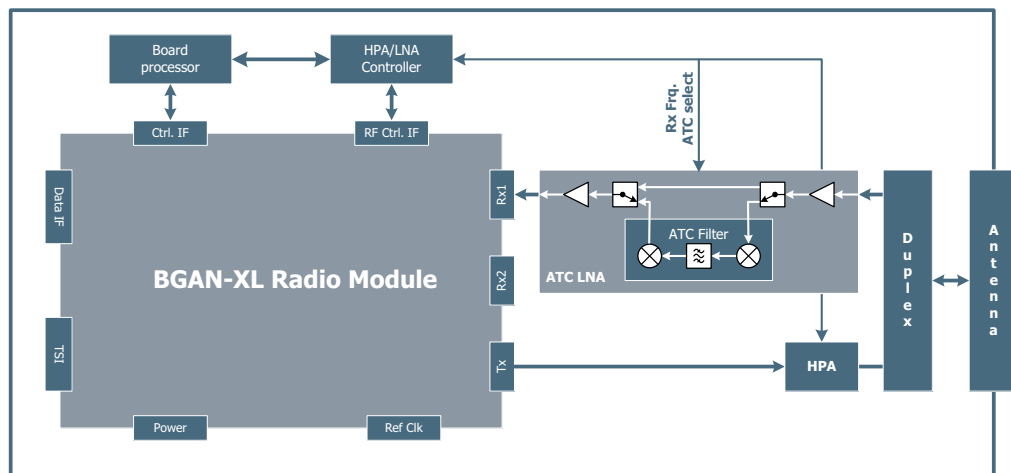


Figure 9-9: Configuration for use in ATC environments (simplified)

In order to operate properly with an externally connected ATC filter, the RM must be informed about change in the delay in the circuit as shown in the figure below.

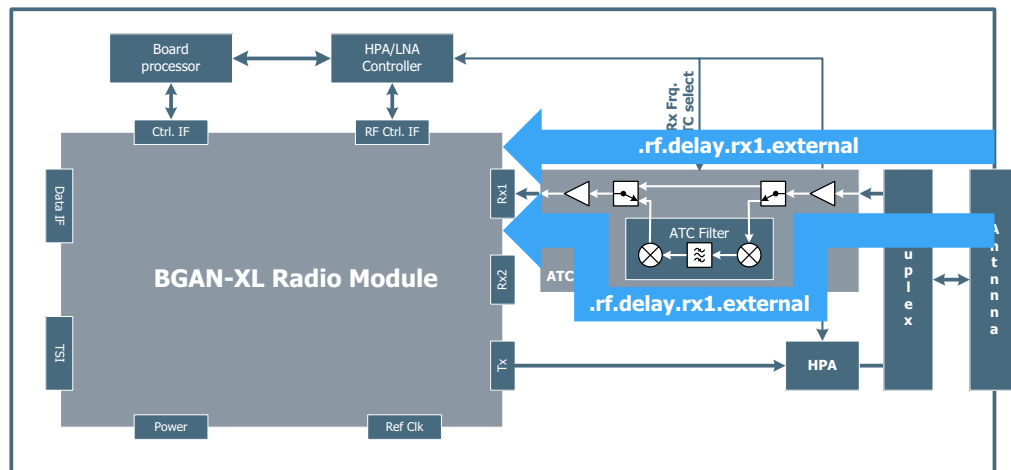


Figure 9-10: Configuration for use in ATC environments (simplified)

Important Remember to reprogram the parameter **.rf.delay.rx1.external** if the delay changes in the receive chain.

In case of battery-powered terminals the external ATC filter above might not be feasible to implement. Here large interfering signals from adjacent bands or systems are present (which could originate from an Ancillary Terrestrial Component). In this case the BGAN XL Radio Module can be programmed to reduce the receiver gain substantially (ATC mode), this will minimize the harmful clipping and intermodulation distortion that the interference generates inside the analogue front-end of the RM.

The ATC mode will in many cases result in the degradation of the overall performance in terms of system G/T, but the link might be sustained. It is up to the terminal design to ensure that this degradation is within an acceptable level. ATC MTR tests will verify the terminal's performance.

If there is no external interference filter in the terminal, it is up to the integrator to design an power detector circuit for interference that informs the RM when interference is present resulting in a switch to ATC mode (reduced gain/high IIP3).

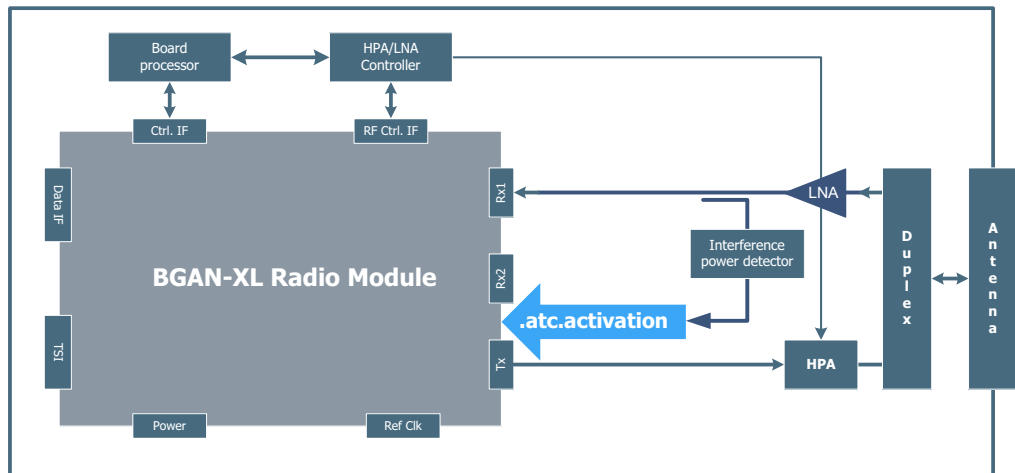


Figure 9-11: Configuration with interference power detector (simplified)

To allow the integrator to signal if a high-level interferer is present or not the BGAN XL Radio Module has the parameter **.atc.activation** which is described in section 6.8.7 on page 6-52.

When the **.atc.activation** parameter is set, the RM will reduce its RF input gain and increase the supply voltage to the analogue front-end components.

9.2 RF control interface

The BGAN XL Radio Module has a dedicated RF control interface which consists of a standard 4-wire SPI controller and four discrete pins as illustrated below. The interface is used for communication of timing-critical information between the physical layer of the BGAN modem and an external connected HPA/LNA.

SPI transfers always consist of a data exchange. While the master is sending data to the slave on the MOSI line, the slave sends data back to the master on the MISO line as indicated on the figure below. Further details about the electrical characteristics can be found in section 5.7.3 on page 5-21.

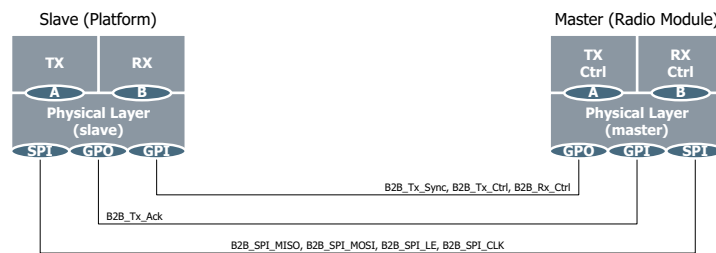


Figure 9-12: RF control interface, slave and master

Note All signals in the RF control interface except the B2B_Tx_Sync output are per default deactivated at start-up.

9.2.1 Tx control signal (B2B_Tx_Ctrl)

This signal notifies about an active (High) or inactive (Low) transmitter chain. The signal is mainly included to satisfy the strict requirements from the portable and battery driven terminal products.

The Tx control signal operates as a transmit enable signal. When the signal is active it indicates that the BGAN XL Radio Module is going to transmit while inactive indicates that no transmission is scheduled. As standard the signal will be activated 2.5 ms prior (t_{up}) to t_0 and deactivated 0.5 ms after t_1 (t_{down}). The timing can be configured using the parameters **.rfctrl.tx.burst.up** and **.rfctrl.tx.burst.down** (see section 6.5.5.1 on page 6-25). The B2B Tx Ctrl signal is active high (i.e. high = active, low = not inactive).

Note | Note that the B2B_Tx_Ctrl signal does not directly indicate that an L-band signal is being transmitted from the BGAN XL Radio Module, but should rather be seen as an early warning.

9.2.2 Rx control signal (B2B_Rx_Ctrl)

This signal notifies about an active (High) or inactive (Low) receiver chain. The signal is mainly included to satisfy the strict requirements from the portable and battery driven terminal products.

The Rx control signal operates as a receive enable signal. When the signal is active it indicates that the BGAN XL Radio Module enters the active state and begins to receive, whereas inactive indicates that no reception is in progress. As standard the signal will be activated 9.0 ms prior (r_{up}) to r_0 and deactivated (r_{down}) less than 1 ms before it is re-entering the inactive state. This leaves a response time of maximum 3 ms (as illustrated in the figure below) before the first Rx frequency message (r_{info}) will be transmitted over the SPI interface.

The Rx_up time can be controlled via the parameter **.rfctrl.rx.receiver.up** (see section 6.5.5.2 on page 6-26). The B2B_Rx_Ctrl signal is active high (i.e. high = active, low = inactive).

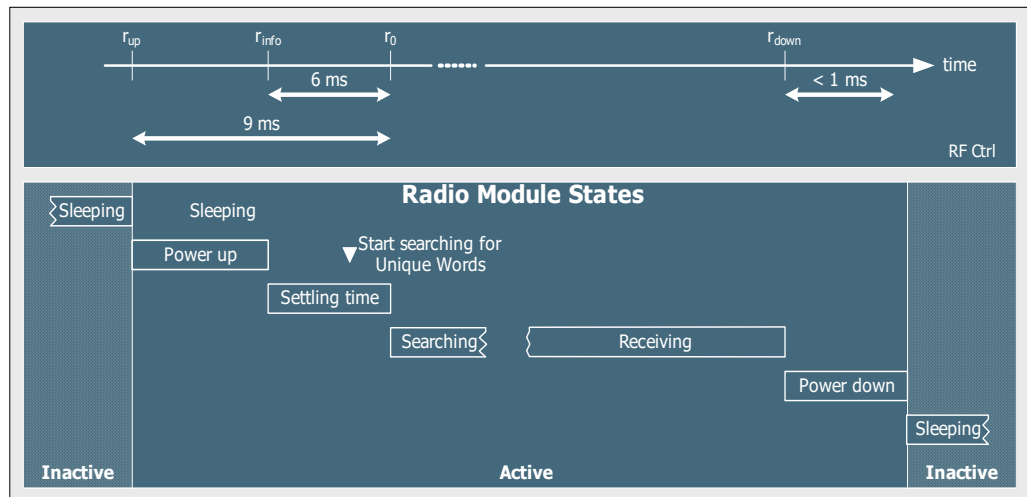


Figure 9-13: Timing of the Rx control signal (B2B_Rx_Ctrl)

9.2.3 Tx synchronization signal (B2B_Tx_Sync)

To assist correct synchronization of an externally connected HPA the RF control signals (and messages) are timed in respect to the RF signal. This timing point, t_0 , represents a fixed point (in time) on the power envelope of the bursts and is described separately in the following section.

The synchronization signal is divided into two parts;

1. The rising edge of the signal is referred to as **Burst init (t_{init})**. Burst init is meant to be used by activate amplifiers (HPAs) to initialize the gain correctly according to bearer type, EIRP level and frequency range.
2. The falling edge of the signal is referred to as **Burst start (t_{start})**. Burst start is meant to be used to accurately synchronize the EIRP to a certain level.

The standard values of **Burst init (t_{init})** and **Burst start (t_{start})** are illustrated in the table below, but values are configured using the parameters **.rfctrl.tx.burst.init** and **.rfctrl.tx.burst.start** (see section 6.5.5.1 on page 6-25).

Signal description	Signal timing in respect to t_0	Tolerance
Burst init (rising)	- 180 μ s	± 250 ns
Burst start (falling)	- 44.63 μ s	± 250 ns

Table 9-3: Standard timing of Tx synchronization signal

9.2.4 Tx acknowledge signal (B2B_Tx_Ack)

The Tx acknowledge signal is used for fail-safe supervision of the external part of the transmitter chain (i.e. HPA supervision). When the external part transmits a burst an acknowledge indication must be signalled back to the BGAN XL Radio Module via this dedicated Tx acknowledge signal.

The RM expects the Tx acknowledge signal to follow the following format:

- In no-transmissions periods, the B2B_Tx_Ack must be de-asserted.
- In transmission periods, the B2B-Tx_Ack must be asserted.

Note Notice that the actual supervision and control of the HPA must be done by a fail-safe supervisor located outside the BGAN XL Radio Module (e.g. in the board processor).

Figure 9-14 illustrates the timing requirements of the Tx acknowledgement signal when the transmission supervisory functionality is activated. The figure includes the two periods: no-transmission and transmission. The transition between these periods are guarded by a guard period that allows a delay between the two. The length of the guard is set by the parameter **.rfctrl.tx.ack.guard** (see section 6.5.5.3 on page 6-26).

Furthermore the B2B_Tx_Ack signal is filtered to avoid erroneous trigs by glitches and consecutive burst spacing time.

Note For BGAN classes using BGAN LDR transmission with 80 ms preambles, the guard parameter should be set to give a larger than normal delay, since the preamble uses very slow ramp-up and ramp-down timing (1.5 ms).

- During transmission: If B2B_Tx_Ack is de-asserted, an informational syslog event will be generated to inform the integrator about the abnormality.
- During no-transmission: If B2B_Tx_Ack is asserted, the BGAN XL Radio Module will generate an abnormal behaviour message, MSG_ABNORMALITY (see section 8.5.6.1

on page 8-51), and enter a dedicated error state where all modem functionality will be deactivated.

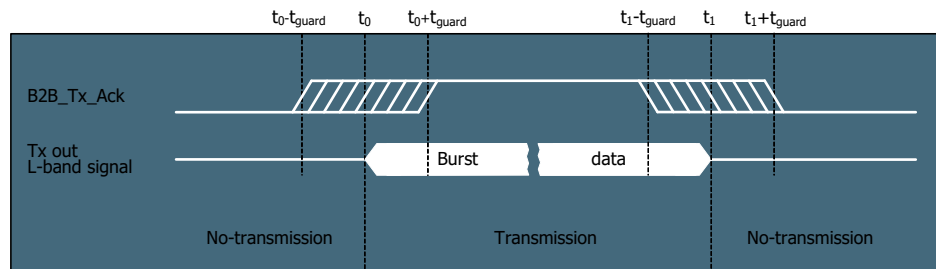


Figure 9-14: Timing of the Tx acknowledgement signal (B2B_Tx_Ack)

The transmission supervisory functionality is per default activated. It can be deactivated by the parameter **.rfctrl.tx.ctrl.tx_ack_en** (see section 6.5.5 on page 6-24).

Note Notice that the transmission supervisory functionality also is active in no-transmission periods whereas the Tx acknowledgement signal must have the same polarity as the Tx control signal. If this is not the case an abnormal behaviour message (MSG_ABNORMALITY) will be generated and the error state will be entered.

The B2B_Tx_Ack signal is active high (i.e. high = transmitting, low = not transmitting).

9.2.5 Definition of timing points t_0 and t_1

The timing point, t_0 , is defined as a point on the ramp-up period of a burst. It represents a fixed point (in time) on the power envelope of the bursts which is at a certain power level. This point corresponds to the start of the first CW symbol (half a symbol prior to optimum symbol timing) as illustrated in the following figure.

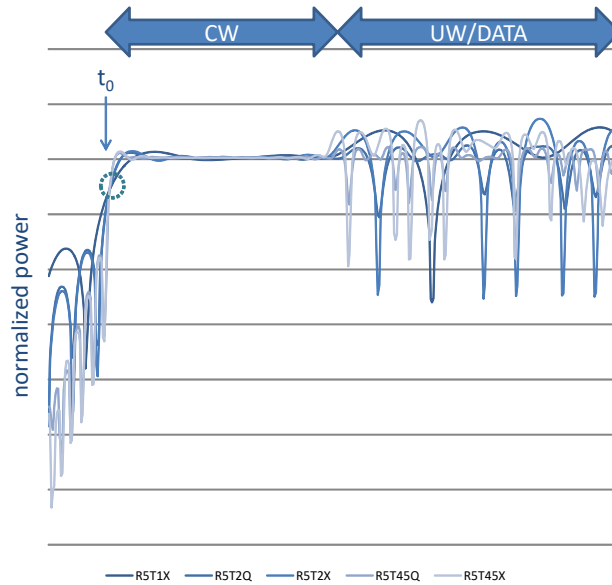


Figure 9-15: Illustration of the timing point t_0 .

Applicable for all BGAN bearer types:

- t_0 : Start of first CW symbol. Instantaneous Tx power level of -6 dBc (according to Tx burst information EIRP).

For 79.52 ms preamble possibly preceding the R80T0.5Q and R80T1Q bearer types:

- t_0 : Start of first preamble symbol. 655 μ s prior to instantaneous Tx power level of -6 dBc (according to Tx burst information EIRP).

t_0 : Start of first preamble symbol. 1369 μ s prior to instantaneous Tx power level of 0 dBc (according to Tx burst information EIRP).

The figure illustrates how the RF control timing events are aligned accordingly to the burst power mask where the specified timings offsets (T1 ..T10) are as defined in the SDM.

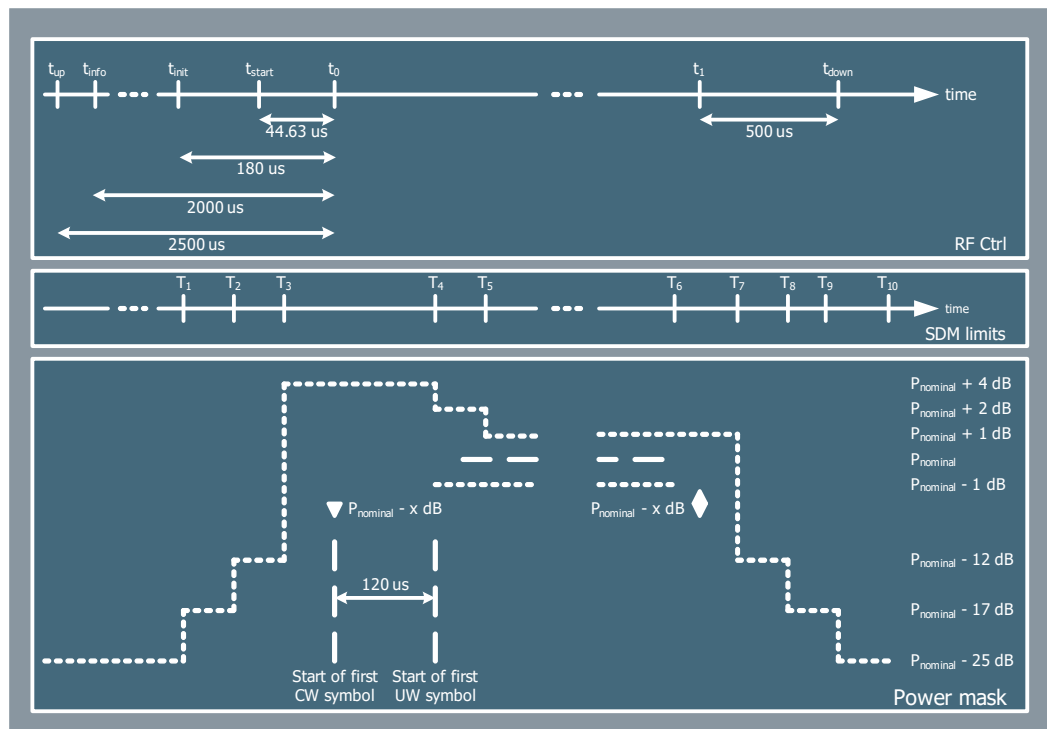


Figure 9-16: Alignment of RF control timing events to the burst power mask

9.2.5.1 Definition of t_1

The timing point, t_1 , is defined as a point on the ramp-down period of a burst. It represents a displacement compared to t_0 and depends on the specific burst type which is transmitted. The point is as shown in Figure 9-16 above as the rhombus and can be calculated using the equation below:

$$t_1 = t_0 + \frac{D}{f_{sym}}$$

This equation defines how the t_1 displacement compared to t_0 can be calculated using information about the number of symbols (D) in a burst and the actual symbol rate. The parameter D is summarized in Table 9-5 below where N represents the number of 80 ms frames transmitted when operating in continuous transmission mode.

Symbol rate	Burst Duration			
f_{sym}	5 ms (R5)	20 ms (R20)	80 ms (R80)	
			With preamble	Without preamble
16.800 (T0.5)	n.a.	330	1344+1344 X N	2+1344 X N
33.600 (T1)	156	660	2688+2688 X N	4+2688 X N
67.200 (T2)	312	1320	n.a.	n.a.
84.000 (T2.5)	n.a.	n.a.	n.a.	10 + 6720 X N
151.200 (T4.5)	702	2970	n.a.	n.a.
168.000 (T5)	n.a.	n.a.	n.a.	20 + 13440 X N

Table 9-4: Burst duration in symbols (D)

9.2.5.2 Continuous transmission operation

When operating in continuous transmission mode, where more than one 80 ms frame is transmitted, the synchronization signals, related to t_{info} , t_{init} and t_{start} , will be activated repeatedly as shown in the following figure.

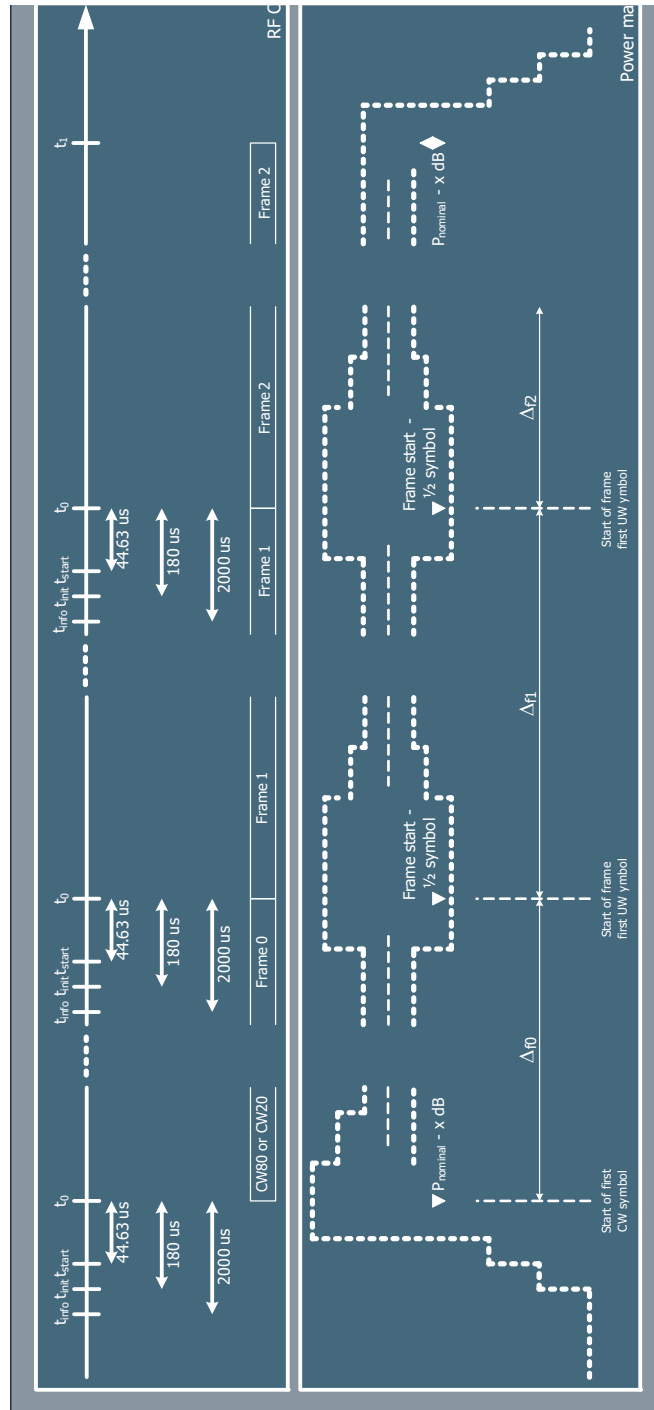


Figure 9-17: Continuous transmission operation

During continuous transmission the definition of the initial timing point, t_0 , is identical to the definition described in section 9.2.5. Consecutive timing points (also defined as t_0 in the following figure) are defined as half a symbol before frame start. This results in a non-uniform time distribution of t_0 as the time between the first and the second t_0

point (as defined by Δ_{f0} , Δ_{f1} and Δ_{f2}) is larger than later intervals (summarized in the table below).

Symbol rate	Time between consecutive t_0					
f_{sym}	Δ_{f0}		Δ_{f1}		Δ_{f2}	
	With preamble	Without preamble	With preamble	Without preamble	With preamble	Without preamble
16.800 (T0.5)	1342 (79.88 ms)	2+1344 (80.12 ms)	2+1344 (80.12 ms)	1344 (80 ms)	1344 (80 ms)	1344 (80 ms)
33.600 (T1)	2684 (79.88 ms)	4+2688 (80.12 ms)	4+2688 (80.12 ms)	2688 (80 ms)	2688 (80 ms)	2688 (80 ms)
84.000 (T2.5)	n.a.	10+6720 (80.12 ms)	n.a.	6720 (80 ms)	n.a.	6720 (80 ms)
168.000 (T5)	n.a.	20+13440 (80.12 ms)	n.a.	13440 (80 ms)	n.a.	13440 (80 ms)

Table 9-5: Duration between consecutive t_0 .

During a continuous transmission the BGAN XL Radio Module is allowed to change the output power level at a maximum rate of 1 dB per frame. Power level adjustments will always be executed on frame boundaries and will always be synchronized with t_0 .

9.2.6 Timing corrections

The BGAN system has incorporated a mechanism whereby the RAN can instruct a particular terminal to make timing corrections of the transmitted signal. These timing corrections are issued during normal operation which means that the terminal must be able to carry out the instruction on-the-fly (while transmitting bursts).

During a continuous transmission the BGAN XL Radio Module performs any instructed timing corrections smoothly over time. However, during burst transmissions the correction will be executed in the guard time between bursts (min: $\pm 120 \mu\text{s}$ and max: $\pm 180 \mu\text{s}$).

In cases where a negative timing correction is required two subsequent bursts will not be exactly aligned in time, but will have minor overlap in time (the ramp-down period

of the previous burst will enter the ramp-up period of the next burst) as illustrated in the figure below.

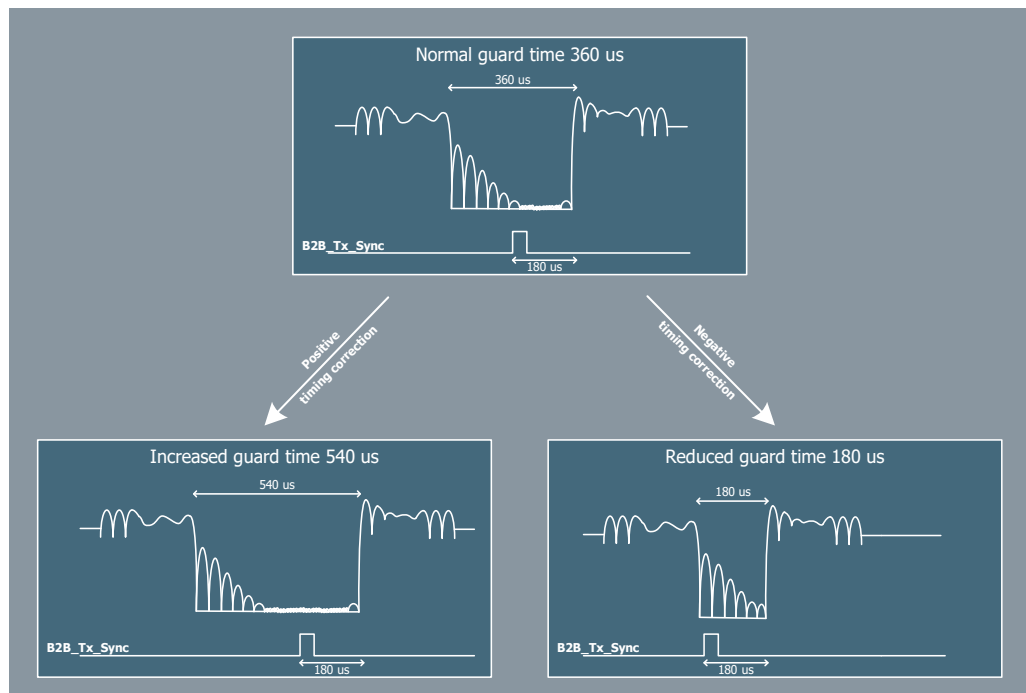


Figure 9-18: Timing corrections during burst transmissions

9.2.7 Burst sequence example

The example in the figure below illustrates how the RF control interface signals, during a two-burst sequence, will be exercised.

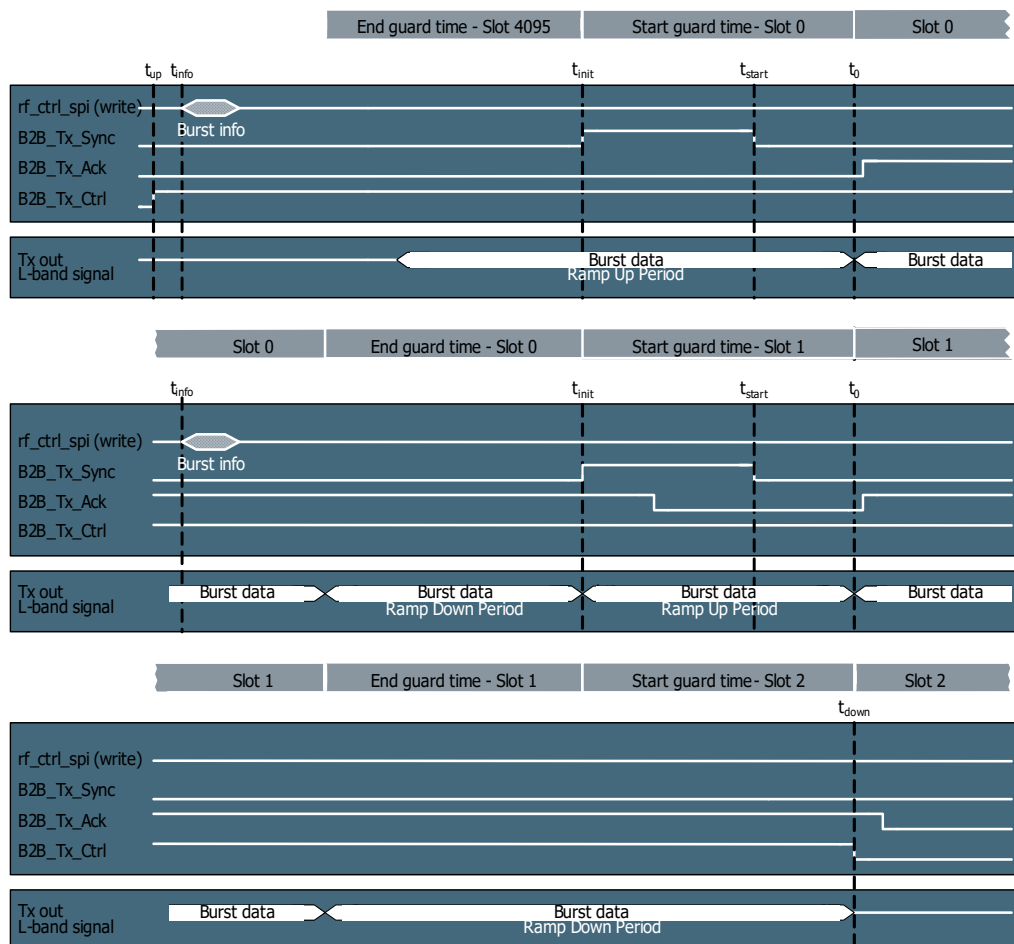


Figure 9-19: RF control interface signals during a two-burst sequence

9.2.8 SPI interface

The SPI words have a length of 40 bits where 32 of them are used for the data message and the remaining 8 bits serves as a control byte to the slave and as a status byte to the

master. The definitions of the different messages are described in detail in section 9.2.8.3 on page 9-24.

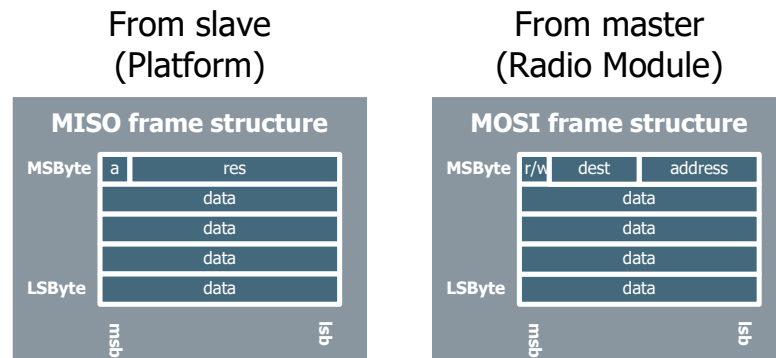


Figure 9-20: Structure of the SPI words

9.2.8.1 RM write - MOSI format

All RF-control SPI write commands has the format of an 8-bit control word followed by a 32-bit data message as shown below

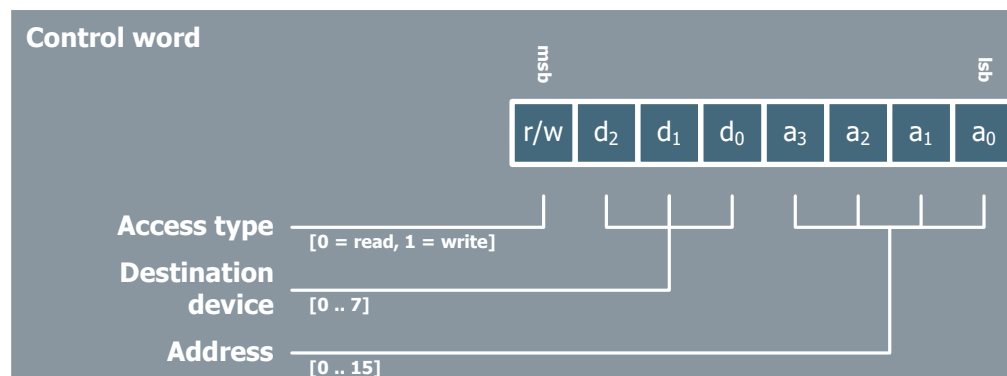


Figure 9-21: Structure of the control word

The slave can choose to support the relevant RM write commands and ignore the rest.

9.2.8.2 SPI read - MISO

Currently SPI read commands originating from the RM (Master) are not used, all data returned over the MISO line are ignored.

The slave must respond to each message from the BGAN XL Radio Module with an 8 bit status word in front of the data message formatted as shown below.

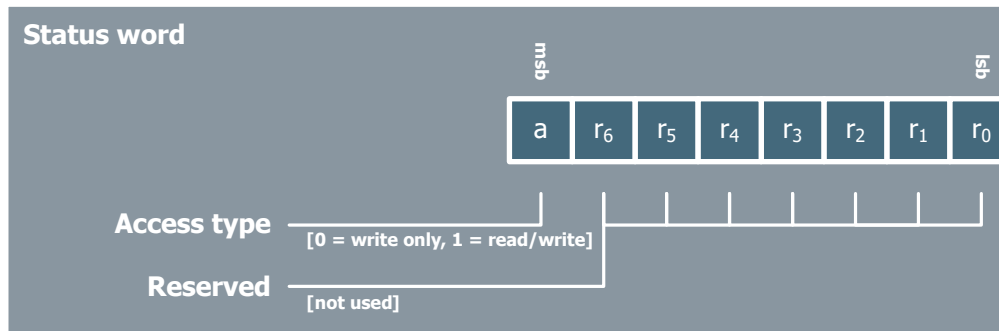


Figure 9-22: Structure of the status word

- The **Access type bit** is used to signal if the slave supports read accesses. If this bit is set to zero (by the slave) the RM will ignore the content of the received data message. If read access is supported the slave must be able to handle all the defined read requests.

9.2.8.3 Messages

The following sections describe the different messages sent on the RF control interface (SPI messages).

9.2.8.3.1 Tx burst information

The message 'Tx burst information' gives the integrator prior notice about the bearer type transmitted from the BGAN XL Radio Module. The notification contains information about EIRP level, frequency range and specifies the next return bearer type that will be transmitted. The intention with a prior notification is to give the integrator an opportunity to adjust or configure external devices and thereby optimise

the efficiency of the user terminal. A detailed description of the return bearer types and their subtype identifiers are in chapter 2 (or in the latest version of the SDM).

R/W (1 bit)	Destination (3bit)	Address (4 bit)	Message name	Description
W(1)	Tx (000)	0x0 (0)	Tx Burst information	A burst message to the external transmitter chain containing information about transmitted burst type, frequency and EIRP level. The message is as standard sent 1.97 ms before t_0 but can be configured using the parameter .rfctrl.tx.burst.info (see section 6.5.5.1 on page 6-25). Bit 31..24: Spare Bit 23..16 : EIRP level as described below. Bit 15..08 : Frequency range as described below. Bit 00..07 :Bearer type as described below.

Table 9-6: Tx burst information messages

EIRP level (backoff)	8- bit value	Frequency range	8- bit value
Max EIRP	0x00 (0)	- 1625.4	0x00 (0)
Max - 0.1 dB	0x01 (1)	1625.4 - 1625.6	0x01 (1)
Max - 0.2 dB	0x02 (2)	1625.6 - 1625.8	0x02 (2)
Max - 0.3 dB	0x03 (3)	1625.8 - 1626.0	0x03 (3)
Max - 0.4 dB	0x04 (4)	1626.0 - 1626.2	0x04 (4)
Max - 0.5 dB	0x05 (5)	1626.2 - 1626.4	0x05 (5)
Max - 0.6 dB	0x06 (6)	1626.4 - 1626.6	0x06 (6)
Max - 0.7 dB	0x07 (7)	1626.6 - 1626.8	0x07 (7)
Max - 0.8 dB	0x08 (8)	1626.8 - 1627.0	0x08 (8)
Max - 0.9 dB	0x09 (9)	1627.0 - 1627.2	0x09 (9)
Max - 1.0 dB	0x0A (10)	1627.2 - 1627.4	0x0A (10)
...	...	...	...
Max - 25.3 dB	0xFD (253)	1675.8 - 1676.0	0xFD (253)
Max - 25.4 dB	0xFE (254)	1676.0 - 1676.2	0xFE (254)
Max - 25.5 dB	0xFF (255)	1676.2 -	0xFF (255)

Table 9-7: EIRP level and frequency range

Bearer type	Code rate range	No	8-bit value
R5T1X (burst)	L3 (11) to H6(20)	0	0x00
R5T2X (burst)	L3 (11) to H6(20)	1	0x01
R5T4.5X (burst)	L3 (11) to H6(20)	2	0x02
R20T1X (burst)	L3 (11) to H6(20)	3	0x03
R20T2X (burst)	L3 (11) to H6(20)	4	0x04
R20T4.5X (burst)	L3 (11) to H6(20)	5	0x05
R5T2Q (burst)	L8 (6) to RE(14)	6	0x06
R5T4.5Q (burst)	L8 (6) to RE(14)	7	0x07
R20T0.5Q (burst)	L8 (6) to RE(14)	8	0x08
R20T1Q (burst)	L8 (6) to RE(14)	9	0x09
R20T2Q (burst)	L8 (6) to RE(14)	10	0x0A
R20T4.5Q	L8 (6) to RE(14)	11	0x0B
R80T0.5Q (w. preamble)	L14 (0) to RE(14)	12	0x0C
R80T1Q (w. preamble)	L14 (0) to RE(14)	13	0x0D
R80T0.5Q (w.o. preamble)	L14 (0) to RE(14)	14	0x0E
R80T1Q (w.o. preamble)	L14 (0) to RE(14)	15	0x0F
FR80T2.5X4 (cont)	L8 (6) to L1(13)	16	0x10
FR80T2.5X16 (cont)	L3 (11) to H6(20)	17	0x11
FR80T2.5X32 (cont)	H1 (15) to H6(20)	18	0x12
FR80T2.5X64 (cont)	RE (14) to H6(20)	19	0x13
FR80T5X4 (cont)	L8 (6) to L1(13)	20	0x14
FR80T5X16 (cont)	L3 (11) to H6(20)	21	0x15
FR80T5X32 (cont)	H1 (15) to H6(20)	22	0x16
FR80T5X64 (cont)	RE (14) to H6(20)	23	0x17
CW (unframed)	n.a	24	0x18
T0.5Q (unframed)	n.a	25	0x19
T1Q (unframed)	n.a	26	0x1A

Table 9-8: Identification of the return bearer type

Bearer type	Code rate range	No	8-bit value
T2Q (unframed)	n.a	27	0x1B
T2.5Q (unframed)	n.a	28	0x1C
T4.5Q (unframed)	n.a	29	0x1D
T5Q (unframed)	n.a	30	0x1E
T0.5X4 (unframed)	n.a	31	0x1F
T1X4 (unframed)	n.a	32	0x20
T2X4 (unframed)	n.a	33	0x21
T2.5X4 (unframed)	n.a	34	0x22
T4.5X4 (unframed)	n.a	35	0x23
T5X4 (unframed)	n.a	36	0x24
T0.5X16 (unframed)	n.a	37	0x25
T1X16 (unframed)	n.a	38	0x26
T2X16 (unframed)	n.a	39	0x27
T2.5X16 (unframed)	n.a	40	0x28
T4.5X16 (unframed)	n.a	41	0x29

Table 9-8: Identification of the return bearer type (Continued)

Bearer type	Code rate range	No	8-bit value
T5X16 (unframed)	n.a	42	0x2A
T0.5X32 (unframed)	n.a	43	0x2B
T1X32 (unframed)	n.a	44	0x2C
T2X32 (unframed)	n.a	45	0x2D
T2.5X32 (unframed)	n.a	46	0x2E
T4.5X32 (unframed)	n.a	47	0x2F
T5X32 (unframed)	n.a	48	0x30
T0.5X64 (unframed)	n.a	49	0x31
T1X64 (unframed)	n.a	50	0x32
T2X64 (unframed)	n.a	51	0x33
T2.5X64 (unframed)	n.a	52	0x34
T4.5X64 (unframed)	n.a	53	0x35
T5X64 (unframed)	n.a	54	0x36

Table 9-8: Identification of the return bearer type (Continued)

9.2.8.3.2 RX frequency

This message is sent every time the frequency of the receiver is changed.

R/W (1bit)	Destination (3bit)	Address (4bit)	Message name	Description
W(1)	RX (001)	0x00 (0)	RX frequency	A message containing the Rx frequency in Hz (represented by 32bits). The frequency synthesizer connected to this message must be settled within 6 ms (< 10 Hz) measured from the time where this message leaves the RF control interface. This message can also be used to control any externally connected PLL related the secondary receive chain (Rx2). Bit 31..0 :Rx Frequency in Hz

Table 9-9: Rx frequency range

Test & diagnostics

This chapter has the following sections:

- 10.1 Self testing 10-2
- 10.2 Continuous monitoring 10-6
- 10.3 Fail-safe feature 10-11
- 10.4 Error mode 10-16
- 10.5 Diagnostic reporting 10-17

10.1 Self testing

During startup the BGAN XL Radio Module performs a minor subset of tests to validate the internal connectivity to its sub-components and to verify that the RM is still operational. The table below shows the entries in the configuration system where the results are stored ('<u>' is an integer that indicates the unit number. '<n>' is an integer that indicates the POST number).

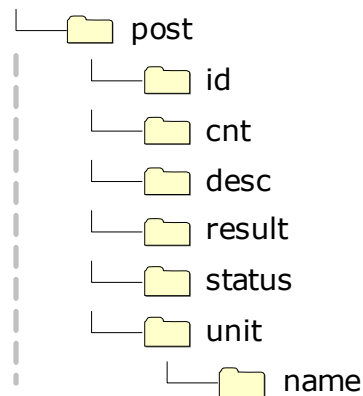


Figure 10-1: Parameter hierarchy for POST parameters.

Parameter name post	External access	Type / Domain	Range [min;max]	Comment
.unit.cnt	r	int / ram	[0..2^32-1]	Number of units to perform POST in BGAN XL Radio Module
.unit.name.<u>	r	string / ram	n.a.	Unit-name of a particular unit
.status.<u>	r	int / ram	[0..4]*	POST status of a particular unit
.cnt.<u>	r	int / ram	[0..2^32-1]	Number of POSTs for a particular unit
.desc.<u>.<n>	r	string / ram	n.a.	Description of a current POST
.result.<u>.<n>	r	int / ram	[0..4]*	Result of a current POST

Table 10-1: General structure of the internal POST results

Note

Each test case has an accompanying test-result identifier (post.result.u.n) and each unit has an accompanying status identifier (post.status.u) which is interpreted as; 0 = Passed, 1 = Failed, 2 = Disabled, 3 = Not tested or 4 = Ongoing.

10.1.1 Internal POST, UNIT 0

This subsection presents unit 0 POST entries which are related to the operation of the protocol layers (CPU/Interfacing/Digital Hardware).

Parameter name post	External access	Type / Domain	Range [min;max]	Comment
.unit.name.0	r	string / ram	'RM CPU'	Unit-name of unit 1.
.status.0	r	int / ram	[0..4]*	POST status of unit 1
.cnt.0	r	int / ram	[0..2 ³² -1]	Number of POSTs for unit 0
.desc.0.0	r	string / ram	-	Testing CPU connectivity.
.result.0.0	r	int / ram	[0..4]*	Result

Table 10-2: Test results for the protocol layers

Note | post.status.0 and post.result.0.0 are interpreted as; 0 = Passed, 1 = Failed, 2 = Disabled, 3 = Not tested or 4 = Ongoing.

10.1.2 Internal POST, UNIT 1

This subsection presents unit 1 POST entries which are related to the operation of the physical layers (i.e. digital signal processing and RF hardware).

Parameter name post	External access	Type / Domain	Range [min;max]	Comment
.unit.name.1	r	string / ram	'RM DSP'	Unit-name of unit 1.
.status.1	r	int / ram	[0..4]*	POST status of unit 1
.cnt.1	r	int / ram	[0..2 ³² -1]	Number of POSTs for unit 1. (5)
.desc.1.0	r	string / ram	'DSP POST McASP'	Testing McASP IF connectivity.
.result.1.0	r	int / ram	[0..4]*	Result
.desc.1.1	r	string / ram	'DSP POST ADC'	Testing ADC connectivity.
.result.1.1	r	int / ram	[0..4]*	Result
.desc.1.2	r	string / ram	'DSP POST DAC'	Testing DAC connectivity.
.result.1.2	r	int / ram	[0..4]*	Result

Table 10-3: Test results for the physical layers

Parameter name post	External access	Type / Domain	Range [min;max]	Comment
.desc.1.3	r	string / ram	'DSP POST RX PLL'	Testing RX PLL connectivity.
.result.1.3	r	int / ram	[0..4]*	Result
.desc.1.4	r	string / ram	'DSP POST TX PLL'	Testing Tx PLL connectivity.
.result.1.4	r	int / ram	[0..4]*	Result
.desc.1.5	r	string / ram	'DSP POST FPGA'	Testing FPGA interface connectivity.
.result.1.5	r	int / ram	[0..4]*	Result
.desc.1.6	r	string / ram	'DSP POST FPGA DDR-RAM'	Testing FPGA DDR RAM connectivity.
.result.1.6	r	int / ram	[0..4]*	Result

Table 10-3: Test results for the physical layers (Continued)

Note | post.result.u.n is interpreted as; 0 = Passed, 1 = Failed, 2 = Disabled, 3 = Not tested or 4 = Ongoing.

- McAsp IF - validates that the interface can deliver data within the specified timing constraints. If the McAsp IF test fails a syslog entry will appear:

```
Event log:
0: Jan 01 00:18:23 POST Failed: [0100] - DSP POST McAsp
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0100] - DSP POST McAsp
```

- ADC - validates the connectivity by writing to internal ADC registers and reading them afterwards with the specified timing constraints. Furthermore registers containing information about the Chip ID and Speed Grade are also validated. If the ADC test fails a syslog entry will appear:

```
Event log:
0: Jan 01 00:18:23 POST Failed: [0101] - DSP POST ADC
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0101] - DSP POST ADC
```

- DAC - validates the connectivity by writing to internal DAC registers and reading them afterwards with the specified timing constraints. If the DAC test fails a syslog entry will appear:

```
Event log:
0: Jan 01 00:18:23 POST Failed: [0102] - DSP POST DAC
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0102] - DSP POST DAC
```

- RX PLL - validates that the internal local oscillator can tune to a specific l-band frequency with the specified timing constraints and that the lock detect signal can signal both in-lock and out-of-lock. If the RX PLL test fails a syslog entry will appear:

```
Event log:
0: Jan 01 00:18:23 POST Failed: [0103] - DSP POST RX PLL
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0103] - DSP POST RX PLL
```

- TX PLL - validates that the internal local oscillator can tune to a specific l-band frequency with the specified timing constraints. If the TX PLL test fails a syslog entry will appear:

```
Event log:
```

```
0: Jan 01 00:18:23 POST Failed: [0104] - DSP POST TX PLL
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0104] - DSP POST TX PLL
```

- **FPGA - validates that the interface connectivity between the DSP and FPGA. If the test fails a syslog entry will appear:**

Event log:

```
0: Jan 01 00:18:23 POST Failed: [0105] - DSP POST FPGA
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0105] - DSP POST FPGA
```

- **FPGA DDR-RAM - validates that the interface connectivity between the FPGA and the DDR-RAM. If the test fails a syslog entry will appear:**

Event log:

```
0: Jan 01 00:18:23 POST Failed: [0106] - DSP POST FPGA DDR-RAM
1: Jan 01 00:18:23 Undefined Alarm for POST id: [0106] - DSP POST FPGA
DDR-RAM
```

10.2 Continuous monitoring

The BGAN XL Radio Module provides functionality to continuously monitor the internal system components and operational mode. This functionality is referred to as continuous monitoring and uses syslog for distribution of events and data logging.

10.2.1 Events

The syslog events of the BGAN XL Radio Module provide detailed information of events and exceptions during start-up and operation. Events are sent as a normal syslog message using Facility code 0 (kernel messages), and apart from the severity code they contain a simple text string describing the event.

To ease external processing the first part of the text string has the format <group>/<sub-group>, where <group> and <sub-group> are descriptive strings identifying the origin of the event. See a few examples below.

Example: modem/main: Modem state -> Standby BGAN

Example: pppoe/handler: enabled, 11 sessions supported

Example: modem/rfctrl: TxAck enabled

The following sub sections present the different events from the RM together with a short explanation of the cause.

10.2.1.1 Error severity

The following syslog messages are used if the modem enters error mode (see 10.4.2 on page 10-16).

Group	Syslog Text	Explanation
modem/main	Internal error detected - string	The diagnostic system has detected an internal error and generates an abnormal behavior message. string: Detailed information
modem/fec	Internal error detected - string	The diagnostic system has detected an internal error and generates an abnormal behavior message. string: Detailed information

Table 10-4: Events - severity level 3

Group	Syslog Text	Explanation
modem/main	Inconclusive sequencing - [Service|Operating BGAN] activation!	A fatal error occurred during activation and the modem cannot complete the requested startup procedure.
modem/rfctrl	TxAck - Active during none transmission!	The BGAN XL Radio Module has detected that the polarity of the Tx acknowledgement signal is active during a none-transmission period. This generates an abnormal behavior message.
modem/rf	Internal [Rx|Tx] frequency synthesizer out-of-lock!	The modem has detected an unintended out-of-lock situation of one the RF frequency synthesizers. This generates an abnormal behavior message.
modem/rf	Internal error detected - [Rx ADC|Tx DAC] clock!	The diagnostic system has detected a clock error. This generates an abnormal behavior message.
modem/post	POST Failed: [value] - string	The internal POST system has detected an error (see section 10.1.2 on page 10-3).

Table 10-4: Events - severity level 3 (Continued)

10.2.1.2 Warning severity

Group	Syslog Text	Explanation
modem/main	Vital configuration (t3§1, t3§2 or t3§3) is missing!	A mandatory configuration is missing during waveform activation and the modem cannot proceed until this has been resolved.
modem/fec	Vital configuration (t1§1, t1§2 or t1§3) is missing!	A mandatory configuration is missing during service activation and the modem cannot proceed until this has been resolved.
modem/main	Inconclusive sequencing - [Service|Operating BGAN] activation!	The sequence during activation is inconclusive and the modem cannot complete the requested startup procedure.
modem/main	Inconclusive sequencing - Service shutdown!	The sequence during service shutdown is inconclusive and the modem cannot complete the shutdown sequence.
modem/clk	Reference Clock Selection not defined!	An internal error that indicates that the modem cannot determine whether to use internal or external clock as reference.

Table 10-5: Events - severity level 4

Group	Syslog Text	Explanation
modem/main	Internal error detected - string	The diagnostic system has detected an internal minor error. string : Detailed information
modem/fec	Internal error detected - string	The diagnostic system has detected an internal minor error. string : Detailed information
modem/main	Inconclusive sequencing - string	The sequence of a requested terminal support function is inconclusive and modem cannot complete the requested operation. string : Detailed information
modem/main	Invalid syntax - string	The syntax of message parameters is incorrect. string : Detailed information
modem/fec	Aero equalizer not supported in HW!	The BGAN XL Radio Module does not support the selected BGAN class.

Table 10-5: Events - severity level 4 (Continued)

10.2.2 Data logging

Data logging can be enabled by the integrator to get information about certain system variables inside the BGAN XL Radio Module. Data logging is intended for debug purposes only and should thus not be used as input for e.g. an MMI.

Data logging messages are sent as a normal syslog message using Facility code 0 (kernel messages) and apart from the severity code they contain a simple text string describing the logging values.

The following sub sections present the different logging message from the RM together with as short explanation of the data content.

Note To enable data logging set the persistent setting **services.syslog.severity** to value 6 and enable the relevant data configuration parameter (see section 6.10.4 on page 6-616.10.4 on page 6-61).

10.2.2.1 Messages

Group	Syslog Text	Explanation
modem/clk	mode= value1 , drift= value2 ppm x100	Specifies the mode (value1) of the clock drift estimation and the estimated clock drift (value2) in ppm x 100
modem/main	evm^2= value	Specifies the mean squared estimate of the EVM as defined in the SDM. Update rate: every 4th second
modem/main	EsN0= value dB	Specifies the signal-to-noise ratio of the received signal in decibel. Update rate: every 4th second
modem/main	Freq Offset= value Hz	Specifies the frequency offset of the received signal in Hz. Update rate: every 4th second
modem/main	Channel Power= value dBm	Specifies the channel power of the received signal in dBm. Default update rate: Every 4th second.
modem/aero	Multipath delay= value us	Specifies the multipath delay (in microseconds) used by the aeronautical demodulator. Default update rate: Every 4th second.
modem/aero	C/M= value dB	Specifies the Carrier-to-Multipath level (in dB) of the aeronautical equalizer. Default update rate: Every 4th second.
modem/main	state= value	Specifies the current state of the demodulator.
modem/main	reacq= value	Specifies whether the demodulator has performed re-acquisition - or not.
modem/main	errored frame count= value	Specifies the number of frames with errors found by the demodulator since the latest re-tune command.
modem/main	UW errors= value	Specifies the number of UW bit errors in one demodulated 80 msec. frame.
modem/main	Pilot errors= value	Specifies the number of Pilot bit errors in one demodulated 80 msec. frame.

Table 10-6: Data - severity level 6

Group	Syslog Text	Explanation
modem/main	gain adj= value dB	Specifies the latest gain adjustment (in dB) performed by the demodulator AGC.
modem/main	input distance= value	Specifies the input symbol distance (in 15 bit unsigned ADC units) measured by the demodulator.
modem/main	code rate (UW)= value	Specifies the code rate (range [0..14]) found by the demodulator (found from UW).
modem/main	bearer type (re-tune)= value	Specifies the bearer type (range [0..14]) used by the demodulator.
modem/main	instantaneous relative frequency offset= value Hz	Specifies the instantaneous relative frequency offset measured by the demodulator relative to the one used in the previous frame.
modem/main	PER= value	Specifies the Packet Error Rate (in floating point exponential notation) measured by the decoder. Default update rate: Every 4th second.
modem/main	bearer type string - on decoding error	Specifies the bearer type (in clear text) found during decoding error. -1 signifies no decoding error.
modem/main	code rate string - on decoding error	Specifies the code rate (in clear text) found during decoding error (found from UW or AVP). -1 signifies no decoding error.
modem/main	MP delay= value us - on decoding error	Specifies the multipath delay (in microseconds) used during decoding error. -1 signifies no decoding error.
modem/main	FEC No.= value - on decoding error	Specifies the FEC number (range [0..12]) during decoding error. -1 signifies no decoding error.
modem/main	Sequence No.= value - on decoding error	Specifies the sequence number used during decoding error. -1 signifies no decoding error.

Table 10-6: Data - severity level 6 (Continued)

10.3 Fail-safe feature

The BGAN XL Radio Module has a variety of fail-safe features which prevent incorrect transmission and makes sure that fault conditions are quickly observed and reported. If something goes wrong as described in the following sections, a message is relayed to the Board Processor which must take appropriate action, see the message definition with suggested action in section 8.5.6.1 on page 8-51.

10.3.1 Watchdog

A supervisory timer (watchdog) is present in order to protect against operational software faults as well as a continuous polling mechanism making sure the internal processes are healthy. In case the watchdog is triggered or the polling mechanism does not receive a response, an entry is created in the syslog. The RM is rebooted in order to restore functionality.

10.3.1.1 Alive surveillance

Alive surveillance of the BGAN XL Radio Module is recommended but not required for operating the RM. Examples of alive methods are listed below:

Interface	Function	Description
Data interface	ICMP/PING	The Data interface can be verified using PING packets. If the RM stops responding to PING packets, the data interface has stopped working.
Data interface	Register for relevant notifications in the RM	The data-interface user can register for changes in the RM parameters. If the notification link is broken before the keep-alive timeout, and no further notification requests are accepted, the RM is non-functional.
Control interface	Poll sys.status.uptime	The control-interface master can poll the sys.status.uptime to verify the RM is alive and responding on the control interface. If the sys.status.uptime is less then the previous value the RM has been reset. Reading parameters using the control interface does not impact power consumption.

Table 10-7: Examples for alive surveillance of the BGAN XL Radio Module

Important

The integrator may have to take power consumption into consideration when monitoring the RM. Use of the data interface results in increased power consumption in the RM whereas use of the control interface has no impact on the power consumption.

10.3.2 RF monitoring

The BGAN XL Radio Module can monitor the RF Interface (see section 9.1 on page 9-2) for abnormalities. If any issues are observed, all transmission is stopped and the RM will generate an abnormal behavior message, **MSG_ABNORMALITY** (see section 8.5.6.1 on page 8-51), enter a dedicated error state and create an entry in the syslog.

The following issues with the RF interface are supervised:

- Discrepancies with Tx_Acknowledgement signal (see section 9.2.4 on page 9-14)
- PLL out of lock
- Rx ADC clock failure
- Tx DAC clock failure

The supervision of Tx_Acknowledgement can be enabled or disabled by the user. If enabled the functionality is active in all modes of operation.

All fail-safe alerts are published via the syslog.

10.3.3 Temperature monitoring

To avoid overheating of the BGAN XL Radio Module, a temperature sensor is used to detect temperature changes. Necessary actions to take in case of changes in temperature is mainly the responsibility of an attached application processor. This section describes which features the BGAN XL Radio Module makes available to an integrator and which actions the RM takes by itself.

The behaviour of the RM can be adjusted through a series of configuration parameters described later in this section. Depending on the temperature, any of the user events shown in Table 10-8 can be issued. The current temperature of the mainboard sensor on the RM is stored in the configuration system in degrees Celsius, see section 6.4.3 on page 6-15.

10.3.3.1 Events for temperature changes

These user events are sent when the RM reaches the temperature limits as shown below. The user events can be used to identify if precautionary measures must be taken, allowing the RM to cool down. This includes but is not limited to shutting off any PoE devices or limiting the transmission data rate. The following section shows the temperature event flow chart and describes which parameters can be modified to tailor the behaviour of the RM.

Event id	Event text	Temperature limit
0x1000	Low temperature	-25 degree Celsius
0x1020	Too low temperature warning	-35 degree Celsius

Table 10-8: User events related to temperature reported by RM temperature sensor.

Event id	Event text	Temperature limit
0x1010	Temperature too low (critical)	-40 degree Celsius
0x1100	High temperature	70 degree Celsius
0x1120	Too high temperature warning	75 degree Celsius
0x1110	Temperature too high (critical)	84 degree Celsius

Table 10-8: User events related to temperature reported by RM temperature sensor. (Continued)

Note

Temperatures listed in the table above refer to the temperature measured by the BGAN XL Radio Module (see section 6.4.3 on page 6-15).

10.3.3.2 Temperature handling flow chart

The only action taken by the BGAN XL Radio Module by itself is to reset if the temperature gets critically high, as well as sending a message informing of the fact (see section 8.5.6.1). It is up to the integrator to determine if power to the RM should be completely shut off. These two actions can be overridden by using the configuration parameters described in section 6.4.3.

It is recommended as a precautionary measure to limit the transmission data rate when the 'Too high' event is generated. This can be done by using the configuration parameter described in section 6.4.13. Additionally it is recommended at this point to shut down any open streaming connections as well as disable the ability to create new streaming connections while the temperature remains at a 'Too high' level. The reduction in transmission rate does NOT affect streaming connections.

Below is a flow chart of how the various events are raised in the BGAN XL Radio Module.

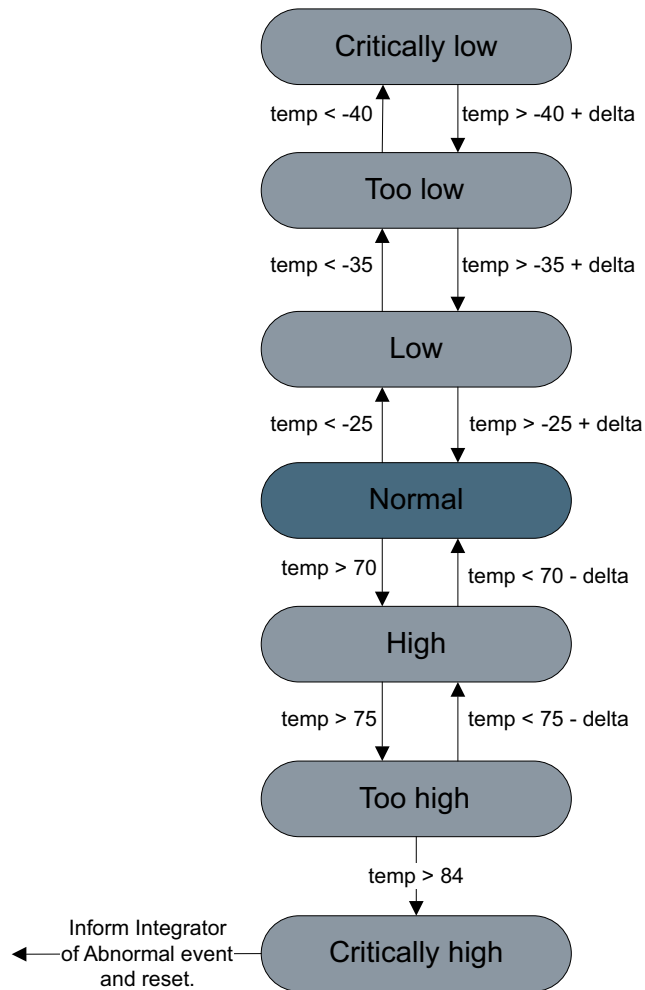


Figure 10-2: Temperature handling flow chart

The delta value when moving between events is not a static value, but a built-in hysteresis in the range of 3 – 5 degrees Celsius depending on the current active event.

10.3.4 Internal fatal errors

Various scenarios can occur which brings the BGAN XL Radio Module in a state where it is not deemed operational, in these cases a fatal error is reported to the internal errorlog of the BGAN XL Radio Module, the syslog and the board processor (see MSG_ABNORMALITY, cause code 3 in section 8.5.6.1).

Fatal errors can be a result of software or hardware errors (or a combination). They can be caused by invalid configuration parameters, continuous monitoring discovering that an internal process has stopped working, erroneous information from the RAN and so on.

10.3.5 Navigational monitoring

When the Doppler correction is enabled (see section 6.6.3 on page 6-29), then the BGAN XL Radio Module compensates its receive and transmit frequencies according to the calculated Doppler velocity. The calculated Doppler velocity is the terminal velocity vector projected onto the terminal to satellite direction.

The calculation is based on input data extracted from the navigational reports (**MSG_NAV_REPORT**, see section 8.5.4.2 on page 8-33) and the position of the selected satellite:

Input data parameter	Source
Satellite position	From the satellite earth station.
Terminal position	The integrator must deliver position, using MSG_NAV_REPORT . Used fields are: • Latitude • Longitude • Altitude
Terminal velocity vector	The integrator must deliver position, using MSG_NAV_REPORT . Used fields are: • Velocity ECEF x • Velocity ECEF y • Velocity ECEF z

Table 10-9: Doppler data

When the Doppler correction is enabled, the received navigational reports are monitored by the RM to ensure that reports are received at an acceptable rate and do not indicate large movement discontinuities or fix changes. The monitoring ensures that the RM cannot under any conditions transmit at a frequency with a potential error larger than 427 Hz if the following rules are fulfilled:

- Navigational reports with a fix type of at least 3D are received within the last 4 seconds.
- Navigational reports do not indicate a Doppler velocity of more than 600 m/s.
- Navigational reports do not indicate a change in Doppler velocity resulting in accelerations larger than 50 m/s^2 .
- Navigational reports do not give rise to a change in Doppler velocity, giving an averaged acceleration larger than 10 m/s^2 (50.6 Hz/s @ L-band), averaged over a period of 8 seconds.

If the position data in the navigational reports does not fulfil the above requirements, i.e. due to large position inaccuracies/discontinuities or fix changes, the RM will stop the transmission and send a syslog message and a message to the board processor. This will happen both during entry and exit of the condition. Furthermore, the RM will filter any change in Doppler velocity giving an acceleration larger than 6.0 m/s^2 ($> 30 \text{ Hz/s}$ differential Doppler frequency on L-band).

10.4 Error mode

The BGAN XL Radio Module will enter the **error mode** (**sys.status.mode**) if one of the following situations occur:

1. Internal POST fails.
2. If an abnormal behaviour of the modem has been detected which causes the RM to enter fail-safe operation. Fail-safe operation is activated if one of the following circumstances has been detected:
 - The Tx Acknowledge signal indicates an ongoing transmission although the transmitter inside the RM is inactive.
 - An unintended out-of-lock situation of one the RF frequency synthesizers has been detected.
3. Detection of internal errors.

In case of an error, any affected units will also enter the **error mode**.

10.4.1 Protocol error

The BGAN XL Radio Module will enter the protocol **error mode** (**sys.status.unit.0.mode**) if one of the following situations occur:

1. Internal fatal error preventing normal operation.

10.4.2 Modem error

The BGAN XL Radio Module will enter the modem **error mode** (**sys.status.unit.1.mode**) if one of the following conditions is not met:

1. A mandatory configuration is missing during service or waveform activation and the modem cannot proceed to normal operation. In this situation the RM will generate (severity level 5 as described in section 7.7.2 on page 7-33) syslog entries about the missing configuration parameters which are mandatory (§1, §2 and §3). To repair the damage the missing parameters must be written to the configuration system followed by a new activation request. When the configuration is accepted **sys.status.unit.1.mode** will be displaying **service** or **operating BGAN**.
2. Hardware error or internal error captured by the fail-safe feature (see 10.3 on page 10-11)

10.5 Diagnostic reporting

The BGAN XL Radio Module provides a diagnostic report for identifying problems in the field and during integration. The diagnostic report contains events, status and internal system information of the RM and is very useful for the support team. The RM uses Syslog to output real-time status information, while the diagnostic report is primarily used after a failing operation to collect additional system information for the support team. The contents of the diagnostic report is not documented in this manual.

10.5.1 Generating the diagnostic report

The diagnostic report is generated using the data interface and by invoking the HTTP GET method for the URL `http://[rm-ip]:8080/diagnostic/report.xml`. The response body is of MIME type "text/xml" and consists of relevant system information encoded as an XML document. It takes up to two seconds for the report.xml file to be generated.

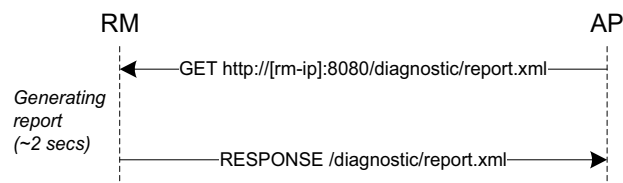


Figure 10-3: Diagnostic report request

10.5.2 Viewing the diagnostic report

The diagnostic report can be viewed using a web-browser or another XML viewing software. The BGAN XL Radio Module also provides an XSL style sheet which converts the XML formatted diagnostic report to a readable HTML page. The BGAN XL Radio Module provides three files:

- /diagnostic/report.xml
- /diagnostic/index.html
- /diagnostic/diagnostic.xsl

The index.html page contains javascripts which parse the report.xml and diagnostic.xsl to an html page that can be read in a browser.

The HTML representation of the diagnostic report can be viewed using the URL [http://\[rm-ip\]:8080/diagnostic](http://[rm-ip]:8080/diagnostic).

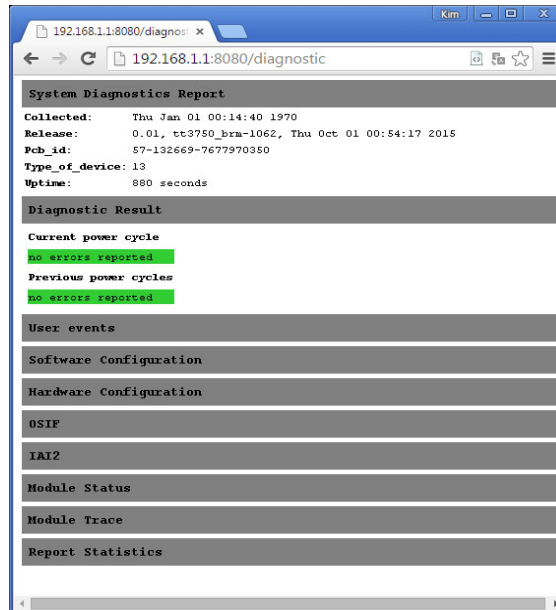


Figure 10-4: Diagnostic report browser view using Chrome

The diagnostic view is grouped into sections which can be expanded and collapsed to get an overview of the diagnostic report. All the sections can be expanded using the query string [http://\[rm-ip\]:8080/diagnostic?show=expanded](http://[rm-ip]:8080/diagnostic?show=expanded).

A custom view of the diagnostic report can be implemented using a custom style sheet located at the client/AP. The contents of the diagnostic report can also be embedded into platform/product specific diagnostic reports by reading and parsing the report.xml file.

10.5.3 Recommended use

When the BGAN XL Radio Module is used during integration or is active in the field, the diagnostic report is vital to understand and troubleshoot problems.

A diagnostic report should be fetched from the RM when the following situations occur:

- The RM is in error mode (**sys.status.mode**)
- On-air connection problems
- Configuration problems
- RM misbehaviour according to this manual

Terminal support

This chapter describes the following sections:

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11.1 Overview

A number of functions are implemented in the BGAN XL Radio Module to support integration, operation and troubleshooting of the complete terminal.

BGAN XL Radio Module Mode	Service	Operating		
Protocol mode (Unit 0)	Service	BPLT	BPT	IAI2
Modem mode (Unit 1)	Service	BGAN	BGAN	BGAN
<i>Software update</i>	x	x	x	x
<i>Extended POST</i>	x			
<i>Drift estimation</i>		x	x	x
<i>SDM sleep</i>				x
<i>Suspend</i>		x	x	x
<i>AP - BP links</i>	x	x	x	x
Integrators Interface				
<i>CW transmission</i>	x	x		
<i>Unframed transmission</i>	x			
<i>BGAN transmission</i>		x		
<i>BGAN reception</i>		x		
<i>Spectrum analyzer</i>	x			

Table 11-1: Functionality versus operating mode

11.2 Software update

11.2.1 Introduction

The software of the BGAN XL Radio Module is updated through the data interface using the HTTP protocol and the PUT method (RFC 2616 [13]).

11.2.2 Update procedure

If there is valid application software in flash and the control interface interrupt input signal (Irq_In, see 5.7.1 on page 5-20) is not active high when the RM is taken out of reset, the RM will start the application software.

The flow of the RM software update without a board processor is illustrated in the figure below.

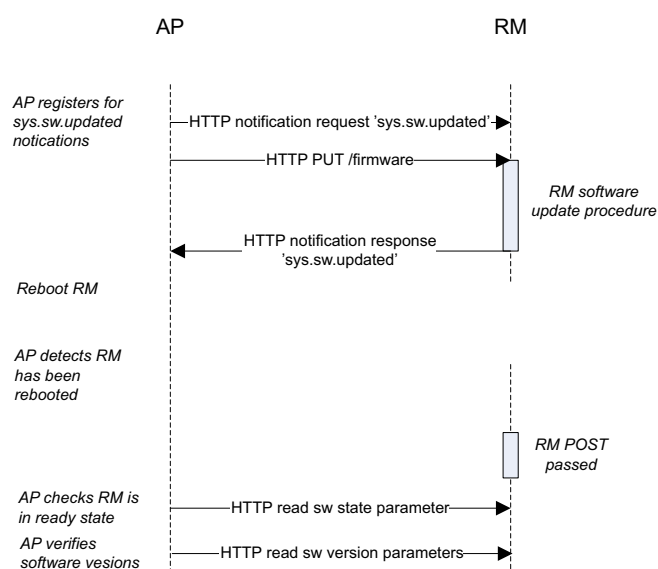


Figure 11-1: Typical software update flow with RM, AP and no BP

The AP uses the HTTP notification interface to request notification events on the **sys.sw.updated** parameter. This parameter is set when the RM software update procedure is successfully completed. The RM software update procedure is completed when the received software is verified successfully. The AP transmits a new software file using HTTP PUT to [RM-IP]:8080/firmware and the RM will verify the received software file. The port number can be changed using the setting described in 6.4.14 on page 6-19.

When the software is successfully transferred to the RM and the **sys.sw.updated** flag is set, the RM will attempt to boot the updated software after a system reset. When the RM has validated the new software during the first boot attempt the updated software is marked valid. If the RM detects a problem when starting the updated software for the

first time, the software will be marked invalid, and the RM will use the previous loaded software after a system reset. A software update is accepted if the RM exits the 'initial' state, which can be checked using the **sys.status.mode** parameter.

Note

It is important not to reboot the RM when it is booting the updated software for the first time. If the RM is reset during the first boot attempt, the internal software update validation will fail and the RM will not apply the updated software.

11.2.3 Platform update procedure (FOR INTERNAL USE)

In some cases, the RM will be controlled by a separate board processor using the serial control interface. If the AP updates the RM with software that contains a Platform TIIF the BP can fetch this software using a TFTP like protocol over the serial control interface (see 8.5.2.7 on page 8-21). In this case the BP and not the AP should control the reboot of the RM. This is illustrated in the following figure.

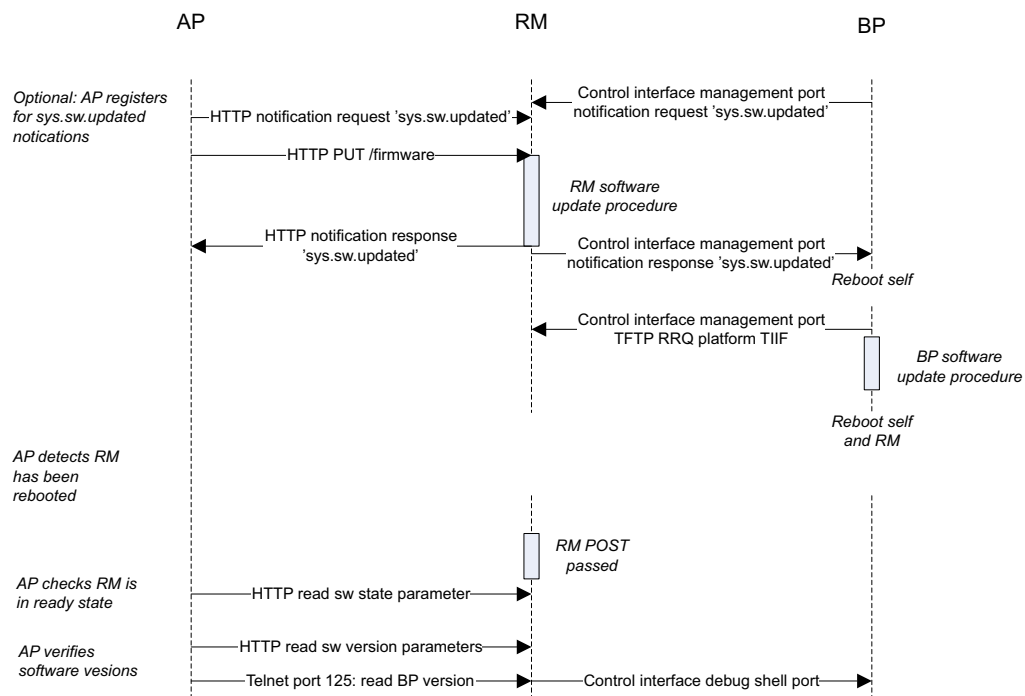


Figure 11-2: Typical software update flow with RM, AP and BP

11.2.4 Software fallback / recovery

The BGAN XL Radio Module will stop in safemode/bootloader if there is no bootable application in flash, or the Control Interface interrupt input signal (Irq_In, see 5.7.1 on page 5-20) is active high when the RM is taken out of reset.

When the BGAN XL Radio Module is in bootloader mode it will present itself with the serial number "boot loader" and device description "TT-3750 BGAN-XL Radio Module Bootloader" on the Data Interface.

In safemode/bootloader the serial Control Interface is disabled and the BGAN XL Radio Module will only accept Telnet connections on the static IP 192.168.1.1 port 23. The software update procedure uses TFTP and is initiated by the shell command “tftp_ttif x.x.x.x software_file.ttif”. The sequence is illustrated below.

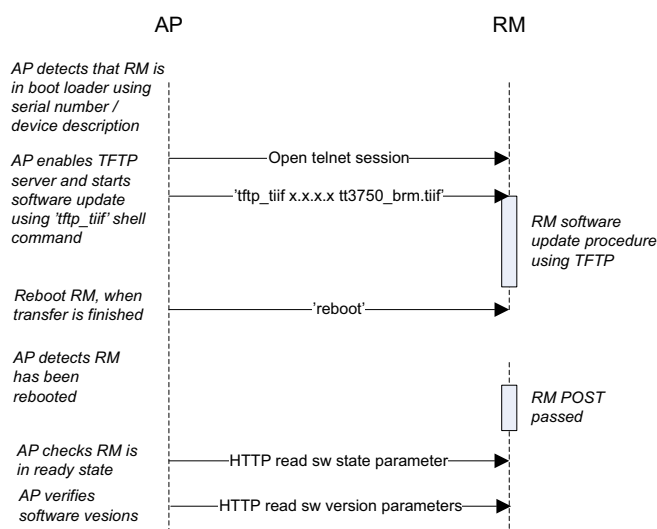


Figure 11-3: Software update from the RM boot loader

11.2.5 Verification

The software update process is continuously verified at different levels in the software. The USB layer and TCP/IP layer have their own checksum validation of network traffic, and the RM will verify the checksum of the received file before a successful software update is signalled.

When the updated software is booted for the first time it will be marked as valid when the RM enters the ‘ready’ mode. If the RM does not enter ‘ready’ mode during the first boot attempt, the updated software is not marked as valid, and the previous RM software version will be applied when the RM is rebooted.

The following events and causes will cancel or abort a software update:

- Invalid file format
- CRC check failed
- Size constraints have been exceeded
- AP connection lost during data transfer
- RM does not enter Ready state during first boot
- Internal error in the RM (see syslog for details)

11.3 Extended POST

When in **service mode** the BGAN XL Radio Module provides test functions to make interconnection tests of its various interfaces in order to allow the integrator to perform thorough testing of the terminal. These test functions are referred to as extended POST and are controlled by the integrator who must perform the pass/fail validation. The extended POST functions support tests of the following interfaces:

- RF control interface (read/write test).
- TSI interface (loop-back).
- RF interfaces (loop-back).
- Bit Error Rate testing using Rx and Tx signals (available in a later version).

11.3.1 RF control interface

The RF control interface consists of an SPI bus, 3 discrete outputs and 1 discrete input as described in section 9.2. The test will enable check of all the individual signals comprising the RF control interface.

The extended POST of the RF control interface will run a simulated sequence of setting up Rx reception at 1545.0 MHz followed by a 80 ms transmission of a CW at 1550.0 MHz (the CW signal from the BGAN XL Radio Module will be muted during this test to prevent illegal transmission of signal power on-air).

11.3.1.1 Configuration parameter dependent behaviour

The actual signals presented on the RF control interface pins during extended POST depends on the configuration of the interface (see section 6.5.5 on page 6-24). The configuration used in this test will therefore be identical to the configuration chosen for **operating mode**, thus the interface functionality tested will be the same as used during operation.

Note

If the `.rfctrl.tx.ctrl.tx_ack_en`, `.rfctrl.tx.ctrl.spi_en` or `.rfctrl.rx.ctrl.spi_en` parameters are enabled, the BGAN XL Radio Module will expect the signals to be operated as if a real transmission is present (see section 9.2.4 on page 9-14 and on page 9-23). If this is not the case the BGAN XL Radio Module could enter the **error mode**.

11.3.1.2 Test procedure

The extended POST of the RF control interface is controlled by a number of dedicated messages. They can be accessed on the control interface (see section 8.5.9 on page 8-55).

The test procedure is as follows:

1. Start the test by sending the following message on the control interface:
MSG_EXT_POST_RF_CONTROL
2. The BGAN XL Radio Module will now initiate the test sequence described in section 11.3.1.3 below.
3. When the test sequence has ended after approximately 100 ms the BGAN XL Radio Module will return the test results on the control interface in the following message:
MSG_EXT_POST_RF_CONTROL_RESP

It is up to the integrator to evaluate the received values to determine if the test is passed or failed.

11.3.1.3 Sequence of the RF control interface signals

Figure 11-4 below shows how the RF control interface signals will be exercised during an extended POST. The timing indicated in the figure is given relative to the reception of the start message on the RF control interface.

The integrator must implement the required functionality to detect if the behaviour of all the output signals in RF control interface are in accordance with the behaviour depicted in Figure 11-4 below.

For the input signals (SPI MISO and B2B_Tx_Ack) the BGAN XL Radio Module will sample these and return the result on the control interface for evaluation by the integrator.

The data field of the response message **MSG_EXT_POST_RF_CONTROL_RESP** from the RM after test is defined as follows:

Tx Acknowledge

The B2B_Tx_Ack signal is sampled twice during the test and the returned result is defined by:

Tx Acknowledge response = **NOT**(sample1) **AND** (sample2)

During normal operation a sampling of LOW is expected initially and HIGH in the middle of the test resulting in a response equal to 1 (HIGH).

Note If a power detector is connected directly to the B2B_Tx_Ack pin this will not be triggered during the test since no RF is transmitted. Thus the Tx_Ack response cannot be used.

11.3.1.3.1 SPI MISO

The SPI MISO signal is sampled simultaneously with the transmission of the second MOSI message as shown in the figure below. The content of the MISO message is returned to the integrator for evaluation.

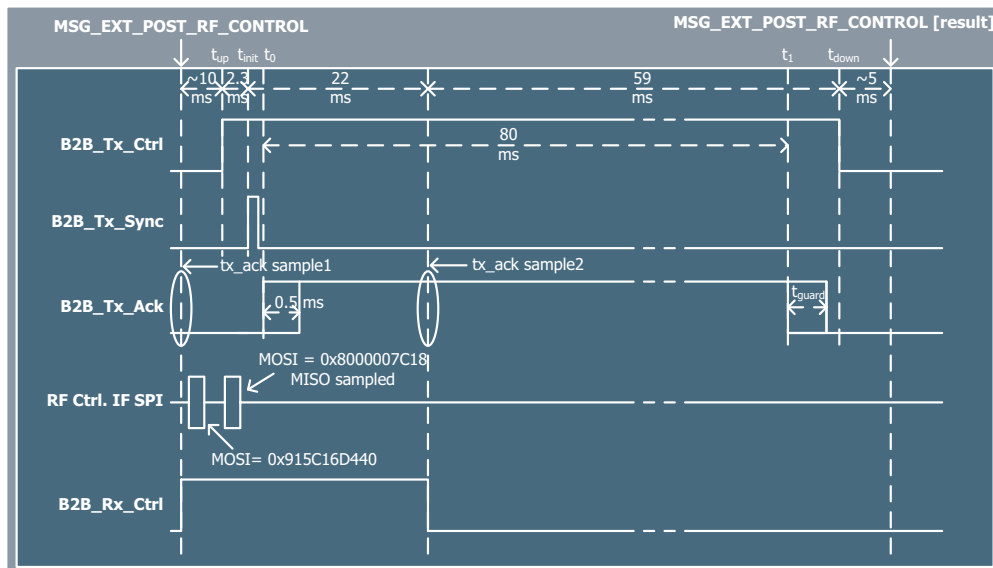


Figure 11-4: Sequence of the RF control interface signals during extended POST

The figure above shows a scenario where all functionality of the RF control interface is enabled. If e.g. `.rfctrl.rx.ctrl.spi_en` and `.rfctrl.rx.ctrl.rx_ctrl_en` configuration parameters both are disabled, the B2B_SPI MOSI message will not be transmitted and B2B_Rx_Ctrl will not be set high during the test.

11.3.2 RF Loop-back

The BGAN XL Radio Module offers functionality so that the integrator can perform a simple loop-back test of the Tx and Rx L-band signals using an *external* loop-back circuit.

When in **service mode** the integrator has the opportunity to transmit either a Continuous Wave (CW) signal or an unframed modulated signal on a specific frequency and with a certain power level (see section 11.7.2 on page 11-18). Likewise there is access to the internal spectrum analyzer which can be configured to analyse a signal injected at the Rx connector (see section 11.12 on page 11-32). The measured frequency offset, phase noise and signal level will be returned to the integrator so that it can be used for pass/fail validation.

11.3.3 Bit-Error-Rate testing (BER)

The BGAN XL Radio Module offers a functionality so that the integrator can perform a simple Bit Error Rate test of an L-band signal (injected at the Rx connector via an external BGAN modulator).

The integrator has the opportunity to bypass the FEC decoding (via the parameter specified in section 6.6.8 on page 6-31) and thereby get the raw bits from the channel.

If the BGAN XL Radio Module is configured to operate in **BPLT mode** the integrator can get access to the received FEC blocks and thereby perform some additional processing (i.e. bit-error-rate calculation) externally.

Note In order to evaluate the bit-error rate of the received signal the integrator must be in control of an externally connected BGAN transmitter and have knowledge of the transmitted bit patterns.

11.3.4 TSI Loop-back

TSI Loop-back is intended for testing of the TSI interface during integration or connection verification during production tests. When enabled, the BGAN XL Radio Module will loop-back data received in channel 0.

The following procedure must be followed to enable TSI Loop-back:

- Bring the RM in Service Mode
- Set the TSI parameters:
 - **sys.bus.pcm.txdatdly** and **sys.bus.pcm.rxdatdly** to match setup
 - **sys.bus.pcm.rxslots** to 1
 - **sys.bus.pcm.txslots** to 1
- Enable TSI using **sys.bus.pcm.enabled**
- Enable TSI Loop-back using **sys.bus.pcm.loopback.enable**
- The RM will now loop-back data in channel 0

The RM must be restarted to end the TSI Loop-back mode.

11.4 Drift estimation

During normal run time operation the BGAN XL Radio Module offers the possibility to distribute various drift information to the integrator via a dedicated slot on the TSI bus:

1. The symbol clock drift of the received forward channel (which is directly related to a misalignment of the reference oscillator) is continuously measured. The clock drift information is available via a set of parameters located in the configuration system (see section 6.7.2 on page 6-37) which can be read asynchronously by the integrator.
2. The drift of the circuit switched fifo (directly related to the drift in the plesiochronous buffers) is continuously measured.

Some applications require that the drift information is distributed in a more synchronous way, because it must be used to adjust an externally controlled clock (e.g. adjusting the clock rate of the PCM/TSI bus). To fulfil this requirement the RM can be configured to distribute the drift information on user-specified slots on the TSI bus as illustrated in the figure below.

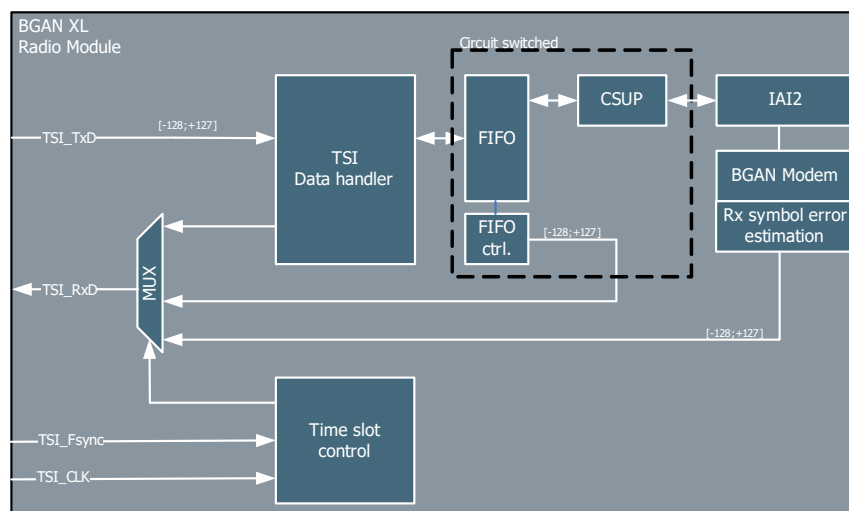


Figure 11-5: Drift distribution on the PCM/TSI bus.

11.4.1 Clock drift

The clock drift information is distributed over the PCM/TSI bus. It is represented as an 8-bit signed value (byte 2) which yields a range of:

$$[-2^7, 2^7-1] \times 0.0625\text{ppm} = [-8.0000, +7.9375]\text{ppm} = [0x80, 0x81 \dots 0xFF, 0x00, 0x01 \dots 0x7E, 0x7F]$$

This 8-bit representation covers the worst-case drift of the internal reference oscillator and provides a resolution of 0.0625 ppm (equal to an L-band frequency error of approximately 96 Hz@1542 MHz) which is considered to be accurate enough for the majority of the applications using the BGAN XL Radio Module. A set of parameters

located in the configuration system (see section 6.6.5) controls enabling of the clock drift information.

11.4.2 CS FIFO drift

The CS FIFO drift information is distributed over the PCM/TSI bus. It is represented as an 8-bit signed value (byte 3) which yields a range of:

$$[-2^7, 2^7-1] \times 0.0625\text{ppm} = [-8.0000, +7.9375]\text{ppm} = [0x80, 0x81 \dots 0xFF, 0x00, 0x01 \dots 0x7E, 0x7F]$$

This 8-bit representation covers the worst-case drift in the circuit switched fifo. A set of parameters located in the configuration system (see section 6.6.5 on page 6-30) controls enabling of the CS FIFO drift information.

11.5 Power management

The BGAN XL Radio Module is designed to save as much power as possible for two main reasons:

1. Save battery power, relevant for battery powered (portable) products.
2. To reduce the heat dissipation (all products) in the terminal.

When in **service** or **operating** mode the BGAN XL Radio Module operates with an autonomous power management scheme which is designed to save as much power as possible at all times. The various sub-modules in the BGAN XL Radio Module will be powered down whenever possible while respecting functional requirements given by the actual operational mode.

The BGAN XL Radio Module supports sleep mode operation¹ as defined by the SDM (see [18]). To avoid confusion among the operational modes defined in section 6.1.1 on page 6-2 this state will be referred to as **SDM sleep** further on. If activated by the integrator in the configuration system the BGAN XL Radio Module will enter this power management state when it is in **operating iai2** mode and is registered to the BGAN network if no PS or CS connection is established.

In certain applications it may be convenient for the integrator to instrument the internal power management schemes to immediately save power while maintaining the ability to resume to normal operation as soon as possible. For this purpose the BGAN XL Radio Module supports a special message on the control interface which will bring the BGAN XL Radio Module into a low-power state designated **suspend**.

Detailed information on **SDM sleep** and **suspend** can be found the following sub-sections.

11.5.1 SDM sleep

Support of **SDM sleep** is enabled using the configuration parameter described in section 6.4.5 on page 6-16.

1. Not applicable to all terminal classes; see the SDM [18].

The following figure illustrates an example of an **SDM sleep** scenario. The RM (mainly the IAI2- and UMTS protocol) is inactive in 58 frames (each 80 ms), then the receiver is started up with a ramp up of 5 frames waiting for any data in the 64th frame.

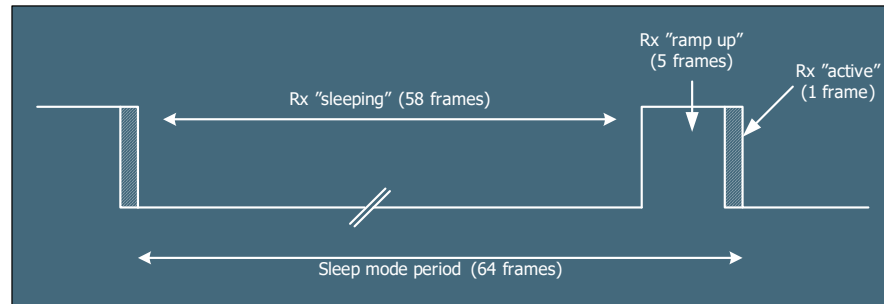


Figure 11-6: SDM sleep mode sequence (example).

During **SDM sleep** a number of internal interfaces are powered down or forced into a power saving mode.

In active mode, power save also takes place as the various entities will go into a power saving mode when not being used e.g. when not transmitting various components in the transmitter chain are powered down.

Note The sleep-mode parameters used by a specific terminal may be modified by the BGAN earth station whenever the terminal is in an 'active' state. So the integrator is highly encouraged to make a design that does not anticipate a fixed sleep mode interval (e.g. 1 frame every 64th). The integrator should consult the latest version of the BGAN SDM to get figures for minimum and maximum sleep mode period.

11.5.2 Suspend

The BGAN XL Radio Module offers support functionality for short-term power outage (also referred to as power hold-up) so that the integrator can reduce the power consumption for a short period of time at the expense of interruptions in the data session.

Suspend can be enabled with **MSG_SUSPEND_REQ** (see section 8.5.2.8 on page 8-24) and **sys.suspend.enable** (see section 6.6.11 on page 6-32)

Important **MSG_SUSPEND_REQ** should be used if timing is critical (e.g. power loss) but it **cannot** be used together with SDM sleep.

sys.suspend.enable has a slower timing but can be used together with SDM sleep.

Timing diagrams in this chapter are for using **MSG_SUSPEND_REQ**.

Upon reception of a suspend request, the RM will initiate the powerdown sequence illustrated in the left half of Figure 11-7. When the sequence has been completed the RM will be held in the lowest possible power consumption.

The RM will initiate the power up sequence illustrated in the right half of Figure 11-7 upon reception of an abort notification (refer to section 8.5.2.8 on page 8-24 or section 6.6.11 on page 6-32).

In most short-term power failures (10 ms .. 200 ms) the RM will be capable of restoring any active calls and/or data sessions after the power has been re-established and the power up sequence has completed.

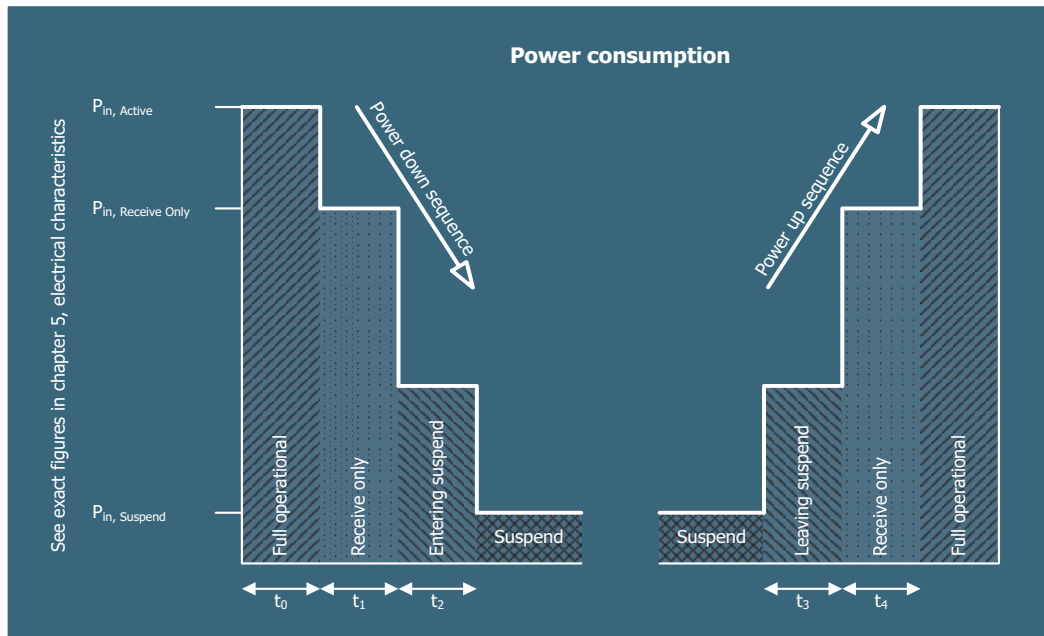


Figure 11-7: Suspend power down sequence.

The exact figures of the power consumption in the different states shown in the figure above can be found 5.6.1 on page 5-14, whereas the different timing intervals are summarized in the table below.

Name	Time [ms]	Description
t_0	20	The typical time consumed from a MSG_SUSPEND_REQ message has been received and until an ongoing transmission has been ceased and the transmitter chain is brought into its low power mode.
t_1	2	The typical time consumed during termination of an ongoing reception and bringing the receiver chain into its low power mode.
t_2	1	The typical time consumed to prepare the entire modem for suspend mode with lowest possible power consumption.

Table 11-2: Description of suspend timing intervals

Name	Time [ms]	Description
t_3	20	The typical time consumed from a MSG_SUSPEND_ABORT is received to bring the entire modem out of suspend mode and enter receive only state.
t_4	240	The typical time consumed to enter the full operational state. Depending on the physical conditions on the forward channel the time can in some scenarios be higher than 420 ms. It takes some additional time before the RM has received reservations from RAN and can transmit.

Table 11-2: Description of suspend timing intervals

Note

It is not recommended to write configuration parameters to the RM while it is in suspend mode.

- RM will use extra power to handle write operations.
- RM can miss configuration parameter changes if many parameters are written in the same suspend period.

The response to protocol messages for antenna pointing (section 8.5.5 on page 8-36) will be delayed until suspend has ended.

11.5.3 Modem recovery

The BGAN XL Radio Module has incorporated a mechanism (when the modem is in **operating bgan**) which makes the modem more tolerant to disruptions of the satellite signal and facilitates lower power consumption. The mechanism includes 2 different behavioural modes which can be controlled by the integrator.

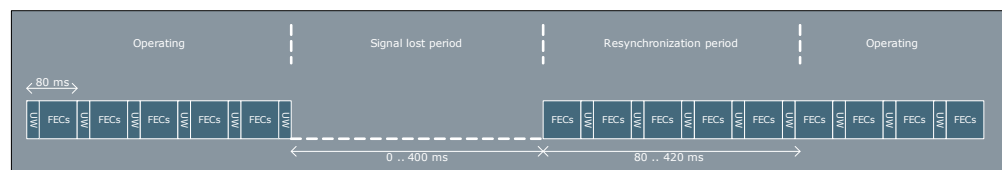


Figure 11-8: Modem re-synchronization.

1. In scenarios where the satellite signal disappears in a short period of time (up to 400 ms). This mode does not require any interaction from the Integrator as the modem automatically detects **signal blocking**. When signal blocking is detected the modem will stop any transmission in progress and continuously wait for the signal to reappear. When the signal reappears the re-synchronization period will be within the range from 80 ms to 320 ms depending on the specific channel conditions and forward bearer type. The estimated power consumption in this mode is shown in table below.

2. If the integrator needs the power consumption to be reduced significantly, as described in the previous section, interaction from the RM is required. In scenarios where the integrator has knowledge that the satellite signal is not available the RM can be forced into **suspend**. In suspend, all modem activities will be de-activated until the RM is informed otherwise. The recovery period (after suspend) will be in the range of 280 ms to 420 ms depending on the specific channel conditions and forward bearer type. The end of the recovery period is the point in time where the modem again has a lock on a forward carrier. It takes some additional time before the RM has received reservations from the RAN and can transmit

Mode	Recovery time		Estimated power consumption ^a
	Min	Max	
Signal blocking	80 ms	320 ms	$P_{in, \text{Receive Only}}$
Suspend	280	420	$P_{in, \text{Suspend}}$

Table 11-3: Modem recovery times

- a. Refer to section 5.6.1 on page 5-14.

11.6 AP - BP links

As illustrated in the figure below the BGAN XL Radio Module provides two different mechanisms to assist communication between the data interface and the control interface. A simple **put** and **get** interface (via the internal configuration system) and a more sophisticated data tunnel using UDP/TCP.

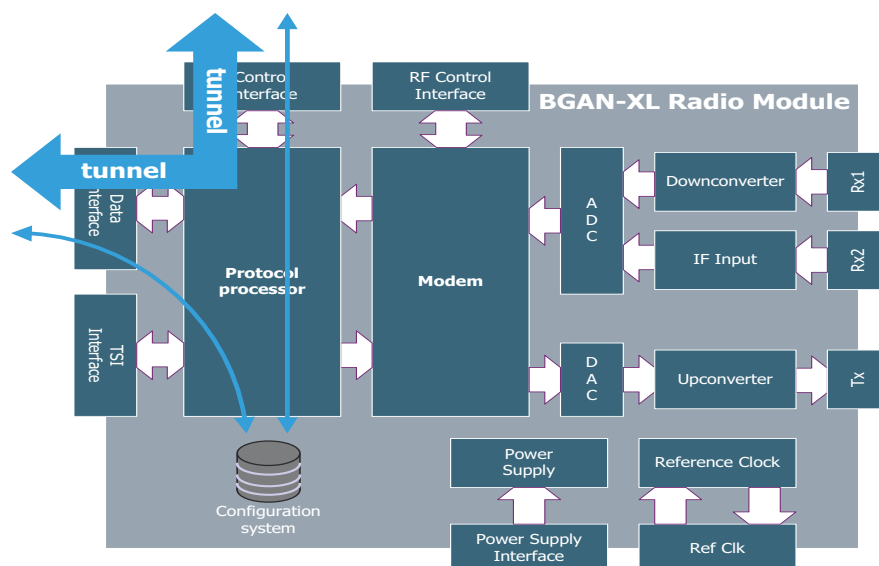


Figure 11-9: AP - BP links

Four **data tunnels** are providing communication links between the data interface and the control interface. Details about this data tunnel protocol can be found in respectively section 7.7.5 on page 7-39 and in section 8.5.7 on page 8-53.

The **put** and **get** interface offers dynamic creation of parameters in the configuration system, by the Board Processor or Application Processor. This can be used to exchange simple status and configuration information between the Application Processor and Board Processor.

All created parameters must be written in the **platform** parameter group as seen in section 6.3.1 on page 6-11. The **platform.usim** parameter group is reserved for USIM parameters (6.5.1 on page 6-21).

The Application Processor must access the platform specific settings using the HTTP path **/platform/...** whereas BGAN XL Radio Module parameters must be accessed using the **/setting/...** path.

Note | Currently there are no limitations or restrictions for creating dynamic parameters in the **platform** parameter group. In future releases there will be a limit of 100 allowed parameters.

11.7 Integrator's interface

The Integrator's interface is an HTTP based interface to a number of functions relevant to an entity implementing the BGAN XL Radio Module in a product.

The following functions are supported:

- *CW transmission*
- *Unframed transmission*
- *BGAN transmission*
- *BGAN reception*
- *Spectrum analyzer*

Not all functions can be used concurrently, i.e. the three transmission functions are mutually exclusive. Also the different functions are only supported in specific RM modes.

The interface is a simple HTTP error code based interface where URLs with key/value pairs are called, success/failure is returned, and the overall system state can be polled as well, making this interface ideal for scripted access from a number of platforms.

11.7.1 Prerequisites

An HTTP client is needed. This could be a normal web browser, for testing, a CLI-based HTTP client such as wget or curl for automation, or a library such as Python's http.client for scripting.

Additionally, the BGAN XL Radio Module must be connected to a PC or an AP and the CDC-EEM link needs to be up, providing Ethernet connectivity (see section 7.2).

11.7.2 Test signal generation

The BGAN XL Radio Module offers functionality so that the integrator can transmit various test signals:

- Transmission of a continuous wave signal (CW)
- Transmission of an unframed modulated carrier with the possibility to specify:
 - Modulation schemes: $\pi/4$ -QPSK, 4-QAM, 16-QAM, 32-QAM or 64-QAM
 - Symbol rate: 16800, 33600, 67200, 84000, 151200 and 168000 S/s
- Transmission of all BGAN-XL defined return bearers (including LDR and HDR) with the possibility to specify:
 - Tx frequency
 - Number of bursts to transmit
 - EIRP backoff
 - Data payload (random, zero-frame or one-frame)

- Timing corrections
- Synchronized by demodulator or simulated
- If CW80 is present or not for LDR bearer types.

These transmitter functions are described in the following sections together with a thorough description of their interfaces.

11.7.3 Test signal reception

The BGAN XL Radio Module offers functionality that makes the integrator capable of receiving test signals using:

- The spectrum analyzer
- The BGAN demodulator

These receiver functions are described in the following sections together with a thorough description of their interfaces.

11.7.4 General use of the integrator's interface

All functions are accessed by calling various URLs that start with:

`http://192.168.1.1:8080/intif/`

Here it is assumed that the BGAN XL Radio Module is configured with the IP address 192.168.1.1. If configured differently, substitute the IP address. In the following sections this URL is referred to as:

`.../intif/`

The subsequent path determines the functionality and action, and parameters in key/value pairs are used for configuration. Parameters can be mandatory or optional. For instance, the Tx Burst functionality can be started by calling:

`.../intif/txburst/start?freq=1675000000&bearer=R5T1X&coderate=R&reps=100`

And stopped by calling:

`.../intif/txburst/stop`

In general all functions must be finished, before they can be restarted, e.g. due to the continuous nature of CW and unframed transmission, these must always be stopped before a new transmission can be started.

At any time, the current state of the functionality and the BGAN XL Radio Module can be seen at the status URL:

`.../intif/status`

11.8 CW transmission

The BGAN XL Radio Module offers the capability to transmit a continuous wave (CW) manually. This functionality is a special case of the unframed transmission functionality (see section 11.9) and can be achieved in '**service**' and '**BPLT waveform**' modes.

The CW is RRC filtered and generated with a symbol rate of 168000 S/s which generates harmonics (+/- 168 kHz away from the CW). The typical level of this harmonic is -50dBc

11.8.1 Integrator's interface

Functionality	Tx Cont (/txcont/)
Actions	start, stop
States	Idle, Transmitting CW
Modes supported	Service, BPLT
Blocks functionality	Yes, blocks unframed and BGAN transmission.

Parameter	Name	Valid Values	Mandatory	Default
Frequency (Hz)	freq	1518000000..1700000000 (in steps of 1 Hz)	Yes	N/A
EIRPbackoff	backoff	0.00..10.00 (in steps of 0.01 dB)	No	0

Table 11-4: Parameter overview for CW transmission

Example: Start CW transmission at 1546 MHz and backoff: 3.25 dB

```
.../intif/txcont/start?freq=1546000000&backoff=3.25
```

Example: Stop CW transmission

```
.../intif/txcont/stop
```

11.8.2 Python

Function name	Description
start(...)	This function starts a CW transmission ('service', 'BPLT waveform' mode). Parameters: <freq> Frequency in Hz [1518000000..1700000000], in steps of 1 Hz <backoff> EIRP backoff in dB [0..10] with 0 as max, in steps of 0.01 dB Constraints: Expect a delay of approx. 55 ms from Tx start to the signal is present on the RF connector.
stop()	This function stops an ongoing CW transmission. Constraints: Expect a delay of approx. 160 ms from Tx stop to the signal is removed from the RF connector.

Table 11-5: Support functionality: .\scripts\tt\brm\tx_cw.py

Note

The example file **ex_tx_cw.py** illustrates how a CW is generated using the functions described above. The example is on the accompanying CDROM which is delivered with the Integrators development kit which must be purchased separately (see details about ordering in section 3.10 on page 3-11).

11.9 Unframed transmission

The BGAN XL Radio Module offers the capability to transmit a modulated carrier (without framing) manually. This functionality can be achieved in '**service**' mode.

The integrator must be aware that the unframed transmission allows combinations of symbol rate and modulation type which are not supported by the SDM. In these scenarios the roll-off factor of the channel filter is linked to the symbol rate such that carriers with symbols rates of 16800, 33600, 67200 and 151200 S/s are filtered with a roll-off factor of 0.25, whereas carriers with symbol rates of 84000 and 168000 S/s are filtered with a roll-off factor of 0.13.

11.9.1 Integrator's interface

Functionality	Tx Cont (/txcont/)
Actions	start, stop
States	Idle, Transmitting Unframed
Modes supported	Service
Blocks functionality	Yes, blocks CW and BGAN transmission.

Parameter	Name	Valid Values	Mandatory	Default
Frequency (Hz)	freq	1518000000..1700000000 (in steps of 1 Hz)	Yes	N/A
EIRP backoff	backoff	0.00..10.00 (in steps of 0.01 dB)	No	0
Symbol Rate	symbolrate	16800, 33600, 67200, 84000, 151200, 168000	No	168000
Modulation	modulation	Q, X4, X16, X32, X64 Q: pi/4-QPSK X4: QPSK X16: 16-QAM X32: 32-QAM X64: 64-QAM	Yes	

Table 11-6: Parameter overview for Unframed transmission

Example: Start unframed transmission at 1546 MHz, backoff: 3.25 dB, symbolrate: 151200 S/s and modulation: 32-QAM

```
00./intif/txcont/start?freq=1546000000&backoff=3.25&modulation=X32&symbolrate=1512
```

Example: Stop unframed transmission

```
.../intif/txcont/stop
```


11.9.2 Python

Function name	Description
start(...)	This function starts an unframed transmission ('service' mode). Parameters: <freq> Frequency in Hz [1518000000..1700000000], in steps of 1 Hz <backoff> EIRP backoff in dB [0..10] with 0 as max, in steps of 0.01 dB <symbolrate> Symbol rate in S/s [16800, 33600, 67200, 84000, 151200, 168000] <modulation> Known modulations ['Q', 'X4', 'X16', 'X32', 'X64'] Constraints: Expect a delay of approx. 55 ms from Tx start to the signal is present on the RF connector.
stop()	This function stops an ongoing unframed transmission. Constraints: Expect a delay of approx. 160 ms from Tx stop to the signal is removed from the RF connector.

Table 11-7: Support functionality: .\scripts\tx_unframed.py

Note The example file **ex_tx_unframed.py** illustrates how an unframed transmission is generated using the functions described above. The example is on the accompanying CDROM which is delivered with the Integrators development kit which must be purchased separately (see details about ordering in section 3.10 on page 3-11).

11.10 BGAN transmission

The BGAN XL Radio Module offers the capability to transmit BGAN formatted bursts manually. This functionality can be achieved in '**BPLT waveform**' mode.

To transmit BGAN formatted bursts the BGAN XL Radio Module must be locked to a forward BGAN carrier as the Tx carrier is synchronised to it. The BGAN reception functionality (see section 11.11) can be used to acquire a 'simulated' or 'real life' BGAN carrier (which enables burst transmission). Only combinations of bearer type, code rate and cw80, that are supported by the SDM can be transmitted.

11.10.1 Tx time-plan

In addition to the transmission of BGAN-XL defined bearers, the BGAN XL Radio Module also offers a capability to specify transmit patterns (emulating BGAN return schedules). This functionality is referred to as a 'Tx time-plan' which offers the possibility to specify:

- Transmit patterns (bearer types and frequency offsets)
- EIRP back-off patterns
- Timing correction patterns
- Coding rate patterns

The Tx time-plan can be specified via the configuration system as described in section 6.10.2 on page 6-59. An example of a Tx time-plan is illustrated in the figure below.

Tx timeplan example (slot 0 = R5T4.5QL8 and slot 8 = R5T1XL3)

5 ms time slots	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bearer Type	R5T4.5QL8	NA	NA	NA	NA	NA	NA	NA	R5T1XL3	NA	NA	NA	NA	NA	NA	NA
Coding Rate	L8								L3							
Freq offset	0								50000							
EIRP backoff	0								0							
Timing	0								0							

← 80 ms →

Figure 11-10: Tx time-plan (ex_tp1)

As shown in the figure above, the Tx time-plan consists of 16 entries, each corresponding to a 5 ms time slot for a total period of 80 ms. Each entry consists of the following fields:

- Bearer type as specified in *Table 9-8 on page 9-26*
- Coding rate as specified in *Table 9-8 on page 9-26*

- Frequency offset in Hz (range from -100 kHz to +100 kHz from centre)¹
- EIRP backoff in dB (range from 0 dB to 10 dB)
- Timing in microseconds (range from -180 μ s to +180 μ s)²

The figure above holds an example where a R5T4.5QL8 burst is transmitted in slot 0 and R5T1XL3 is transmitted in slot 8. All the remaining slots (1..7 and 9..15) are empty.

Bearer types corresponding to 20 ms bursts are specified on 4-slot boundaries (i.e., entries 0, 4, 8, 12). If a 20 ms bearer type has been specified, the contents of the following three slots will be ignored as illustrated in the figure below.

Tx timeplan example (slot 0, 4, 8, 12 = R20T1QL8)

5 ms time slots	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bearer Type	R20 T1Q	NA	NA	NA	R20 T1Q	NA	NA	NA	R20 T1Q	NA	NA	NA	R20 T1Q	NA	NA	NA
Coding Rate	L8				L8				L8				L8			
Freq offset	0				0				0				0			
EIRP backoff	0				0				0				0			
Timing	0				0				0				0			

← 80 ms →

Figure 11-11: Tx time-plan with four 20 ms bursts (ex_tp2).

HDR and LDR bearer types corresponding to 80 ms bursts are specified on 80 ms frame boundaries (rather than 5 ms frame boundaries) as illustrated in the following figure. The example illustrates a transmission of sixteen FR80T5X frames. The first eight are transmitted with 16-QAM modulation and L3 code rate whereas the last eight are 32-QAM with H1.

1. Note that the sum of the frequency offset and the Tx frequency must be within the range [1518000000...1700000000].
2. Note that the sum of the self imposed delay (SID) and the timing correction must be within the range [0...80000].

Tx timeplan example (frame 0..7 = FR80T5X16L3 and frame 8..15 = FR80T5X32H1)

80 ms time frame	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bearer Type	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X16	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32	FR8 OT5 X32
Coding Rate	L3	L3	L3	L3	L3	L3	L3	L3	H1	H1	H1	H1	H1	H1	H1	H1
Freq offset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EIRP backoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Timing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

← 16x80 ms →

Figure 11-12: Tx time-plan with four 80 ms bursts (ex_tp3).

Note | Note that it is only permitted to combine 80 ms bearers with the same symbol rate in a Tx time-plan i.e. T2.5 bearers with 4-QAM, 16-QAM, 32-QAM and 64-QAM or T5 bearers with 4-QAM, 16-QAM, 32-QAM and 64-QAM.

Not all combinations of data in the Tx time-plan are legal. If an illegal combination is created the Tx output will be one of the following 3 categories:

- No slots are sent
- Only legal slots are sent
- Some or all sent slots contain undefined data

Independent of error category, an illegal Tx time-plan can cause error messages in the event log.

Note the following Tx time-plan constraints:

- Max 'Frequency offset' is
 - 0 Hz for T45 and T5 bearers
 - 50 kHz for T2 and T25 bearers
 - 75 kHz for T1 bearers
 - 87.5 kHz for T05 bearers
- For a timing offset change between adjacent R5/R20 slots, the timing offset for the second slot must be larger than the timing offset for the previous minus 6 symbols (-178 µs).
- Minimum pause between legacy bearers slots (R5, R20) and HDR/LDR slots (R80) is 20 ms
- Maximum 'EIRP back off change' between adjacent HDR/LDR slots is 1 dB
- Timing offset change between adjacent HDR/LDR slot is illegal
- Freq offset change between adjacent HDR/LDR slots is illegal
- R20 slots is only legal in 5 ms slot time 0, 4, 8 or 12

11.10.2 Integrator's interface

Functionality	Tx Burst (/txburst/)
Actions	start, stop
States	Idle, Bursting
Modes supported	BPLT
Blocks functionality	Yes, blocks CW and unframed transmission
Notes:	

- Tx Burst requires an input signal from either an internal BGAN frame generator, a Physical Layer Tester or a real signal to work, as this is used for synchronization.
- When using the Tx time-plan bearer type, code rate and backoff are determined by the Tx time-plan entry, whereas the entries for frequency and timing are used as offsets to the values provided through the Integrator's Interface.
- Each Tx time-plan entry counts as one burst, e.g. for transmitting a Tx time-plan with four entries twice, the reps-parameter must be set to 8.

Parameter	Name	Valid Values	Mandatory	Default
Bearer Type	bearer	R5T1X, R5T1XD, R5T2X, R5T2XD, R5T45X, R5T45XD, R20T1X, R20T1XD, R20T2X, R20T2XD, R20T45X, R20T45XD, R5T2Q, R5T2QD, R5T45Q, R5T45QD, R20T05Q, R20T05QD, R20T1Q, R20T1QD, R20T2Q, R20T2QD, R20T45Q, R20T45QD, R80T05Q, R80T1Q, FR80T25X4, FR80T25X16, FR80T25X32, FR80T25X64, FR80T5X4, FR80T5X16, FR80T5X32, FR80T5X64, F80T025Q1, F80T1Q4, F80T1X4, F80T45X8, F80T1Q1	Yes	N/A
Code Rate	coderate	L14, L13, L12, L11, L10, L9, L8, L7, L6, L5, L4, L3, L2, L1, R, H1, H2, H3, H4, H5, H6	Yes	N/A
CW80 Preamble	cw80	on, off	No	off
EIRP backoff	backoff	0..10 (in steps of 0.01 dB)	No	0
Frequency (Hz)	freq	1518000000..1700000000 (in steps of 1250 Hz)	Yes	N/A

Table 11-8: Parameter overview for BGAN transmission

Parameter	Name	Valid Values	Mandatory	Default
Payload Data	pd	ones: payload data is filled with all ones. zeroes: payload data is filled with all zeroes. random: payload data is filled with a random sequence of bytes. Seed value used to determine the random values are only modified with each byte written. counter: payload data is filled with a 16 bit continuous counter. Start value is incremented by 1 for each FEC block. prbs: A different variant of random bytes, the seed value used to generate the random data is modified with each byte written as well as when a new FEC block is started.	No	random
Number of bursts	reps	0..4294967295 (0 = continuous Tx)	No	0
Self Imposed Delay (μs)	sid	0..80000	No	0
Time-plan	timeplan	on, off	No	off

Table 11-8: Parameter overview for BGAN transmission (Continued)

Example: Start BGAN transmission at 1546 MHz, bearer: FR80T25X4, code rate: L3

```
.../intif/txburst/start?freq=1546000000&bearer=FR80T25X4&coderate=L3
```

Example: Stop BGAN transmission

```
.../intif/txburst/stop
```

11.10.3 Python

Function name	Description
start(...)	This function starts a BGAN transmission ('<i>BPLT waveform</i>' mode). Parameters: <freq> Frequency in Hz [1518000000..1700000000], in steps of 1250 Hz <bearer> Bearer type (e.g. R5T1X) <coderate> Code rate [L14..L1,R,H1..H6] <sid> Self Imposed Delay in μs [0..80000] <backoff> EIRP backoff in dB [0..10] with 0 as max, in steps of 0.01 dB <pd> Payload data (ones zeroes random counter prbs) <reps> Number of bursts to transmit (0 = continuous Tx) <cw80> Use CW80 (Only certain bearers) (on off) <timeplan> Use Tx time-plan (on off) Constraints: Expect a delay of approx. 80 to 160 ms from Tx start to the signal is present on the RF connector.
stop()	This function stops an ongoing BGAN transmission. Constraints: Expect a delay of approx. 160 ms from Tx stop to the signal is removed from the RF connector.
configure_timeplan(...)	This function configures a Tx time-plan. Parameters: <slot_index> Slot number [0..15] <bearer> Bearer Type (R5T1X, R5T2X etc.) Empty string if slot is unused <coderate> Code rate (L14..L1,RE,H1..H6) <freq_offset> Frequency offset in Hz [-100000..100000] <backoff> EIRP backoff in dB [0;10] with 0 as max, in steps of 0.01 dB <timing> Timing displacement of the burst in μs [-180..180]

Table 11-9: Support functionality: .\scripts\tt\brm\tx_burst.py

Note

The example file **ex_tx_burst.py** illustrates how a burst transmission is generated using the functions described above. The example is on the accompanying CDROM which is delivered with the Integrators development kit which must be purchased separately (see details about ordering in section 3.10 on page 3-11).

11.11 BGAN reception

The BGAN XL Radio Module offers the capability to manually set up a reception of a carrier with a BGAN formatted bearer type. This functionality can be achieved in '**BPLT waveform**' mode.

When the forward bearer synchronisation is simulated the reference clock will be initialised to the value specified in section 6.7.2 on page 6-37.

11.11.1 Integrator's interface

Functionality	Rx Receive (/rxreceive/)
Actions	start, stop
States	Idle, Receiving
Modes supported	BPLT
Blocks functionality	None

Parameter	Name	Valid Values	Mandatory	Default
Frequency (Hz)	freq	1500000000..1600000000 (in steps of 1250 Hz)	Yes	N/A
Bearer Type	bearer	F80T025Q1B, F80T1Q4B, F80T1X4B, F80T45X8B, F80T1Q1B, F80T25X4, F80T25X16, F80T25X32, F80T25X64, F80T5X4, F80T5X16, F80T5X32, F80T5X64	Yes	N/A
Frame Generator	simulate	on, off	No	off
Acquisition	acquisition	warm, initial	No	warm

Table 11-10: Parameter overview for BGAN reception

Example: Start BGAN reception at 1546 MHz, bearer: F80T25X4, frame generator: on

```
.../intif/rxreceive/start?freq=1546000000&bearer=F80T25X4&simulate=on
```

Example: Stop BGAN reception

```
.../intif/rxreceive/stop
```


11.11.2 Python

Function name	Description
start(...)	This function is used to start an reception of a BGAN bearer (<i>BPLT waveform</i> mode). Parameters: <freq> Frequency in Hz [1500000000..1600000000], in steps of 1250 Hz <bearer> Bearer type (e.g. F80T25X4) <simulate> Simulate reception of a forward channel signal (on | off) Constraints: Expect a delay of approx. 5 ms before the command has been issued.
stop()	This function is used to stop an ongoing BGAN reception.

Table 11-11: Support functionality: .\scripts\brm\rx_receive.py

Note

The example file **ex_rx_receive.py** illustrates how a BGAN reception is configured (and used as reference for burst transmissions) using the functions described above. The example is on the accompanying CDROM which is delivered with the Integrators development kit which must be purchased separately (see details about ordering in section 3.10 on page 3-11).

11.12 Spectrum analyzer

The spectrum analyzer (SA) is meant as a tool to be used in development, in production and in the field in any terminal using the BGAN XL Radio Module. The FFT based SA is available when the BGAN XL Radio Module is operating in '**service**' mode.

The SA is able to calculate parameters characterising the signal and to generate data to be used in a plot of the power spectrum of the signal applied.

Two interfaces to the spectrum analyzer exist; a GUI which allows basic configuration and viewing of the resulting power spectrum, and an HTTP-based interface which allows advanced configuration and extraction of the parameters characterising the signal. The two interfaces can be used in combination, e.g. by using the HTTP-based for configuration and the GUI for viewing the spectrum.

This section will illustrate how the spectrum analyzer is used. Section 12.5 holds examples of typical use cases of the spectrum analyzer.

11.12.1 Basic operation

The basic sequence when using the spectrum analyzer is:

1. Ensure that the BGAN XL Radio Module is in service mode.
2. Access the HTTP based interface on **<http://192.168.1.1:8080/fft/>**, in the following referred to as **.../fft/** (substitute IP address if non-standard IP configuration is used).
3. Configure the parameters for the spectrum and click the "Save All" button. Alternatively, the parameters reflect the ones in the configuration system, so they can also be configured there. See section 6.10.1 on page 6-58 for a full list of configuration parameters related to the spectrum analyzer.
4. On the web page, click **Run Spectrum** followed by **Refresh Spectrum**. A spectrum should appear. For continuous "sweeping" select **Continuous**. The spectrum will then be renewed approximately once per second, or when a new spectrum is ready, depending on the configuration.

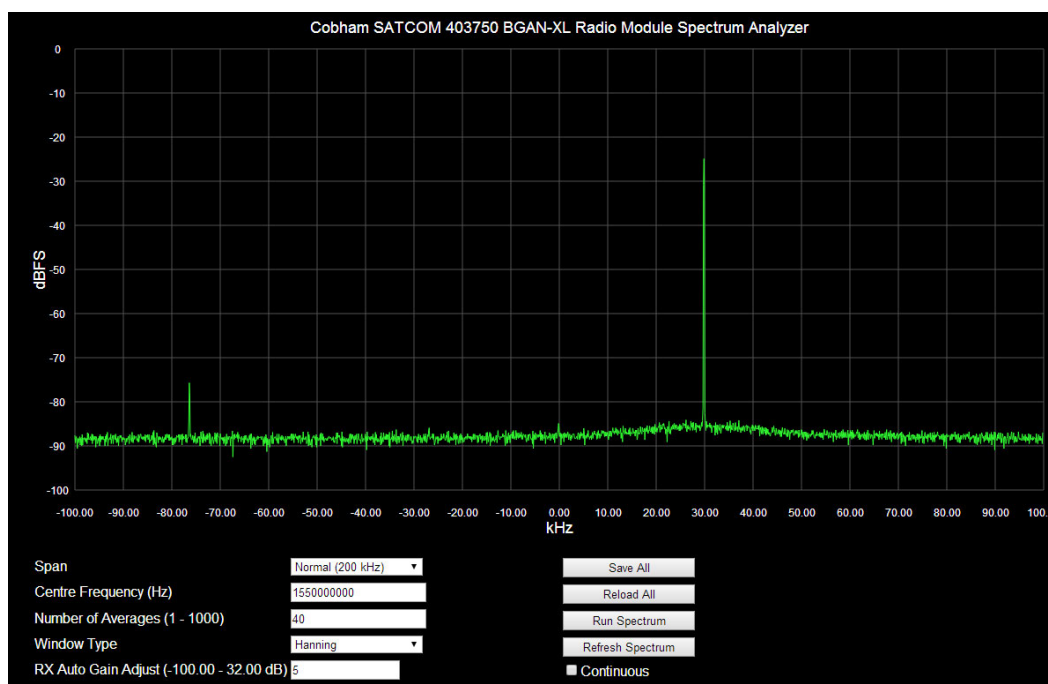


Figure 11-13: Example of a spectrum as shown in a web browser

The spectrum plot above illustrates a spectrum of a CW signal at 1550030000 Hz which has been applied to the Rx1 connector of the BGAN XL Radio Module.

The x-axis (frequency axis) will auto-scale depending on the span chosen. The y-axis has a fixed-scale dBFS (dB Full Scale).

The raw data being plotted can be accessed at: [.../fft/fft_data](#). It contains the results of various measurements performed by the SA, described below. The data is formatted in XML; the XML schema with comments can be downloaded at the address [.../fft/fftsa.rng](#).

11.12.2 Measurement principles

The following subsections summarize the measurement principles used by the spectrum analyzer. The figure below is used to visualize the different power definitions.

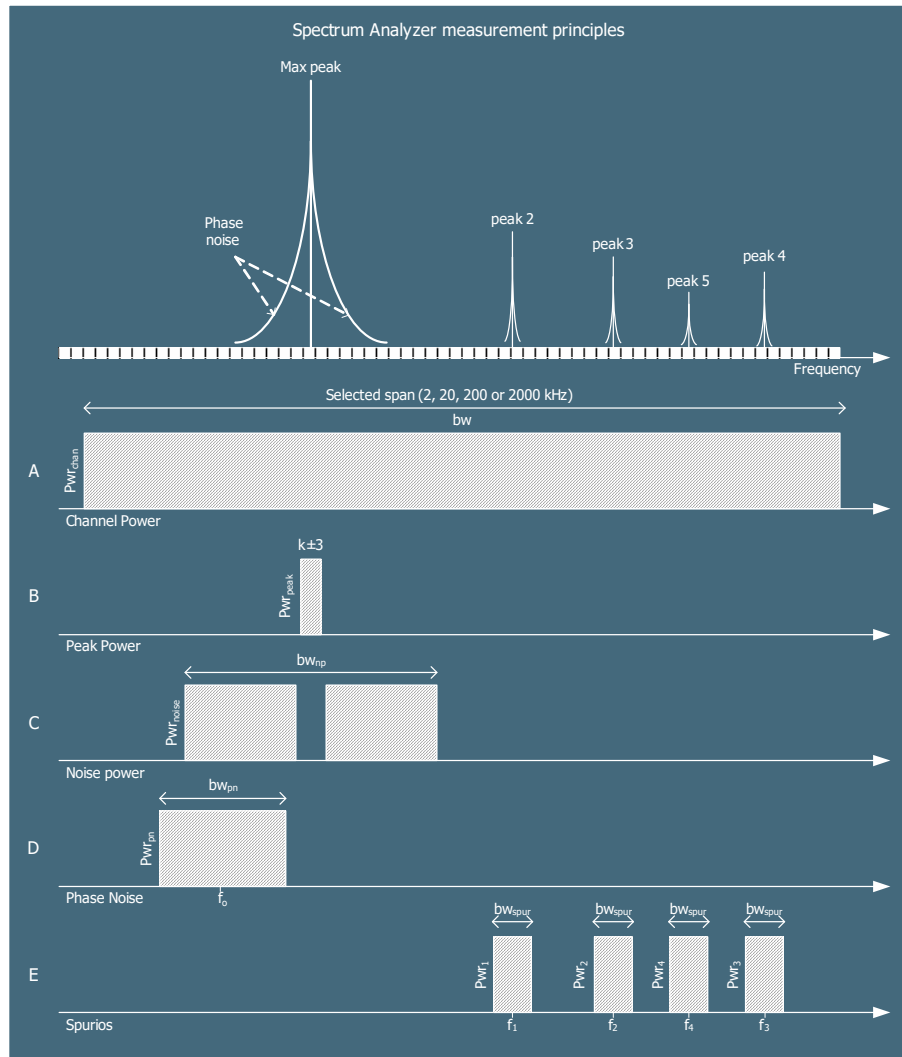


Figure 11-14: Power measurements

11.12.2.1 Channel power

The channel power (A) is calculated in dBm as the total power within the selected bandwidth (bw) of either; 2 kHz, 20 kHz, 200 kHz or 2 MHz.

The channel power value is given in dBm and the value can be extracted from: [.../fft/fft_data](#) via the variable `spectrum.header.channel_power.rx1`.

11.12.2.2 Max peak

The peak power (B) is calculated in dBm as the total power within a band of +/- 3 bins from the maximum FFT bin:

$$Pwr_{peak} = 10 \cdot \log \left(\sum_{i=k-n}^{k+n} P_i \right)$$

The peak power value is given in dBm and the value can be extracted from: [.../fft/fft_data](#) via the variable **spectrum.header.peak_power.rx1** likewise the frequency offset of the max peak frequency (given in Hz) is located in the variable **spectrum.header.peak_freq**.

11.12.2.3 Noise floor

The noise floor (C) is calculated as the mean power within a predefined band centred around the largest bin in the FFT spectrum. The calculation excludes the band which is used for the peak power (B) calculation, see section 11.12.2.2.

$$Pwr_{noise} = 10 \cdot \log \left(\frac{Pwr_{mean}}{B} \right)$$

In the formula above B is defined as the distance between the FFT bins and Pwr_{mean} is defined as:

$$Pwr_{mean} = \frac{1}{N} \cdot \left[\sum_{i=k-m}^{k-n} P_i + \sum_{i=k+n}^{k+m} P_i \right]$$

and k is the maximum power bin, n is 3, m is 683 and N is defined as $2 \cdot (m+1-n)$.

The noise floor value is given in dBm and the value can be extracted from: [.../fft/fft_data](#) via the variable **spectrum.header.noise_floor.rx1**.

11.12.2.4 C/No

The carrier-to-noise ratio (C/No in dBHz) is calculated as the ratio between the peak power (B) and the noise floor (C) as defined in section 11.12.2.2 and section 11.12.2.3.

$$C/N_o = Pwr_{peak} - Pwr_{Noise}$$

The C/No value is given in dBHz and the value can be extracted from: [.../fft/fft_data](#) via the variable **spectrum.header.c_no**.

11.12.2.5 Phase Noise

The phase noise power (D) is calculated as difference between a selected band and the peak power (B):

$$Pwr_{pn} = Pwr_{pnoffset} - Pwr_{peak}$$

In the formula above the power in the phase noise offset $Pwr_{pnoffset}$ is defined as;

$$Pwr_{pnoffset} = 10 \cdot \log(P_{po}) - (10 \cdot \log(bin_{dist}))$$

where k is the maximum power bin, $N = 2 \cdot bw + 1$ and P_{po} :

$$P_{po} = \frac{1}{N} \cdot \sum_{i=k+f_o-bw}^{k+f_o+bw} P_i \quad f_o = \frac{pnoffset}{bin_{dist}} \quad bw = \frac{pnbw}{(2 \cdot bin_{dist})}$$

The phase noise value is given in dBc/Hz and the value can be extracted from: [.../fft/fft_data](#) via the variable **spectrum.header.phase_noise**.

11.12.2.6 Spurious

The spurious power (E) and frequency are calculated for 4 bins (listed in descending order) ranging in size just below the one for which peak power, section 11.12.2.2, is calculated.

The spurious power values are given in dBm and the values can be extracted from: [.../fft/fft_data](#) via the variables **spectrum.header.spur[1..4].power** likewise the frequency offset (given in Hz) of the peaks are located in the variables **spectrum.header.spur[1..4].freq**.

11.12.2.7 FFT windows

In order to reduce the signal energy leakage when making FFT spectra for non-periodic signals, a window can be applied before making the FFT.

Window-dependent gain compensation has been made, such that the various FFT windows yield identical channel power measurements.

11.12.2.8 Resolution bandwidth

The spectrum analyzer utilizes a fixed number of FFT bins (2000 points) whereas the resolution bandwidth becomes scalable with the selected span as listed in the table below.

Span	Resolution bandwidth (RBW)
2 kHz	1 Hz
20 kHz	10 Hz
200 kHz	100 Hz
2 MHz	1 kHz

Table 11-12: RBW versus selected span

11.12.3 Measurement considerations

To get reliable (and usable) results from the spectrum analyzer the integrator must carefully consider a few important topics which can have great influence on the spectrum analyzer results. The following subsections highlight these considerations.

11.12.3.1 Reference clock

The integrator must be aware of the impact of the absolute frequency accuracy that the reference clock will contribute. If the reference clock is misaligned with e.g. 1 ppm, this in itself will result in a frequency offset of the spectrum analyzer peak that equals 1 ppm (of the frequency applied at Rx1 = at L-band).

The spectrum analyzer can be used to calibrate the reference by applying a known CW signal to the BGAN XL Radio Module input and then adjust the spectrum analyzer so that the peak is exactly centred. Using the narrow bandwidth this adjustment can be done with an accuracy of approximately 0.5 Hz.

If the integrator needs measurements with a higher accuracy than 0.5 Hz an external reference clock with sufficient accuracy must be connected.

11.12.3.2 Gain

To ensure optimum performance of the spectrum analyzer the applied signals must have a correct level. If not the results will be unreliable.

As the signal fed to the spectrum analyzer passes through several gain components inside the BGAN XL Radio Module (before it reaches the actual FFT algorithm), it is a complex task to adjust each gain component individually. To ease the control of the gain settings the BGAN-XL Radio Module offers an interface with a single gain level (ranging from -100 dB to +32 dB). This is referred to as: Rx Manual Gain Adjust.

The different gain contributions are listed in the table below, for internal information only, however it is beyond scope of this manual to go into details about how these are controlled.

Section	Gain
Analog	LNA: enabled (+17 dB) / bypassed VGA1: enabled (+17 dB) / bypassed VGA2: variable 0 – 28 dB
Digital	DDC: variable 0 – 32 dB

Table 11-13: Gain

11.12.4 Integrator's interface

Functionality	FFT Spectrum Analyzer (/fftsa/)
Actions	config, makefft
States	Idle, Pending
Modes supported	Service
Blocks functionality	None
Notes	The config action is used to configure the SA, while the makefft action is used to execute the SA. The current configuration can be viewed by requesting the config action with no parameters. Note that a new configuration or FFT cannot be made while the spectrum analyzer is pending. After the spectrum has been completed, the result can either be viewed with the graphical spectrum analyzer at .../fft/, or the resulting data can be fetched from .../fft/fft_data. The data always contains the latest spectrum. The SA uses configuration parameters (see section 6.10.1 on page 6-58), hence the default values in the following table equals the default values in the configuration system. If the configuration parameters values are changed elsewhere, so is the default SA configuration.

Parameter	Name	Valid Values	Mandatory	Default
Centre Frequency (Hz)	freq	1500000000..1600000000 (in steps of 1 Hz)	No	1550000000
Span (kHz)	span	2, 20, 200, 2000	No	200 kHz
Number of Averages	avg	1..1000	No	1

Table 11-14: Parameter overview for Spectrum Analyzer

Parameter	Name	Valid Values	Mandatory	Default
Window Type	win	none, hanning, hamming, blackman	No	none
Phase Noise Offset (Hz)	pno	-span/2..span/2	No	0
Phase Noise Bandwidth (Hz)	pnbw	1..span-1	No	1
Spur Search Bandwidth (Hz)	spur	1..span-1	No	1
Receiver Gain (dB)	gain	-100..32 (in steps of 0.01 dB)	No	0

Table 11-14: Parameter overview for Spectrum Analyzer (Continued)

Example: Configure spectrum analyzer to span: 200 kHz, window: hamming and gain: 13.2 dB

```
.../intif/ffttsa/config?span=200&win=hamming&gain=13.2
```

Example: Make FFT

```
.../intif/ffttsa/makefft
```

11.12.5 Python

Function name	Description
make_FFT()	This function starts an FFT measurement according to specified configuration.
configure(...)	This function configures the complete spectrum analyzer. Parameters: Span in kHz [2, 20, 200 or 2000] <freq> Frequency in Hz [1500000000..1600000000], in steps of 1 Hz <avg> Number of averages [1..1000] <win> Window type [none | blackman | hanning | hamming] <pno> Phase noise offset in Hz <pnbw> Phase noise bandwidth in Hz
configure_freq(...)	This function configures the frequency of the spectrum analyzer. Parameters: <freq> Frequency in Hz [1500000000..1600000000], in steps of 1 Hz

Table 11-15: Support functionality: .\scripts\tt\brm\spectrum_analyzer.py

Function name	Description
configure_spur(...)	This function configures the spur search bandwidth of the spectrum analyzer. Parameters: <spur> Spur search bandwidth in Hz [1..span-1]
configure_gain(...)	This function configures the gain of the spectrum analyzer. Parameters: <gain> Gain in the receiver chain in dB [-100..32], in steps of 0.01 dB
set_FFT(...)	This function configures the complete spectrum analyzer in one of four modes. Parameters: <setting> Setting: 0: span = 2, avg = 4, pno = 100 1: span = 20, avg = 10, pno = 1000 2: span = 200, avg = 100, pno = 10000 3: span = 2000, avg = 1000, pno = 100000 Common: win = hanning, pnbw = pno/20
get_value(...)	This function gets a specific result from the spectrum analyzer. The values are extracted from the XML file located at .../fft/fft_data. Parameters: <param> specifies which parameter value to obtain: 'channel_power/rx1', 'channel_power/full_scale' 'peak_power/rx1', 'peak_power/full_scale', 'peak_freq' 'noise_floor/rx1', 'noise_floor/full_scale' 'c_no', 'phase_noise' 'spur1/power', 'spur1/freq' 'spur2/power', 'spur2/freq' 'spur3/power', 'spur3/freq' 'spur4/power', 'spur4/freq', 'all' <i>For advanced users only:</i> 'dbm_offset', 'centre_freq', 'rbw', 'peak_x' 'scaling/x_max', 'scaling/x_min', 'scaling/y_max', 'scaling/y_min', 'n_fft_used', 'no_avg', 'n_serial'
get_configuration()	This function gets the current configuration of the spectrum analyzer. Returns: <result_text> contains all information about the configuration

Table 11-15: Support functionality: .\scripts\fft\brm\spectrum_analyzer.py (Continued)

Function name	Description
get_bins()	This function gets the bins of a calculated spectrum. Returns: <data_array> contains all the bins <data_n> specifies the number of bins <freq_span> specifies span/2 <dbm_offset> data_array contains spectrum in dBFS, subtract the value of dbm_offset to get spectrum in dBm
configure_manual_gain(...)	This function configures the gain the spectrum analyzer manually. <i>For advanced users only.</i> Parameters: <lna> <i>For advanced users only</i> <vga1> <i>For advanced users only</i> <vga2> <i>For advanced users only</i> <ddc> <i>For advanced users only</i>

Table 11-15: Support functionality: .\scripts\tt\brm\spectrum_analyzer.py (Continued)

Note

The example file **ex_spectrum_analyzer.py** illustrates how the internal spectrum analyzer is configured using the functions described above. The example is on the accompanying CDROM which is delivered with the Integrators development kit which must be purchased separately (see details about ordering in section 3.10 on page 3-11).

11.13 SIM lock

This section describes the SIM lock (or personalization lock) interface on the BGAN XL Radio Module. Three different SIM lock types are supported. It is possible to lock the user terminal to:

- (2) A specific service provider by using the group identifier of the USIM card.
- (3) A specific corporate SIM card owner by using the group identifier.
- (4) A specific SIM card.

The values (2, 3 and 4) associated with the corresponding type of lock are used later in this section in the description of the SIM lock interface.

11.13.1 Installation of the SIM lock code

As part of the manufacturing of a terminal that supports SIM lock, a SIM lock code must be installed on the RM. The SIM lock code is encrypted and stored in write-once memory on the RM. In order to get access to change the SIM lock settings, the correct SIM lock code must be entered.

Parameter name protocols.umts.personalization	External access	Type / Domain	Values [min;max]	Comment
.set.password	w t4 §4	string / flash	n.a.	Set SIM lock code Must be 32 bytes hex characters + 0 terminator.
.set.password_result	r/w t4 §4	int / ram	[0..255]	Indicate result of the set operation. ~~Table x~~ Table 11-17 shows result codes.

Table 11-16: Parameters used to enter SIM lock code

To set the SIM lock code on the RM, the integrator must do the following:

- Write the SIM lock code to **.set.password**
- Write 255 to **.set.password_result**
- Read **.set.password_result** until **.set.password_result** < 255
- Evaluate result code from **.set.password_result**. Possible result codes are shown in the following table.

Code	Description
0	Ok. SIM lock code was stored
1	Operation failed because a SIM lock code already has been stored
2	String in .set.password is too short
3	String in .set.password is too long
4	String in .set.password parameter contain invalid characters. Valid characters are: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b,c, d,e, f, A, B, C, D, E, F
5	Could not write to flash
6	.set.password is empty or significantly too long
15	Unspecified error
255	Operation in progress

Table 11-17: .set.password_result result codes

11.13.2 SIM lock interfaces

This section describes the configuration interface to the various functions of the SIM lock interface. Different return codes can occur when the SIM lock interface is used, Table 11-18 below shows a list of the return codes.

Return code	Description
0	Operation went ok.
1	Invalid IMSI number supplied.
2	Invalid DP code supplied.
3	Invalid ISP supplied.
4	No DP code on USIM.
5	NO ISP on USIM.
6	General error reading from USIM.
7	An unspecified error occurred.
8	Operation blocked by penalty time.
9	Storage write operation failed.

Table 11-18: Return codes from the SIM lock interface

Return code	Description
10	Storage read operation failed.
11	Wrong code entered.
255	Used to trigger a request. See the next section for a description.

Table 11-18: Return codes from the SIM lock interface (Continued)

There are 5 interfaces for communication with the SIM lock feature, they are asynchronous of nature. The following steps are general guidelines for all 5 interfaces.

1. Each interface has a **.result** parameter. Before making a request, the client must read this key. If it starts with '*result=255*', the SIM lock interface is already processing a request, and the client must wait for a few milliseconds and try again.
2. When the interface is ready, i.e. the **.result** parameter does not start with '*result=255*' anymore, write the configuration parameters (if any) that are needed in the following request.
3. Writing the value '*result=255*' to the **.result** parameter will trigger a request which will be completed once the **.result** value is once again different from '*result=255*'.
4. When the request has been processed, the result is written back to the **.result** parameter. The value will always start with the text '*result=<errorcode>*', where *<errorcode>* is one of the numeric codes in Table 11-18 above.

Some interfaces enforce a penalty time if a request fails. Any additional requests inside the penalty time window will result in the return code 8 being returned. The penalty time is increased with each failed 'check SIM lock password' attempt and cleared on success. The penalty time is the number of failed attempts squared, in minutes.

The following sections describe each of the 5 interfaces in detail as well as a syntax description of each of the result strings.

11.13.2.1 Check SIM lock password

This interface is used to enter the SIM lock code in order to verify it (after encryption) against the SIM lock code installed by the integrator (see section 11.13.1 on page 11-42).

Parameter name protocols.umts.personalization	External access	Type / Domain	Values [min;max]	Comment
.check.sim_lock_passwd	r/w t4 §4	string / ram	n.a.	SIM lock code (password) which must be verified. The code must be provided in order to get access to the SIM lock information. Must be 32 bytes hex characters.
.check.result	r/w t4 §4	string / ram	n.a.	The result of the .sim_lock_passwd check. A SIM lock code must be written to .sim_lock_passwd above before triggering this request.

Table 11-19: Check SIM lock password configuration parameters

Result syntax:

.check.result = <errorcode>[;<ptime>] where
 <errorcode> is one of the numeric codes from Table 11-18 and
 <ptime> is the penalty time in seconds. Only present if verification was unsuccessful, i.e. if <errorcode> is not 0.

The interface **Check SIM lock password** enforces a penalty time on each failed request.

11.13.2.2 Get SIM lock penalty time

This interface is used to get the remaining penalty time in seconds.

Parameter name protocols.umts.personalization	External access	Type / Domain	Values [min;max]	Comment
.penalty_time.result	r/w t4 §4	string / ram	n.a.	Result string containing information of the current penalty time.

Table 11-20: Get SIM lock penalty time configuration parameters

Result syntax:

.penalty_time.result = <errorcode>;<ptime> where
 <errorcode> is one of the numeric codes from Table 11-18 and
 <ptime> is the penalty time in seconds, only valid if <errorcode> is 0.

11.13.2.3 Set SIM lock

This interface is used to set a SIM lock of a specific category.

Parameter name protocols.umts.person alization	External access	Type / Domain	Values [min;max]	Comment
.set.lock_category	r/w t4 §4	int / ram	[2..4]	Integer representation of the lock category.
.set.imsi_or_gid2	r/w t4 §4	string / ram	n.a.	String contains the following: -IMSI if lock_category=4, -gid2 if lock_category=2 or 3
.set.gid1_or_na	r/w t4 §4	string / ram	n.a.	String containing the ISP (gid1) value if lock_category=3, otherwise it is not used.
.set.entered_vals	r/w t4 §4	int / ram	[0..1]	1: Values (imsi_or_gid2 and/or gid1_or_na) are defined and to be used. 0: Values are not defined and should be taken from the SIM card.
.set.result	r/w t4 §4	string / ram	n.a.	Result of the set lock request. All the above parameters must be set accordingly before the operation can succeed.

Table 11-21: Set SIM lock configuration parameters

Result syntax:

.set.result = <errorcode> where
 <errorcode> is one of the numeric codes from Table 11-18

11.13.2.4 Get SIM lock

This interface is used to get information on the current SIM lock category, if any.

Parameter name protocols.umts.personalization	External access	Type / Domain	Values [min;max]	Comment
.get.result	r/w t4 §4	string / ram	n.a.	A result string containing information regarding the current SIM lock, if any is present.

Table 11-22: Get SIM lock information

Result syntax:

.get.result = <errorcode>[;<lock_parameters>] where
 <errorcode> is one of the numeric codes from Table 11-18
 <lock_parameters> are only present if the read went ok, i.e. <errorcode> is 0.
 <lock_parameters> = <category>;[<sim_parms>|<service_parms>|<corporate_parms>]

The three different types of parameters correspond to the respective three legal values of category.

If <category> is 5 (no SIM lock), no parameters follow the <category>.

<sim_parms> = <imsi> where
 <imsi> is the IMSI number of the lock.
 <service_parms> = <dp> where
 <dp> is the gid2 value formatted as a 4 digit hexadecimal number.
 <corporate_parms> = <dp>;<isp> where
 <dp> is as defined above and
 <isp> is the ISP value gid1 formatted as a 4 digit hexadecimal number.

11.13.2.5 Remove SIM lock

This interface is used to remove a SIM lock already in place.

Parameter name protocols.umts.personalization	External access	Type / Domain	Values [min;max]	Comment
.unlock.result	r/w t4 §4	string / ram	n.a.	A result string containing information when a request to remove the SIM lock is issued.

Table 11-23: Remove SIM lock

Result syntax:

.unlock.result = <errorcode>[;<ptime>] where
 <errorcode> is one of the numeric codes from Table 11-18 and
 <ptime> is the penalty time in seconds. Only present if the unlock was unsuccessful, i.e. if <errorcode> is not 0.

11.14 Supplementary services (eMLPP registration)

Most supplementary services (call forward, call barring etc.) can be set with AT commands (see 7.5.11 on page 7-12).

For eMLPP the AT command AT+CAEMLPP can be used to set the eMLPP priority in the network. The AT command must however only set the priority if this is allowed by the SIM card.

For terminals implementing Multi-Voice (SDM v3c2) or SwiftBroadband Oceanic Safety Service (SDM v3c3) there is a requirement for setting the eMLPP priority in the network unconditionally, without respecting the SIM card settings.

To support this the BGAN XL Radio Module offers another interface for eMLPP registration in the network.

Parameter name protocols.umts.supplementary_ service	External access	Type / Domain	Values [min;max]	Comment
.emlpp.priority	w t4 §4	int / ram	[0..4]	Writing to this starts an eMLPP registration.
.emlpp.result	r	int / ram	[0..255]	255: Operation in progress 0: Success (eMLPP priority has been registered in network) - or no operation has been started. Other values: Failure code from UMTS Core Network. Default value: 0

Table 11-24: eMLPP registration

To start an eMLPP registration the terminal must be registered on the BGAN network (eMLPP settings are stored in the Core Network). If **.emlpp.result** reads 255 an eMLPP registration is already in progress and a new registration can not be started.

The integrator starts the eMLPP registration by checking that **.emlpp.result** is not 255 and then writing the priority to **.emlpp.priority**.

The RM will then set **.emlpp.result** to 255 and start the operation of setting the eMLPP priority in the Core Network. Once the operation is completed **.emlpp.result** will contain the result (0 = success or a failure cause code from the Core Network).

11.15 S-Band terminal (FOR INTERNAL USE)

The BGAN XL Radio Module is normally used in L-Band terminals, but can also be used in Aeronautical S-Band class 7S terminals with external frequency conversion.

If using the RM in S-Band class 7S terminal the following parameters must be set:

- **sys.product_type** = 5
- **protocols.bgan.functionality.sband** = 1
- **protocols.bgan.functionality.class** = 7
- **protocols.bgan.functionality.ssr_muting.enable** = 1

Important

If moving the RM between an L-Band and an S-Band setup it is the integrators responsibility to make factory reset of the RM after **protocols.bgan.functionality.sband** has been set. This is required to ensure that the RM uses the correct satellite table.

Use cases

This chapter has the following sections:

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12.2 Calibration 12-4

12.3 Network registration 12-6

12.4 Connection setup 12-8

12.5 Operation 12-10

12.6 Services 12-11

12.7 Physical & protocol layer test 12-17

12.1 Startup and mandatory configuration

12.1.1 Service activation

This use case presents a simplified description of the required service activation procedure to get access to the service related API offered by the BGAN XL Radio Module.

1. Power up the BGAN XL Radio Module
2. Read the configuration parameter: '**sys.status.mode**'
3. Loop step 2 until '**sys.status.mode**' is '**ready**'.
4. Read the configuration parameters: '**post.status.1**' and '**post.status.2**' to evaluate the results of the internal connectivity tests. Both parameters must be **PASSED** as 100% conformity is required. If this is not the case, terminate the activation procedure and refer to the troubleshooting section.
5. Provide the RM with mandatory configuration via the configuration system.
6. Activate service by sending: **MSG_WAVEFORM (activate, service)**.
7. Wait for acknowledge via the message: **MSG_ACK**.

The service mode is now active and the entire service API can be used (e.g. to make extended connectivity tests, calibration, manual transmission and spectrum analyzer measurements).

12.1.2 Waveform activation (IAI2 mode)

This use case presents a simplified procedure describing how a waveform is loaded in the BGAN XL Radio Module and activated to operate in IAI2 mode. The use case assumes that the RM has already been brought into an active service mode.

1. Load the waveform by sending: **MSG_WAVEFORM (load=0, IAI2=0)**.
2. Wait for acknowledge via the message: **MSG_ACK**.
3. Read the configuration parameter: '**sys.status.mode**' and verify that the RM is in '**standby**' state.
4. Provide the RM with additional configuration via the configuration system.
5. Activate the waveform by sending: **MSG_WAVEFORM (activate=1, IAI2=0)**.
6. Wait for acknowledge via the message: **MSG_ACK** and verify that '**sys.status.mode**' is in '**operating**' state.

The IAI2 waveform is now active and the sky-scan procedure can be initiated.

12.1.3 Waveform activation (BPLT mode)

This use case presents a simplified procedure describing how a waveform is loaded in the BGAN XL Radio Module and activated to operate in BPLT mode. The use case assumes that the RM has already been brought into an active service mode.

1. Load the waveform by sending: **MSG_WAVEFORM (load=0, BPLT=1)**.
2. Wait for acknowledge via the message: **MSG_ACK**.
3. Read the configuration parameter: '**sys.status.mode**' and verify that the RM is in '**standby**' state.
4. Provide the RM with additional configuration via the configuration system.
5. Activate the waveform by sending: **MSG_WAVEFORM (activate=1, BPLT=1)**.
6. Wait for acknowledge via the message: **MSG_ACK** and verify that '**sys.status.mode**' is in '**operating**' state.

The BPLT waveform is now active and the RM is ready to receive test instructions from the BGAN Physical Layer Tester (BPLT).

12.1.4 Waveform activation (BPT mode)

This use case presents a simplified procedure describing how a waveform is loaded in the BGAN XL Radio Module and activated to operate in BPT mode. The use case assumes that the RM has already been brought into an active service mode.

1. Load the waveform by sending: **MSG_WAVEFORM (load=0, BPT=3)**.
2. Wait for acknowledge via the message: **MSG_ACK**.
3. Read the configuration parameter: '**sys.status.mode**' and verify that the RM is in '**standby**' state.
4. Provide the RM with additional configuration via the configuration system.
5. Activate the waveform by sending: **MSG_WAVEFORM (activate=1, BPT=3)**.
6. Wait for acknowledge via the message: **MSG_ACK** and verify that '**sys.status.mode**' is in '**operating**' state.

The BPT waveform is now active and the RM is ready to receive test instructions from the BGAN Protocol Tester (BPLT).

12.2 Calibration

12.2.1 Tx power calibration

This use case presents a simplified description of a calibration procedure for an antenna cable loss. The procedure is initiated and controlled by an antenna control module (ACM) located outside the BGAN XL Radio Module.

1. Put the RM into 'service mode' (refer to section 12.1.1).
2. Put the antenna into 'cable loss calibration mode'.
3. Select the appropriate cable loss calibration algorithm according to class type and antenna type.
4. Signal **start cable loss calibration** to the antenna.
5. Set the parameter **protocols.bgan.interface.rf.gain.tx.locked** to 1 indicating that the parameters are being updated.
6. Configure nominal EIRP in the RM via the parameter:
protocols.bgan.interface.rf.gain.tx.nominal_power.
7. Disable compensation of gain variations in the RM by setting the parameter:
protocols.bgan.interface.rf.gain.tx.pwr_pairs to zero.
8. Reset **protocols.bgan.interface.rf.gain.tx.locked** to indicate that the parameters have been updated and are ready to be used.
9. Initiate a cable loss calibration algorithm:
 - Instruct the RM to transmit a CW at a specific frequency.
 - Wait for an acknowledge signal from the RM.
 - Instruct the HPA (in the antenna) to measure the power level of the transmitted CW.
 - Wait for a power level response from the antenna.
10. Loop step 9 according to specifications.
11. Calculate the cable loss (in dB x100) and verify that it is within the specified range. If the cable loss is not valid, generate an appropriate error message and terminate the calibration procedure.¹
12. Adjust the nominal EIRP of the RM via the parameter:
protocols.bgan.interface.rf.gain.tx.nominal_power, using the information about the calculated cable loss.
13. Fetch the antenna configuration parameters (ADU temperature and HPA gain variations) and calculate a combined compensation table (versus frequency).

1. In this situation the integrator must decide if it is allowed to operate or if the transmission must be stopped.

14. Set the parameter **protocols.bgan.interface.rf.gain.tx.locked** to 1 indicating that the parameters are being updated.
15. Configure the RM with the calculated compensation factor via the parameters: **protocols.bgan.interface.rf.gain.tx.pwr_freq1..15** and **protocols.bgan.interface.rf.gain.tx.pwr1..15**.
16. Set the parameter: **protocols.bgan.interface.rf.gain.tx.pwr_pairs** to the needed number of frequency points (1..15).
17. Reset **protocols.bgan.interface.rf.gain.tx.locked** to indicate that the parameters have been updated and are ready to be used.
18. Signal **cable loss calibration done** to the antenna and the RM.

12.2.2 Temperature drift

This use case presents a simplified description of a temperature drift surveillance procedure which is initiated and controlled by an antenna control module (ACM) located outside the BGAN XL Radio Module.

1. The RM is operating in 'bgan_waveform mode'.
2. The antenna is operating in 'normal operation mode'.
3. Initiate the temperature drift surveillance algorithm:
 - At fixed time intervals (e.g. every 1 minute) fetch information about the temperatures (T_{new}) in the system.
 - If the drift of the temperature is more than a specified value (see formula below) a new calculation of a combined compensation table (versus frequency) is initiated.
$$|T_{new} - T_{old}| > \Delta_{threshold}$$
 - Register the current temperature $T_{old} = T_{new}$.
 - Set the parameter **protocols.bgan.interface.rf.gain.tx.locked** to 1 indicating that the parameters are being updated.
 - Configure the RM with the newest calculated compensation factors via the parameters: **protocols.bgan.interface.rf.gain.tx.pwr_freq1..15** and **protocols.bgan.interface.rf.gain.tx.pwr1..15**.
 - Set the parameter: **protocols.bgan.interface.rf.gain.tx.pwr_pairs** to the needed number of frequency points (1..15).
 - Reset **protocols.bgan.interface.rf.gain.tx.locked** to indicate that the parameters have been updated and are ready to be used.
4. Loop step 3 with no end time.

12.3 Network registration

12.3.1 Global beam search

This use case presents a simplified description of an antenna pointing procedure, which is initiated and controlled by the satellite search protocol.

The integrator should execute the following steps using an appropriate antenna pointing procedure suited to the antenna type. For example antennas with build-in power detector are free to skip measurements of channel power. For antennas that does not include a power detector the normal case would be to make large number of measurements of channel power while stepping the antenna, followed by a BGAN waveform check on just the point with highest power. The following use case would be most useful for a manually pointed antenna whereas other antenna types should use a custom version.

1. Put the antenna into **sky scan** mode.
2. Allow sky-scan in the BGAN XL Radio Module by sending **MSG_BGAN_SKYSCAN_ALLOWED** and by sending position data with **MSG_NAV_REPORT** (see 8.5.4.2 on page 8-33).
3. The RM responds by sending **MSG_BGAN_SKYSCAN_ALLOWED_RESP**. If valid = true then the RM responds by sending **MSG_BGAN_START_SKYSCAN** with one or more channel numbers of global BGAN signal carriers.
4. Initiate the signal validation algorithm in the RM.
 - Instruct the RM to measure the channel power at 1 (or up to 16 different) specific frequency by sending **MSG_BGAN_CHECK_POWER**.
 - Wait for a power level response (**MSG_BGAN_CHECK_POWER_RESP**) from the RM.
 - Instruct the RM to check a global bearer at a specific frequency by sending **MSG_BGAN_CHECK_WAVEFORM**.

Wait for response (**MSG_BGAN_CHECK_WAVEFORM_RESP**) from the BGAN XL Radio Module.

 - **Waveform check succeeded** – the response includes a valid CNo estimate and indicates that the global bearer has been acquired correctly. The response will be followed by a **MSG_BGAN_WAVEFORM_CNO** message with a valid CNo estimate every 80ms.
 - **Waveform check failed** (time-out) - the Valid flag in the response is set to 0 (CNo not valid).
5. Loop step 4 according to the antenna pointing procedure.
6. Terminate when a correct global bearer has been acquired. Alternatively sending **MSG_BGAN_SKYSCAN_RESULT** indicating that the sky-scan has failed will allow a retry by looping from step 3 with a new **MSG_BGAN_START_SKYSCAN**.

7. Stop sky-scan in the BGAN XL Radio Module by sending:
MSG_BGAN_SKYSCAN_RESULT indicating that the sky-scan has succeeded.
8. Signal **sky-scan mode done** to the antenna.

12.3.2 Registration

When the preceding two use cases have been successfully done the next steps of the registration procedure are as follows:

1. Notify the BGAN XL Radio Module that a USIM card is available by setting the configuration parameter **platform.usim.status** to 1. The RM now uses the protocol specified in section 8.5.2.11 on page 8-29 to access the USIM card.
2. Provide the RM with a valid GPS position for the current location. This is done by sending **MSG_NAV_REPORT** to the RM.
3. Wait for response from the RM:
 - **MSG_NAV_ACK** if the RM accepted the message.
 - **MSG_NAV_NACK** if the RM did not accept the message.
4. The RM will now automatically initiate the network registration procedure for CS services.
5. The status of this procedure may be monitored by reading the configuration parameter **protocols.umts.cs.status**:
 - **Attaching**: The registration procedure is ongoing.
 - **Attached**: The registration procedure was successful.
 - **Attach rejected**: The registration procedure failed.

Note

To successfully register with the BGAN network a valid and provisioned BGAN USIM card is required.

12.4 Connection setup

12.4.1 PS setup

This use case presents a simplified description of how to do a PS setup of a primary PDP context from a module in the application processor.

12.4.1.1 General note on AT commands for PS setup

As described in section 7.6.4 on page 7-21, parameters for a PDP context family can be manipulated on the BGAN XL Radio Module via an AT shell on the RM. In order to create a telnet connection into the RM on which to issue commands to this AT-Shell, an IP address is needed on the RM. This IP address is however not available until after the PPPoE connection has been established (primary PDP context is activated).

This means that AT commands for PS setup that fall before activation of the primary PDP context must be handled on the application processor and not the RM.

12.4.1.2 Define an activate PDP context

The first step in the setup procedure is to define the PDP context and QoS parameters. This corresponds to the functionality of the AT commands **+CGDCONT** and **+CGEQREQ** (see TS 27.007 [1]).

When the PDP context has been defined, activate it by starting a PPPoE connection using above AT commands in the service name (7.6.3 on page 7-19):

Example:

```
XBB:AT+CGDCONT=2,ip,bgan.inmarsat.com;+CGEQREQ=2,3
```

Wait for the PPPoE connection to become active. If it fails, status parameters described in 6.7.7.1 on page 6-42 can be used to determine the reason.

Once the PPPoE connection is active it is possible to telnet to the IP address of the PPPoE end-point on the RM to get access to the AT shell. On this AT shell the primary PDP context can be modified or secondary PDP contexts can be added / deleted / modified (using **+CGDCONT**, **+CGEQREQ**, **+CGEQMIN**, **+CGACT**, **+CGCMOD** etc).

This AT shell is only valid as long as the PPPoE connection is active.

12.4.2 CS setup

To be able to dial out or receive incoming calls using the default CS configuration (section 6.9.1 on page 6-56) of the BGAN XL Radio Module, you must setup the SIP

client with the following parameters. The exact naming of these parameters depends on your choice of SIP implementation on the application processor.

Parameter	Value
Server address	192.168.1.1 ^a
Server port	5060
User name (protocols.sip.user-name)	sip1
Password (protocols.sip.password)	sip1
Register with server to make outgoing calls	Yes
Codec (protocols.sip.codecs)	PCMA
RTP packet time (ptime)	20 ms

Table 12-1: CS setup

- a. Under the assumption that this is the configured address of the BGAN XL Radio Module.

12.4.3 AMBE Voice Call

Before making an AMBE voice call the BGAN XL Radio Module must be registered with the BGAN network and attached for CS services. This can be checked by verifying that the configuration parameter **protocols.ums.cs.status** has the value "Attached". Secondly the SIP client on the application processor must have performed a successful registration with the SIP server in the RM, using the user name and password specified above.

Under the assumption that 192.168.1.1 is the IP address of the RM, set up your SIP client to send an INVITE request to the following URI:

```
sip:+<country code><destination>@192.168.1.1
```

Example: sip:+4512345678@192.168.1.1 for dialing the number 12345678 in Denmark (country code 45).

12.5 Operation

12.5.1 ATC handling

This use case presents a simplified flow of an ATC configuration without an external ATC filter (the responsibility of detecting an ATC interferer is performed externally).

1. Provide the RM with mandatory and additional configuration as described in section 12.1.1 and 12.1.2.
2. Activate the RM to operate in 'bgan_waveform mode'.
3. Before the sky-scan procedure is activated ensure that the RM is configured to operate in the ATC active mode either by enabling the external ATC filter or via the parameter: **protocols.bgan.functionality.atc.activation = 1**.
4. Now sky-scan can be activated and pointing be performed.
5. After completion of the pointing procedure (and during operating) a surveillance algorithm that monitors the external ATC detector must be activated.
 - If the state of the external ATC detector changes this must also change any external ATC filter or be reported to the RM via the **atc.activation** parameter. If extra circuitry is included or removed from the receive chain externally to the RM, the **.rf.delay.rx1.external** parameter must be updated accordingly.
 - Each state change of the ATC mode could result in a gap in RF the transmission (for approx. 100 ms to 250ms) as the BGAN XL Radio Module receiver fails to track the forward channel due to changes in the delay/level. This triggers new information on the RF Control interface. A conservative switching strategy is therefore recommended to minimize these data losses.
6. Loop step 5 continuously.

12.6 Services

12.6.1 Spectrum analyzer (spectrum measurement)

This use case illustrates how the internal spectrum analyzer is configured and activated to generate an FFT spectrum of a received forward signal. The use case assumes that the BGAN XL Radio Module has already been brought into an active service mode and a signal has been injected at Rx1 at 1550.01 MHz.

The following example illustrates how a simple spectrum measurement is accomplished (substitute the IP address, if non-standard IP address is used):

1. First ensure that no other service-related functions are active.
2. Set the span to 2 MHz, the centre frequency to 1550 MHz, the number of averages to 100, the window type to Hanning and the gain to -1.00 dB by filling the appropriate boxes at <http://192.168.1.1:8080/fft/> and clicking *Save All*
3. Instruct the spectrum analyzer to perform the FFT/measurements by clicking *Run Spectrum* followed by *Refresh Spectrum*
4. Now the measured spectrum can be visually inspected
5. You can find additional measurements at http://192.168.1.1:8080/fft/fft_data, which contains information similar to:

```
<header>
  <dbm_offset>49.080</dbm_offset>
  <channel_power>
    <rx1>-78.281</rx1>
    <full_scale>-29.201</full_scale>
  </channel_power>
  <peak_power>
    <rx1>-78.296</rx1>
    <full_scale>-29.216</full_scale>
  </peak_power>
  <peak_freq>10000.000</peak_freq>
  <noise_floor>
    <rx1>-165.577</rx1>
    <full_scale>-116.497</full_scale>
  </noise_floor>
  <c_no>87.282</c_no>
  <phase_noise>-33.799</phase_noise>
  <centre_freq>1550000000</centre_freq>
  <peak_x>10.000</peak_x>
  <spur1>
    <freq>9000.000</freq>
    <power>-86.077</power>
  </spur1>
  <spur2>
    <freq>11000.000</freq>
    <power>-86.092</power>
  </spur2>
  <spur3>
    <freq>-237000.000</freq>
    <power>-116.751</power>
  </spur3>
  <spur4>
    <freq>-238000.000</freq>
    <power>-116.778</power>
  </spur4>
  <rbw>1000.000</rbw>
  <scaling>
```

```
<x_max>1000000.000</x_max>
<x_min>-1000000.000</x_min>
<y_max>-24.216</y_max>
<y_min>-126.497</y_min>
</scaling>
<n_fft_used>2000</n_fft_used>
<no_avg>100</no_avg>
<n_serial>1</n_serial>
</header>
```

12.6.2 Spectrum analyzer (spurious search)

This use case illustrates how the internal spectrum analyzer is configured and activated in relation to spurious measurements of a received forward signal. The use case assumes that the BGAN XL Radio Module has already been brought into an active service mode and a signal has been injected at Rx1 at 1550.01 MHz.

The following example illustrates how a measurement can give a more precise location of spurious's located at around -240 kHz and -390 kHz. It is also assumed that the applied signal (is centred at 10 kHz) is relatively wide at the lower end.

1. First ensure that no other service related functions are active.
2. Set the span to 2 MHz, the number of averages to 100, the window type to Hanning, the centre frequency to 1550 MHz and the gain to -1.00 dB by accessing **<http://192.168.1.1:8080/intif/fftsa/config?span=2000&avg=100&win=hanning&freq=1550000000&gain=-1>** (similar to use case in section 12.6.1).
3. The spurious are relatively far away from the applied signal, so the spurious (removal) bandwidth is set to 50 kHz by accessing **<http://192.168.1.1:8080/intif/fftsa/config?spur=50000>**
4. Instruct the spectrum analyzer to perform the FFT/measurements by accessing **<http://192.168.1.1:8080/intif/fftsa/makefft>**
5. Verify that the spectrum analyzer is in the idle state and thus the measurements are done, by accessing **<http://192.168.1.1:8080/intif/status>**
6. Now the measured spectrum can be visually inspected by accessing **<http://192.168.1.1:8080/fft/>** and clicking *Refresh Spectrum*
7. The spur measurements can be found at **http://192.168.1.1:8080/fft/fft_data**, which contains information similar to (note the spur1..spur4 values):

```
<header>
  <dbm_offset>49.080</dbm_offset>
  <channel_power>
    <rx1>-78.325</rx1>
    <full_scale>-29.245</full_scale>
  </channel_power>
  <peak_power>
    <rx1>-78.340</rx1>
    <full_scale>-29.260</full_scale>
  </peak_power>
  <peak_freq>10000.000</peak_freq>
  <noise_floor>
    <rx1>-165.583</rx1>
    <full_scale>-116.503</full_scale>
  </noise_floor>
  <c_no>87.243</c_no>
  <phase_noise>-33.799</phase_noise>
```



```

<centre_freq>1550000000</centre_freq>
<peak_x>10.000</peak_x>
<spur1>
  <freq>-237000.000</freq>
  <power>-116.721</power>
</spur1>
<spur2>
  <freq>388000.000</freq>
  <power>-124.279</power>
</spur2>
<spur3>
  <freq>-158000.000</freq>
  <power>-127.197</power>
</spur3>
<spur4>
  <freq>178000.000</freq>
  <power>-128.352</power>
</spur4>
<rbw>1000.000</rbw>
<scaling>
  <x_max>1000000.000</x_max>
  <x_min>-1000000.000</x_min>
  <y_max>-24.260</y_max>
  <y_min>-126.503</y_min>
</scaling>
<n_fft_used>2000</n_fft_used>
<no_avg>100</no_avg>
<n_serial>2</n_serial>
</header>

```

The response now includes more precise locations for the spurious and their power levels.

12.6.3 Spectrum analyzer (phase noise measurement)

This use case illustrates how the internal spectrum analyzer is configured and activated in relation to phase noise measurements of a received forward signal. The use case assumes that the BGAN XL Radio Module has already been brought into an active service mode and a signal has been injected at Rx1 at 1550.01 MHz.

The following example illustrates a measurement of the phase noise 300 kHz below the centre frequency in a band of 2 kHz:

1. First ensure that no other service related functions are active.
2. Set the span to 2 MHz, the number of averages to 100, the window type to Hanning, the centre frequency to 1550 MHz, the gain to -1.00 dB and the spurious (removal) bandwidth to 50 kHz by accessing **<http://192.168.1.1:8080/intif/fftsa/config?span=2000&avg=100&win=hanning&freq=1550000000&gain=-1&spur=50000>**
3. Set the phase noise offset to -300 kHz and the phase noise bandwidth to 2 kHz by accessing **<http://192.168.1.1:8080/intif/fftsa/config?pno=-300000&pnbw=2000>**
4. Instruct the spectrum analyzer to perform the FFT/measurements by accessing **<http://192.168.1.1:8080/intif/fftsa/makefft>**
5. Verify that the spectrum analyzer is in the idle state and thus the measurements are done, by accessing **<http://192.168.1.1:8080/intif/status>**

6. Find the phase noise measurements at http://192.168.1.1:8080/fft/fft_data, which contains information similar to (note the phase_noise value):

```
<header>
  <dbm_offset>49.080</dbm_offset>
  <channel_power>
    <rx1>-78.333</rx1>
    <full_scale>-29.253</full_scale>
  </channel_power>
  <peak_power>
    <rx1>-78.348</rx1>
    <full_scale>-29.268</full_scale>
  </peak_power>
  <peak_freq>10000.000</peak_freq>
  <noise_floor>
    <rx1>-165.565</rx1>
    <full_scale>-116.485</full_scale>
  </noise_floor>
  <c_no>87.217</c_no>
  <phase_noise>-88.010</phase_noise>
  <centre_freq>1550000000</centre_freq>
  <peak_x>10.000</peak_x>
  <spur1>
    <freq>-238000.000</freq>
    <power>-116.735</power>
  </spur1>
  <spur2>
    <freq>388000.000</freq>
    <power>-124.472</power>
  </spur2>
  <spur3>
    <freq>178000.000</freq>
    <power>-127.087</power>
  </spur3>
  <spur4>
    <freq>-76000.000</freq>
    <power>-129.206</power>
  </spur4>
  <rbw>1000.000</rbw>
  <scaling>
    <x_max>1000000.000</x_max>
    <x_min>-1000000.000</x_min>
    <y_max>-24.268</y_max>
    <y_min>-126.485</y_min>
  </scaling>
  <n_fft_used>2000</n_fft_used>
  <no_avg>100</no_avg>
  <n_serial>3</n_serial>
</header>
```

As an example a measurement is made around the highest spurious which is located at -238 kHz.

7. As the phase noise offset is relative to frequency (peak_freq) the phase noise offset must be set to -248 kHz by accessing [**http://192.168.1.1:8080/intif/fftsa/config?pno=-248000**](http://192.168.1.1:8080/intif/fftsa/config?pno=-248000)
8. Note that for the best dynamic range for phase noise measurement, the channel power (full scale) should be in the range -10 to -4 dBFS. This can be achieved by changing the gain to 20 dB by accessing [**http://192.168.1.1:8080/intif/fftsa/config?gain=20**](http://192.168.1.1:8080/intif/fftsa/config?gain=20)
9. Instruct the spectrum analyzer to perform the FFT/measurements by accessing [**http://192.168.1.1:8080/intif/fftsa/makefft**](http://192.168.1.1:8080/intif/fftsa/makefft)
10. Verify that the spectrum analyzer is in the idle state and thus the measurements are done, by accessing [**http://192.168.1.1:8080/intif/status**](http://192.168.1.1:8080/intif/status)

- Find the phase noise measurements at http://192.168.1.1:8080/fft/fft_data, which contains information similar to (note the significantly higher phase_noise value):

```
<header>
  <dbm_offset>70.100</dbm_offset>
  <channel_power>
    <rx1>-78.480</rx1>
    <full_scale>-8.380</full_scale>
  </channel_power>
  <peak_power>
    <rx1>-78.487</rx1>
    <full_scale>-8.387</full_scale>
  </peak_power>
  <peak_freq>10000.000</peak_freq>
  <noise_floor>
    <rx1>-168.817</rx1>
    <full_scale>-98.717</full_scale>
  </noise_floor>
  <c_no>90.330</c_no>
  <phase_noise>-70.047</phase_noise>
  <centre_freq>1550000000</centre_freq>
  <peak_x>10.000</peak_x>
  <spur1>
    <freq>-238000.000</freq>
    <power>-116.850</power>
  </spur1>
  <spur2>
    <freq>388000.000</freq>
    <power>-124.841</power>
  </spur2>
  <spur3>
    <freq>178000.000</freq>
    <power>-129.328</power>
  </spur3>
  <spur4>
    <freq>-158000.000</freq>
    <power>-129.810</power>
  </spur4>
  <rbw>1000.000</rbw>
  <scaling>
    <x_max>1000000.000</x_max>
    <x_min>-1000000.000</x_min>
    <y_max>-3.387</y_max>
    <y_min>-108.717</y_min>
  </scaling>
  <n_fft_used>2000</n_fft_used>
  <no_avg>100</no_avg>
  <n_serial>4</n_serial>
</header>
```

12.6.4 Changing satellite table

This use case illustrates how to change the satellite table. This can be used for testing purposes.

- Put the RM into 'waveform mode' (refer to section 12.1.2).
- Set the parameter **protocols.bgan.functionality.satellite_table.change.locked** to 1 indicating that the parameters are being updated.
- Set the parameter **protocols.bgan.functionality.satellite_table.change.satellite_id** to the same ID used in the satellite table entry that should be changed.
- Set the parameters **protocols.bgan.functionality.satellite_table.change.position**, **protocols.bgan.functionality.satellite_table.change.channel.primary** and

protocols.bgan.functionality.satellite_table.change.channel.alternate to the new values.

5. Set **protocols.bgan.functionality.satellite_table.change.default** to 0.
6. Reset **protocols.bgan.functionality.satellite_table.change.locked** to indicate that the parameters have been updated and are ready to be used.
7. The RM will now read the changed values and update the satellite table. The satellite table will only be update if the **.satellite_id** set in step 3 already exists.

12.6.5 Reset satellite table to default

If the satellite table manually has been altered (section 12.6.4) to fit some test scenarios, it may eventually be necessary to reset it to default.

This use case illustrates how to reset the satellite table to default.

1. Put the RM into 'waveform mode' (refer to section 12.1.2).
2. Set the parameter **protocols.bgan.functionality.satellite_table.change.locked** to 1 indicating that the parameters are being updated.
3. Set **protocols.bgan.functionality.satellite_table.change.default** to 1.
4. It is not necessary to set any of the other **protocols.bgan.functionality.satellite_table.change** parameters.
5. Reset **protocols.bgan.functionality.satellite_table.change.locked** to indicate that the parameters have been updated and are ready to be used.
6. The RM will now reset the satellite table.

12.7 Physical & protocol layer test

12.7.1 BPLT testing

Square Peg communications Inc. has created an elaborate User's Guide to the BPLT which provides a system overview and instructions as to how the environment is installed, operated and maintained as well as hints to troubleshooting the BPLT setup if it malfunctions.

In order for the BGAN XL Radio Module to be able to communicate with the BPLT, it is necessary to activate the BPLT waveform. The steps to achieve this are described in 12.1.3 on page 12-3. When the BPLT waveform is active on the RM it can interact with the BPLT according to the BPLT/UT interface specification written by Square Peg Communications Inc.

The basic setup when performing the physical layer testing is as follows:

1. Connect the user terminal to the RF unit of the BPLT.
2. A network cable interconnecting the BPLT with the user terminal.

All information related to the setup of the environment can be changed by modifying the configuration files of the BPLT, refer to the BGAN Physical Layer Tester User's Guide from Square Peg Communications Inc. for further information.

The following figure shows a standard test setup.

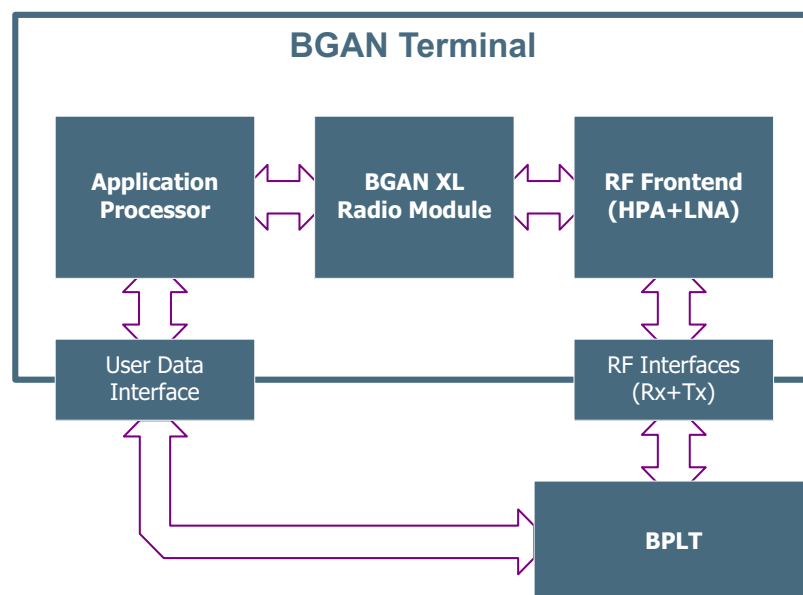


Figure 12-1: Physical and protocol layer test, setup

In order for BPLT tests to be performed, a range of information must be passed to the BGAN XL Radio Module via IP. This includes but is not limited to specifications of

forward/return data, satellite longitude and UE position. The full range of necessary information is described in the documentation from Square Peg¹. Most requirements for how to execute a BPLT are described in these documents, but special attention is necessary regarding Doppler correction.

12.7.1.1 Doppler correction in BPLT Waveform

The BGAN XL Radio Module can calculate Doppler compensation/correction, if enabled by the physical layer scripts, based on the navigation information received from the BPLT as TCP and UDP datagrams. Doppler is enabled using the Set Doppler Correction Mode message defined in BPLT/UT Interface Specification from Square Peg,

The required information in order to calculate the Doppler compensation is:

- The position of the user terminal
- The velocity of the user terminal
- The satellite longitude.

This information is supplied by the BPLT in a mixture of ARINC-429 messages and BPLT messages and received by the RM across multiple interfaces (see 7.8.1 on page 7-40)

If Doppler compensation is enabled, the RM will not set up a channel and start demodulating before all the information required for the Doppler compensation has been received.

If Doppler compensation has been enabled, and the RM is set up to tune to a specific frequency slot and acquire a bearer (via the 'Configure LESP bearer message' described in the BPLT/UT Interface Specification), all necessary Doppler information must have been received prior. If not, the demodulator is not started and the request to set up the demodulator is postponed until all the necessary information has been received.

If all Doppler compensation source data has been received and a bearer has been acquired, changes in the Doppler compensation source data are immediately.

1. Two documents specify the interaction between User Terminal and BPLT: PLT/UT Interface Specifications and BPLT ARINC-429 Interface Specification.

Time	BPLT Input				Transmit output	
	Satellite Longitude	UE Position	UE Velocity	LESP	Doppler Input ser	Channel
1	N/A	N/A	N/A	N/A	N/A	N/A
2	S1	P1		L1		
3						
4						
5			V1		S1, P1, V1	
6	S2				S2, P1, V1	L1
7					S2, P1, V2	

Table 12-2: Doppler compensation execution as result of Doppler compensation source data input to the RM

Table 12-2 shows an example of how the RM uses the Doppler compensation source data to calculate the Doppler compensation based on when the source data is received in conjunction with the configuration of the bearer. The number in the following list, refers to the Time in the table.

1. Restart of the RM (Doppler correction mode is enabled).
2. First satellite longitude is received.
3. First position is received.
4. Configure LESP Bearer received but not executed since velocity is required until Doppler compensation can be calculated.
5. First velocity message is received, Doppler compensation can now be calculated and the stored Configure LESP Bearer message is handled.
6. New satellite longitude received.
7. New velocity message received.

12.7.1.2 BPLT Test setup NF calibration guideline

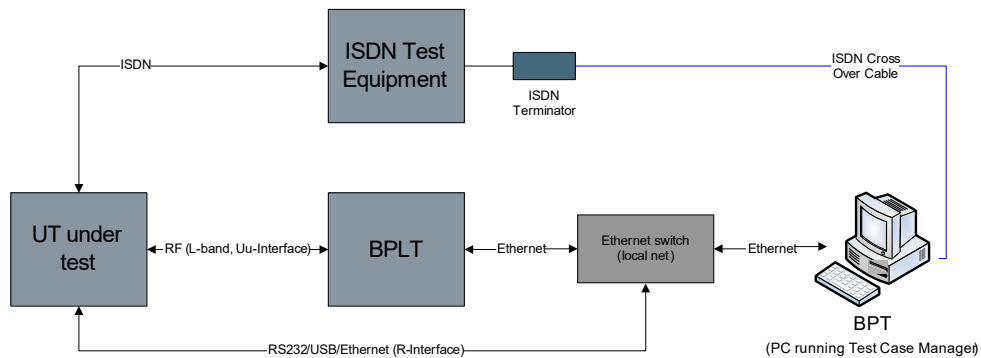


Figure 12-2: Noise figure calibration

Before running the BPLT MTR tests, the BPLT test setup should have its UT Noise Figure calibrated with respect to the external attenuator and written into the relevant BPLT **ut.ini** file.

This calibration step is very important for MTR's 7, 8, 9, 10 and 23, and the calibration procedure is described below. The NF calibration needs to be run for each tested forward frequency at each tested temperature point.

Prerequisites:

- The UT under test must use a factory calibrated Radio Module.
- Boltzmann constant:

$$k = 1.38 \times 10^{-23}$$

Calibration procedure:

1. Verify the attenuator setting in **bplt.ini**

- RFU attenuator.

$$Attn_{RFU} = xx[db]$$

- Measure and log the External Attenuation including cables into **bplt.ini**
(Attenuation between BPLT/RFU and UT)

$$Attn_{Extern} = xx[db]$$

2. Boot UT Radio Module into service mode, See 12.1.1 on page 12-2

3. Measure and log the temperature of the test:]

$$T_e = 20[^\circ \text{Celsius}]$$

4. Manually setup a CW on the BPLT and log the Tx Level from Bearer status window at 1542 MHz:

$$Level_{BPLT} = -xx[db]$$

5. Calculate the UT input level:

$$Level_{UT} = Level_{BPLT} - Attn_{RFU} - Attn_{Extern}[db]$$

6. Run the spectrum analyzer (see 12.6.1 on page 12-11) with the following parameters set
 - Span: 200 kHz
 - Centre frequency: 1542.0 MHz
 - Number of averages: 64
 - Window Type: Blackman
 - Rx Auto Gain: 0 dB
 - Click *Save All* and then *Run Spectrum* followed by *Refresh Spectrum*.

7. Log the CW Level found by the Spectrum analyzer (<peak_power> <rx1>). See 12.6.1 on page 12-11:

$$Level_{RM} = -xx[dBm]$$

8. Calculate the UT LNA gain between UT input and RM input:

$$Gain_{LNA} = Level_{RM} - Level_{UT}[dB]$$

9. Tear down the CW on the BPLT completely in bearer and channel control.

10. Run the spectrum analyzer with the following parameters set

- Rx Auto Gain: 32 dB
- Click *Save All* and then *Run Spectrum* followed by *Refresh Spectrum*.

11. Log the Noise Level found by the Spectrum analyzer (<noise_floor> <rx1>):

$$Noise_{RM} = -xx\left[\frac{dBm}{Hz}\right]$$

12. Calculate the Thermal Noise given a perfect receiver:

$$Noise_{UT} = 10 \cdot \log_{10}(10^3 \cdot k \cdot (T_e + 273))\left[\frac{dBm}{Hz}\right]$$

13. Calculate the Noise Figure:

$$NF_{UT} = (Noise_{RM} - Gain_{LNA}) - Noise_{UT}[dB]$$

14. Repeat Steps 3-13 for all relevant temperatures and frequencies.

15. Boot UT Radio Module into BPLT mode to perform MTR tests

12.7.2 BPT testing

The test equipment for performing the protocol testing is as follows:

1. BPLT (BGAN Physical Layer Tester)
2. BPT (BGAN Protocol Tester, a PC running the Test Case Manager application)
3. User terminal under test
4. All necessary cables (see figure below)

Note that when performing the protocol tests, it is assumed that all lower layers are tested and working properly.

12.7.2.1 Test setup

The following illustration shows a standard test setup.

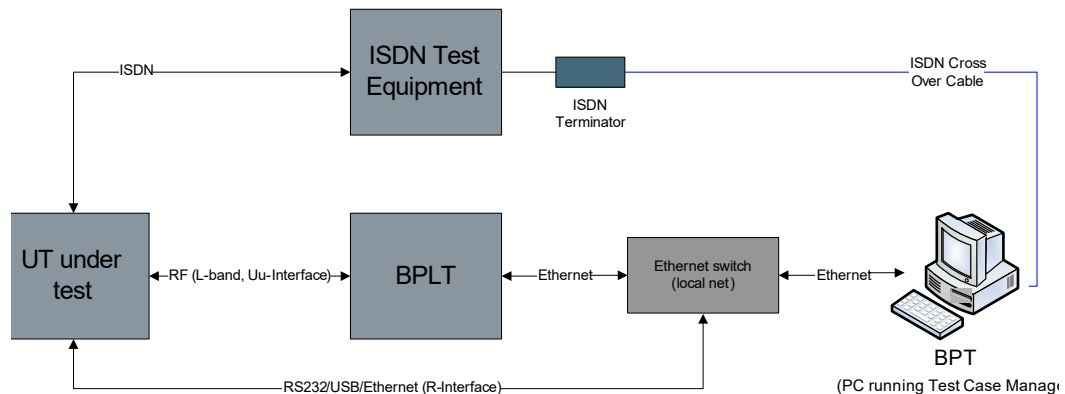


Figure 12-3: Physical and protocol layer test, setup

Specific information for the setup of the environment, IP addresses, port numbers etc. should be properly configured to ensure communication between the entities. The test setup parameters can be verified in the Test Case Manager application and in the configuration files of the BPLT.

The complete set of tests is divided into different suites (REGM, BCn, BCt, NAS etc.) and might be even further divided into subsets.

Before starting a test, make sure that:

1. The latest version of the test suites has been obtained from Inmarsat and installed.
2. Appropriate changes to the test parameters have been made to accommodate for the particular configuration of the User Terminal under test.
3. The latest release of the BPT and BPLT have been installed and configured.

12.7.2.2 Configuring the BGAN XL Radio Module for protocol testing

The BGAN XL Radio Module must be set up correctly when performing protocol tests. In order to simplify the process, a package of Python scripts are delivered as part of the Integrators development kit. The following step procedure is a quick reference which must be followed closely when preparing the RM for protocol testing. It is necessary that the scripts are executed in the order mentioned below and that the changes to related test files are made.

The Python scripts must be executed on a PC with an Ethernet connection to the user terminal. A Telnet session is established with the RM and a sequence of necessary commands are executed.

1. Load and activate an IAI2 waveform (see section 12.1.2 on page 12-2).
2. Execute the initial Python script in order to set values needed for protocol testing inside the RM.

- Reboot the RM for changes to take effect.
 - It is only necessary to run this script once when setting up a user terminal for protocol testing.
3. Execute the appropriate Python script, depending on which MTR script(s) must be executed. As a rule of thumb, one Python file corresponds to a test suite, however it is worth noting that some MTR scripts require a slightly different configuration and is therefore associated with a different Python script than the suite it is a part of. A complete list of MTR scripts with corresponding Python script is supplied in the Python script package under the filename *ScriptList.txt*.
 - When starting a new MTR test script, the related Python script **must** be executed.
 - Several MTR tests sharing a Python setup script can normally be executed without the need to run the Python setup script between tests.
 4. Make sure the variables in the pixit files (.tsp files supplied by Inmarsat along with the MTR scripts) contains the correct values in accordance with the User Terminal under test. The following values must be set correctly (the parentheses indicates the related field in the pixit file):
 - IMEI number of the user terminal (*px_IMEI_def*)
 - Combined IMEI and software version number (*px_IMEISV_def*)
 - User terminal class (named differently in each MTR test suite, see specific MTR suite documentation)
 - For classes 6, 7, 10 and 11 set:


```
pxb_bganx = True
pxb_bplt_rx_bearer_type = 61
```

 otherwise:


```
pxb_bganx = False
pxb_bplt_rx_bearer_type = 62
```
 5. There must be a special protocol test (dummy) SIM card in the user terminal. The *px_AuthK* and *px_ck* field in the pixit files must be adjusted to correspond with the value on the SIM card.

The pixit files contain a large number of test-specific parameters. For further information, refer to the specific MTR documentation from each test suite supplied by Inmarsat.

12.7.3 VCTS testing

This use case presents a simplified description of how to perform VCTS end-to-end testing. The test is performed as a part of the type approval to test the signal path from the 2-wire connector to the output of the AMBE+2 voice codec and vice versa. The test setup consists of a BPT, BPLT, VCTS, VCDS and the terminal under test as shown in the figure below. It can be seen as a protocol test just with the addition of the VCTS and therefore the preparations for a protocol test also apply here regarding IP addresses,

port numbers etc. The BGAN XL Radio Module shall also be in test script mode during the test.

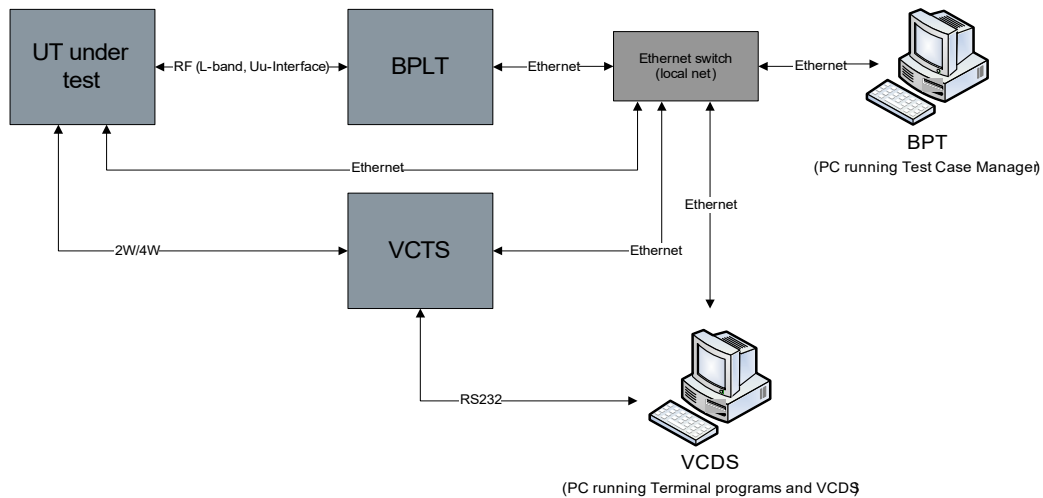


Figure 12-4: VCTS test setup

The principle of operation is as follows. A circuit-switched call is established between the terminal and the BPT/BPLT. The VCTS sends audio signals to the terminal via the 2-wire interface. The audio signals are encoded into AMBE frames and transmitted over the RF interface to the BPLT. The BPLT demodulates the frames and sends them to the BPT which passes them on to the VCTS where they are stored on the hard drive. Data also goes in the other direction; the VCTS sends AMBE+2 encoded frames via the BPT to the BPLT where they are modulated and sent to the terminal over the RF interface. In the terminal the frames get demodulated, AMBE+2 decoded into audio and sent to the VCTS via the 2-wire interface where the data is saved on the hard drive. After a test instance has been completed the VCDS reads the data from the VCTS analyzes it and presents the result. The test procedure is as follows:

1. Connect the test equipment as pictured above.
2. Run the Python script `VCTS_end_to_end.py` that sets the terminal up for VCTS testing.
3. Set up the VCDS for a new test.
4. Run the script `VCTS_end_to_end.rls` in Test Case Manager.
5. When the CS connection has been established make all end-to-end tests in the VCDS software.

When the tests are completed inspect the test results, verify that they are as expected.

Applications

This chapter has the following sections:

13.1 Typical application 13-2

13.2 Minimum application 13-3

13.1 Typical application

Figure 13-1 shows a block diagram of a typical integrated terminal based on a BGAN XL Radio Module.

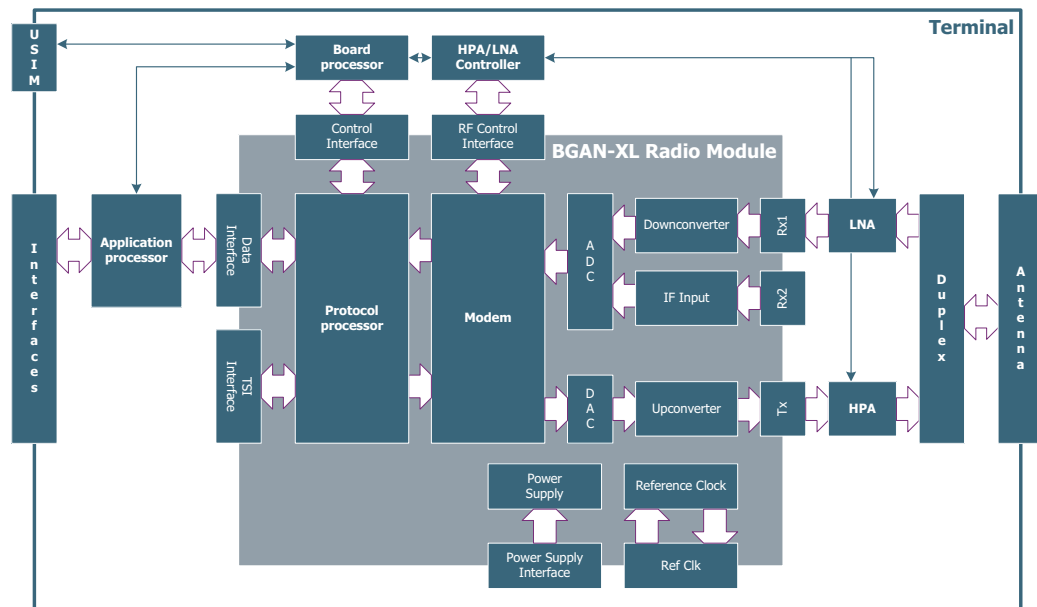


Figure 13-1: Typical application

13.1.1 Comments

The HPA/LNA Controller may be realized in a small FPGA to accommodate for the timing requirements set up by a HPA implementing an ALC circuit.

Alternatively the HPA may be implemented as a fixed gain HPA where only the transmitter timing synchronization signal (B2B_Tx_Sync) is used to synchronize the sampling of RF power detectors to the transmitted bursts. The sampled power may be used by an AGC circuit to maintain a fixed gain. It is expected that this approach will reduce the complexity and cost of the HPA/LNA Controller.

13.2 Minimum application

Figure 13-2 shows a block diagram of a minimum terminal based on a BGAN XL Radio Module

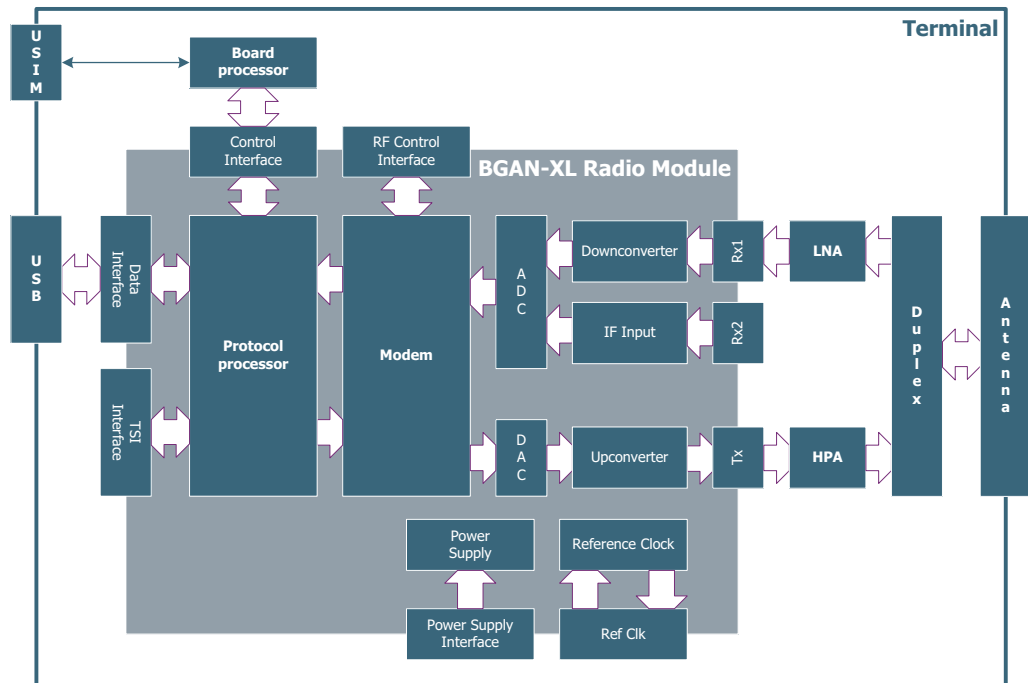


Figure 13-2: Minimum application

13.2.1 Comments

The minimum application depicted in Figure 13-2 above does not include an application processor. This implies that the integrator must implement functions like e.g. software upload, firewall, NAT, PABX, MMI etc. external to the terminal in e.g. a PC running a dedicated application for this.

Type approval

This chapter has the following sections:

14.1 Introduction 14-2

14.2 Pre-approved MTRs 14-6

14.3 Physical layer 14-7

14.4 Protocol layer 14-18

14.5 Audio tests 14-19

14.1 Introduction

A BGAN terminal must undergo a type approval campaign and be type approved by Inmarsat before it can be sold to customers. A type approval campaign will typically comprise the steps shown in the figure below.

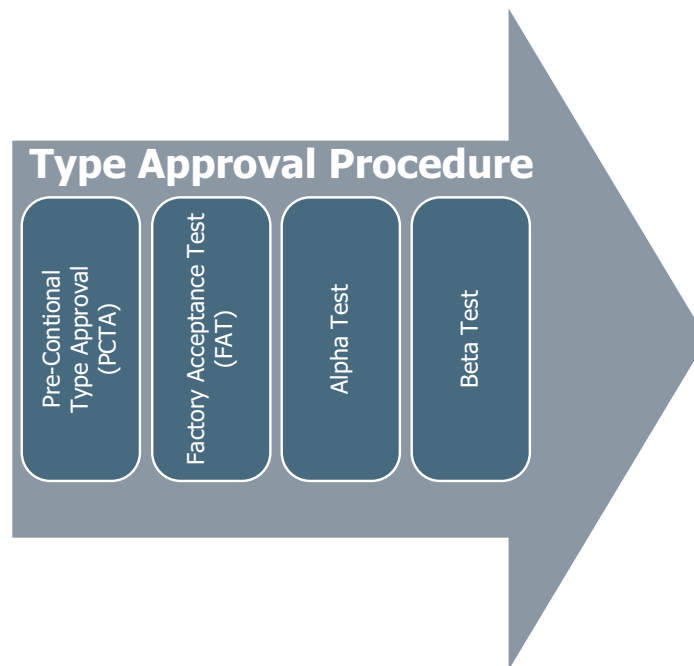


Figure 14-1: Typical Type Approval Procedure

Upon completion of all the tests included in the type approval campaign, Inmarsat will evaluate the test reports and if satisfied grant the user terminal type approval that will give permission to release and start shipping the user terminal to customers.

For the BGAN XL Radio Module, a full type approval campaign has not been performed as the RM does not implement a complete user terminal. However, a number of mandatory type approval tests have been pre-approved by Inmarsat in order to ease the type approval process for the user terminal. Refer to section 14.2 on page 14-6 for more information.

Important

It is the responsibility of the user terminal vendor to agree with Inmarsat on the exact content of a type approval campaign before it is undertaken.

14.1.1 Mandatory test requirements

The backbone of the type approval for any new BGAN terminal is formed by a set of Mandatory Test Requirements (MTR) specified by Inmarsat. The MTRs are divided in three groups namely:

- Physical Layer MTRs
- Protocol Layer MTRs

- Audio Tests MTRs

Normally, a product is required to pass all of the specified tests in order to be granted a type approval. Some tests may be excluded though, if they do not apply to the particular terminal class in question.

The MTRs are defined in documents which are written and provided to the terminal manufacturers by Inmarsat. The actual MTR documents are covered by an NDA and may not be reproduced here. The integrator can request them directly from Inmarsat.

An MTR document describes the general test setup for all the test cases defined in the MTR. Each test case is defined by a purpose, a test procedure and a pass/fail criterion. Typically the test procedure includes a script which performs the actual test.

The entire suite of MTR documents consists of around 35 documents, most of which concern the physical layer. Each document covers a single functional area of a BGAN terminal and will typically contain several test cases within the particular functional area.

The full suite of MTR tests spans the entire set of requirements in the SDM from hardware functions and performance, physical layer performance including modem performance to a large number of protocol tests. Parsing the applicable MTRs will prove that the terminal operates in accordance with the SDM, both with respect to the physical layer and in relation to the Inmarsat Air Interface protocol (IAI2).

14.1.2 Pre-conditional type approval

The Pre-Conditional Type Approval (PCTA) serves as an Inmarsat approval milestone that - when passed - will grant permission to operate the terminal on-air and start the alpha test execution.

The PCTA campaign consists of execution and reporting of a selected and agreed subset of the MTRs. The MTRs conducted during the PCTA is practically a full Inmarsat Type Approval test, with the exception that the tests are performed in a laboratory environment only. During the full Factory Acceptance Test (FAT) campaign, some tests are repeated under different environmental conditions such as vibrations, humidity and extreme temperatures, thus multiplying the test time with a factor of three or more. However, functionally and performance-wise the PCTA contains exactly the same tests as performed during the FAT. The PCTA test reports are reviewed by Inmarsat, who grants the PCTA if the test results are satisfactory.

The PCTA will typically include the following tasks:

- Test execution:
 - Selected set of BGAN Physical Layer Test (BPLT) scripts
 - Full set of BGAN Protocol Test (BPT) scripts
- Test result reporting:
 - BPLT MTR test results
 - BPT test results

14.1.3 Factory acceptance test

The Factory Acceptance Test (FAT) serves as an Inmarsat approval milestone that - when passed - will grant permission to go ahead with the beta test campaign with selected customers and pave the way towards full type approval.

The FAT campaign consists of re-execution and reporting of MTRs but in addition to the PCTA some of the scripts must be executed in different environmental conditions (vibrations, humidity and extreme temperatures). In addition the alpha test specification must be reviewed and approved.

The FAT includes the following tasks:

- Test Execution
 - Test/re-test of selected BGAN Physical Layer Test (BPLT) scripts
 - Test/re-test of selected BGAN Protocol Test (BPT) scripts
- Test Result Reporting
 - Updated BPLT test results data
 - Updated BPT MTR test results data
- Alpha test specification
 - Reviewed and approved alpha test specification
- Beta test specification
 - Reviewed and approved beta test specification

14.1.4 Alpha test

Having achieved PCTA the BGAN terminal may be used for on-air testing on a limited scale via Inmarsat I4 satellites. This will allow to perform additional on-air verification testing and prepare for the formal alpha test.

The alpha test shall validate performance and stability of the BGAN terminal in an on-air environment as in normal use by the end user, i.e. the complete system is installed in a target environment.

The alpha test will be conducted by the BGAN terminal manufacturer and may include mobile tests where the BGAN terminal is mounted on a car as well as maritime test where the system is installed on a vessel. The alpha test campaign will traditionally focus on three areas: Product stability, product performance and mobile test behaviour.

The alpha test campaign will typically consist of the following tasks:

- In-house alpha test dry-run
- Alpha field test execution
 - Alpha test report reviewed and approved

14.1.5 Beta test

The purpose of the beta test is to validate the BGAN terminal in the target environment by real customers in order to spot possible issues and obtain end-user feedback about the product. The beta test will be performed by end-users identified by the BGAN terminal vendor. Also, Inmarsat will typically be offered a system in order to make a test and provide feedback. The scope of the specified beta test requires the end-user to make some predefined tests. It will also enable the end user to gain experience with the system.

The end users must fill out a beta test report documenting the executed tests and providing feedback about the product performance. Upon completion of the beta test a report must be generated and forwarded to Inmarsat.

The beta test campaign will typically consist of the following tasks:

- In-house beta test dry-run
- External beta test with selected customers
- Possible test and feedback by Inmarsat
- Beta test report reviewed and approved

14.2 Pre-approved MTRs

In order to ease the type approval process for integrators certain MTRs have been pre-approved in agreement with Inmarsat. This means that integrators can refer to these pre-approvals in their test plans when they apply for type approval.

The pre-approved MTRs are all testing functional areas of which the performance is defined by the BGAN XL Radio Module. The figure below shows on a high level how the different MTRs are distributed between the RM (and thereby being pre-approved) and the surrounding functionality provided by the integrator.

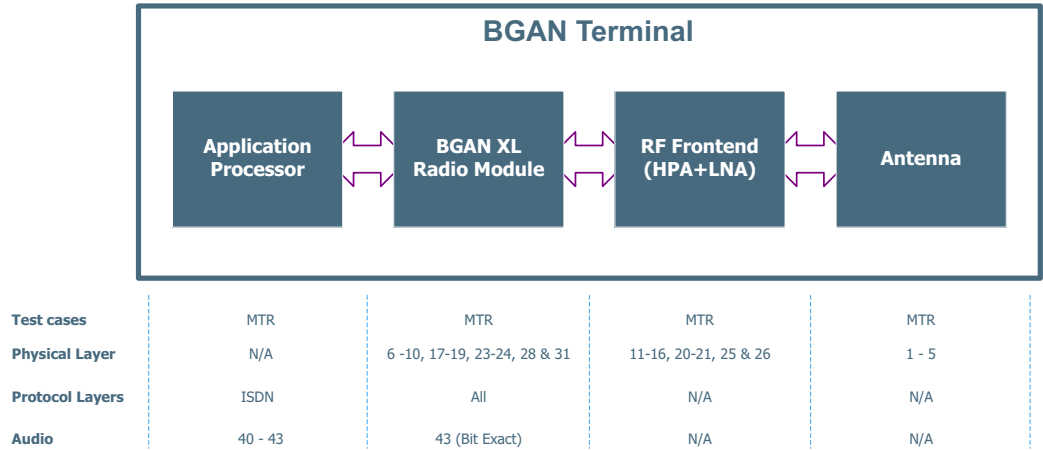


Figure 14-2: MTR Segmentation Overview

Sections 14.3 and 14.4 show in detail the extent of the pre-approved MTRs by defining on sub-test level which tests are already pre-approved and which should be a part of an approval campaign for the BGAN terminal.

Note At the time of writing the BGAN XL Radio Module has currently been pre-approved for Class 1 HDR & 2. However, the current pre-approvals will always be defined in the applicable Release Note for the RM software!

14.3 Physical layer

The test setup for verification of the physical layers is based on a BPLT. The BPLT executes MTR defined test scripts which are specially designed to verify the performance of the BGAN physical layers.

The BPLT contains channel boards interfacing to the RF interface of the BGAN terminal and an Ethernet interface connecting it to a data interface of the BGAN terminal as shown in the following figure. The setup thus forms a closed loop enabling the BPLT to control the BGAN terminal to send and receive different bearer types using various channels while verifying performance.

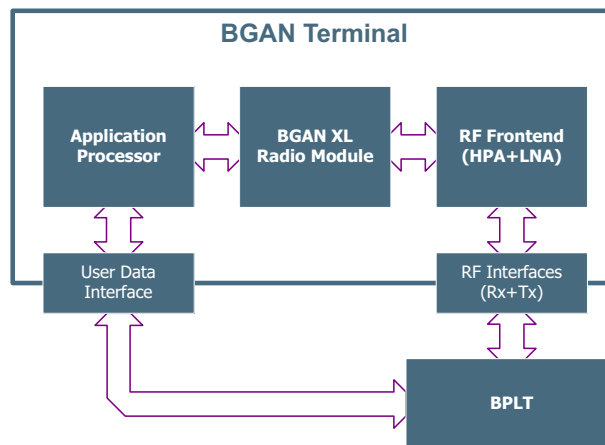


Figure 14-3: BPLT test setup

The physical layer test campaign is based exclusively on the test suite defined by the physical layer MTR documents, of which only a subset apply to the BGAN XL Radio Module as the RM does not form a complete BGAN terminal. The following subsections give an overview of the test suite developed to verify the performance of the BGAN physical layer and identifies the pre-approved BGAN XL Radio Module subset using the following nomenclature:

- **RM** means that the sub-test is a part of the pre-approved test suite as the test outcome is defined by the RM.
- **INT** means that the test outcome is defined by other parts of a terminal than the RM (e.g. HPA, LNA etc.) and is thus not a part of the RM pre-approval and should be addressed by the integrator.
- **RM/INT** means that the test is a part of the RM release test suite but it does not hold a pre-approval as part of a BGAN terminal may affect the test outcome.
- **A blank field** indicates that the given sub-test is not defined for the particular terminal class.

Each sub test requires that the BGAN terminal under test can be controlled independently of the bearer control layer. The RM supports this when operated in BGAN BPLT mode as described in section 6.1 on page 6-2. When operated in BGAN

BPLT Mode the RM can be controlled using the interface protocols described in section 7.8.1 on page 7-40.

Important The BGAN XL Radio Module holds a deviation for MTR 7, 9 and 23. The exact extent of these deviations are described in a subsection under the respective MTRs!

Important ATC MTR is not part of the subsections below and must be tested by the integrator.

14.3.1 MTR 6 Receiver Tuning Range

MTR 6 Receiver Tuning Range, verifies the ability of the receiver to tune over the entire receive frequency range and anywhere within a sub band, within the minimum specified step interval.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM	RM	RM	RM	RM	RM

Table 14-1: Sub test specifications: Receiver Tuning Range.

14.3.2 MTR 7 QPSK frame acquisition

MTR 7 QPSK frame acquisition, verifies the frame-acquisition performance of the BGAN terminal when receiving a QPSK forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
B	RM	RM	RM	RM	RM	RM
C	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
E	RM	RM	RM	RM	RM	RM
F ^a	RM	RM	RM	RM	RM	RM
G ^a	RM	RM	RM	RM	RM	RM
H ^a	RM	RM	RM	RM	RM	RM
J ^a	RM	RM	RM	RM	RM	RM
K			RM	RM	RM	RM

Table 14-2: Sub test specifications: QPSK frame acquisition

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
L			RM	RM	RM	RM
M			RM	RM	RM	RM
O			RM	RM	RM	RM
W			RM	RM		
X			RM	RM		
Y			RM	RM		
Z			RM	RM		

Table 14-2: Sub test specifications: QPSK frame acquisition (Continued)

a. Not required for type approval.

14.3.2.1 Deviation

MTR	Name and Function	Sub-test	Class	Deviation granted
7	QPSK Frame Acquisition	E	All	July 2nd 2013
Re-acquisition after blockage Original requirement: Blocking level: -20 dB, PER (6th frame): 0.01, PER (7th frame): 0.001 Achieved performance: Blocking level: -20 dB, PER (6th frame): 0.02, PER (7th frame): 0.001 The BGAN XL Radio Module has been granted a permanent deviation on this MTR.				

Table 14-3: Deviations on QPSK Frame Acquisition

14.3.3 MTR 8 QPSK packet error rate

MTR 8 QPSK packet error rate verifies the packet error rate performance of the terminal when receiving a QPSK forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
C	RM	RM	RM	RM	RM	RM

Table 14-4: Sub test specifications: QPSK Packet Error Rate.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
L			RM			
W			RM	RM		

Table 14-4: Sub test specifications: QPSK Packet Error Rate.

14.3.4 MTR 9 QAM Frame Acquisition

MTR 9 QAM Frame Acquisition, verifies the Frame Acquisition performance of the terminal when receiving a QAM forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
B	RM	RM	RM	RM	RM	RM
C	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
E	RM	RM	RM	RM	RM	RM
G	RM	RM	RM	RM	RM	RM
H	RM	RM	RM	RM	RM	RM
J	RM	RM	RM	RM	RM	RM
L			RM	RM	RM	RM
M			RM	RM	RM	RM
O			RM	RM	RM	RM
W			RM	RM		
X			RM	RM		
Y			RM	RM		

Table 14-5: Sub test specifications: QAM Frame Acquisition

14.3.4.1 Deviations

MTR	Name and Function	Sub-test	Class	Deviation granted
9	QAM Frame Acquisition	E	All	July 2nd 2013
Re-acquisition after Blockage Original requirement: Blocking Level: -20 dB, PER (6th frame): 0.01, PER (7th frame): 0.001 Achieved Performance: Blocking Level: -30 dB, PER (6th frame): 0.20, PER (7th frame): 0.001 The BGAN XL Radio Module has been granted a permanent deviation on this MTR.				
9	QAM Frame Acquisition	J	All	July 2nd 2013
Re-acquisition after Blockage (dual-rate) Original requirement: Blocking Level: -20 dB, PER (6th frame): 0.01, PER (7th frame): 0.001 Achieved Performance: Blocking Level: -30 dB, PER (6th frame): 0.20, PER (7th frame): 0.001 The BGAN XL Radio Module has been granted a permanent deviation on this MTR.				

Table 14-6: Deviations on QAM Frame Acquisition

14.3.5 MTR 10 QAM Packet Error Rate

MTR 10 QAM Packet Error Rate, verifies the Packet Error Rate performance of the terminal when receiving a QAM forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H, 7H	Class 8, 9, 14	Class 10, 11
A	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
C	RM	RM	RM	RM	RM	RM
W			RM	RM		

Table 14-7: Sub test specifications: QAM Packet Error Rate.

14.3.6 MTR 11 QPSK selectivity

MTR 11 QPSK selectivity, verifies the Packet Error Rate performance of the terminal in the presence of out-of-band interfering signals and in-band adjacent channel interferers, when receiving a QPSK forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT

Table 14-8: Sub test specifications: QPSK selectivity.

14.3.7 MTR 12 QAM selectivity

MTR 12 QAM selectivity verifies the Packet Error Rate performance of the terminal in the presence of out-of-band interfering signals and in-band adjacent channel interferers, when receiving a QAM forward bearer.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT

Table 14-9: Sub test specifications: QAM selectivity.

14.3.8 MTR 13 Receiver dynamic range

MTR 13 receiver dynamic range verifies the receive dynamic range of the terminal, and that for Aeronautical terminals the receiver can withstand specified flux densities without sustaining damage.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT

Table 14-10: Sub test specifications: Receiver dynamic range

14.3.9 MTR 14 EIRP Determination and Stability

MTR 14 EIRP Determination and Stability, verifies the transmitted EIRP of the terminal.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	INT	INT	INT	INT	INT	INT
B	INT	INT	INT	INT	INT	INT
H	INT		INT	INT		
I	INT		INT	INT		
L			INT			
M			INT			

Table 14-11: Sub test specifications: EIRP determination and stability

14.3.10 MTR 15 Transmitter Off Level

MTR 15 Transmitter Off Level, verifies that the transmitted fundamental, spurious and harmonic signals of the terminal comply with the requirements of the BGAN SDM while the transmitter is idle.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT

Table 14-12: Sub test specifications: Transmitter Off level.

14.3.11 MTR 16 Spurious and Harmonics

MTR 16 Spurious and Harmonics, verifies that the transmitted spurious and harmonic signals of the terminal comply with the requirements of the BGAN SDM while the transmitter is active.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT
H	INT		INT			
L			INT			

Table 14-13: Sub test specifications: Spurious and Harmonics.

14.3.12 MTR 17 Transmitter Phase Noise

MTR 17 Transmitter Phase Noise, verifies the transmitted phase noise of the terminal.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM	RM	RM	RM	RM	RM

Table 14-14: Sub test specifications: Transmitter Phase Noise.

14.3.13 MTR 18 Transmitter Tuning Performance

MTR 18 Transmitter Tuning Performance, verifies the ability of the transmitter to tune over the complete transmit frequency range, within the minimum specified step interval.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	RM	RM	RM	RM	RM	RM
B	RM	RM	RM	RM	RM	RM
C	RM	RM	RM	RM	RM	RM
L			RM			

Table 14-15: Sub test specifications: Transmitter Tuning Performance.

14.3.14 MTR 19 Transmitter Frequency Accuracy and Stability

MTR 19 Transmitter Frequency Accuracy and Stability, verifies the transmitted frequency accuracy and stability of the terminal.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM	RM	RM	RM	RM	RM
H	RM		RM	RM		
L			RM			

Table 14-16: Sub test specifications: Transmitter Frequency Accuracy and Stability

14.3.15 MTR 20 Modulator Performance

MTR 20 Modulator Performance, verifies the modulation characteristics of the terminal.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
H	RM/INT		RM/INT	RM/INT		
L			RM/INT			

Table 14-17: Sub test specifications: Modulator Performance

Note The BGAN XL Radio Module is tested against a tougher requirement: EVM^2 1.5e-3 and then released.

14.3.16 MTR 21 Transmit Burst Characteristics

MTR 21 Transmit Burst Characteristics, verifies the transmitted burst power profile.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
H	RM/INT		RM/INT			
L			RM/INT			

Table 14-18: Sub test specifications: Transmitter Bursts Characteristics

14.3.17 MTR 23 C/No Measurement and Reporting

MTR 23 C/No Measurement and Reporting, verifies that the terminal is able to measure the forward bearer carrier-to-noise (C/No) ratio correctly.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
B			RM	RM	RM	RM
W			RM	RM		

Table 14-19: Sub test specifications: C/No Measurements and Reporting

14.3.17.1 Waiver

MTR	Name and Function	Sub-test	Class	Deviation granted
23	C/No Measurement and Reporting	A	1/HDR, 2, 3	July 2nd 2013
At high C/No the demodulator estimates slightly too low (~0.1 dB). A new algorithm for C/No estimation is planned and will be implemented in a future software release. The BGAN XL Radio Module has been granted a temporary waiver on this MTR.				

Table 14-20: Waivers on C/No measurement

14.3.18 MTR 24 Transmitter Coding Performance

MTR 24 Transmitter Coding Performance, verifies that the transmitted bursts are coded and formatted correctly.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM	RM	RM	RM	RM	RM
H	RM		RM	RM		
L			RM			

Table 14-21: Sub test specifications: Transmitter Coding Performance

14.3.19 MTR 25 Transmitter Burst Timing Accuracy and Stability

MTR 25 Transmitter Burst Timing Accuracy and Stability, verifies the transmitted burst timing accuracy and stability.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
A	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
B	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT	RM/INT
H	RM/INT		RM/INT	RM/INT		
I	RM/INT		RM/INT	RM/INT		
L			RM/INT			
M			RM/INT			

Table 14-22: Sub test specifications: Transmitter Burst Timing Accuracy and Stability

14.3.20 MTR 26 Transmitter Power Spectral Density

MTR 26 Transmitter Power Spectral Density, verifies the transmitted burst spectral shape.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	INT	INT	INT	INT	INT	INT
H	INT		INT			
L			INT			
M			INT			

Table 14-23: Sub test specifications: Transmitter Power Spectral Density

Note

The BGAN XL Radio Module is release-tested against a tougher spectral mask: mask reduced by 8 dB for the R80T0.5Q bearer and with 9 dB for all other bearer types.

14.3.21 MTR 28 Code Rate Detection

MTR 28 Code Rate Detection, verifies that the terminal can correctly determine the coding rate of the first FEC block in a forward frame.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
	RM	RM	RM	RM	RM	RM
A			RM	RM		
B			RM	RM		

Table 14-24: Sub test specifications: Code Rate Detection

14.3.22 MTR 31 Dynamic Modulation

MTR 31 Dynamic Modulation, verifies that the terminal can correctly receive FR80T2.5X4/16 and FR80T5X4/16 bearers with modulation and coding rate varying within the frame.

Sub-Test	Class 1H	Class 2	Class 4	Class 6H,7H	Class 8,9,14	Class 10,11
			RM			
A			RM			
B			RM			

Table 14-25: Sub test specifications: Dynamic Modulation

14.4 Protocol layer

The test setup used for verification of the protocol layers is based on a BGAN Protocol Tester (BPT). The BPT executes the different protocol layer test scripts defined by protocol test MTR documents. The protocol tests are performed in a closed loop test setup using a BPT and a BPLT as outlined in Figure 14-4 below. The BPT can automatically execute test scripts for a vast number of test scenarios using the BPLT to simulate the air interface and interfacing directly to the data interface of the terminal under test.

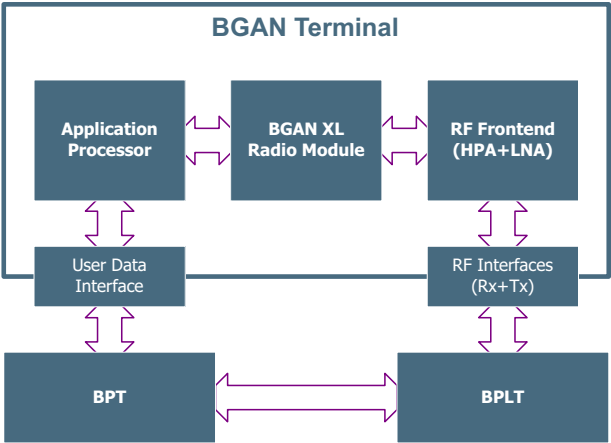


Figure 14-4: BPT Test Setup

Table 14-26 below presents an overview of the test suites developed by Inmarsat to verify the functionality of the BGAN protocol layers.

Title	Suite name
NAS Layer	NAS
ISDN Layer	ISDN
Adaptation Layer	REGM
	RBC
Bearer Connection Layer	BCn
Bearer Control Layer	BCt1 (includes some HDR test cases)
	BCt2 (includes some HDR+LDR test cases)

Table 14-26: Protocol layer test cases

All in all, roughly 1200 scripts are included in the 7 test suites, all applicable test cases have been validated against the BGAN XL Radio Module before the software is released. Not all test cases are applicable for all terminals. A class 2 user terminal with

no HDR or ISDN support for example, has not been validated against the ISDN suite or the HDR test cases.

The test results can be replicated and verified by the integrator by following the guidelines described in section 12.7.2 on page 12-21 along with the protocols and software mentioned in section 7.8 on page 7-40. It may be necessary for the integrator to at least verify the ISDN test result with their own ISDN equipment.

14.5 Audio tests

A number of different MTRs are defined for test of the audio quality of the terminal. These tests are all utilizing different test setups which can be seen in the MTR document specifying the respective test case.

To undergo the various audio tests the terminal must support a dedicated test protocol. The BGAN XL Radio Module supports this when operated in VCTS mode. When operated in BGAN VCTS Mode the BGAN XL Radio Module can be instrumented using the interface protocols described in section 7.8.3.

14.5.1 MTR 40 Handset Audio Levels & bluetooth audio

MTR 40 Handset Audio Levels & bluetooth audio, evaluates the audio performance of any handset supplied with a BGAN terminal.

Sub-Test	All Classes
All	INT

Table 14-27: Sub test specifications: Handset Audio Levels & bluetooth audio.

14.5.2 MTR 41 DTMF via audio channel tests

MTR 41 DTMF via audio channel tests, verifies that the terminal correctly handles DTMF tones.

Sub-Test	All Classes
	INT

Table 14-28: Sub test specifications: DTMF via audio channel tests.

14.5.3 MTR 42 Echo canceller tests

MTR 42 Echo canceller tests, verifies that the echo canceller complies with ITU-T recommendation G.168, and subjectively checks echo canceller performance.

Sub-Test	All Classes
	INT

Table 14-29: Sub test specifications: Echo canceller tests.



Access to two 4-wire interfaces is required in order to perform this test.

14.5.4 MTR 43 Voice Codec Testing Using VCTS

MTR 43 Voice Codec Testing Using VCTS, evaluates the quality of AMBE+2 voice codec implementation in a terminal.

Sub-Test	All Classes
Bit Exact	RM
End-to-End	INT

Table 14-30: Sub test specifications: Voice Codec Testing Using VCTS.

References

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- [20] Request for Comments: 4938, February 2010, PPPoE Extensions for Credit Flow and Link Metrics.
- [21] 3GPP TS 31.102 V4.15.0 (2005-06), 3rd Generation Partnership Project; Technical Specification Group Terminals; Characteristics of the USIM Applications (Release 4)
- [22] 3GPP TS 27.010 V4.2.0 (2002-03), 3rd Generation Partnership Project; Technical Specification Group Terminals; Terminal Equipment to User Equipment (TE-UT) multiplexer protocol (Release 4)

A

AAGW	ACARS Aircraft Gateway. A functional block inside the aeronautical class terminal.
ACARS	Aircraft Communication Addressing and Reporting System. A system for transmission of short messages between aeronautical class terminals and ground stations.
ACM	Antenna Control Module.
ADC	Analog-to-Digital Converter is a device that converts an analog signal into a digital signal.
AGC	Automatic Gain Control is a technique to adjust the receiver gain to optimize the signal-to-noise ratio when receiving weak signal levels and avoid overloading when receiving stronger signals.
AMBE	Advanced Multi-Band Excitation.
APDU	Application Protocol Data Unit is the communication unit used exchange of USIM data.
APDU	Application Protocol Data Unit.
API	Application Programming Interface is a protocol intended to be used as an interface by a software module to communicate with other software module.
APN	Access Point Name. The Access Point Name is used by the terminal operator to establish the connection to the required destination network.
ARINC	Aeronautical Radio, Incorporated. A provider of transport communications and systems engineering solutions.
ARP	Address Resolution Protocol is a protocol used for resolution of network layer addresses into link layer addresses.
ASCII	American Standard Code For Information Interchange.
ATC	Ancillary Terrestrial Component, a technique for using a "terrestrial" network of cell-phone towers to supplement a Mobile Satellite Service (MSS) provided by orbiting communication satellites.

B

BGAN	Broadband Global Area Network. A satellite network based on geostationary satellites, delivering data rates of up to 492 kbps and telephony to virtually any part of the earth, with full UMTS (3G) compatibility. BGAN enables users to access e-mail, corporate networks and the Internet, transfer files and make telephone calls.
------	---

BOM A bill of materials (BOM) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture a product.

BPLT BGAN Physical Layer Tester. A tester that supports the testing of physical layer performance and User Terminals (UTs) implementing Inmarsat's Broadband Global Area Network (BGAN), Fleet Broadband and Swift Broadband services.

BPT BGAN Protocol Tester.

C

CDC EEM Communication Device Class - Ethernet Emulation Model.

CLIR Calling Line Identification Restriction.

CN Core Network.

CS Circuit Switched or Circuit switching is a methodology of implementing a network in which two nodes establish a dedicated communications channel through the network before they may communicate. The circuit guarantees the full bandwidth of the channel and remains connected for the duration of the communication session.

CW Continuous Wave is an electrical signal with a constant amplitude and frequency.

D

DAC Digital-to-Analog Converter is a device that converts a digital signal into an analog signal.

dBFS Decibels relative to full scale, commonly abbreviated dBFS, measures decibel amplitude levels in digital systems which have a defined maximum available peak level. 0 dBFS is assigned to the maximum possible at the ADC input. For example, a signal that reaches 50% of the maximum level at any point would reach -6 dBFS at that point, 6 dB below full scale.

DHCP Dynamic Host Configuration Protocol.

DTMF Dual Tone Multi Frequency. The keypad signaling technology that generates two distinct tones when each key is pressed. This system allows navigation of voice menus and other advanced calling services. All wireless phones use DTMF dialing.

E

ECEF Earth-Centered, Earth-Fixed.

EIRP Effective Isotropically-Radiated Power. The amount of power that would have to be emitted by an isotropic antenna (that evenly distributes power in all directions) to produce the peak power density observed in the direction of maximum antenna gain.

eMLPP	Enhanced Multi-Level Precedence and Preemption. A supplementary service used to deliver Safety Priority Voice Calls as defined by Inmarsat.
ESD	ElectroStatic Discharge is the sudden flow of electricity between two objects caused by contact, an electrical short, or dielectric breakdown. ESD can be caused by a buildup of static electricity by tribocharging, or by electrostatic induction.
EVM	The error vector magnitude is here defined as the Euclidian distance between an actual demodulated soft-symbol and the expected demodulated signal, at the output of a noise-free linear channel of the same average delay and power gain as the test signal and with perfect estimation and matched filtering

F

FAT	Factory Acceptance Test.
FEC	Forward Error Correction.
FFT	Fast Fourier transform (FFT) is an algorithm to compute the discrete Fourier transform.
FPGA	Field Programmable Gate Array.

H

HDR	High Data Rate. Service defined by Inmarsat providing up to 858 kbps data.
HPA	High Power Amplifier is a device that responds to a small input signal and delivers a larger output signal with the same waveform as input to the antenna.
HTTP	Hypertext Text Transfer Protocol.

I

IAI	Inmarsat Air Interface.
ICMP	Internet Control Message Protocol. An Internet protocol mostly used for diagnostics.
IF	Intermediate frequency is a term used to describe a frequency that is lower than the frequency transmitted/received but higher than those contained in the information being transmitted/received.
IIP3	Third-order Input Intercept Point
IMEI	International Mobile Equipment Identity. A unique number identifying your terminal.
IMSO	International Mobile Satellite Organisation. An intergovernmental organisation that oversees certain public satellite safety and security communication services provided via the Inmarsat satellites.

ISDN Integrated Services Digital Network is a set of communication standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.

ITSI Time-Slot Interchange, a technique used in switches in communications networks to allow multiple inputs and outputs to be interchanged on the same interface.

L

LDR Low Data Rate.

LESP LES Packet (channel type), LES = Land Earth Station.

LNA Low Noise Amplifier is an electrical amplifier used to amplify very weak signals from an antenna.

LTE Long-Term Evolution (also called 4G), a standard for wireless communication of high-speed data for mobile phones and data terminals.

M

McAsp Multichannel Audio Serial Port. A general-purpose multichannel audio serial port found in Texas Instruments family of digital signal processors (DSPs). It consists of transmit and receive sections that may operate synchronized, or completely independently with separate master clocks, bit clocks, and frame syncs, and using different transmit modes with different bit-stream formats.

MIME Multi-Purpose Internet Mail Extensions is an extension of the original Internet e-mail protocol that is use to exchange different kinds of data files. ,

MISO Master Input, Slave Output.

MMI Man-Machine Interface.

MO Mobile Originated.

MOSI Master Output, Slave Input.

MTBF Mean Time Between Failure.

MTR Mandatory test requirements is test descriptions provided by Inmarsat. The descriptions includes test cases which must be completed to gain a type approval of a BGAN product.

N

NAT Network Address Translation.

NDA Non-Disclosure Agreement.

O

OSI	Open Systems Interconnection is a standard defined software model which holds a prescription of characterizing and standardizing the functions of a communications system in terms of abstraction layers. In the OSI model the communication functions are grouped into logical layers and a layer serves the layer above it and is served by the layer below it.
OTG	On-The-Go.

P

PABX	Private Automatic Branch Exchange.
PAST	Person Activated Self Test.
PCB	Printed Circuit Board.
PCMA	A-law companded Pulse Coded Modulation.
PCTA	Pre-Conditional Type Approval.
PDCP	Packet Data Convergence Protocol.
PDP	Packet Data Protocol. A network protocol used by external packet data networks that communicate with a GPRS network. ,
PDU	Protocol Data Unit
PDU	Protocol Data Unit is a term that describes information that is delivered as a unit among peer entities of a network and that may contain control information, such as address information, or user data.
PER	Packet Error Rate.
PLL	Phase Locked Loop.
POST	Power On Self Test.
POTS	Plain Old Telephony System.
ppm	Part Per Million denotes one part per 1.000.000 parts (0.0001%).
PPP	Point-to-Point Protocol is a data link protocol used to establish a direct connection between two nodes in a data network.
PPPoE	Point-To-Point Protocol over Ethernet.
PS	Packet-switched. Packet switched networks move data in separate, small blocks (packets) based on the destination address in each packet.
PSU	Power Supply Unit.

Q

QAM	Quadrature Amplitude Modulation.
QoS	Quality of Service refers to several related aspects of telephony that allow the transport of traffic with special requirements on aspects of a connection. It comprises aspects of a connection relating to capacity and coverage of a network, for example guaranteed maximum blocking probability and outage probability.

R

r_0	Time definition of the point where the RF signal must be present on the Rx connector(s) as the Radio Module will begin the reception of the BGAN carrier.
RAN	Radio Access Network.
r_{down}	Time definition of the point where the pin B2B_Rx_Ctrl becomes inactive which is less than 1 ms before the inactive state is entered.
REST	REpresentational State Transfer.
r_{info}	Time definition of the point where the rx spi information is sent. 6ms prior to r_{up} .
RNC	Radio Network Controller.
RoHS	Restriction of Hazardous Substances.
RTCA	Radio Technical Commission for Aeronautics.
RTP	Real Time Protocol.
r_{up}	Time definition of the point where the pin B2B_Rx_Ctrl becomes active. Can be adjusted via the parameter protocols.bgan.interface.rfctrl.rx.receiver.up

S

SAS	Satellite Access Station.
SDM	System Definition Manual.
SDP	Session Description Protocol.
SDR	Software defined radio, is a radio communication system where components that typically have been implemented in hardware (such as mixers, filters, amplifiers, modulators/demodulators and detectors) are now implemented by means of software in an embedded system to provide a more flexible design.
SDU	Service Data Unit is a unit of data that has been passed down from an upper layer to a lower layer and that has not yet been encapsulated into a protocol data unit (PDU) by the lower layer. It is a set of data that is sent by a user of the services of a given layer, and is transmitted semantically unchanged to a peer service user.

SDU	Service Data Unit.
SID	Self Imposed Delay is a delay calculated by the BGAN mobile to achieve a correct transmit timing. The value depends on the position (on the earth) of the mobile and the satellite state vector describing the current position of the Inmarsat satellite (I4).
SIP	Session Initiation Protocol is a signaling protocol widely used for controlling communication sessions such as voice and video calls over Internet Protocol (IP). The protocol can be used for creating, modifying and terminating media streams (or sessions).
SMS	Short Message Service.
SPI	Serial Peripheral Interface.
SS	Supplementary Services is a method in the 3GPP standard that makes it possible to query and set certain service parameters (e.g., call forwarding) directly from mobile devices.
T	
t_0	Time definition of the start point of the burst. The point corresponds to half a symbol prior to optimum symbol timing of the preamble.
TCM	Test Case Manager.
TCP	Transmission Control Protocol.
TFT	Traffic Flow Templates.
TFTP	Trivial File Transfer Protocol. A very simple file transfer protocol, with the functionality of a very basic form of FTP. Since it is so simple, it is easy to implement in a very small amount of memory.
t_{init}	Time definition of the point where the pin B2B_Tx_Sync becomes active. Can be adjusted via the parameter protocols.bgan.interface.rfctrl.tx.burst.init
t_{start}	Time definition of the point where the pin B2B_Tx_Sync becomes inactive. Can be adjusted via the parameter protocols.bgan.interface.rfctrl.tx.burst.start
t_{up}	Time definition of the point where the pin B2B_Tx_Ctrl becomes active. Can be adjusted via the parameter protocols.bgan.interface.rfctrl.tx.burst.up
U	
UE	User Equipment is used as a term in the UMTS standard to describe a device which is used directly by an end-user to communicate with the base station (which in the BGAN system will be the RAN).
URL	Uniform Resource Locator. A name used to describe the address of a specific resource

on the internet.

USIM Universal Subscriber Identity Module.

W

WEEE Waste Electrical and Electronics Equipment.

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