MBF, Multi Band Repeater

Product Description and User's Manual

This revision of the MBF manual is valid for single, dual and tri band repeaters covering the frequency bands LTE 700, 850, 900, 1800, 1900, 2200 and AWS

Firmware release version

- Common Commands and Attributes v 1.3.2
- MBF Commands and Attributes v 1.0.0

Table of Contents

Safety Instructions and Warnings

Guarantees

All antennas must be installed with lightning protection. Damage to power modules, as a result of lightning are not covered by the warranty.

Switching on AC or DC power prior to the connection of antenna cables is regarded as faulty installation procedure and therefore not covered by the Axell Wireless warranty.

The repeater box should be closed using the two screws. The screws must be fully tightened. Failure to do so may affect the IP65 compliancy and therefore any warranty.

Safety to Personnel

Before installing or replacing any of the equipment, the entire manual should be read and understood. The user needs to supply the appropriate AC or DC power to the repeater. Incorrect power settings can damage the repeater and may cause injury to the user.

Caution
Please be aware that the equipment may, during certain conditions become very warm and can cause minor injuries if handled without any protection, such as gloves.

Throughout this manual, there are "Caution" warnings. "Caution" calls attention to a procedure or practice, which, if ignored, may result in injury or damage to the system, system component or even the user. Do not perform any procedure preceded by a "Caution" until the described conditions are fully understood and met.

Caution
This notice calls attention to a procedure or practice that, if ignored, may result in personal injury or in damage to the system or system component. Do not perform any procedure preceded by a “Caution” until described conditions are fully understood and met.

Safety to Equipment

When installing, replacing or using this product, observe all safety precautions during handling and operation. Failure to comply with the following general safety precautions and with specific precautions described elsewhere in this manual violates the safety standards of the design, manufacture, and intended use of this product. Axell Wireless assumes no liability for the customer's failure to comply with these precautions. This entire manual should be read and understood before operating or maintaining the repeater.

Electrostatic Sensitivity

Observe electrostatic precautionary procedures.

Caution
ESD = Electrostatic Discharge Sensitive Device

Semiconductor transmitters and receivers provide highly reliable performance when operated in conformity with their intended design. However, a semiconductor may be damaged by an electrostatic discharge inadvertently imposed by careless handling.

Static electricity can be conducted to the semiconductor chip from the centre pin of the RF input connector, and through the AC connector pins. When unpacking and otherwise handling the repeater, follow ESD precautionary procedures including use of grounded wrist straps, grounded workbench surfaces, and grounded floor mats.

Class 1 Laser

This product is equipped with class 1 lasers, as per definition in EN 60825-1.

Caution

Un-terminated optical receptacles may emit laser radiation. Do not stare into beam or view with optical instruments.

Optical transmitters in the opto module can send out high energy invisible laser radiation. There is a risk for permanent damage to the eye.

Always use protective cover on all cables and connectors which are not connected. Never look straight into a fibre cable or a connector. Consider that a fibre can carry transmission in both directions.

During handling of laser cables or connections ensure that the source is switched off. Regard all open connectors with respect and direct them in a safe direction and never towards a reflecting surface. Reflected laser radiation should be regarded as equally hazardous as direct radiation.

Radiation Hazard

This equipment emits radio frequency radiation and can, if used the wrong way, be hazardous for personnel. Here follows an example of the power densities from an intentional radiator.

For radiation from a general antenna, the power density (S) at some distance is according to the well-known formula:

$$S = \frac{G_t P_t}{4\pi R^2} = \frac{E^2}{377}$$

For the repeaters described in this handbook the maximum output powers are 5 W for 900 / 1800 MHz and 10 W 2100 MHz. The corresponding power densities using a + 10 dBi antenna as an example at 1 m will be 4 W/ m² for the 900/1800 MHz output and 8 W/ m² for 2100 MHZ output.

1 m distance from the antenna at these frequencies is used as a minimum distance for practical exposure of the public. It is also difficult to have a developed EMF at distances closer than 1 m.

According to R&TTE Health requirements referring to the 1999 Council recommendation, the reference level for the frequency range of 400 – 2000 MHz is f/ 200 W/ m² (f in MHz) and above 2 GHz, 10 W/ m².

For the repeaters in this manual the levels are:

GSM 900 (960 MHz) = 4.8 W/m²
DC 1800 (1880 MHz) = 9.4 W/m²
UMTS 2100 (2170 MHz) = 10 W/m².

This means that an installation with a +10 dBi antenna does not exceed the basic restriction levels according to the recommendations.

For frequencies between 400 and 2000 MHz the ICNIRP occupational guideline level of exposure is f /40 W/m² (f in MHz), and 50 W/m² for frequencies above 2 GHz.

The ICNIRP levels for the frequency above bands:

GSM 900 (960 MHz) = 24 W/m²
DC 1800 (1880 MHz) = 47 W/m²
UMTS 2100 (2170 MHz) = 50 W/m².

There are no radiation health issues with the above + 10 dBi antenna installations. However, the repeater is marked with radiation hazard warning.

References

This document covers both GSM and WDCMA repeaters. These references are valid for respective repeater type.

ETSI TS 25.106	Universal Mobile Telecommunications System (UMTS); UTRA repeater radio transmission and reception 3GPP TS 25.106 version 5.8.0 Release 5)
ETSI TS 25.143	Universal Mobile Telecommunications System (UMTS); UTRA repeater conformance testing (3GPP TS 25.143 version 5.8.0 Release 5)
ETSI EN 301 908-3	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETSI EN 301 489-23	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 23: Specific Conditions for IMT-2000 CDMA Direct Spread (UTRA) Base Station (BS) radio, repeater and ancillary equipment
EN 60 950	Information technology equipment - Safety - Part 1: General requirements
EN 301 502	Harmonized EN for Global System for Mobile communications (GSM); Base station and Repeater equipment covering essential requirements under article 3.2 of the R&TTE directive (GSM 13.21 version 8.1.2. Release 1999)
ETS 300 342-3	Radio Equipment and Systems (RES); Electro-Magnetic Compatibility (EMC) for European Digital Cellular Telecommunications systems. Base Station Radio and ancillary equipment and Repeaters meeting phase 2 GSM requirements.
R & TTE Directive: ETS EN 301 502 (ETS EN 300 609-4/GSM 11.26)	Harmonized EN for Global System for Mobile communications (GSM); Base Station and Repeater equipment covering essential requirements under article 3.2 of the R&TTE directive
ETS EN 301 489-8	Electromagnetic Compatibility (EMC) Standard For Radio Equipment And Services; Part 8: Specific Conditions For GSM Base Stations
ETS 300 342-3	Electromagnetic Compatibility (EMC) For European Digital Cellular Telecommunications System (GSM 900 MHz and DCS 1 800 MHz); Part 3: Base Station Radio and Ancillary Equipment And Repeaters Meeting Phase 2 GSM Requirements

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Definitions, Abbreviations and Acronyms

AEM	Axell Element Manager A software tool for operation and monitoring a network consisting of Axell Wireless products. Previous name of this product was Avitec Element Manager.
ALC	Automatic Limit Control
Antenna	The part of a radio transmission system designed to radiate or receive electromagnetic waves
Antenna beamwidth	More properly referred to as the half-power beamwidth, this is the angle of an antenna pattern or beam over which the relative power is at or above 50% of the peak power
Antenna directivity	This is the relative gain of the main beam of an antenna pattern to a reference antenna, usually an isotropic or standard dipole
Base station	The central radio transmitter/receiver that maintains communications with a mobile radio equipment within a given range
BCCH	Broadcast Control Channel
BTS	Base Transceiver Station, one part of a base station. A base station is composed of two parts, a Base Transceiver Station (BTS) and a Base Station Control Module (BSC). A base station is often referred to as BTS. The BTS is also sometimes called an RBS or Remote Base Station.
Carrier-to-interference ratio, C/I	The ratio of power in an RF carrier to the interference power in the channel
Carrier-to-noise ratio, C/N	The ratio of power in an RF carrier to the noise power in the channel
Channel	In all Axell Wireless documentation a channel is the same as a carrier.
Coverage area	The geographical reach of a mobile communications network or system
Coverage hole	An area within the radio coverage footprint of a wireless system in which the RF signal level is below the design threshold. Coverage holes are usually caused by physical obstructions such as buildings, foliage, hills, tunnels and indoor parking garages
dB	Decibel, A technique for expressing voltage, power, gain, loss or frequency in logarithmic form against a reference.
dBi	Decibels referenced to an isotropic antenna. A technique for expressing a power gain measurement in logarithmic form using a theoretical isotropic antenna as a reference
dBm	Decibels referenced to 1 mW. A technique for expressing a power measurement in logarithmic form using 1 mW as a reference.
Dead spot	An area within the coverage area of a wireless network in which there is no coverage or transmission falls off. Dead spots are often caused by electronic interference or physical barriers such as hills, tunnels and indoor parking garages. See also coverage area.
Distributed antenna system	A type of antenna system that is distributed or remotely located away from the transmitter. Such an antenna or series of antennas can be connected via coaxial

	cable, leaky feeder or optical fibre link.
DL, Downlink	The transmission path from the base station down to the mobile station
EAM	External Alarm Messaging
EDGE	Enhanced Data for Global Evolution. A technology that gives GSM and TDMA similar capacity to handle services for the third generation of mobile telecom. EDGE was developed to enable the transmission of large amounts of data at a high speed of 384 kilobit per second, or more.
EMC	Electromagnetic Compatibility. The ability of a device or system to function in its intended electromagnetic environment
ERP	Effective Radiated Power
ETSI	European Telecommunications Standard Institute. The European standardization body for telecommunications
GND	Ground
Hand-over	The passing of a call signal from one base station to the next as the user moves out of range or the network software re-routes the call
ISI	Inter Symbol Interference. An interference effect where energy from prior symbols in a bit stream is present in later symbols. ISI is normally caused by filtering of the data streams
LED	Light Emitting Diode
Link budget	A calculation involving the gain and loss factors associated with the antennas, transmitters, transmission lines and propagation environment used to determine the maximum distance at which a transmitter and receiver can successfully operate.
LMT	Local Maintenance Terminal
LNA	Low Noise Amplifier. A receive preamplifier having very low internal noise characteristics.
Logical channel	A communications channel derived from a physical channel. A physical channel, i.e. RF channel, typically carries a data stream that contains several logical channels. These usually include multiple control and traffic channels.
LOS	Line of Sight. A description of an unobstructed radio path or link between the transmitting and receiving antennas of a communications system
MCPA	Multi Carrier Power Amplifier
MS	Mobile Station (e.g. mobile phone)
MTBF	Meantime Between Failures
NA	Not Applicable
NC	Not Connected
NF	Noise Figure
Noise figure	A figure of merit for receivers and preamplifiers representing the amount of excess noise added to the signal by the amplifier or receiving system itself. The lower the noise figure, the less excess noise is added to the signal
ODF	Optical Distribution Frame, used for connection and patching of optical cables
OMC	Operations and Maintenance Centre. A location used to operate and maintain a wireless network

OMU	Optical Master Unit, translates between RF signals and optical signals so that fibre fed repeaters can be used.
PA	Power Amplifier. A device for taking a low or intermediate-level signal and significantly boosting its power level. A power amplifier is usually the final stage of amplification in a transmitter.
PSTN	Public Switched Telephone Network, standard domestic and commercial phone service
Radio link	The equipment and transmission path (propagation channel) used to carry on communications. It includes the transmitting system, the propagation channel and receiving system
Repeater	A bi-directional Radio Frequency (RF) amplifier that can amplify and transmit a received Mobile Station (MS) signal in the MS transmit band. Simultaneously it amplifies and transmits a received Base Transceiver Station (BTS) RF signal in the BTS transmit band.
RF	Radio Frequency, 9 kHz – 300 GHz

Designation	Abbreviation	Frequencies
Very Low Frequency	VLF	9 kHz - 30 kHz
Low Frequency	LF	30 kHz - 300 kHz
Medium Frequency	MF	300 kHz - 3 MHz
High Frequency	HF	3 MHz - 30 MHz
Very High Frequency	VHF	30 MHz - 300 MHz
Ultra High Frequency	UHF	300 MHz - 3 GHz
Super High Frequency	SHF	3 GHz - 30 GHz
Extremely High Frequency	EHF	30 GHz - 300 GHz

RMC	Repeater Maintenance Console. Software tool to monitor and control Axell Wireless repeaters via local or remote access
RS232	Serial interface standard
RS485	Serial Interface standard
Service area	The specified area over which the operator of a wireless communications network or system provides services
Signal-to-interference ratio, S/I	The ratio of power in a signal to the interference power in the channel. The term is usually applied to lower frequency signals, such as voice waveforms, but can also be used to describe the carrier wave. See also carrier-to-interference ratio.
Signal-to-noise ratio, S/N, SNR	The ratio of power in a signal to the noise power in the channel. This term is usually applied to lower frequency signals, such as voice waveforms. See also carrier-to-noise ratio
SMSC	Short Messaging Service Centre
TCH	Traffic Channel. A logical channel that allows the transmission of speech or data. In most second generation systems, the traffic channel can be either full or half-rate
Transceiver	A transmitter and receiver contained in one package. A 2-way radio or cell phone is an example of a transceiver
Transmitter	Equipment which feeds the radio signal to an antenna, for transmission. It consists of active components such as the mixer, driver and PA and passive components such as the TX filter. Taken together, these components impress a signal onto an RF carrier

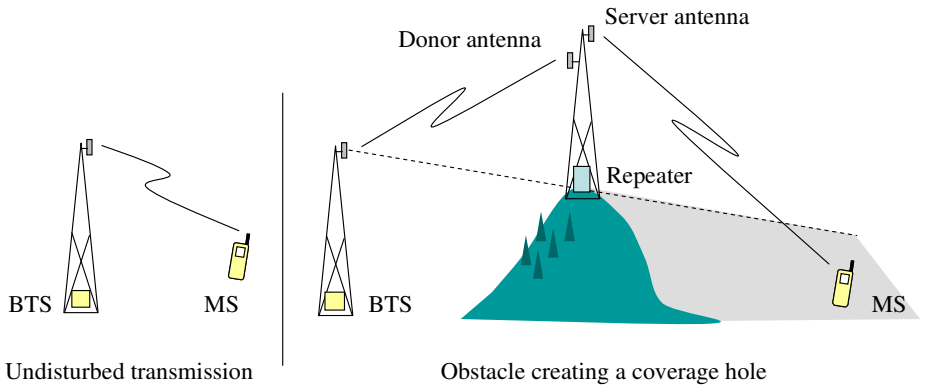
	of the correct frequency by instantaneously adjusting its phase, frequency, or amplitude and provide enough gain to the signal to project it through the ether to its intended target
UL, Uplink	The transmission path from the mobile station up to the base station
WDM	Wavelength Division Multiplexing. A technology that uses optical signals on different wavelengths to increase the capacity of fibre optic networks in order to handle a number of services simultaneously
VSWR	Voltage Standing Wave Ratio

1 Repeater Technology

1.1 Basic Repeater Features

A basic feature of a mobile communication system is to transmit RF signals between base stations and mobile radio equipment.

When there is a blocking object, such as a mountain or a building, preventing the base station signal to reach the mobile equipment, a repeater can be used to extend the base station's coverage area.



In the downlink path (from the base station to the mobile phone) the repeater picks up the signal in the air via a donor antenna, amplifies it and re-transmits it into the desired coverage area via a server antenna. In the uplink path (from the mobile phone to the base station) the repeater receives the signals from mobile transmitters in the covered area and re-transmits them back to the base station.

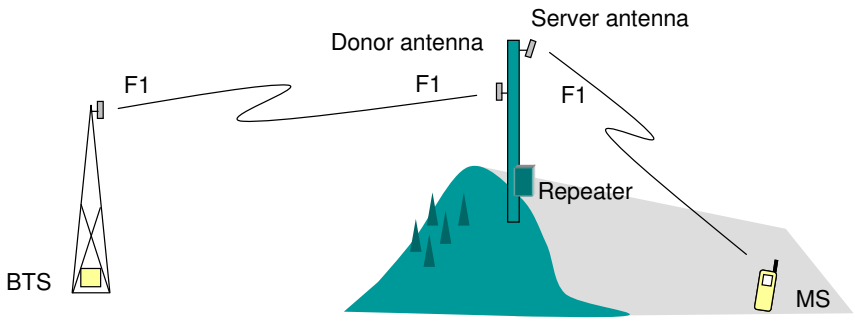
A repeater can work off-air, as the repeater in the example above, or be fed over fibre from an optical master unit, OMU. The OMU taps the signal directly off a base station via a coupler, converts it to light and transmits it to a number of repeaters via fibre.

1.2 Repeater Types

1.2.1 Channel Selective Repeaters

Channel selective repeaters are mainly used for coverage of dead zones, shadows, in-building coverage or other areas with inadequate signal strength. The output power of a channel selective repeater is sufficient to cover an area shadowed by a building or other obstacle.

In a channel selective repeater each carrier is separately filtered, amplified and retransmitted.



A channel selective repeater system consists of one repeater unit complemented with one antenna facing the donor BTS and another antenna directed towards the coverage area. The repeater site needs to be located

where the BTS signal strength is large enough to be usable by the system. Ideally the repeater's donor antenna should have line of sight (LOS) contact with the BTS antenna. If the signal strength is high enough, LOS may in some cases not be necessary.

The signal generated by the BTS is picked up at the repeater site via the donor antenna. The repeater filters and amplifies the signal before retransmitting it at the same frequency over the server antenna.

The isolation between the antennas at the repeater site has to be high in order to prevent degradation of signal quality and risk of oscillation. Ways to achieve this can be large physical separation between the antennas, usage of highly directional antennas with good front-to-interference ratio or external shielding between the antennas. Another option is to use a Frequency Translating repeater (see description below).

Channel selective repeaters may have higher output power per carrier and typically have better spurious rejection than band selective repeaters. The maximum output power per carrier can be several watts.

1.2.2 Band Selective Repeaters

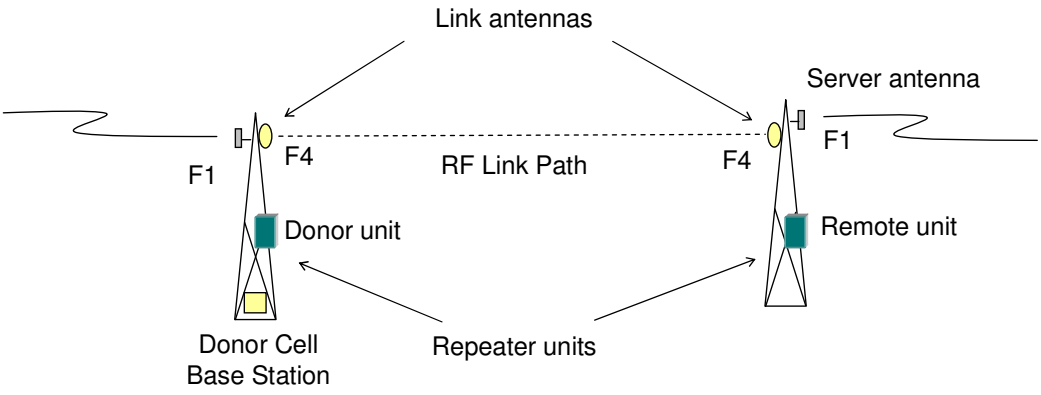
Band selective repeaters have the same functionality as channel selective repeaters. The difference is that band selective repeaters do not separate out specific carriers but amplify and retransmit all signals within a defined frequency band.

The risk for intermodulation distortion leads in most cases to a lower output power per carrier in a band selective repeater than in a channel selective repeater.

1.2.3 Frequency Translating Repeaters

A frequency translating repeater provides output power levels comparable to a base station. The concept allows for high gain without the high antenna isolation required for channel selective repeaters.

The frequency translating repeater consists of two units; one donor unit and one remote unit.



The donor unit is mounted at the base station site where the signal enters the repeater via a directional coupler. In the donor unit, the signal is translated into another frequency, the link frequency, amplified and transmitted via a link antenna. At the remote site, a link antenna picks up the signal and feeds it to the remote unit. The signal is translated back into the original frequency and retransmitted over the server antenna.

Only 2 guard channels are needed between the radio frequency and the link frequency.

The isolation between antennas at the remote site seldom needs to be more than 75dB. This value that can be achieved with a limited antenna displacement, often as low as 3 meters. The relatively modest isolation requirement allows the use of omni-directional antennas for the service area.

Important applications for frequency translating repeaters are road coverage, rural coverage or for transferring capacity from a base station to another area.

1.2.3.1 Donor Unit

There are two types of donor units – single donor (SD) and double donor (DD).

A single donor (SD) unit has one input connector. The input signal from the BTS is split in two *within* the repeater unit. In the opposite direction – in the uplink – the signals are combined *within* the repeater before being sent to the BTS.

A double donor (DD) unit has dual inputs. This can be used in combination with a BTS that uses air combining, and hence has a separate antenna for each TRU. A double donor unit can alternatively handle two signals from two separate BTS.

1.2.3.2 Remote Unit

There are two types of remote units – internal combining (IR) and external combining (ER).

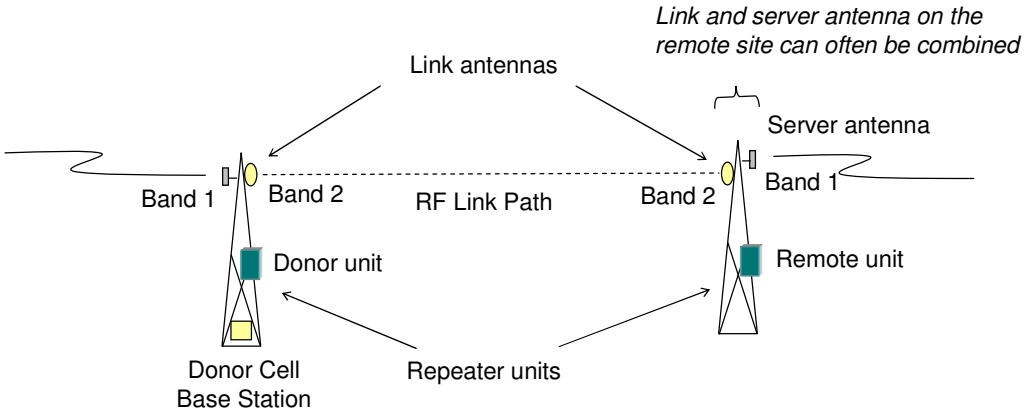
In an internal combining (IR) remote unit output from the power amplifiers in the downlink is combined and filtered before being passed on to the server antenna. In the uplink the signal is separated within the remote unit.

An external combining remote (ER) unit has two server antenna ports and the signal is combined in the air. Since the ER model needs no combiner the output signal and gain is 3dB higher than in the IR model.

1.2.4 Band Shifting Repeaters

Band shifting repeaters are based on the same concept as frequency translating repeaters described above.

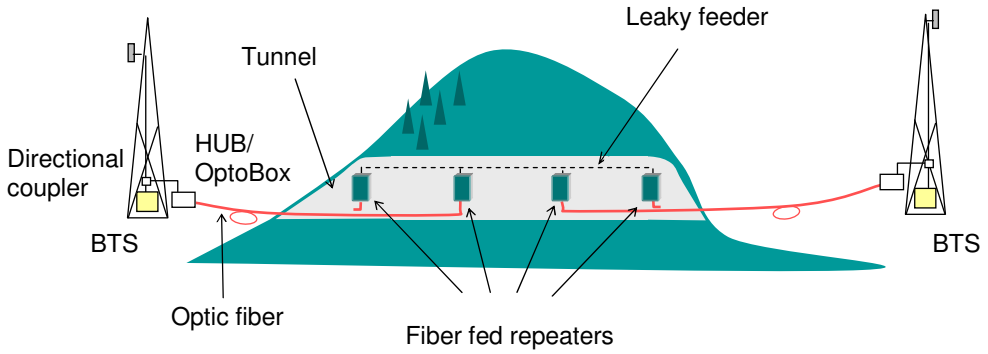
In contrast to a frequency translating repeater, which uses another frequency within the same band for the link, a band shifting repeater uses another band. For instance can a repeater operating on the 900MHz band use the 1800MHz band for the link and vice versa. Other combinations are also possible.



By using another band for the link the isolation between antennas at the remote site becomes very low. It might in some applications even be possible to use the same antenna for both the link and the service area.

1.2.5 Fiber Fed Repeaters

The fiber fed repeater is primarily designed for coverage of tunnels and large buildings.



A fiber fed repeater can be either channel selective or band selective. It receives the RF signals from the base station via a HUB or an OptoBox which translates the RF signal to an optical signal and sends it to the repeater via a fiber optic cable. The repeater unit can be installed up to 20 km away from the base station.

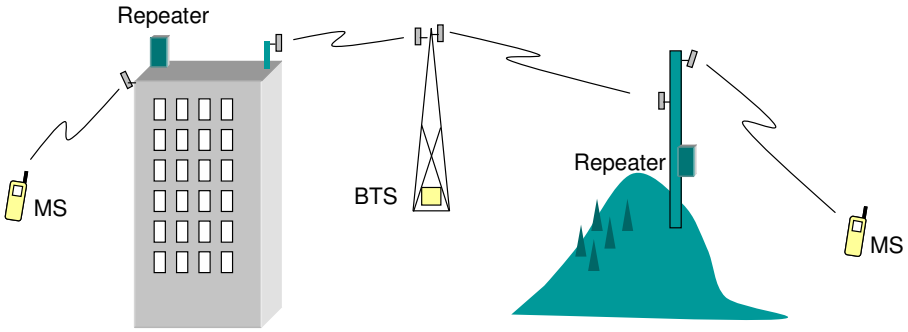
Inside the tunnel leaky feeders or antennas can be used for transmission to the mobile units.

1.3 Repeater Applications

1.3.1 Channel Selective Repeaters

1.3.1.1 Shadow Coverage and Gap Filling

When there are coverage holes caused by buildings or mountains, a channel selective repeater can be used to extend coverage into the “dead zone”. The building can sometimes be used as physical shield to create the necessary antenna isolation.



The terrain is often seen as a limiting factor when striving for flawless radio coverage. The gap-filler repeaters can be used as a complement to the network of base stations.

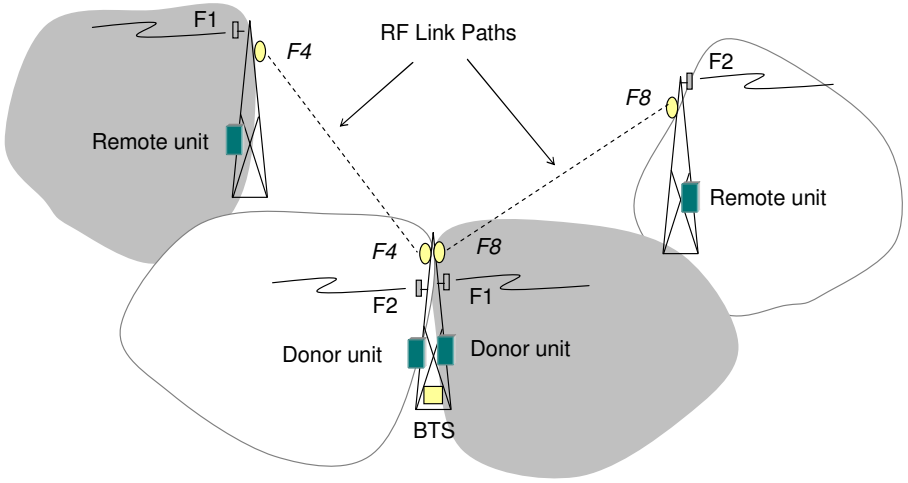
1.3.2 Frequency Translating Repeaters

1.3.2.1 Low Traffic Coverage

The example shows coverage extension in an area with low traffic by using frequency translating repeaters.

A two sector BTS is extended with two frequency translating repeaters. Both donor units are mounted at the base station site and connected to the base station via directional couplers.

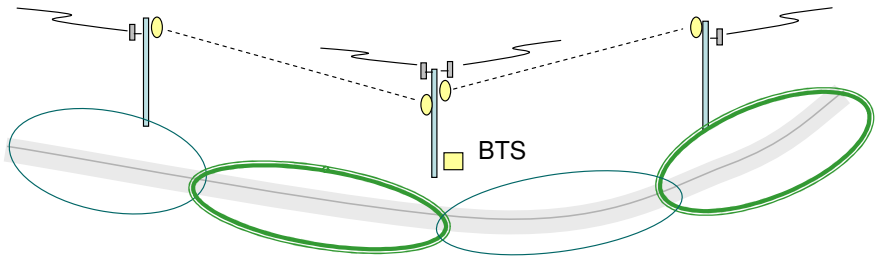
Each repeater has a different link frequency and transmits the frequency of the opposite base station sector, thus minimizing interference or multi-path propagation problems. A normal handover is performed between the repeater coverage area and the neighboring base station coverage area.



Since the installation of frequency translating repeaters requires moderate antenna isolation, remote site requirements are very moderate.

1.3.2.2 Highway Coverage

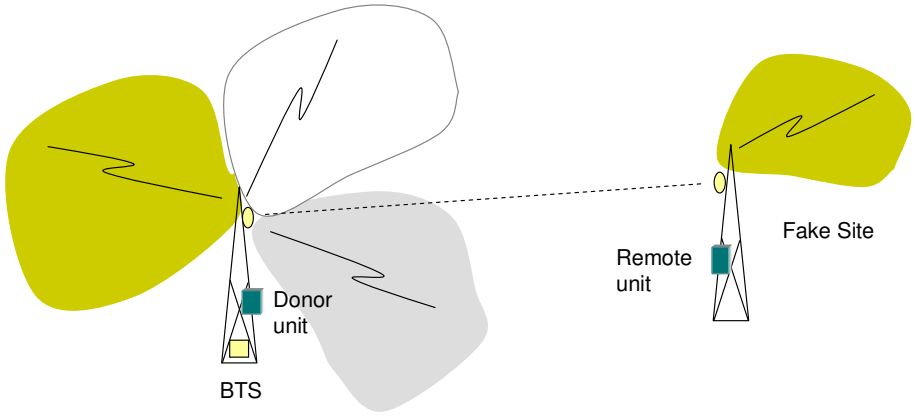
One two-sector BTS feeds two frequency translating repeaters, each covering an area comparable to the base station. This is a way to get maximum coverage out of the one BTS, with one connection point for transmission.



Since antenna isolation requirements are low for frequency translating repeaters, omni-directional antennas can be used at the remote sites to achieve good coverage.

1.3.2.3 "Fake site" – Moving Capacity

In this application the BTS is upgraded with an additional "sector" used for feeding a frequency translating repeater to cover an area up to 20km away from the BTS. This is an effective alternative when no transmission point is available in the area to be covered. The frequency translating repeater "moves" capacity from the base station site to the new location.



This type of installation takes full advantage of the high output power and high sensitivity of the frequency translating repeater.

1.3.3 Band Shifting Repeaters

A band shifting repeater can be used in the same way as a frequency translating repeater if the user has access to frequencies on two different bands.

1.3.4 Fiber Fed Repeaters

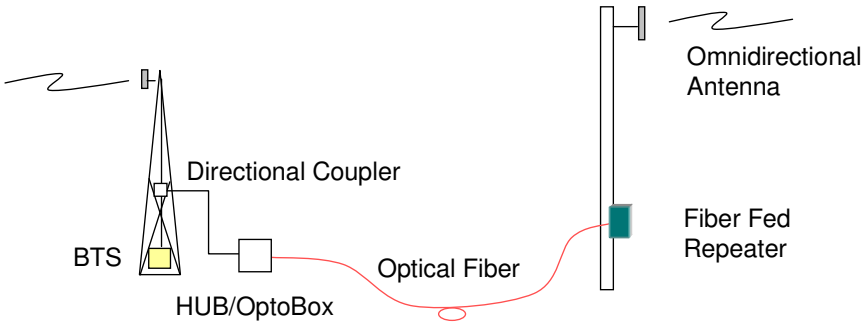
1.3.4.1 Tunnel Coverage

Fiber optic fed repeaters makes it possible to cover long tunnels from one or two BTS sites nearby. The hub unit at the BTS site can feed up to 24 repeaters. The repeaters distribute the signal in the tunnel with antennas or radiating cables (leaky feeders).

Using leaky feeders is normally the most effective way to cover a tunnel, since the signal is evenly distributed along the tunnel. Achieving good coverage in a train tunnel, for instance, using antennas can be difficult as the trains tend to block signal propagation.

1.3.4.2 Open Area Coverage

A fiber optic fed repeater can be used in combination with a HUB or an OptoBox to move the repeater away from the base station. This can in some cases be used to avoid antenna isolation problems.



In this example a HUB/OptoBox is placed at the BTS site. The RF signal is tapped from the antenna by a directional coupler, translated into an optical signal and sent to the repeater over a fiber optic link. At the repeater site a fiber fed repeater receives the signal, translates it back to RF and sends it to the antenna. This antenna can be for instance omni-directional because the distance to the BTS is no longer a problem.

2 Software Overview

Axell Wireless mainly supplies three different types of software; Repeater firmware, Repeater Maintenance Console and Axell Element Manager.

2.1 Repeater Firmware

The repeater firmware is the software inside the Control Module of the repeater. It is command line based, with simple SET and GET commands. A rich variety of commands are available to control and monitor all subsystems of the repeater from a normal VT100 terminal emulation program, such as MiniCom (Linux/Unix) or HyperTerminal (Windows). This also means that any standard laptop is able to control a repeater without additional software installed.

The repeater firmware has three main tasks:

- Set and configure parameters in the repeater, such as channel numbers, gain, power levels, and different report configurations
- Monitor and measure alarm sources, alarm parameters and repeater utilization
- Send reports and alarms to the repeater OMC

Communication with the repeater can be performed either locally on site or remotely via a built in modem. For local communication a terminal with RS232 interface is needed. For remote communication a computer with a modem is needed as well as a serial communications program such as HyperTerminal™.

2.2 The RMC, Repeater Maintenance Console

RMC is an online software program with an intuitive graphical interface that simplifies control and installation of the repeater or OMU. The RMC is a graphical shell for the repeater's Control Module. It reads commands and attributes from the Control Module and displays them in an intuitive layout. This eliminates the need to learn commands and attributes for controlling the repeater or OMU.

Login can be made locally via the LMT port or remotely via a modem or via Ethernet. As soon as the RMC is connected it constantly polls the repeater or OMU for parameters such as power supply levels, in and out levels, temperature, traffic, etc. If the repeater is a slave type repeater, the OMU manages the data collection from the repeater.

The RMC program can be installed from a CD. It is a Windows based application that runs on Windows 2000 and Windows XP.

2.3 The AEM, Axell Element Manager

AEM is a complete operations and maintenance centre for Axell Wireless repeater networks.

The AEM takes control of the repeater – or the OMU-Repeater system - once the installation at site is completed. The repeater gets integrated into the network and will be controlled by the Element Manager. During integration all repeater parameters and statuses are downloaded into a database. The database is regularly updated with all incoming alarms and reports, and will hence contain a copy of the repeater configuration so that current repeater information will be accessible without setting up communication with the repeaters.

Communication between the AEM and the repeaters are message based. This means that the operator does not have to await message delivery, but will be informed when the message is delivered to the repeater

The Axell Element Manager is a Windows™ based application that runs on Windows 2000, Windows 2003 Server and Windows XP.

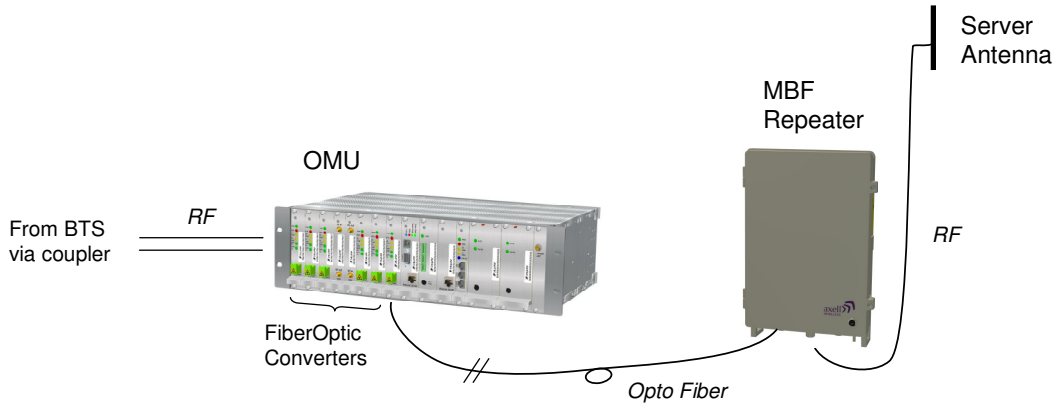
For more information please refer to the separate AEM User's Manual.

3 Product and System Description

3.1 Overview

The MBF family of repeaters include band selective, fibre fed repeaters with one, two or three bands integrated into one repeater box. The repeaters are named MBF (Multi Band Fibre) with an extension that defines the number of bands and the type of band. The number of bands is indicated by a letter where "S" stands for single band, "D" for dual band and "T" for tri band. The frequencies covered are indicated by numbers where "7" stands for 700MHz, "8" stands for 850MHz, "9" for 900 MHz, "18" for 1800MHz, "19" for 1900 MHz, "22" for 2100MHz and "17" for the AWS band.

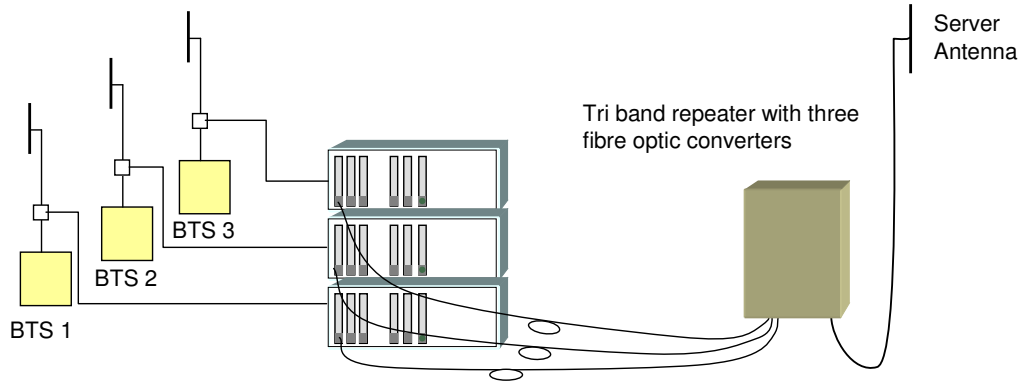
The MBF repeater is a systems component and needs to be fed from an Optical Master Unit, OMU. Each OMU can be equipped with up to 6 fibre optic converters. Several OMUs can also be cascaded to form more extensive repeater systems.



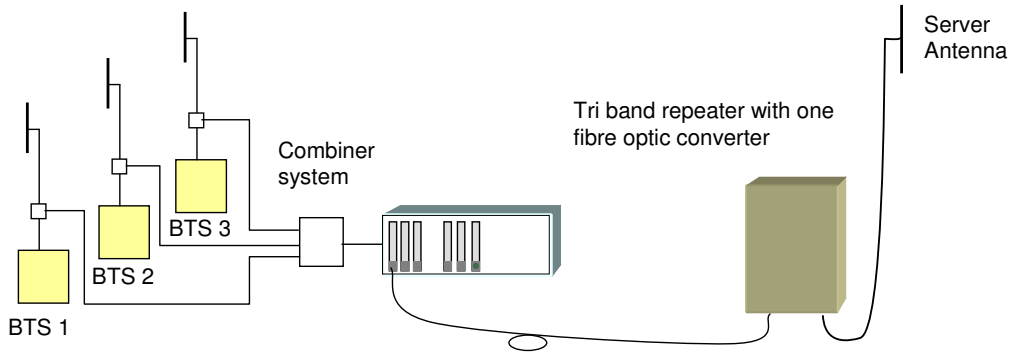
Standard OMU-Repeater application where one OMU is used

In a standard OMU-Repeater application as illustrated above, the input signal to the system is tapped off a base station via a directional coupler. In the OMU the RF signal is converted into an analogue optical signal and transported via optic fibre to the fibre fed repeater MBF. The repeater converts the optical signal back into an RF signal which is then amplified and transmitted via a server antenna. In the uplink direction the OMU receives the signal from the repeater via the fibre optical cable, converts it to an RF signal and sends it back to the base station via the coupler. The OMU-Repeater system can also be fed from one a repeater. In this case the signal is tapped from the repeater's server antenna port. The repeater in its turn can be linked to an antenna that picks up the signal off air.

An MBF repeater with more that one band can be equipped with one fibre optic converter which is shared between the bands or have one converter for each band. Below are the two options exemplified.



A tri band repeater with three fibre optic converters fed by three OMUs



A tri band repeater with one fibre optic converter fed by one OMU

An OMU-Repeater system can be expanded to handle up to 24 repeaters and cover a distance of to up to 20 km of fibre between the OMU and the most distant repeater.

3.2 Repeater Models

The MBF repeater can be configured in many combinations. These are the most common ones.

Single Band	
MBF-S-7	LTE-700
MBF-S-8	GSM/WCDMA850
MBF-S-9	E-GSM
MBF-S-18	GSM1800
MBF-S-19	GSM/WCDMA1900
MBF-S-22	WCDMA2100

Dual Band	
MBF-D-9-22	E-GSM and WCDMA2100
MBF-D-8-19	GSM/WCDMA850 and GSM/WCDMA1900
MBF-D-7-17	LTE700 and AWS

Tri Band	
MBF-T-9-18-22	E-GSM, GSM1800 and WCDMA2100
MBF-T-8-17-19	GSM/WCDMA850, AWS and GSM/WCDMA1900

3.3 Characteristics

These are some of the most important characteristics of the MBF family of repeaters.

For more detailed information please refer to section 7 Specifications.

MBF	
System	GSM/WCDMA850, E-GSM, GSM1800, GSM/WCDMA1900, AWS, LTE and WCDMA2100
Composite Output Power DL 850MHz	+37 dBm
Composite Output Power DL E-GSM	+37 dBm*
Composite Output Power DL 700MHz	+37dBm
Composite Output Power DL 1800MHz	+37 dBm*
Composite Output Power DL 1900MHz	+37 dBm
Composite Output Power DL 2100MHz	+39 dBm
Gain is defined by the whole link including the OMU	Adjustable in 1dB steps

*** Note!** In repeaters that share a common downlink fibre for 900MHZ and 1800MHz a minimum of 4 carriers in each band is required for the full composite output power to be attainable maintaining full ETSI compliance.

3.4 Casing

Axell Wireless repeaters are relatively small and have low power consumption. They are housed in a die cast aluminum box which makes them light and offers good heat conduction and waterproofing. Cooling is accomplished by convection.

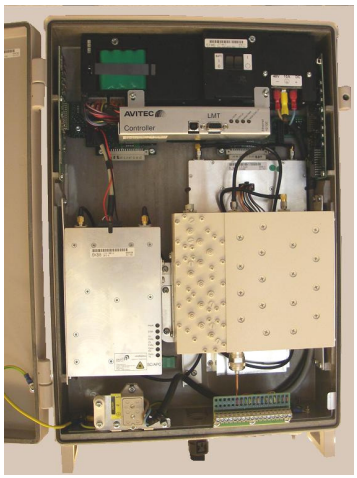
Note! The MBF repeaters are designed primarily for multi carrier purposes. If the repeaters are run at full output power over a longer period the convection cooling might not be enough. The repeaters have a power management function implemented that will step down the power and if needed fully shut down the amplifier chains until temperature has reached normal values. In situations where a repeater will be run in such a manner extra cooling can be provided for instance by putting the repeater in a temperature controlled environment or via external fans.

The housing conforms to IP65 and NEMA 4 standards.

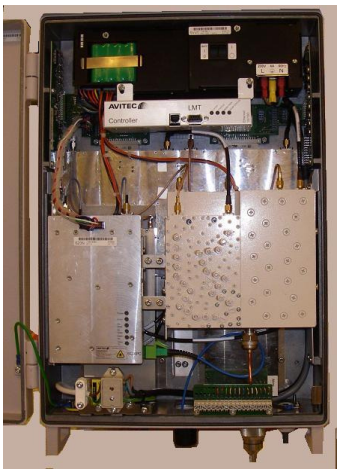
Dimensions, Weight and Power Consumption	
Dimensions	Single and dual band versions: 540 x 350 x 150 mm Tri band version:540 x 350 x 220 mm
Weight	Single band version: 21 kg, Dual band version: 25 kg, Tri band version: 33kg

Single or dual band repeater

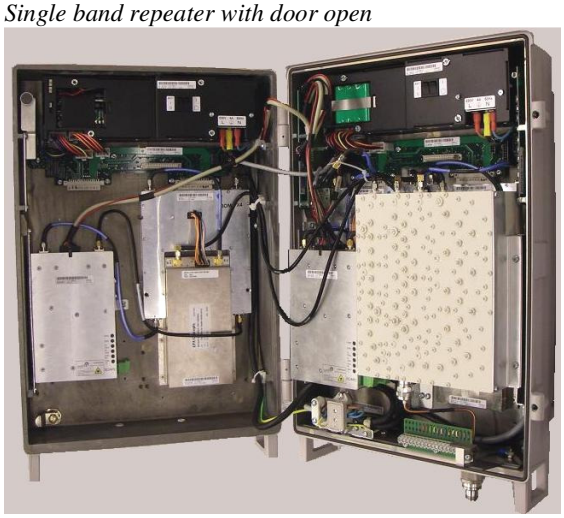
Tri band repeater



Single band repeater with door open



Dual band repeater with door open



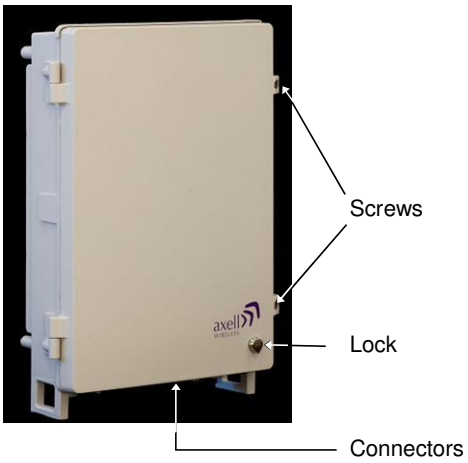
Tri band repeater with door open

The repeaters are closed with two hex screws, M8.

As a complement the repeaters can be locked with a key.

Note! The two screws must be fully tightened. Failure to do so may affect the IP65 compliancy and therefore any warranty.

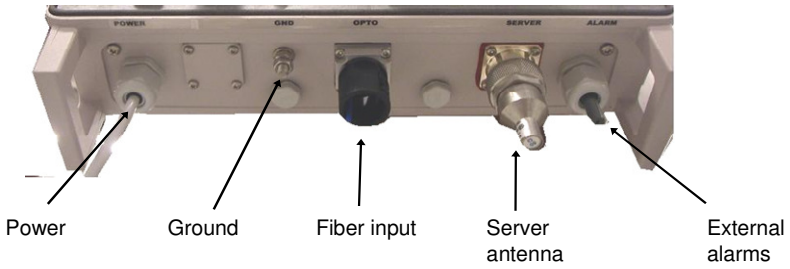
The external connections at the bottom of the repeater can be protected with a cover which is screwed in place.



The repeaters are designed to be mounted on a wall or in a 19" rack. They should always be mounted in a vertical position with the connectors facing downwards.

3.5 Connections

All connections are placed at the bottom panel of the repeater.



- Antenna connection is DIN 7/16" connector, female
- Fibre connector is SC/APC. It is placed on the fibre optic converter(s) inside the repeater
- Plinth connection for power input is described in section 5 Installation
- Plinth connector for external alarms is described in section 5 Installation

Note!

APC connectors need to be used
throughout the whole link between the OMU and the repeater.

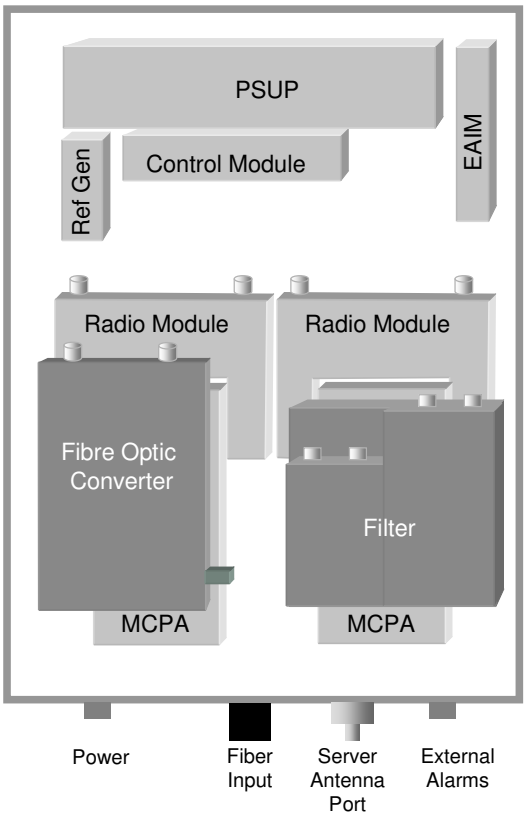
Also all ODF connections need to be of the same type.

3.6 Building Blocks

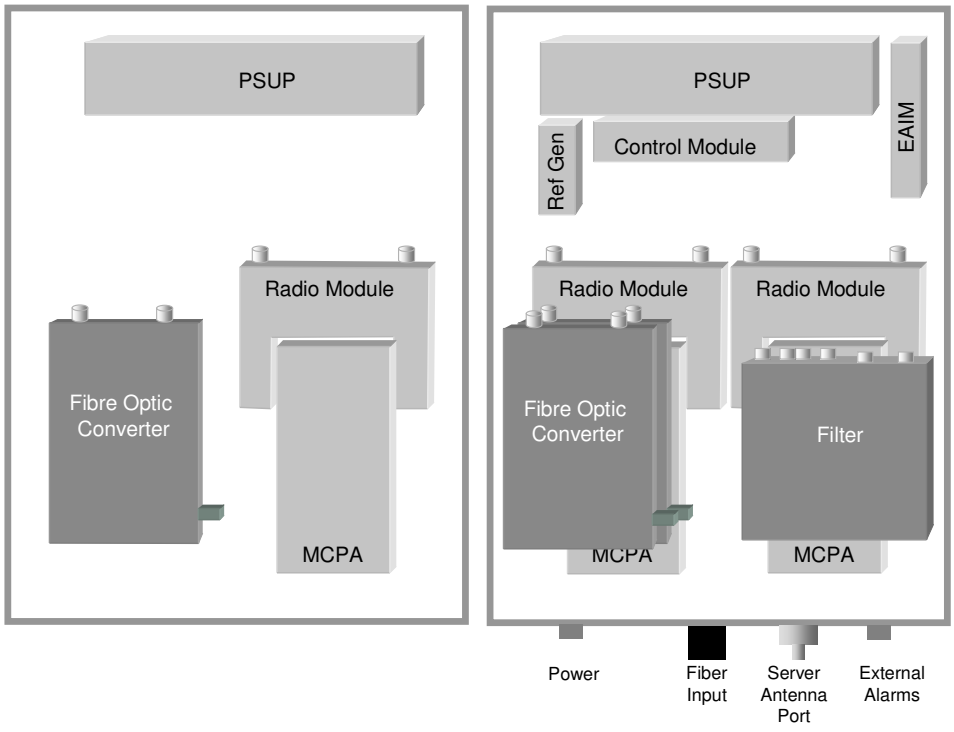
The repeaters consist of the following main building blocks.

- Control Module – all MBF repeaters have one Control Module
- MCPA, Multi Carrier Power Amplifier – an MBF repeater has one MCPA for each band
- Radio Module – an MBF repeater has one Radio Module for each band
- Fibre Optic Converter – an MBF repeater can have one, two or three Fibre Optic Converters
- Filter – all MBF repeaters have one filter for one, two or thee bands
- RefGen, Reference Generator - all MBF repeaters have one RefGen
- EAIM, External Alarm Interface Module - all MBF repeaters have one EAIM
- PSUP, Power Supply Module - single and dual band repeaters have one PSUP, and tri band repeaters have two

The illustration to the right shows a dual band repeater with one fibre optic converter.



The illustration to the left shows a tri band repeater with three fibre optic converters



3.6.1 Control Module

The Control Module manages and controls the repeater and handles alarms. The Control Module keeps track of all modules in the repeater based on serial numbers. Data is collected from modules within the repeater such as MCPA, Radio Module and Fibre Optic Converter. The collected data is processed and if an error is detected the Control Module may send an alarm via a built in modem or via Ethernet to an Operations and Maintenance Center (OMC).

In addition to collecting data from all modules, the Control Module can also collect status of four external alarm inputs connected to the External Interface board. The summary alarm status of the repeater can be indicated on a relay port, available on the external interface connector. This relay can be used to indicate to external equipment if the repeater is functioning properly.

The Control Module includes a Real Time Clock (RTC). The RTC keeps track of at what time alarms and events occur. This RTC has its own backup battery in order to keep up proper time keeping even during long power failures.

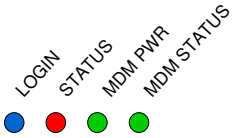
The Control Module contains a RS232 port used for local access to the repeater. The USB connector is not activated in this version of the repeater and cannot be used.

The Control Module can be configured in two different modes:

- Stand-alone Mode – in this mode all communication is made directly with the unit – either locally or remotely via a modem or Ethernet. The communication with the Axell Element Manager is performed using a modem or Ethernet.
- Systems Slave – being a systems slave means all communications with the Axell Element Manager is handled by the Control module in the OMU.

The Control Module has four LEDs which give information regarding the status of the repeater and if someone is logged on to the repeater.

If the repeater is configured as a system slave the two LEDs MDM Power and MDM Status do not fill any function and can be disregarded.



	Quick flash	Control Module switched on, someone logged in locally and/or remotely
	Off (except for a quick flash every 10th second)	Control Module switched on, no one logged in
	Off (permanent)	Control Module switched OFF

	Quick flash	Control Module switched on, one or more errors/alarms detected
	Off (except for a quick flash every 10th second)	Control Module switched on, status OK
	Off (permanent)	Control Module switched off

	On	Modem Power is on
	Off	Modem Power is off

	On	Depending on type of call: Voice call: Connected to remote party Data call: Connected to remote party or exchange of parameters while setting up or disconnecting a call
	Flashing (irregular)	Indicates GPSR data transfer. When a GPRS transfer is in progress the LED goes on within 1 second after data packets were exchanged. Flash duration in approximately 0.5s.
	75ms on/75ms off/75ms on/3s off	One or more GPRS contexts activated
	75ms on/3s off	Logged to network (monitoring control channels and user interactions). No call in progress
	600ms on/600ms off	No SIM card inserted, or no PIN entered, or network search in progress, or ongoing user authentications, or network login in progress
	Off	Modem is off

3.6.1.1 Modem

The repeater can be equipped with a wireless modem or a PSTN modem for remote control and supervision. Different wireless modem types are supported – GSM, EDGE, GPRS, TETRA, etc. If the repeater is equipped with a wireless modem a SIM card holder is mounted on the Control Module.

The repeater can also be accessed via Ethernet.

Wireless modems are placed on the Control Module inside the repeater. A PSTN modem is placed in a separate module within the repeater.

3.6.2 MCPA, Multi Carrier Power Amplifier

There is one MCPA for each band in the repeater.

3.6.3 Radio Module

There is one Radio Module for each band in the repeater. These are RF boards containing two RF-chains, one uplink and one downlink.

3.6.4 Fibre Optic Converter

A single band MBF repeater has only one Fibre Optic Converter. A dual or tri band repeater can have one, two or three converters depending on the mixture of frequency bands and the requirements on the system.

The Fibre Optic Converters contain both a receiver and a transmitter. The two optical signals are combined utilizing WDM technology (Wavelength Division Multiplexing). Hence only one fibre is necessary for transmission. The module also contains a function for the internal communication over the fibre.

The Fibre Optic Modules work in pairs in the system – one in the OMU and one in the repeater. The one placed in the OMU is the master (Optical Master Unit) and the one placed in the repeater is the slave (Optical Slave Unit).

The Fibre Optic Converter has a pilot tone generator that is used for detecting the optical path loss in the fibre. This information can be used for compensation of this loss. Optical loss compensation is always initiated from the Optical Master Unit. In the Optical Slave Unit the pilot tone is normally disabled, and only enabled upon request (from for example the Optical Master Unit).

The Fibre Optic Converter contains two optical alarm sources. These are alarms for transmitted and received optical signal level. The levels of the received optical signals can be monitored on-line via the RMC. This is convenient during installation and tuning of the system. The module also has two alarm sources for the communication between the master and the slave.

There are 6 LEDs on the module to indicate the status.

On	Unit is powered on
Off	Unit has no power
LED 2, Error, Red	
On	Error detected
Off	No error
LED 3, UL Data, Yellow	
On	Communication is ongoing in the uplink direction

Off	No communication
LED 4, DL Data, Yellow	
On	Communication is ongoing in the downlink direction
Off	No communication
LED 5, Opto Rx, Green	
On	Received RF signal on fiber channel is above threshold
Off	Input level below threshold
LED 6, Opto Tx, Green	
On	Transmitted RF signal on fiber channel is above threshold
Off	Output level below threshold

3.6.5 Filter

The filter provides a wide band selective window for the uplink and downlink in each band on the RF antenna end of the repeater.

3.6.6 RefGen, Reference Generator Module

The Reference Generator generates a stable reference frequency which is distributed to the radio modules of the system. It is used as a reference signal in the synthesizer in the repeater and also in the microcontrollers in the MCPA and Radio Module.

3.6.7 EAIM, External Alarm and Interface Module

Four external alarm sources can be connected to the alarm module, EAIM. These sources must generate a voltage between 12 and 24 VDC. The presence or absence of this voltage will trigger the alarm depending on how alarm thresholds have been configured in the controller software.

The module can also supply +15V to external alarm sources. The maximum allowed load on this supply is 100mA.

One relay contact closure is provided to reflect the status of the repeater. This can be used as a sum alarm. For installation of external alarms see section 5 Installation.

3.6.8 PSUP, Power Supply

The PSUP is fed by 110/230 V AC, 50/60 Hz or -48 V DC. The PSUP generates secondary DC voltages for the repeater modules. The input is equipped with a surge, EMI, EMC suppression filter.

The -48VDC version of the power supply is designed to turn off if the supply voltage falls below -36V (±1V). It will turn on again as the supply voltage reaches -43V (± 1V).

On the Power Supply unit a rechargeable battery pack in mounted. This part also includes charging and supervision electronics. The backup battery will provide the Control Module and modem with enough capacity to send an alarm in case of input power failure.

The power supply module is connected to all other electronic modules via the distribution board.

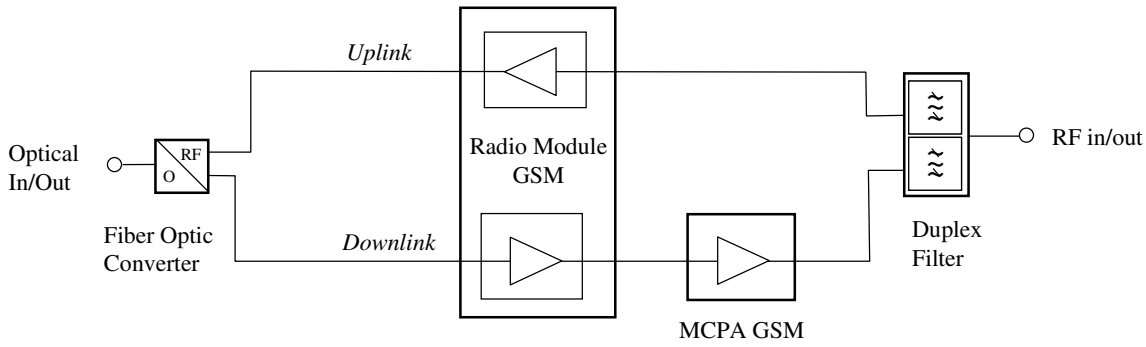
The power supply has a switch which allows it to be set in “on” position or in “stand by”. The battery can be switched on and off.

Power Supply

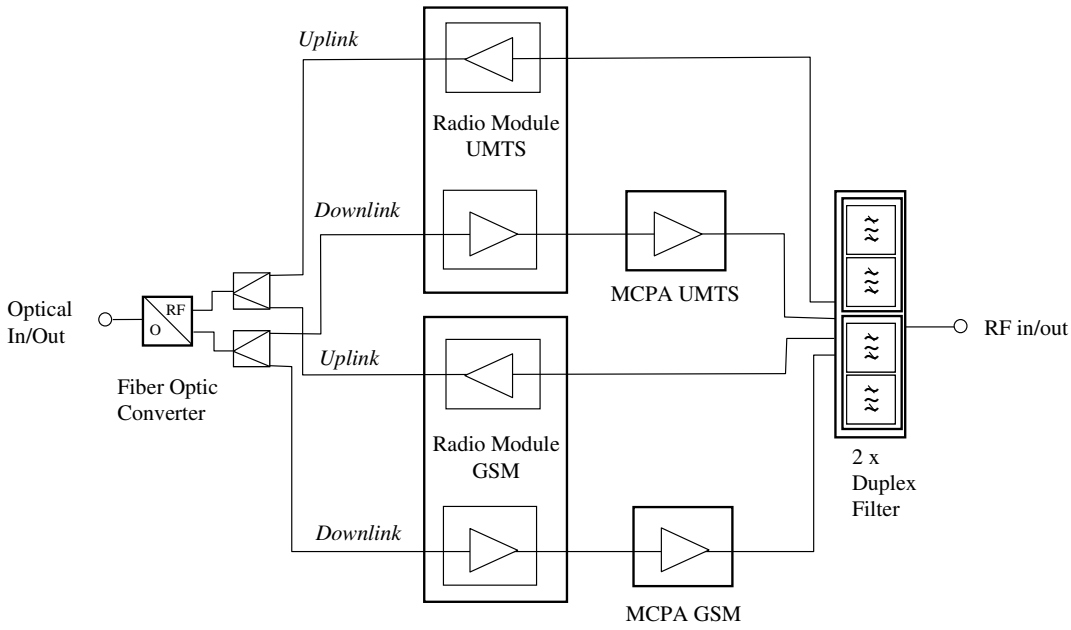
The power supply has 4 LEDs to indicate the status.

Slow flash	Power supply unit operating on AC or DC
OFF	Power supply unit not operating
LED 2, +6V, Red	
Slow flash (every 10 seconds)	+6V power supply operating
Quick flash	+6V power supply not operating or operating with malfunction
LED 3, +15V, Red	
Slow flash (every 10 seconds)	+15V power supply operating
Quick flash	+15V power supply not operating or operating with malfunction
LED 4, +28V, Red	
Slow flash (every 10 seconds)	+28V power supply operating
Quick flash	+28V power supply not operating or operating with malfunction

3.7 Signal Diagrams



Single band repeater for E-GSM



Dual band repeater for E-GSM and UMTS

In the downlink the signal from the OMU enters the fibre optic converter in the repeater that translates the optical signal to RF. The signal is fed to the Radio Modules. The signals are amplified in the Radio Modules and further in the separate MCPAs. It is then fed to the combined duplex filter and out on the server port to the antenna.

In the uplink the signal is amplified in the Radio Modules and translated to an optical signal and fed back to the OMU.

A tri band repeater works in a corresponding way.

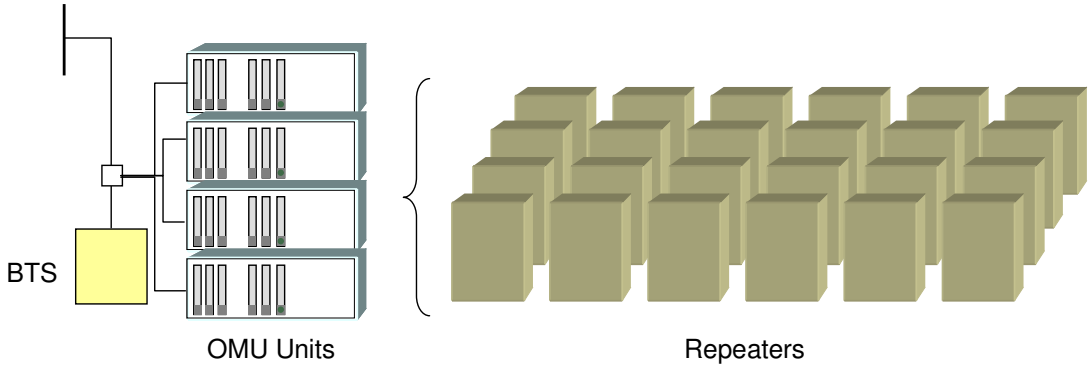
3.8 OMU-Repeater System

An OMU-Repeater system consists of one or more Optical Master Units and one or several fibre fed repeaters.

An Optical Master Unit, OMU, can be equipped with up to 6 fibre optic converters. If more than 6 repeaters are needed in the network there are two ways of expanding the system.

- Link several OMUs together.

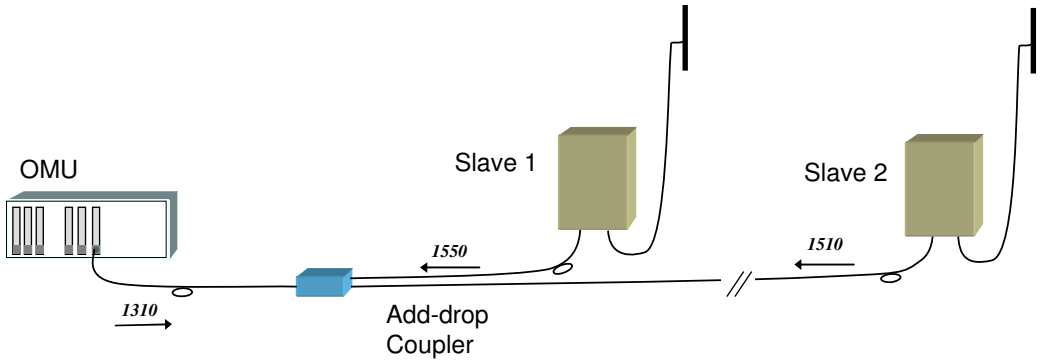
  Up to 4 OMUs can be cascaded in this manner, and operate up to 24 repeaters as one system. When OMUs are cascaded only one is equipped with a Control Module and that one manages the other OMUs as well as all the repeaters.



Four OMUs cascaded in one system

- A laser system with two colors can operate one repeater for each fibre optic converter in an OMU-Repeater system; one color is used for the uplink and one for the downlink. A laser system with three or four colors can operate two or three repeaters per fibre optic converter. One color is used for the downlink which is the same for all repeaters, and in the uplink each repeater uses its own color.

  The connection from one repeater to the next is done via so called add-drop couplers. If needed these couplers can be designed to balance the downlink signal to compensate for different distances to the repeaters.



Two repeaters are connected to the same converter in the OMU via the same fibre but the wavelength for the uplink differs between the units. Slave 1: 1550 ± 3 nm, Slave 2: 1510 ± 3 nm. The downlink signal is the same for both repeaters.

3.9 Access to the System

Important Generic Information

Axell Wireless repeaters and OMUs can be configured in three different ways as regards communication and control. They can be “stand-alone units”, “node masters” or “slaves”.

Stand-alone units do not control any other unit or take control from any other unit. All communication with a stand-alone unit needs to be made directly with the unit – either locally or remotely via a modem or Ethernet. Most stand-alone units are equipped with Ethernet and/or a modem for this purpose.

Node Masters keep track of the slaves that are connected to it. It is the single point of contact for alarm reports and for heart beats in the entire system, and communicates with the AEM. All configuration and control of all units in the network go through this Node Master. Most stand-alone units are equipped with Ethernet and/or a modem for this purpose.

Slaves are linked to a node master. Slaves do not have modems but instead all data is transferred to the master where it is distributed further to the AEM.

An OMU-Repeater system can be designed using repeaters that operate as slaves to the OMU or as stand alone units regarding communication, configuration, alarms etc. Either all communication is handled by the OMU that acts as a node master and the repeaters are slaves, or each repeater (and the OMU) handles this communications and reporting separately.

The most common configuration is the master-slave set up which has several advantages:

- All nodes can be reached from any node in the system. An operator can log in from any node in the system and access all parameters in all nodes, including those in the OMU
- Only one modem is needed for remote communication and configuration of the whole system
- Since the communication runs on the same fibre as the RF, this arrangement gives a reliable supervision of the radio link. If communication between the OMU and a repeater is broken, an alarm can be generated immediately.

Several users at a time can be logged on to the system, for instance one locally via the RS232 interface and one remotely via modem or Ethernet. Only one user at a time can be logged in remotely.

Note! If the network has an OMU from an earlier generation[1], there are some limitations of what can be accessed via a local login to a slave repeater.

3.9.1 Local Access

Local access is achieved via a RS232 interface to the LMT port in the repeater or the OMU. This port is accessible on the front of the OMU and inside the repeater.

3.9.2 Remote Access

Remote access is achieved via modem or via Ethernet. Different types of modems are supported, for example GSM, GSM-R and PSTN.

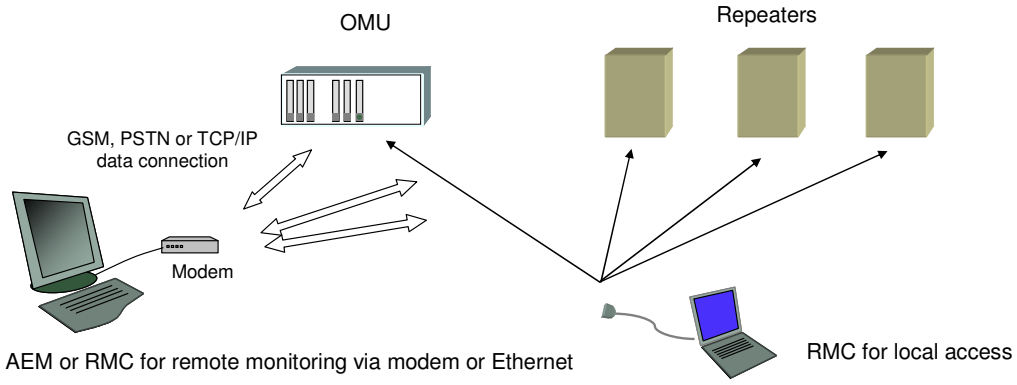
The modem is either placed on the Control Module or as a separate unit. When cascaded OMUs are used, the modem is placed in the OMU unit that holds the Control Module. Ethernet connection is available on the Control Module.

[1] The earlier version of the OMU was called HUB.

3.10 SW for Configuration and Control

There are two SW tools for configuration and control of the Axell Wireless OMU-Repeater system. The RMC, Repeater Maintenance Consol and the AEM, Axell Wireless Element Manger.

- The RMC is an on-line tool that can be used locally or remotely for configuration and monitoring of all parameters in the system. It is installed on a lap-top computer and holds pre-configured screens for each repeater type or OMU that shows the parameters live in a user-friendly manner. All parameters can be accessed and changed on-line. In the RMC there is also a terminal mode that allows for command based communication.
- The AEM is a tool for monitoring and control of a whole network. Data from the network elements are collected at regular intervals and alarm information are sent to the AEM as they occur. All data are stored in a data base and can be presented in maps, reports and diagrams.



4 Monitoring and Control

The MBF repeater can be accessed on site through the Local Maintenance Terminal (LMT) port or remotely over a built in modem or Ethernet in the OMU (for slave-type repeaters) or via a modem or Ethernet in the repeater.

When an RS232 cable is plugged in to the LMT port, there are two options for communication; terminal mode or RMC mode.

- Terminal mode is accessed by using a terminal emulation software, such as HyperTerminal™ or ProComm™. Settings should be ANSI or VT100 emulation, baud rate 9600, 8 data bits, 1 stop bit, No parity and No flow control. A simple command language is used to control the repeater in this mode.
- Repeater Maintenance Console (RMC) mode allows configuration and control of the repeater via a user friendly Windows software.

Note! All instructions in this chapter assumes that the repeater is controlled using the Repeater Maintenance Console, RMC.

For use of the terminal mode please refer to the documents "*Common Commands and Attributes*" and "*MBF Commands and Attributes*" which contain detailed description of all attributes and commands.

Firmware Documentation Structure

The attached documents "*Common Commands and Attributes*" and "*MBF Commands and Attributes*" together describe all functionality in the repeater. The Common part contains functionality that is common for all Axell Wireless repeaters of the latest generation and the MBF part contains functionality that is specific for this repeater type.

Help Functions

When being logged in to a unit using the terminal mode the command

```
HELP
```

will list all attributes and their modes of operation and display them in alphabetic order on the screen.

Further help regarding specific commands can be had by typing

```
INF <command>
```

The INF attribute gives detailed information about a specific attribute.

4.1 Software Features - Overview

The firmware in the repeater controls and monitors all repeater parameters. Statuses and measured levels can be read online via the RMC. This includes for instance voltage levels, RF-levels and temperatures.

In the event of a failure, an alarm is logged in the repeater. If the repeater is controlled by the AEM, the alarm is also transmitted to the AEM. The repeater can be configured to handle alarms concerning a number of different parameters. Each alarm can also be individually configured in a number of ways. The repeater stores approximately 2 000 alarms in a local alarm log. The data stored regarding each alarm is the time at which an alarm occurred and the alarm information which consists of alarm source, alarm severity, alarm attributes and in some cases an additional alarm description.

On regular intervals, the repeater can send a heartbeat report to the AEM to confirm that the repeater is functioning. The heartbeat message contains information about the RF-configuration and the alarm sources. It ensures that the data communication from the repeater to the AEM is working properly. The latest 2 000 heartbeats (approximately) are stored in a log.

The Control Module keeps track of the exact repeater type it is controlling, and its performance parameters, including maximum uplink and downlink gain, serial number of repeater, software version in Control Module, controller hardware version, as well as hardware version of all included components.

The repeater can be equipped with a wireless modem (GSM, GSM-R, EDGE, etc) or a PSTN modem mounted inside the repeater. The repeater is also equipped with Ethernet.

The Control Module contains a battery backed-up real time clock, which will stay active even during a power failure. The real time clock is used for instance to keep track of when an alarm occurred, when to retransmit an alarm and at what time of the day to send traffic report to the AEM.

If the repeater is controlled by the Axell Element Manager, the AEM will automatically time synchronize repeaters, to ensure that the time is always set correctly in the entire repeater network. Slave repeaters are synchronized from the OMU.

4.2 Network Nodes

Note! The description in this section is based on a master-slave set-up of the system, where the OMU is the node master and the repeaters are the slaves.

An Axell Wireless OMU-Repeater system consists of an OMU unit and a number of remote nodes (repeaters) connected to the OMU unit via fibre optic cables. During software setup of the system, all nodes installed in the system are configured in the Control Module. Hence, the node master contains a list of all the repeaters in the system. Once a node is added to the system, it is also written to all the nodes installed. This means that all nodes in the repeater system have information about all other nodes, allowing for a very good overview of the entire repeater system no matter what node the repeater system login is made from.

4.2.1 Node Identification

All nodes have a unique address within the repeater system. This address is based on the serial number of the node. When the system is installed to the Axell Element Manager, the master unit is assigned a unique repeater ID within the AEM database.

This number is on the form:

```
XX-YY-ZZZZ
```

where
XX is the AEM installation number within the network
YY is the region number within the AEM-system
ZZZZ is the site installation number

Within the repeater system, all slave nodes (repeaters) are given a unique ID, based on the AEM assigned ID. The nodes share the XX-YY- part of the master ID, but the ZZZZ is replaced by the node's serial number.

Example:

If the master's ID is 17-42-4711 and the serial number for a node in the system is 23BJ. The node's ID will be 17-42-23BJ.

4.2.2 Node Addressing Modes

When logging in to the OMU-repeater system, it is possible to view information about any of the nodes in the system, as long as they are added to the node list. All nodes can be addressed in four different ways, all starting with the @-sign.

Numeric Addressing

Each node in the network gets a unique ID-number in the Node List as they are added to the system. Node 0 is always the master node.

Addressing is on the format:

```
@K
```

K from 0 to N where N is number of nodes

Reading a parameter from node 3 is entered as:

```
AVITEC AB> @3 GET ATD
14
AVITEC AB>
```

Serial Number Addressing

A node can be accessed using the serial number of the node.

Example:

```
AVITEC AB> @2J34 GET MDL
MBF-I
AVITEC AB>
```

Node ID Addressing

A node can also be addressed using the full Node ID.

Example:

```
AVITEC AB> @01-01-2J34 GET TAG
SITE3_TUNNEL_OPENING
AVITEC AB>
```

Direct Node Addressing

When many attributes are intended for another node, the user can enter Direct Node Accessing mode, where the node the user is logged in redirects all commands to the destination node.

This mode is configured by sending the command:

```
SET DNA [Node Address]
```

where any of the node addressing modes can be used as Node Address.

When going into direct node addressing, the command prompt is changed to reflect what node is currently addressed:

```
AVITEC AB> SET DNA 2J34
AVITEC AB @2J34>
```

Refer to attribute DNA in *OMU Command and Attribute Summary* for further details on direct node addressing.

4.2.3 System Wide Parameters

System Wide Parameters are parameters that when configured should be written to all nodes in the system. When setting a system wide parameter, the parameter is always set in the node master, which is then responsible for setting the parameter to all other nodes. If attempting to set a system wide parameter from a node as access to the node master is not available, setting the parameter will fail.

The following “standard” parameters are treated as system wide parameters (please refer to *OMU Command and Attribute Summary* for details):

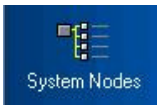
LMT	Local Maintenance Terminal timeout
TIM	Setting the time
DAT	Setting the date
TPD	Setting the time for sending traffic / utilization report to the AEM
UID	User ID’s
PWD	Passwords
RID	Repeater ID

In slave repeaters the OMU is responsible for the communication with the AEM.

4.2.4 Node Access

An operator can login to the system from any node in the network and access all parameters in all nodes, including those in the node master unit. This can be done using a serial cable connected to the node's LMT-port or by remote access over a modem in the master unit.

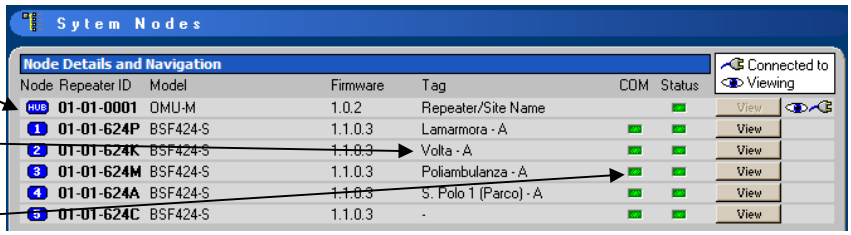
Select "System Nodes"



Node detailes: number, ID, Model

Node name

Node status



Select a node by clicking on 

. The RMC will now connect to the selected node.

The OMU unit polls the connected repeaters / nodes regularly and keeps control of login requests. If a user at a repeater site wants to log in to the system, the OMU Control Module is responsible for granting / denying the login request. If a user forgets to log out from the node when a session is finished, the system will automatically log the user out after a configurable number of minutes of inactivity.

4.3 Fibre Loss Compensation

Each fibre optic link in the system will induce a loss. This loss will also differ in magnitude from one link to another since the distances between each repeater and the OMU is different. The Axell Wireless OMU-repeater system can automatically calculate this loss, compensate for the loss in each link and by that also balance the system.

This is accomplished by using a pilot tone of a well defined level which is sent from the master node to the slave and vice versa. The received level of the pilot tone is measured and the loss is calculated. The Fibre Optic Converter is automatically adjusted to compensate for the loss. The adjustment is made towards a target value which means that the system will also be balanced (all fibers will appear to have the same loss). The maximum compensation is 10dB which equals an unbroken fibre distance of 20 km. For each connection in the link (for instance at the ODF) approximately 0.5 dB will have to be added to the loss.

The loss compensation function is activated by some quick commands as the system is set up. Each time the system has been changed or fibres have been exchanged or moved for some reason, it is recommended to re-activate this function.

4.4 Alarm System

The Axell Wireless repeaters contain a number of different alarm sources, both analogue and digital, to ensure that the repeater works with desired performance.

4.4.1 Alarm Sources

Temperature Related Alarms

Temperature	TEM	Measures the temperature in the Control Module	Temperature too high or too low
Radio Board Temperature	RBT	Measures the temperature on the defined radio or opto module	Temperature too high or too low
Power Supply Temperature	PTM	Measures the temperature in the power supply	Temperature too high or too low

Power Related Alarms

Power Supply Level	PSL	Monitors the input voltage level to the repeater	Level too high or too low
Power Supply 1	PW1	Measures the +28V generated by the repeater's power supply.	Level too high or too low
Power Supply 2	PW2	Measures the +15V generated by the repeater's power supply.	Level too high or too low
Power Supply 3	PW3	Measures the +6.45 V generated by the repeater's power supply	Level too high or too low
Power Supply 4	PW4	Measures the backed up +6.45 V generated by the repeater's power supply	Level too high or too low
Battery Level	BAT	Measures the power level in the battery	Level too high or too low

Repeater Performance Related Alarms

Amplifier/Gain Downlink	AD1-4	The repeater measures the input signal level in the downlink and compares it to expected output power with regards to set attenuation. If the output power is too high or too low an alarm is triggered.	Expected output power too high or too low compared to calculated output power
Amplifier/Gain Uplink	AU1-4	The repeater measures the input signal level in the uplink and compares it to expected output power with regards to the set attenuation. If the output power is too high or too low an alarm is triggered.	Expected output power too high or too low compared to calculated output power
Amplifier	ASD	Measures saturation in the downlink, measured	Saturation enters

Saturation Downlink		on the radio module. An amplifier chain going into saturation means that the input signal level is too high.	defined level
Power Amplifier Downlink Error	PAE	Monitors the alarms from the MCPA	Non-fatal alarms from the MCPA
Power Amplifier Downlink Fatal Error	PAF	Monitors the alarms from the MCPA	Fatal alarms from the MCPA
Power Downlink Level	PD1-4	Measures the output power in the downlink. If it drops below the configured threshold an alarm is generated.	Output power level (too high) or too low

Communication Related Alarms

Communication with Active Devices	COM	Detects errors in the communication between the Control Module and other active devices, such as power supplies, radio module, MCPA, ref generator and Fibre Optic Converter	Errors in the communication
EEPROM CRC check in active devices	CRC	Controls checksum in radio module, MCPA and Fibre Optic Converter	Checksum wrong
Received Data Packet Quality	RXQ	Measures the quality of the received data from the node master	Quality too low
Communication between the Radio Module and the MCPA	CMM	Monitors the communication between the Radio Module and the related MCPA.	Errors in the communication

Opto Related Alarms

Received Optical Level	RXO	Measures the received optical signal level	Optical signal level too low
Transmitted Optical Level	TXO	Measures the transmitted optical signal level	No transmission
Received Pilot Tone Level	RXP	Measures the pilot tone level	Level too high or too low
Synthesizer Pilot Tone Generator	SZP	Measures the pilot tone frequency	Error on pilot tone

Door Alarm

Door	DOO	Checks if the repeater's door is open or closed	Door is open

External Alarms

External Alarm 1	EX1	Monitors any alarm source, for example fire alarms or external door sensors connected to the external interface.	Error from alarm source
External Alarm 2	EX2	Monitors any alarm source, for example fire alarms or external door sensors connected to the external interface.	Error from alarm source
External Alarm 3	EX3	Monitors any alarm source, for example fire alarms or external door sensors connected to the external interface.	Error from alarm source
External Alarm 4	EX4	Monitors any alarm source, for example fire alarms or external door sensors connected to the external interface.	Error from alarm source

Relay Output for Sum Alarm

The module for external alarms contains a relay output. The relay can be used to indicate the summary status of the repeater. Each alarm source can be configured to be affecting the relay or not.

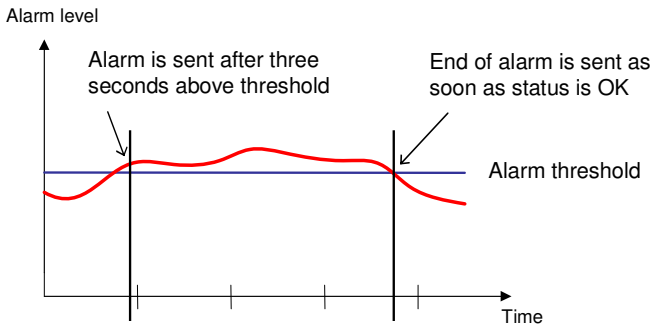
4.4.2 Alarms and End of Alarms

When the Control Module detects a failure in the repeater, an alarm is transmitted to the Axell Element Manager, informing the operator about the error condition. When the alarm has ceased, an end of alarm is sent to the AEM, stating that the alarm source is now OK.

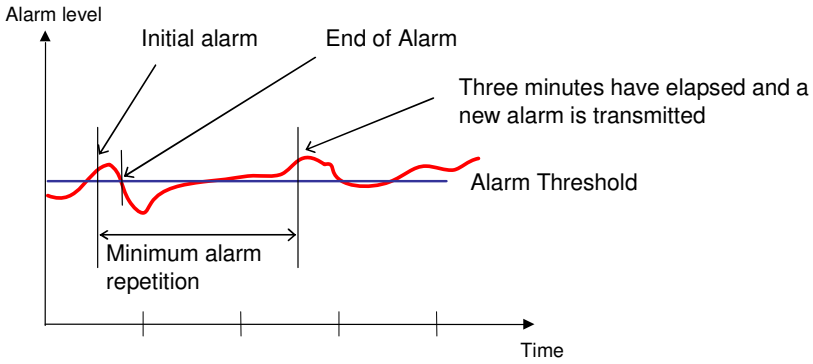
For slave type repeaters in a OMU-repeater system this communication is initiated and managed by the OMU.

Each “alarm” and “end of alarm” updates the AEM database with the latest status of the alarm source, ensuring that the AEM operator always has the correct repeater status in the system.

- To generate an alarm a number of consecutive measurements must first show an error state. This can be configured for each alarm source separately.
- To generate an end of alarm only one OK measurement is needed.



If an alarm should constantly toggle between OK and ERROR the communications interface might be blocked. To prevent this there is a parameter called Minimum Alarm Repetition Cycle. This parameter defines how many minutes must elapse before a new alarm can be transmitted from the same alarm source.

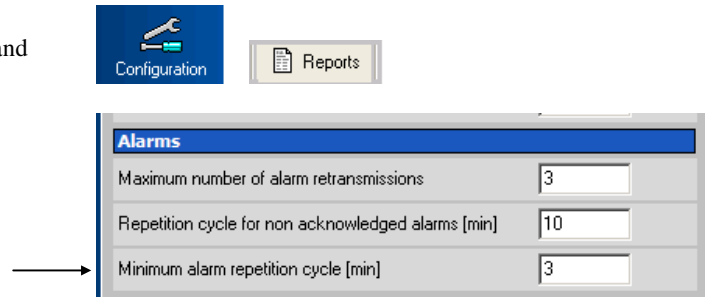


This illustration shows an alarm source with an upper threshold, and a fluctuating level around the alarm threshold. In this example, the first alarm will be sent as indicated. The next alarm will be transmitted after three minutes, when the minimum alarm repetition period has elapsed.

In this configuration a new alarm will not be sent before three minutes have elapsed. This variable can be set from 0 to 99. If it is set to 0 the feature is disabled.

Set Minimum Alarm Repetition Cycle

Select "Configuration " and "Reports"



4.4.3 Alarm Retransmissions and Acknowledgements

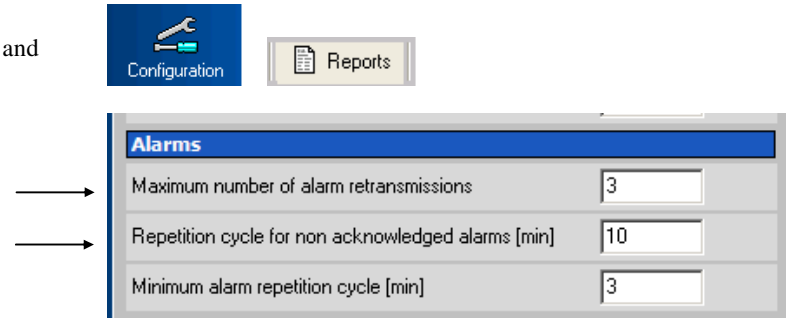
As soon as the repeater detects an alarm or an end of alarm, a connection to the Axell Element Manager is established and the alarm event is reported.

The 2 000 latest alarms and end of alarms are stored in the repeater's local alarm log. In case an alarm is not acknowledged the alarm will be retransmitted to the AEM after a configurable number of minutes. Allowed values are 0 to 999. Default retransmit interval is 10 minutes.

The retransmission will be repeated a configurable number of times. This variable can be set from 0 to 99. Default number of retries is three

Set Number of Retransmissions and Repetition Cycle for Non-acknowledged Alarms

Select "Configuration " and "Reports"



4.4.3.1 Alarm Acknowledgement using the RMC

Each alarm can be manually acknowledged using the Repeater Maintenance Console. However, if the repeater is controlled by the Axell Element Manager, a manual acknowledgement of the alarm means that the AEM will not be aware of the change in the repeater status.

4.4.3.2 Alarm Acknowledgement using the Axell Element Manager

If the repeater is integrated to and controlled by the Axell Element Manager (via an OMU or directly), an alarm is considered acknowledged when the alarm has been delivered to the AEM. Once delivered to the AEM, the acknowledgement of the event is taken care of locally at the AEM, why no dial-back needs to be performed to acknowledge the alarms in the repeater.

4.4.3.3 Alarm Acknowledgement using SMS

Note! SMS functionality is not implemented in this SW release.

If the repeater is configured to send alarms using SMS, alarm acknowledgement can be made in two different ways.

- the alarm is acknowledged as soon as the alarm SMS is successfully received by the Short Message Service Centre

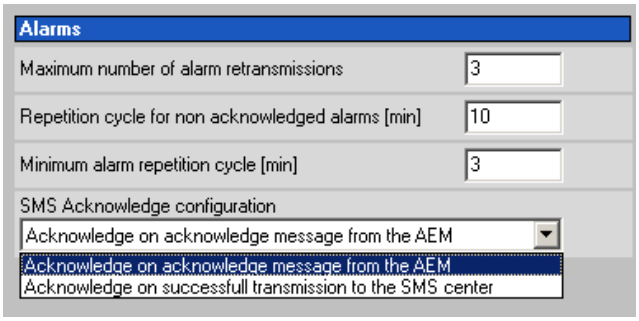
or

- the alarm is acknowledged by sending a special alarm acknowledgement SMS back to the repeater from the alarm destination.

Set Acknowledgement Type for SMS Alarms

Select "Configuration " and "Reports"

Pick one alternative from the drop-down menu



All alarms transmitted from the repeater contain a message number. Acknowledgement of an alarm is done by sending an SMS to the repeater containing this message number.

Note! Only the defined "Primary SMS address" can acknowledge alarms.

The table below displays the format of alarm acknowledgement messages.

Repeater ID	XX-YY-ZZZZ	ID of the repeater that the message is intended for
Message number	NNNNN	Message number set by originator
Command	ACT	Action command
Argument	ACK	Acknowledge action
Argument	MMMMM	Message number of the alarm message to acknowledge

The message fields are separated with blanks.

For example, sending an SMS to the repeater with the text

```
01-42-4711 00242 ACT ACK 00023
```

will acknowledge alarm number 00023 from repeater 01-42-4711.

4.4.4 Alarm Format

Each alarm transmitted from the repeater contains a number of fields, in detail describing the event that caused the alarm. The alarm is transmitted as an ASCII text string, each field separated by a blank/white space.

Using the Axell Element Manager to control the repeater, the alarm string is delivered to the transceiver for further processing in the AEM system.

When SMS is used to control the repeater, the string is sent as clear text to the alarm address (main address).

Note! The SMS functionality is not implemented in repeaters with this SW release.

Repeater ID	XX-YY-ZZZZ	10	ID of the repeater causing the alarm. When monitoring the repeater using the AEM, this repeater ID is set by the AEM during the repeater installation phase. Using SMS, this repeater ID should be modified to uniquely identify the repeater in the network.
Message #	N	1 to 10	This integer value uniquely identifies this message from the repeater and may be from 0 to 2147483648 (231).
Message type	ALARM	5	This text string identifies the message as being an alarm (or end of alarm)
Date	DDMMYY	6	Day, month and year when the alarm was detected
Time	HHMMSS	6	Hour, minute and second when the alarm was detected
Alarm Name	CCC	3	Identifies the alarm type (e.g. PW1, SZU, PDL, etc)
Alarm Severity	CC	2	Abbreviation for severity of the alarm. This severity varies between the different alarm sources. CR = critical MA = major MI = minor WA = warning CL = cleared When an and of alarm is sent, the severity is CL = cleared
Alarm Class	CC	2	Abbreviation for kind of alarm CO = communication alarm EN = environmental alarm QS = quality of service alarm PR = processing alarm EQ = equipment alarm
Status	C	1	This status identifier is 0 if end of alarm and 1 if alarm.
Hardware Enumeration	CCCC	1 to 5	Denotes what hardware module the alarm originates from. If not used, a '-' (dash) is replied.
Position Identifier	CCCCCCCCCCCCC	1 to 12	Gives detailed information about certain alarm sources. For some alarms, such as VLI, LGO and CLR, this may contain user information. If not used, a '-' (dash) is replied.
Additional text	<Text>	60	This quoted string contains additional alarm information, such as measured levels when the alarm condition was detected.

4.4.5 Alarm Class

Each alarm belongs to a class. The defined classes are:

CO	Communications
QS	Quality of service
PR	Software or processing
EQ	Hardware equipment
EN	Environment (enclosing or surrounding equipment)

All alarms are configured to a class at delivery but can be changed by the user. The external alarms do not have a classification at delivery, but can be set by the user.

4.4.6 Alarm Severity

Alarms can be of five different severity levels.

Critical	A critical error has occurred which affects the functionality of the repeater. This type of alarm requires immediate action.
Major	A major error has occurred. This type of alarm should be investigated within a short time.
Minor	A minor error has occurred. This type of alarm should be investigated, but is not urgent.
Warning	Something has occurred that does not affect the operation of the repeater but may be important to notice. For example, someone has logged on to the repeater.
OK Cleared	A cleared alarm. This is the end of alarm.

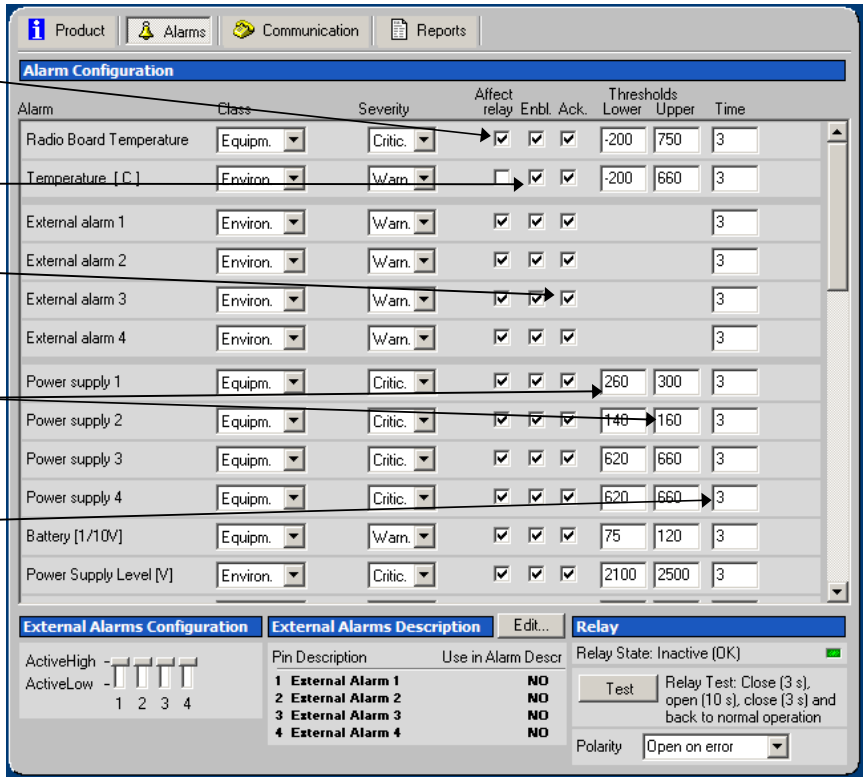
The severity can be defined for each alarm source in the Alarm Configuration screen in the RMC. It is recommended not to change the default settings.

4.4.7 Alarm Configuration

A number of different parameters can be configured for how the alarms are transmitted to the repeater OMC. Each alarm source can also be individually configured in a number of different ways.

Note! The alarm configuration window will differ from the one below but have similar functionality.

Select "Configuration " and "Alarms"



Affect relay	If checked, an active alarm from the alarm source affects the relay status
Enabl.	If checked, the alarm is transmitted to the repeater OMC **Note!** This only affects the transmission of the alarm. The alarm is still measured, and corresponding alarm status is still displayed in the repeater status screen and in the heartbeat reports transmitted to the repeater OMC.
Ack.	All alarms will by default be transmitted to the repeater OMC requiring acknowledgement (the box is checked). Disabling this checkbox removes this requirement, which means that an alarm will only be transmitted once, regardless if an acknowledgement is received or not.
Lower	Lower threshold, not applicable for all alarm sources. Please refer to documents Command and Attribute Summary for details on the usage of thresholds for each alarm source.
Upper	Upper threshold, not applicable for all alarm sources. Please refer to documents Command and Attribute Summary for details on the usage of thresholds for each alarm source.
Time	Defines how many consecutive measurements from one alarm source that should be measured as ERROR before an alarm is triggered.

External Alarms

Four external alarm sources can be connected to the External Alarm module in the repeater. These can be for instance fire alarms or external door sensors.

The alarm sources must generate a voltage between 12 and 24 VDC. The presence or absence of voltage will trigger the alarm depending on how alarm thresholds have been configured in the controller software. Each alarm can also be given a unique name.

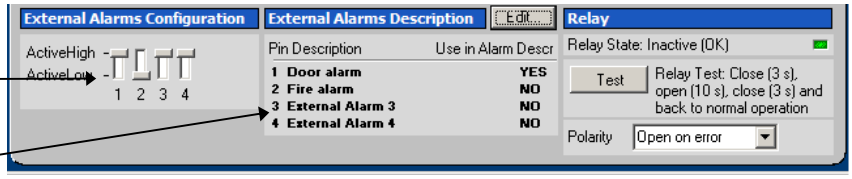
The external alarms can be set as “active high” or “active low”

As for all alarm sources a delay can be set that defines how many seconds an alarm should be in error state before an alarm is generated.

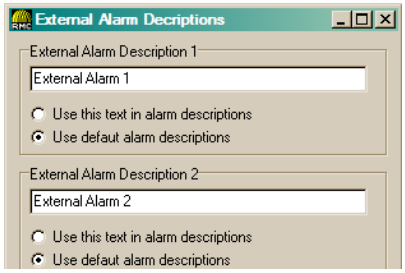
To define names and polarity of the external alarms use the lower part of the Alarm Configuration screen.

Set the dip-switches to configure the external alarms

Name the alarms



The external alarms can be given individual names of up to 19 characters. Click on Edit and insert the new names.



For more information about external alarms see *5.2.7 Connect External Alarms.*

Sum Alarm

The module for external alarms contains a relay output. The relay can be used to indicate the summary status of the repeater. Each alarm source can be configured to be affecting the relay or not.

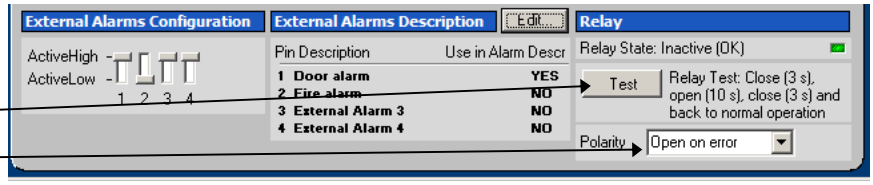
Note! The relay status is not affected by the login / logout alarm parameters.

For installation testing purposes, it is possible to test the open / close function of the relay. This test procedure makes sure the relay is closed for 3 seconds, then opens for 10 seconds, and finally closes for 3 seconds before going back to original state.

The relay can be set to close or open to indicate an alarm. This can be changed by changing the polarity.

Click on Relay Test

Relay polarity



4.4.8 Alarm Monitoring

The alarms can be monitored via the RMC. Each alarm has an indicator that is either green or red.

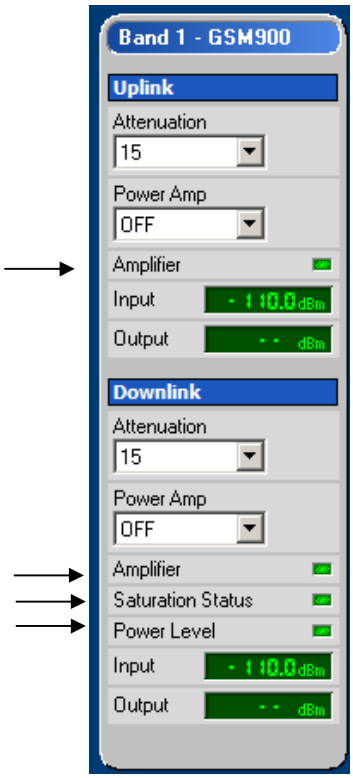
See also reference to section 4.4.1 Alarm Sources.

Uplink Related Alarms

- *Amplifier*, AU1-4. The repeater measures the input signal level in the uplink and compares it to expected output power with regards to set attenuation. If the output power is too high or too low an alarm is triggered.

Downlink Related Alarms

- *Amplifier*, AD1-4. The repeater measures the input signal level in the downlink and compares it to expected output power with regards to set attenuation. If the output power is too high or too low an alarm is triggered.
- *Saturation Status*, ASD. Measures saturation in the downlink.
- *Power Level*, PD1-4. Measures the output power in the downlink.



General Alarms

- *Door*, DOO. Door to repeater open
- *Controller Temp*, TEM. Temperature in Control Module too high or too low
- *External Alarms*, EX1-4. Alarm from external source

Power Supply Related Alarms

- *Com*, COM. Error in communication with Power Supply
- *Temperature*, PTM. Temperature in Power Supply too high or too low
- *Power Supply Input*, PSL. Input power to the repeater too high or too low
- *Battery*, BAT. Power level in battery too high or too low
- *Power P1-4*, PW1-4. +28VDC, +15VDC, +6,45VD and backed up +6,45 VDC too high or too low

Reference Generator Related Alarms

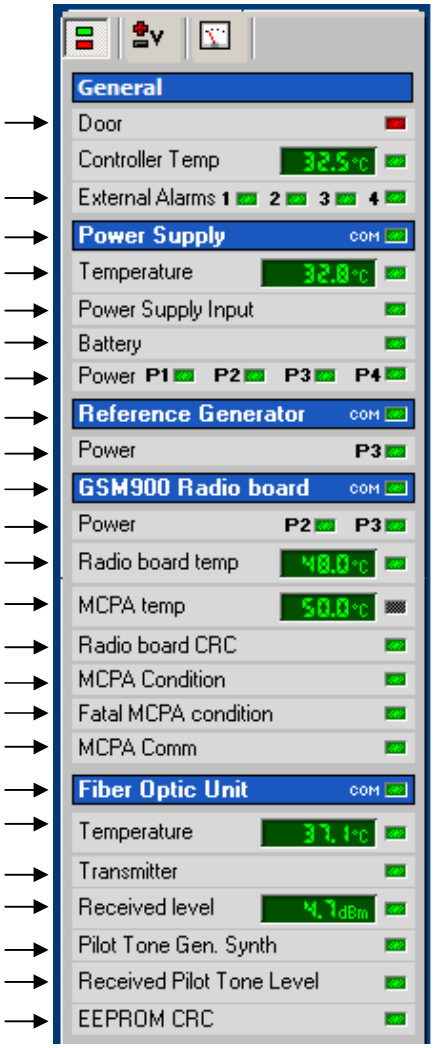
- *Com*, COM Error in communication with module
- *Power P3*, PW3. Relevant power to module too high or too low

Radio Board Related Alarms

- *Com*, COM Error in communication with module
- *Power P2-3*, PW2-3 Relevant power to module too high or too low
- *Radio board temp*, RBT. Temperature in Radio Board too high or too low
- *MCPA temp*, RBT Temperature in MCPA too high or too low
- *Radio board CRC*, CRC Faulty checksum in Radio Board
- *MCPA Condition*, PAE Error in MCPA
- *Fatal MCPA Condition*, PAF Fatal error in MCPA
- *MCPA Com*, CMM Error in communication between the radio board and the MCPA

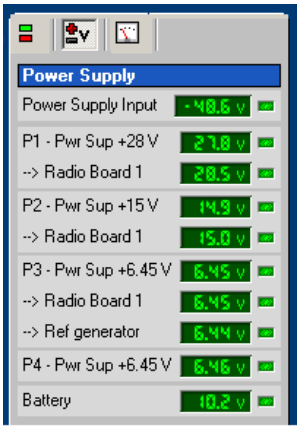
Fibre Optic Converter Related Alarms

- *Com*, COM. Error in communication with module
- *Temperature*, RBT. Temperature in Fibre Optic Converter too high or too low
- *Transmitter*, TXO. No detectable transmitted optical signal
- *Received Level*, RXO. Received optical level too low
- *Pilot Tone Gen Synth*, SZP. Pilot tone frequency faulty
- *Re. Pilot Tone Leve*l, RXP. Pilot tone level too high or too low
- *EEPROM CRC*, CRC. Faulty checksum in Fibre Optic Converter



Power Supply Alarms

Additional power levels and alarms is monitored by clicking 



- *Power Supply Input*, PSL
- *P1 – Pwr Sup +28V*, PW1
- *P2 – Pwr Sup +15V*, PW2
- *P3 – Pwr Sup +6,45V*, PW3
- *P4 – Pwr Sup +6,45V*, PW4
- *Battery*, BAT

System Node Alarms

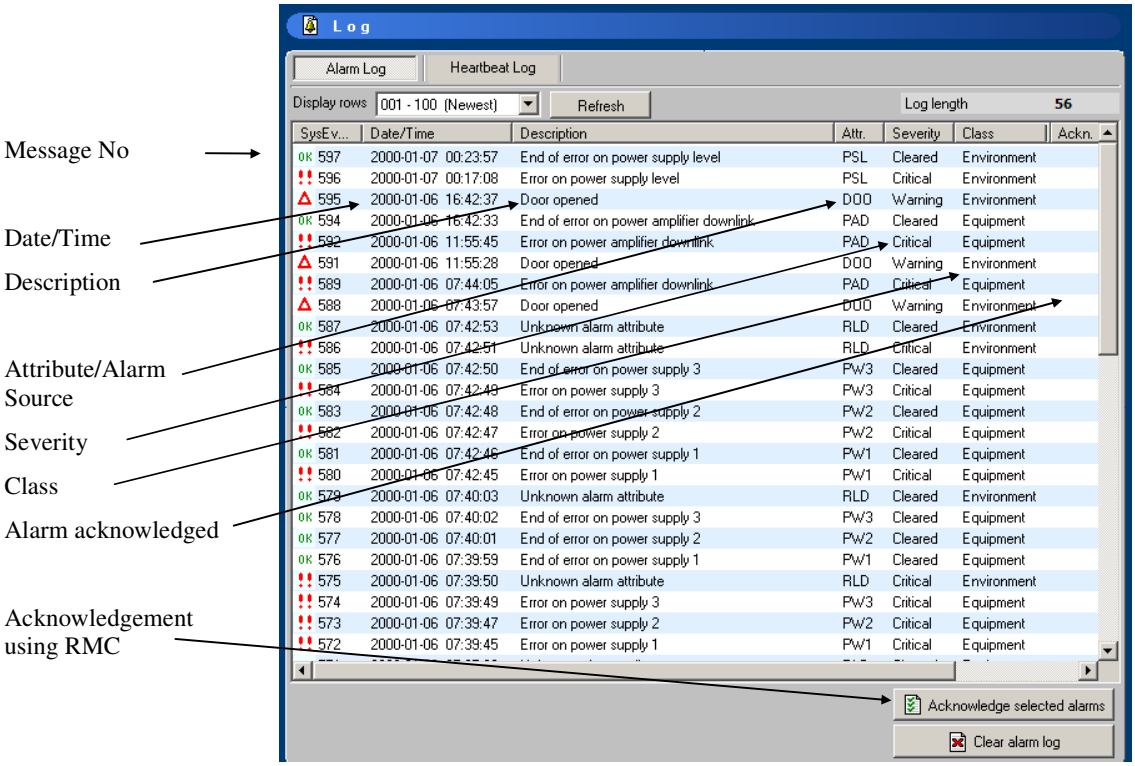
- *COM*, Node Communication, NCO. Error in communication with slave (repeater)
- *Status*. Sum status of slave repeater

4.4.9 Alarm Log

Recent alarms can be viewed in an alarm log that shows details about the alarms.

Note! The alarm log window will differ from the one below but have similar functionality.

Select “Log” and “Alarm Log”



Message No

Date/Time

Description

Attribute/Alarm Source

Severity

Class

Alarm acknowledged

Acknowledgement using RMC

4.5 Repeater Heartbeat

On regular intervals, the repeater sends a heartbeat report to the AEM to confirm that the repeater is functioning. The heartbeat message contains information about the RF-configuration and the alarm sources. It ensures that the data communication from the repeater to the AEM is working properly.

The heartbeat interval can be set from 1 to 1440 minutes. Setting the heartbeat to 0 disables the transmission of heartbeats.

Slave repeaters in OMU-repeater system send the heartbeat messages to the OMU. The heartbeats are sent on to the AEM by the OMU.

4.5.1 Heartbeat Tasks

With the heartbeat reports, a number of tasks are carried out.

4.5.1.1 Ensuring Repeater to AEM Communications path

By configuring the repeater to regularly establish a connection to the AEM, the functionality of the data communications path between the repeater and the AEM is verified. This ensures that for instance the alarms will be transmitted properly.

If an expected heartbeat is not received by the AEM, an alarm is generated to the AEM operator. Reasons for a heartbeat message failing to be delivered can be:

- No power – the repeater site might experience a power failure, and the battery backing up the Control Module and modem is empty
- Broken donor antenna – If the repeater antennas have been tampered with, the repeater might not get adequate signal to establish a connection to the AEM
- Failing BTS – If the feeding BTS for some reason goes down, the repeater will loose its network connection, and hence fail to establish a connection to the Axell Element Manager.

4.5.1.2 AEM Database Synchronization

The Axell Element Manager stores all repeater parameters in a database. This database is populated during the repeater integration into the AEM, when the AEM downloads all the repeater parameters. If the AEM operator wants to monitor the configuration of the repeater, the parameters can be read from the database without having to connect to the repeater.

In case of an alarm, the AEM updates the database with the status of the alarm source. In case the repeater failed to deliver the alarm to the AEM, there will be a discrepancy between the repeater configuration and the configuration in the database. Furthermore, if a technician at site makes changes to the RF-configuration of the repeater, the configuration will differ from the AEM configuration.

For this reason, each heartbeat report contains all the relevant RF-parameters and status of all the alarm sources in the repeater. This means that each heartbeat report will update the AEM with all status and RF parameters.

Note! Once the repeater is integrated to the Axell Element Manager, it is recommended that all reconfigurations are made from the AEM.

Note! If a user logs in to the repeater making changes, as soon as the user logs out, an alarm will be transmitted to the AEM informing the operator that a change has been made. When this alarm is received, the operator can initiate repeater synchronization where all repeater parameters will be updated.

4.5.1.3 Time Synchronization

Each heartbeat message transmitted to the AEM contains a time stamp of the local time inside the repeater. Upon reception in the AEM, the time stamp is compared to the Axell Element Manager time. If the difference between the repeater and AEM time is too big, time synchronization is initiated by the AEM, adjusting the time in the repeater. In this ways, we ensure that a repeater integrated to the Axell Element Manager always contains the correct time information.

Note! If the time is adjusted by a user logged in to the repeater, once the user logs out, a heartbeat is sent to the AEM to ensure that the time is correctly synchronized.

4.5.2 Heartbeat Format

The heartbeat report is transmitted as an ASCII text string, with a number of fields representing the RF-configuration and status parameters, each field separated by a blank/white space.

Using the Axell Element Manager to control the repeater, the heartbeat report is delivered to the Transceiver for further processing in the AEM system.

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Repeater ID</td><td>XX-YY-ZZZZ</td><td>10</td><td></td></tr>
<tr><td>Message no</td><td>NNNNNNNN</td><td>9</td><td></td></tr>
<tr><td>State</td><td>STATE</td><td>5</td><td></td></tr>
<tr><td>Date</td><td>DDMMYY</td><td>6</td><td></td></tr>
<tr><td>Time</td><td>HHMMSS</td><td>6</td><td></td></tr>
<tr><td>IHU</td><td>NNNNNNNNN NNN</td><td>12</td><td>Installed hardware units.
0 = not installed
1 = installed
Hardware order: PSUP1, PSUP2, RefGen, RadioUnit1, RadioUnit2, RadioUnit3, RadioUnit4, FiberOptic1, FiberOptic2, FiberOptic3, FiberOptic4, Comm.Multiplexer</td></tr>
<tr><td>ATD</td><td>XXYYZZWW</td><td>8</td><td>Attenuation in downlink</td></tr>
<tr><td>ATU</td><td>XXYYZZWW</td><td>8</td><td>Attenuation in uplink</td></tr>
<tr><td>LVD/LVU</td><td>JKLMXYZW</td><td>4</td><td>Output Power Enabled / Disabled in downlink/uplink</td></tr>
<tr><td>AMD/AMU</td><td>NN</td><td>2</td><td>Status of amplifier chain downlink/uplink.
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Amplifier Chain 1 Downlink</td><td>Amplifier Chain 2 Downlink</td><td>Amplifier Chain 3 Downlink</td><td>Amplifier Chain 4 Downlink</td></tr>
</table>
Byte 2
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Amplifier Chain 1 Uplink</td><td>Amplifier Chain 2 Uplink</td><td>Amplifier Chain 3 Uplink</td><td>Amplifier Chain 4 Uplink</td></tr>
</table></td></tr>
<tr><td>ASD</td><td>N</td><td>1</td><td>Status of amplifier saturation downlink
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Amplifier Chain 1 Downlink</td><td>Amplifier Chain 2 Downlink</td><td>Amplifier Chain 3 Downlink</td><td>Amplifier Chain 4 Downlink</td></tr>
</table></td></tr>
<tr><td>BAT</td><td>N</td><td>1</td><td>Status of Battery Charge</td></tr>
<tr><td>CMM</td><td>N</td><td>1</td><td>Status of communication between Radio Board and MCPA.
These values are Hex Coded, and should be used in conjunction with COM status for</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>MCPA Comm. Chain 1</td><td>MCPA Comm. Chain 2</td><td>MCPA Comm. Chain 3</td><td>MCPA Comm. Chain 4</td></tr>
</table></td></tr>
<tr><td>COM</td><td>NNNNNNNNNNNN</td><td>12</td><td>Status of communication between controller and active devices</td></tr>
<tr><td>CRC</td><td>NNN</td><td>3</td><td>Status of CRC Status for target firmware. These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>CRC
Radio Unit 1</td><td>CRC
Radio Unit 2</td><td>CRC
Radio Unit 3</td><td>CRC
Radio Unit 4</td></tr>
</table>
Byte 2
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>CRC
Fibre Optic Unit 1</td><td>CRC
Fibre Optic Unit 2</td><td>CRC
Fibre Optic Unit 3</td><td>CRC
Fibre Optic Unit 4</td></tr>
</table>
Byte 3
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Com Mux</td><td>0</td><td>0</td><td>0</td></tr>
</table></td></tr>
<tr><td>MSC</td><td>NN</td><td>2</td><td>Status of MCPA, both errors and fatal errors.
These values are Hex Coded, and should be used in conjunction with CMM status for actual MCPA.
For example, the Byte 1 status is sent as Hex ‘A’, which is extracted to 1010.
Byte 1
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Fatal Error MCPA 1</td><td>Error MCPA 1</td><td>Fatal error MCPA 2</td><td>Error MCPA 2</td></tr>
</table>
Byte 2
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Fatal Error MCPA 3</td><td>Error MCPA 3</td><td>Fatal error MCPA 4</td><td>Error MCPA 4</td></tr>
</table></td></tr>
<tr><td>PDL</td><td>N</td><td>1</td><td>Status of Power Downlink Level.
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Power Level Chain 1 Downlink</td><td>Power Level Chain 2 Downlink</td><td>Power Level Chain 3 Downlink</td><td>Power Level Chain 4 Downlink</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>PSL</td><td>N</td><td>1</td><td>Status of Power Supply Input Level</td></tr>
<tr><td>PTM</td><td>NN</td><td>2</td><td>Status of Power Supply Temperature</td></tr>
<tr><td>PW1</td><td>NN</td><td>2</td><td>Status of 28V Power Supply distribution.
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW1 Power Supply 1</td><td>PW1 Power Supply 2</td><td>PW1 Radio Unit 1</td><td>PW1 Radio Unit 2</td></tr></table>Byte 2<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW1 Radio Unit 3</td><td>PW1 Radio Unit 4</td><td>0</td><td>0</td></tr></table></td></tr>
<tr><td>PW2</td><td>NN</td><td>2</td><td>Status of 15V Power Supply distribution.
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW2 Power Supply 1</td><td>PW2 Power Supply 2</td><td>PW2 Radio Unit 1</td><td>PW2 Radio Unit 2</td></tr></table>Byte 2<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW2 Radio Unit 3</td><td>PW2 Radio Unit 4</td><td>0</td><td>0</td></tr></table></td></tr>
<tr><td>PW3</td><td>NN</td><td>2</td><td>Status of 6.45V Power Supply distribution. These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW3 Power Supply 1</td><td>PW3 Power Supply 2</td><td>PW3 Radio Unit 1</td><td>PW3 Radio Unit 2</td></tr></table>Byte 2<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>PW3 Radio Unit 3</td><td>PW3 Radio Unit 4</td><td>PW3 Ref Gen</td><td>PW3 Com Mux</td></tr></table></td></tr>
<tr><td>PW4</td><td>N</td><td>1</td><td>Status of 6.45V Backup Power Supply distribution</td></tr>
<tr><td>RBT</td><td>NNN</td><td>3</td><td>Status of Radio Board Temperatures.
These values are Hex Coded, and should be used in conjunction with COM status for</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
Byte 1<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>Temp Radio Unit 1</td><td>Temp Radio Unit 2</td><td>Temp Radio Unit 3</td><td>Temp Radio Unit 4</td></tr></table>Byte 2<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>Temp MCPA 1</td><td>Temp MCPA 2</td><td>Temp MCPA 3</td><td>Temp MCPA 4</td></tr></table>Byte 3<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>Temp Fibre Optic Unit 1</td><td>Temp Fibre Optic Unit 2</td><td>Temp Fibre Optic Unit 3</td><td>Temp Fibre Optic Unit 4</td></tr></table></td></tr>
<tr><td>RXO</td><td>N</td><td>1</td><td>Status of Received Optical Level
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>RXO Fibre Optic Unit 1</td><td>RXO Fibre Optic Unit 2</td><td>RXO Fibre Optic Unit 3</td><td>RXO Fibre Optic Unit 4</td></tr></table></td></tr>
<tr><td>RXP</td><td>N</td><td>1</td><td>Status of Received Pilot Tone level
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>RXP Fibre Optic Unit 1</td><td>RXP Fibre Optic Unit 2</td><td>RXP Fibre Optic Unit 3</td><td>RXP Fibre Optic Unit 4</td></tr></table></td></tr>
<tr><td>RXQ</td><td>N</td><td>1</td><td>Status of Received Data Quality If repeater is NOT a system slave, this reports as a dash.</td></tr>
<tr><td>SZP</td><td>N</td><td>1</td><td>Status of Synthesizer in Pilot Tone Generator
These values are Hex Coded, and should be used in conjunction with COM status for actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>SZP Fibre Optic Unit 1</td><td>SZP Fibre Optic Unit 2</td><td>SZP Fibre Optic Unit 3</td><td>SZP Fibre Optic Unit 4</td></tr></table></td></tr>
<tr><td>TEM</td><td>N</td><td>1</td><td>Status of temperature in Controller</td></tr>
<tr><td>TXO</td><td>N</td><td>1</td><td>Status of Optical Transmitter
These values are Hex Coded, and should be used in conjunction with COM status for</td></tr>
</table>

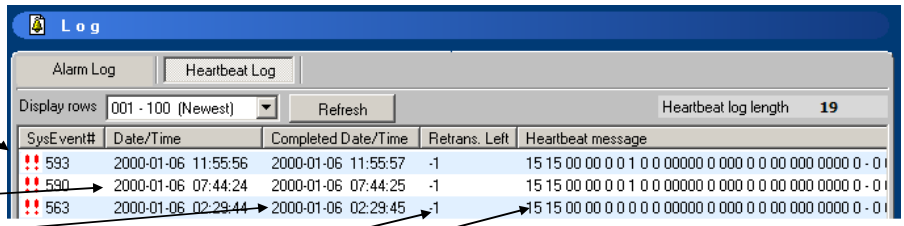
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>actual device.
For example, the Byte 1 status is sent as Hex ‘8’, which is extracted to 1000.
<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>TXO Fibre Optic Unit 1</td><td>TXO Fibre Optic Unit 2</td><td>TXO Fibre Optic Unit 3</td><td>TXO Fibre Optic Unit 4</td></tr>
</table></td></tr>
<tr><td>EX1/EX2/EX3/EX4</td><td>NNNN</td><td>4</td><td>Status of external alarm inputs</td></tr>
<tr><td>DOO</td><td>N</td><td>1</td><td>Door status</td></tr>
<tr><td>NMP</td><td>X</td><td>1</td><td>Communications path to node master in the Communications Multiplexer. If not used, a dash is reported.</td></tr>
<tr><td>RCH</td><td>NNNNNN</td><td>6</td><td>Repetition Cycle for Heartbeat reports</td></tr>
</table>

4.5.3 Heartbeat Log

Recent heartbeats can be viewed in a log that shows details about the alarms.

Monitor Alarm Log via the RMC

Select “Alarm Log” and “Heartbeat Log”



Message No

Date/Time

Description

Retransmissions

Message

The heartbeat message format is described in section 4.5.2 Heartbeat Format.

4.6 RF Parameters

The attenuation can be changed in 1 dB steps. If the attenuation for example is set to 15 dB, the repeater is downgraded 15 dB from its maximum performance.

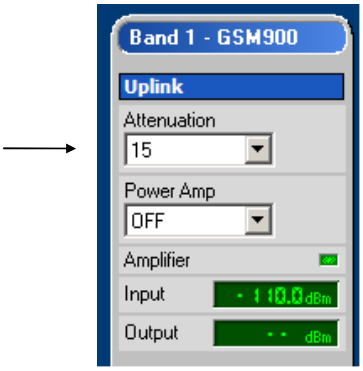
Maximum gain in the repeater can be read from the Product Information menu (choose Configuration/Product).

Setting the gain in the repeater plays an important role in the repeater configuration.

The gain is adjusted by changing the attenuation of the repeater. The setting is done for the uplink and downlink separately.

The attenuation can be changed in 1 dB steps. If the attenuation for example is set to 15 dB, the repeater is downgraded 15 dB from its maximum performance.

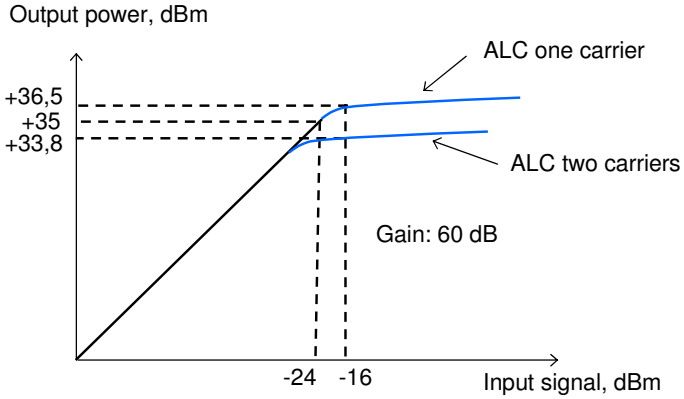
Maximum gain in the repeater can be read from the Product Information menu (choose Configuration/Product).



4.6.1 Power Level

The repeater has a constant gain in both uplink and downlink paths. The gain is set by defining the attenuation as described above.

The repeater has a defined maximum output level. If the input signal amplified by the gain set exceeds the set output limit, an ALC (Automatic Level Control) loop is activated. This ALC ensures that the amplifier does not add distortion to the radio signal. Below are examples of the ALC function for one and two carriers.



4.6.2 Input / Output Levels

By using the input/output values together with the gain settings in the repeater it is possible to monitor the functionality of the amplifier chains. These measurements can also be useful during installation of the repeater.

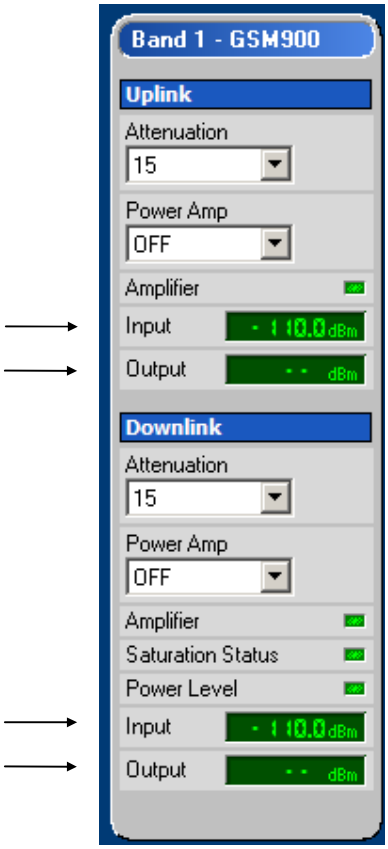
Monitoring the output level is helpful in determining how much the gain must be increased to reach maximum output power.

The input and output power levels to and from the repeater are constantly monitored.

If the power levels are lower than the lowest detectable level, the RMC reports a dash.

Note! Uplink power levels can only be displayed when there is a user in the repeater coverage area generating traffic.

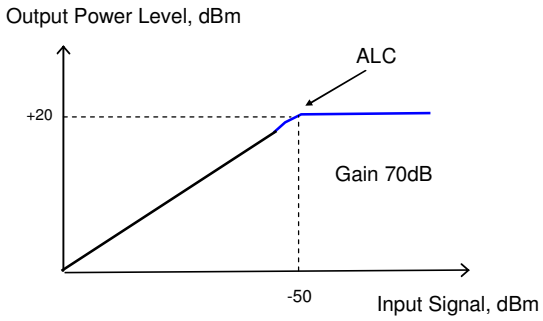
In this example there is no signal on the uplink nor on the downlink.



4.6.3 ALC

The repeater is equipped with an ALC, Automatic Level Control.

The ALC is an immediate reaction to the input signal level which keeps the output level to the maximum defined level.



4.7 Hardware Identification

A repeater contains a number of different modules. Some of these are active devices meaning that they contain a micro controller used for monitoring module parameters. Some are passive devices, for example the external alarm interface.

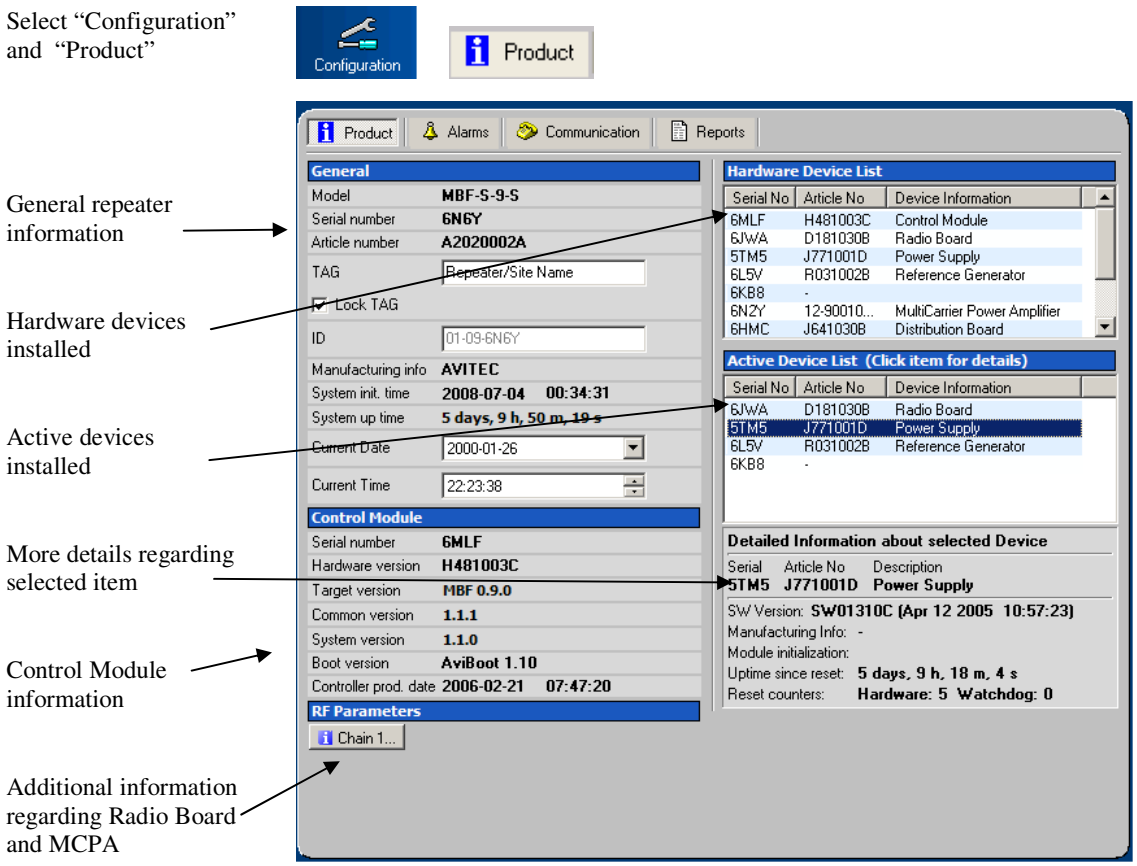
The Control Module communicates with the active devices using a master/slave configuration, where the Control Module is the master and the active devices are slaves. Each active device uses its serial number as an address. A slave only replies to requests with the correct address information.

During manufacturing the repeater is configured with all the serial numbers of all the devices in the system. For passive devices, the article number of the device is added. Once the system is configured, the Control Module polls all the active devices for article numbers and production information as well as software versions and statistics of the active devices.

Via the RMC the full repeater inventory can be read, including statistics of the active devices.

When a login to a repeater is made using the Repeater Maintenance Console, the RMC detects the repeater type and adjusts the user interface correspondingly. The same RMC can be used for all repeater types.

Via the RMC basic information about the repeater configuration can be monitored.



4.8 Tag and ID

When the repeater is integrated into the Axell Element Manager the repeater is assigned a repeater ID, which is a unique identifier in the repeater network. This ID is used by the AEM to keep track of the repeaters in the AEM database.

The repeater Tag can be used to give the repeater a more logical name, such as the site or installation place. If Tag is set during site installation, this can easily be read by the AEM during AEM integration, giving the AEM operator a clear identification of the site.

The repeater tag can be locked so that the tag can not be accidentally changed from the AEM.

Refer to section *5.6.2 Set Repeater Name (TAG)* for information about how to set the repeater Tag.

4.9 User Access

Several users at a time can be logged on to a Repeater, for instance one locally via the RS232 interface and one remotely via modem. There is one default user name and password defined for the repeater.

avitec	AvitecPasswd

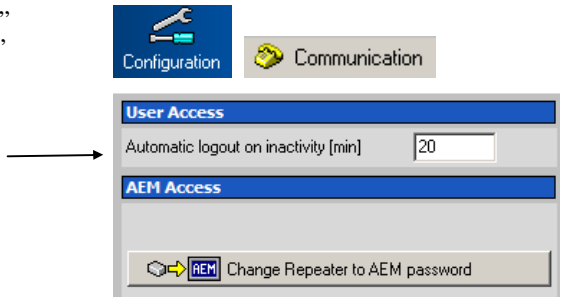
Note! Both the user name and the password are case sensitive.

The password can be changed and new accounts be added once a logon has been made. This is made in terminal mode. Please refer to the Command and Attribute Summary.

A user will be logged out after a configurable number of minutes of inactivity. This time can be defined via the RMC.

4.9.1 Configure Automatic Logout

Select “Configuration” and “Communication”

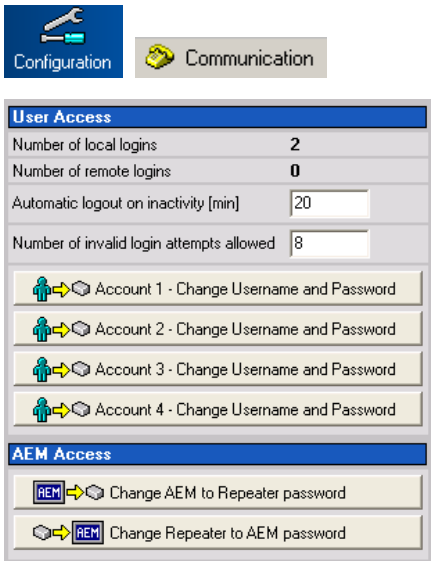


Note! A password for the repeater’s communication with the AEM can be set in the box above but it is recommended that it is done from the AEM, and NOT from here.

4.9.2 Change Username or Password

Select “Configuration” and “Communication”

Make the changes



4.9.3 User Access in a Network Application

An operator can login to the system from any node in the network and access all parameters in all nodes, including those in the node master unit. This can be done using a serial cable connected to the node's LMT-port or by remote access over the modem (GSM or PSTN) in the master unit, or in the repeater itself.

In an OMU-repeater system with slave-type repeaters the OMU unit polls the connected repeaters / nodes regularly and keeps control of login requests. If a user at a repeater site wants to log in to the repeater system, the OMU Control Module is responsible for granting / denying the login request. If a user forgets to log out from the node when a session is finished, the system will automatically log the user out after a configurable number of minutes of inactivity.

All nodes contain a copy of all user accounts (username and password). These are updated as soon as there is a change or at system start-up.

All configuration and changes of this information needs to be made when the node has connection with a master. A node in standalone mode cannot change the username or password.

4.10 Integration into AEM

When the repeater has been installed at site and the remote communication has been enabled, either through the repeater's own modem or via an OMU, the repeater can be integrated to the Axell Element Manager. This is done by the operator of the AEM. After entering the telephone number to the repeater, the AEM dials up the repeater, downloads all the repeater parameters and statuses into a database. When all parameters have been downloaded, the AEM configures the repeater with the telephone number where alarms and reports should be sent, and optionally with a secondary telephone number where the repeater can dial in case connection to primary number fails.

When heartbeat reports and alarms are sent from the repeater to the AEM also the latest information about the status and RF-configuration is included. This means that the AEM operator always has information about the current status in the AEM database (and do not need to call the repeater to find this out).

Note! Once the repeater is integrated to the AEM, all changes to the repeater should preferably be done from the Axell Element Manager in order to ensure that the database always contains correct information.

4.11 Upgrading Firmware

The software installed in the repeater is called firmware. Using the RMC it is possible to see what firmware is installed, install upgrades etc.

The firmware can be upgraded in the field while the repeater is operational.

The RMC is used to upload software to the Control Module. Since the Control Module contains two separate software banks, software can be downloaded to one bank while executing from the other. Once software is successfully uploaded, the new software is executed.

All repeater configurations remain unchanged when upgrading the software to a new version.

The Control Module contains two different program banks. The software can be executed from one bank while new software is downloaded to the other. When new software has been completely downloaded, the execution is moved over to the new program bank. The software download can be done at site, or remotely via a modem.

Note! During software download no measurements will be made in the repeater. However, the RF transmission will still be fully operational.

View the currently installed firmware	1. Open the Firmware upload view in RMC. In the box labeled Installed Firmware information about the currently installed firmware is displayed.
Upload new firmware	1. Open the Firmware upload view in RMC. In the box labeled Firmware Location select the directory where your firmware files (ARF files) are located. 2. Select the firmware to upload from the firmware list, labeled Select new firmware to upload. For each firmware available, there is information about version and compatibility with the repeater you are currently connected to. Below this list there is a box with detailed information about the selected firmware. 3. Click Start Upload. During upload a status screen displays upload progress information while you wait. The upload takes about 10 minutes with a local connection and 15 minutes over the GSM network. 4. Upload completed. 5. The user is logged out and the new firmware is initiated.

5 Installation

5.1 Commissioning Advice

5.1.1 Introduction

To set the proper operating RF levels on the repeaters in the MBF family during commissioning there are six steps to be carried out for each band of operation.

- Set OMU DL attenuation to adjust the RF level from the BTS to suit the fibre optic converter in the OMU (UFO-M)
- Run the OLA (Optical Link Adjustment) command for each band to correct for DL optical fibre loss
- Set the DL attenuation in the repeater to adjust gain following fibre optic converter in the repeater (UFO-S)
- Set the UL attenuation in the repeater to adjust gain before the fibre optic converter in the repeater (UFO-S)
- Run the OLA (Optical Link Adjustment) command for each band to correct for DL optical fibre loss
- Set OMU UL attenuation to adjust the OMU output level to suit the BTS

5.1.2 OMU Point of Interface (POI)

The OMU will usually be fed from the donor BTS via an attenuator or coupling network. The electrical configuration of this OMU Point of Interface (POI) will be system specific depending on the presentation of the BTS RF ports, the power class of the BTS and whether the BTS itself provides coverage via antennas/radiating cable infrastructure or if coverage is only via the MBF repeaters.

The important consideration for commissioning is that the correct attenuation exists between BTS and OMU in order that

- input power limits of OMU ports are not exceeded
- operating levels can be brought into the correct range using the OMU internal attenuators
- isolation is preserved between ports and bands

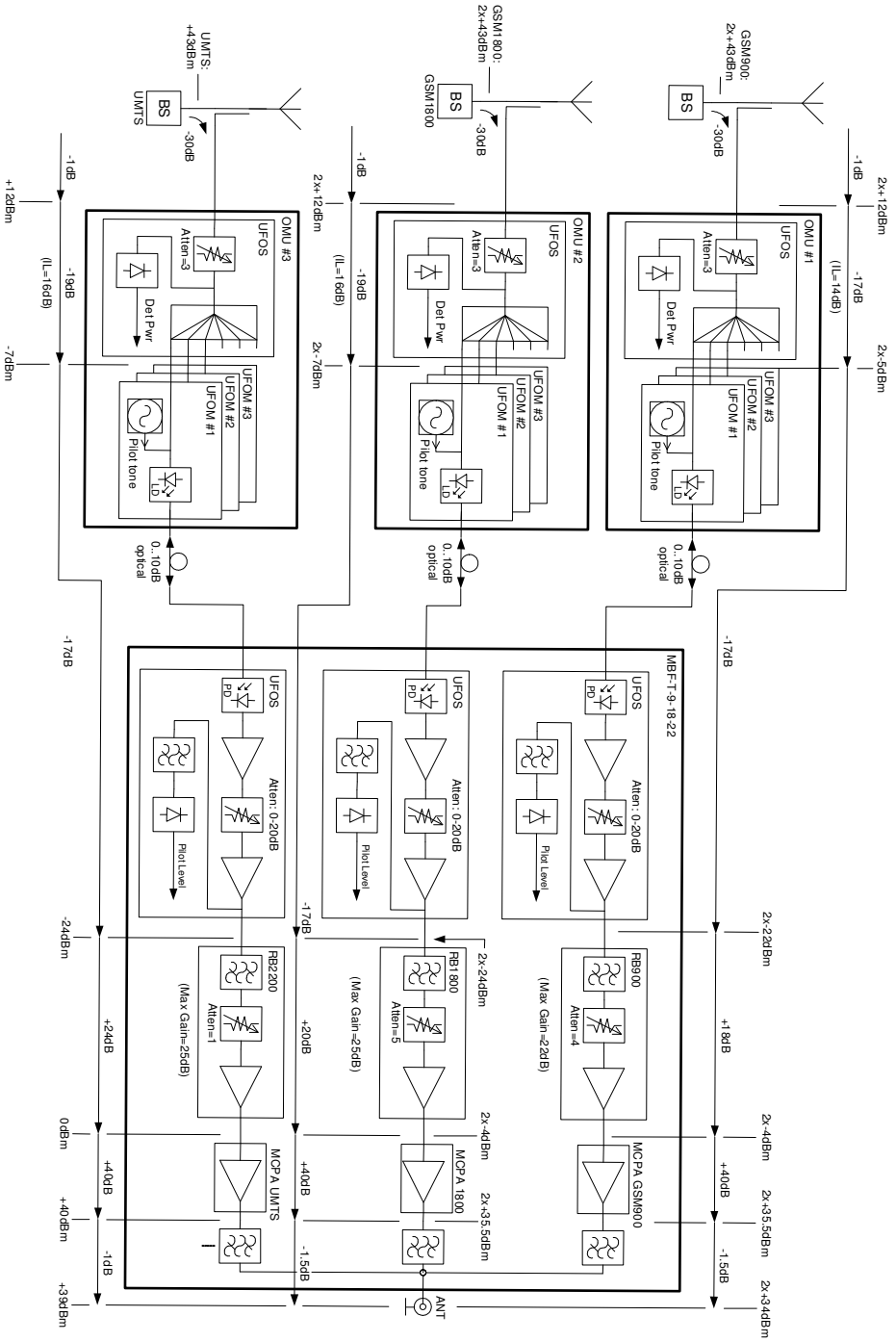
OMU damage levels are 10dBm RF in to the fibre optic converter.

For some systems the commissioning adjustments may be completely independent (e.g. an MBF Tri Band repeater fed by separate OMUs, one per frequency band). For other systems (e.g. an MBF Tri Band repeater fed a by a single OMU carrying all three bands) one adjustment may affect all bands simultaneously. In such cases certain commissioning actions e.g. optical link adjustment only need to be carried out once for all bands but the POI must include some means to level the different frequency bands at the OMU interface ports.

5.1.3 Downlink POI / OMU DL Attenuator Adjustment

The critical aspect for the correct system operating level is the composite power presented at the input of the fibre optic converter in the OMU (UFO-M). The illustration below shows the simplest possible arrangement for a single Tri Band repeater fed by three BTSs - one per band. It is assumed that the BTS for GSM900 and GSM1800 produce two carriers each of +43dBm and that the UMTS BTS produces a single carrier of +43dBm.

The correct interface level at the optical fibre converter is -5dBm/carrier in 900MHz and -7dBm/carrier in both GSM1800 and UMTS bands. An attenuation of 48dB in 900MHz and 50dB in 1800/UMTS is therefore required between them.


GSM900:
2x+43dBm
BS
-30dB
GSM1800:
2x+43dBm
BS
GSM1800
-30dB
UMTS:
+43dBm
BS
UMTS
-30dB
-1dB
2x+12dBm
OMU #1
UFOS
Atten=3
Det Pwr
UFOM #3
UFOM #2
UFOM #1
Pilot tone
LD
(IL=14dB)
-17dB
2x+12dBm
(IL=16dB)
-19dB
2x-7dBm
OMU #2
OMU #3
+12dBm
-7dBm
2x<5dBm
0..10dB
optical
MBF-T-9-18-22
PD
Atten: 0-20dB
Pilot Level
RB900
(Max Gain=22dB)
Atten=4
RB1800
(Max Gain=25dB)
Atten=5
RB2200
(Max Gain=25dB)
Atten=1
2x+24dBm
2x<22dBm
-24dBm
+24dB
+20dB
+18dB
0dBm
+40dB
+40dBm
-1dB
+39dBm
MCPA UMTS
MCPA 1800
MCPA GSM900
2x+40dBm
2x+35.5dBm
-1.5dB
2x<34dBm
ANT

It must also be kept in mind that the OMU might have separated input/output ports for each band (UL/DL) while the interface with the BTS may well be duplex. In that case some duplexing network must be provided to allow these to be brought together. If there is more than one operator's BTS per band the loss of any combining network and any equipment room cabling also becomes part of the overall attenuation required to reach the correct interface level in each frequency band.

The illustration on the next page shows a more complicated arrangement where the same three BTSs feed multiple MBF repeaters (up to 6 is possible using the standard splitter card which fits the OMU rack). In this case an OMU per frequency band is shown. The internal splitter has an insertion loss of 14 or 16dB depending on frequency band. This loss is again a contribution to the overall attenuation which must be provided between BTS and the input ports of the UFO-M for the correct operational levels to be achieved.

The interface levels must be modified to maintain the same composite power if a greater number of carriers is to be applied from the BTS.

The DL POI / OMU Adjustment must be made considering the fully loaded condition – e.g. a BTS capacity of 8 carriers must include a back off of 6dB compared to the 2 carrier level and -11dBm/carrier is then the correct UFO-M drive level for GSM 900. The same rule for back off applies in other bands.

Note that a UMTS BTS at idle (no traffic) will be radiating only a pilot – approx -10dB compared to the average power when it is in traffic. See also section about UMTS Signal Measurement below.

5.1.4 Repeater Downlink Optical Link Adjustment (OLA)

The optical link between the UFO-M of the OMU and the UFO-S in the repeater is equipped with a calibrated pilot tone transmitter/receiver which enables compensation for the loss of the optical fibre plant between them.

The OLA procedure requires a computer running Axell RMC software and an RS232 connection to the LMT Port of the repeater controller.

Start the RMC and login to the repeater as described in the appropriate section of the handbook. Click on the Actions tab on top of the RMC screen. A drop down list will appear where a command will be found to execute the optical link adjustment for each UFO-S module that is fitted to the repeater. Click the command for the desired optical link and following a short delay (2-3 secs) an information screen will be shown describing the result of the automatic setup process.

This procedure is described in the *OMU Manual* section 4.10.

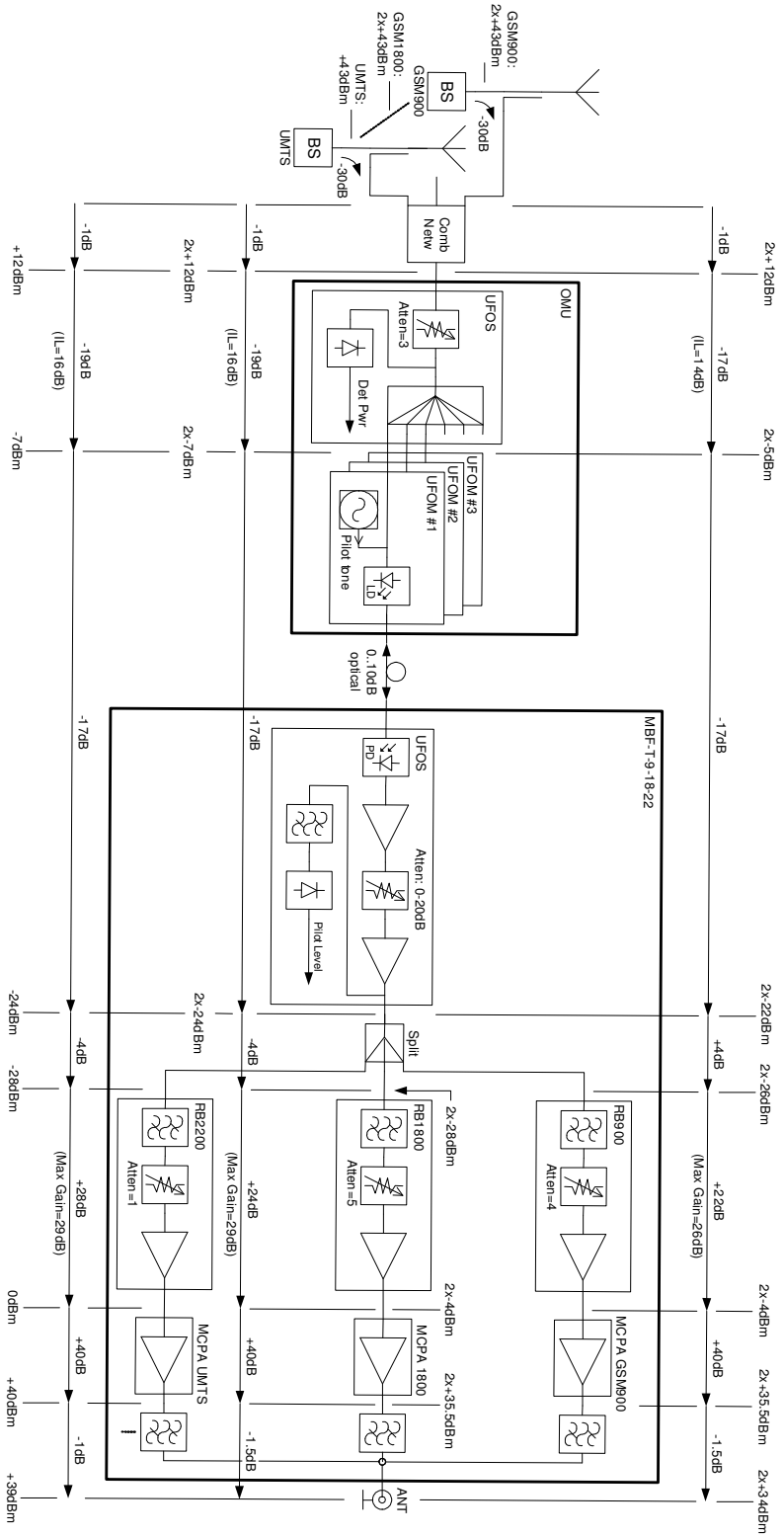
5.1.5 Downlink Repeater Gain Adjustment

When the DL POI levels and the repeater optical links have both been set up as described in the foregoing the MBF repeater set at maximum gain should produce a composite signal level at the output connector of +37dBm for GSM900 and 1800 and +39dBm for UMTS.

The RMC provides sub screens for each band where the downlink power from UFO-S optical receiver /input to the DL radio board and the composite output power level from the MCPA can be viewed.

The power amplifier for each frequency band can be enabled /disabled and the preset DL attenuation in the radio board for each band can be adjusted. A saturation status indicator (red/green) shows whether the radio board ALC is in operation. This indicator should be green. A red indication indicates overdrive the cause of which should be investigated and rectified.

In each band the DL output power per carrier should be measured using a spectrum analyzer. Allowing for the maximum DL carrier quantity in each band the composite level per band under full loading should be calculated to ensure it does not exceed the rated maximum otherwise ALC will be in operation when traffic levels are high. See also section about UMTS Signal Measurement below.


GSM900: 2x+43dBm
GSM1800: 2x+43dBm
UMTS: +43dBm
BS
GSM900
BS
UMTS
-30dB
-30dB
Comb Netw
-1dB
-1dB
-1dB
+12dBm
2x+12dBm
2x+12dBm
OMU
UFOS
Atten=3
Det Pwr
(IL=16dB)
-19dB
(IL=16dB)
-19dB
(IL=14dB)
-17dB
-7dBm
2x-7dBm
2x-5dBm
UFOM #3
UFOM #2
UFOM #1
Pilot tone
LD
0..10dB optical
MBF-T-9-18-22
-17dB
-17dB
-17dB
UFOS
PD
Atten: 0-20dB
Pilot Level
-24dBm
2x-24dBm
2x-22dBm
Split
-4dB
-4dB
+4dB
-28dBm
2x-26dBm
RB2200
Atten=1
RB1800
Atten=5
RB900
Atten=4
(Max Gain=29dB)
+28dB
(Max Gain=29dB)
+24dB
(Max Gain=26dB)
+22dB
2x-28dBm
0dBm
2x-4dBm
MCPA UMTS
MCPA 1800
MCPA GSM900
+40dB
+40dB
+40dB
2x-4dBm
2x-35.5dBm
+40dBm
2x-35.5dBm
-1.5dB
-1dB
-1.5dB
+39dBm
2x-34dBm
ANT

5.1.6 UMTS Signal Measurement

The UMTS signal carries wideband and complex modulation and its properties vary depending on the level of traffic carried.

5.1.6.1 Bandwidth

The first issue is the wideband nature of the signal. It occupies around 3.8MHz and measurements through a narrower filter will reduce the apparent power level since only a portion of the signal reaches the detector in the test equipment.

Equipment that includes a UMTS/3G measurement personality simplifies the task considerably. Usually a stored configuration for power measurement will integrate many samples taken using a narrower filter to display the correct power level for the bandwidth of the signal. Settings can easily become corrupted however leading to erroneous results. In such cases following the manufacturers instructions in detail is advised.

Measuring with a simple spectrum analyzer must use a wider resolution bandwidth than 3.8MHz or else a bandwidth correction factor has to be applied to the observed result. E.g. if measuring with a 300kHz RBW the power level in the centre of the signal would appear to be around 11dB lower than actual (10Log 3.84/0.3).

5.1.6.2 Traffic

A further complication is that the power level of a UMTS signal depends on the traffic level being carried. UMTS carrier power is usually quoted as average values e.g. a 5Watt or 37dBm signal can contain peaks up to 10dB greater when traffic is high. An idling base station carrying no traffic radiates only a Pilot in which case the power observed is around 10dB below the average value with traffic.

Advanced test equipment that can measure the different code power components in the UMTS signal avoids this problem but more often in the field repeater commissioning must be done when only simple test equipment is available. This leads to the need to know and allow for the state of traffic when making repeater setup and diagnostic measurements. It is obvious that adjusting a repeater to maximum rated output power by using BTSs that are idling radiating only the pilot will lead to overloading when they are in traffic.

5.2 Install the Repeater

5.2.1 Unpack the Repeater

Unpack the repeater

Inspect the shipped material before unpacking the equipment, document any visual damage and report according to routines.

A delivery of a repeater from Axell Wireless contains:

- Checklist with delivered items
- Repeater
- Mounting brackets
- 4 bolts for attaching repeater to mounting kit
- Cable cover
- Keys to repeater and insex tool for bolts
- Hose for fibre inlet
- CD containing User's Manual and RMC
- Any other specifically ordered item

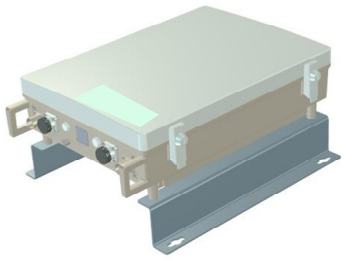
5.2.2 Mount the Repeater

Mount the repeater on a wall, on a pole or in a rack

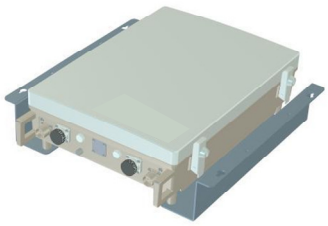
Mount the repeater in an accessible location and in a location that fulfils the environmental requirements.

The repeater can be mounted on the wall or in a 19 inch rack. The Repeater is delivered with mounting brackets.

The repeater needs to be mounted tightly to eliminate vibrations



Mounting bracket position for wall mounting



Mounting bracket position for rack mounting

Ensure proper ventilation

Mount the repeater so that heat can be dispersed from it. The repeater wall mounting kit ensures an optimum airflow between the wall and the repeater itself. Do not block this air channel as it will cause the MTBF of the repeater to drop dramatically, or even in the worst case cause the repeater to fail completely.

If possible use a wall in the shadow to minimize the overall sun loading. If sufficient shielding cannot be obtained, an additional sun shield should be mounted.

Example of a sun shield

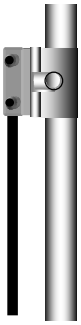
IP65 Casing

Note! The repeater box should be closed using the two screws. The screws must be fully tightened. Failure to do so may affect the IP65 compliancy and therefore any warranty.

5.2.3 Ensure Proper Grounding

Connect the grounding protection

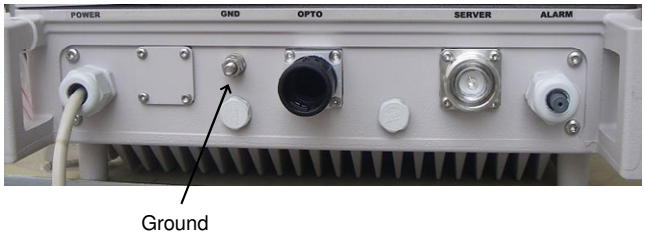
Ensure that good grounding protection measures are taken to create a reliable repeater site. Make sure to use adequately dimensioned grounding cables. The minimum recommended conductive area for a grounding cable is 16mm$^{2.}$



The antenna cabling should be connected to ground every 10m by a reliable grounding kit.

Make sure the grounding product used is suitable for the kind and size of cable being used.

Connect the repeater box bolt to the same ground.



Ground connector on repeater

5.2.4 Ensure Good EMV Protection

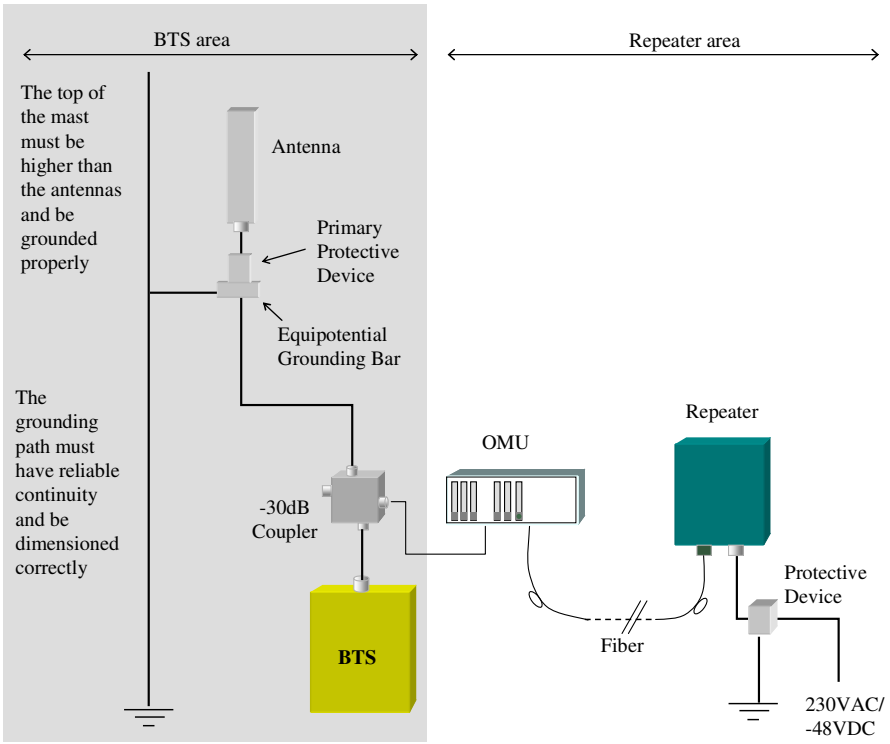
Caution

If insufficient Electromagnetic Protection is provided,
or if EMV measures are not taken, warranties issued by Axell Wireless are not valid.

Connect the lightning protection

The lightning hazard to electric and electronic equipment consists in the interferences of direct lightning current infections and high surge voltages induced by the electromagnetic field of nearby lightning channels or down conductors. Amplitudes from cloud-to-earth lightning amounts to several 10kA and may last longer than 2 ms. The damage caused depends on the energy involved and on the sensitivity of the electronics systems.

Ensure that lightning protection measures are taken to create a reliable repeater site. Protect all coaxial cables and power cables from the transients caused by lightning. Fit all cables with suitable lightning protection devices.



Example of EMV protection for a repeater system

For detailed information please refer to IEC 61024-1 and 61312-1 for international standards for protection of information systems against LEMP, Lightning Electromagnetic Pulse, including radio transmitters. They define proper planning, installation and inspection of effective lightning protection systems.

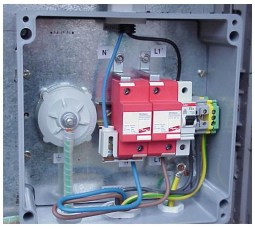
The Axell Wireless repeaters comply with the EN standard ETS 301 498-8 which stipulates demands on lightning/surge protection for typical infrastructure telecom equipment installations.

Several lightning protection devices should be used in series with declining threshold voltages to help attenuate the pulse component which makes it through the first layer of protection.

The primary protective device is part of the site installation and is not supplied by Axell

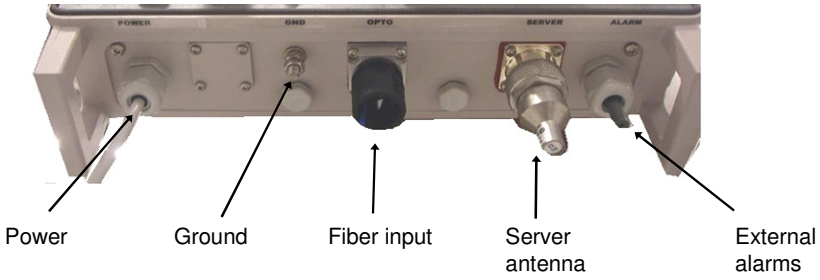
Wireless. Coaxial lightning protection is normally one of these three types: Gas capsule, High-pass and Bandpass.

There also need to be a protective device installed on the power supply cord.



Protective device installed in connection with the power supply

5.2.5 Attach Cabling



5.2.5.1 Attach Fiber Cable

This product is equipped with class 1 lasers, as per definition in EN 60825-1.

Caution

Un-terminated optical receptacles may emit laser radiation. Do not stare into beam or view with optical instruments.

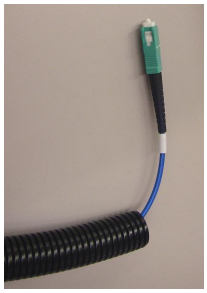
Note!

Angled connectors, APC, need to be used throughout the whole link between the OMU and the repeater. The angle needs to be 8 degrees.
Also the ODF connections need to be APC type.

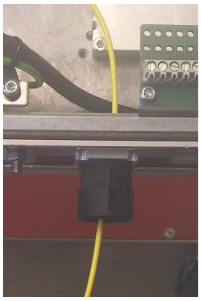
The fibre must be monomode type.

Select fibre	Recommended fibre cable is single mode 9/125.
Connect the fibre	The casing of the repeater is equipped with an inlet. The inlet is designed to go with a corrugated hose, which is included in the shipment. The hose, together with the rubber seal meet the protection standard IP65.

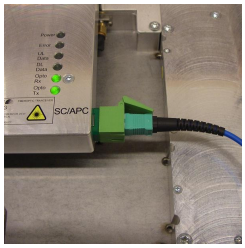
1. Run the fibre through the hose



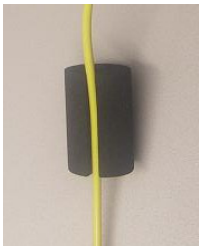
2. Run the fibre through the inlet in the repeater



3. Connect the fibre to the Fibre Optic Converter inside the repeater

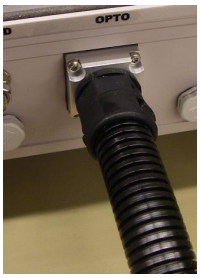


4. Place the fibre in the rubber seal



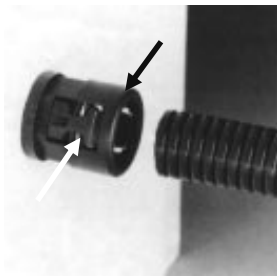
5. Adjust the fibre length inside the repeater and insert the seal into the inlet

6. Attach the hose to the inlet



Note! Make sure the fibre is not bent too sharply inside the repeater. There is room under the optic module to allow for some slack of the fibre.

Note! To insert and extract the hose from the inlet press the side levers.



Make necessary measurements

Make necessary measurements to ensure a correct installation.

When the cable has been installed, the quality of the optical path should be checked for optical path loss and magnitude and location of any reflections. This can be done with an Optical Time Domain Reflectometer (OTDR). The total return loss should be > 45 dB.

Optical reflections can degrade the noise and linearity of a fibre optic link. In particular, reflections that reach the laser can be a problem. Keep all discrete reflections to > 60 dB. The SC/APC connectors are polished to a return loss >60 dB.

Attach the fibre to the fibre optic

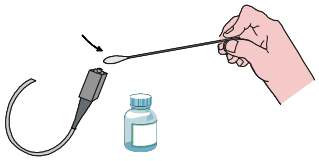
Note! Clean the fibre connector before it is connected, see instruction below.

converter inside the repeater.

Cleaning Optical Connectors

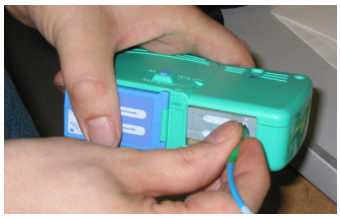
Optical reflections from a discontinuity such as a poor connector interface appear on an RF spectrum analyzer trace as stable variations in the noise floor amplitude that are periodic with RF frequency. If the reflection is bad enough, it could impact the system performance. By far, the most common cause for a large discrete reflection is a dirty optical connector. A bit of dust or oil from a finger can easily interfere with, or block this light. Fortunately, it is very easy to clean the connector.

Be sure to use the correct procedure for the given connector. When disconnected, cap the FC/APC connector to keep it clean and prevent scratching the tip of the ferrule.



Alternative 1

Swipe the tip of the ferule 2-3 times with a cotton swab soaked in alcohol. Let it air dry.



Alternative 2

Use a product specially designed for the purpose.

5.2.6 Supply Power to the Repeater

Caution!

The antenna cables must be connected to the repeater before mains power is switched on. Alternatively the antenna connections on the repeater can be terminated with 50ohm termination plugs.

Note! The repeater can be fed by 230 VAC 50 Hz, 115 VAC 60 Hz or -48 VDC. Ensure that the right voltage is used.

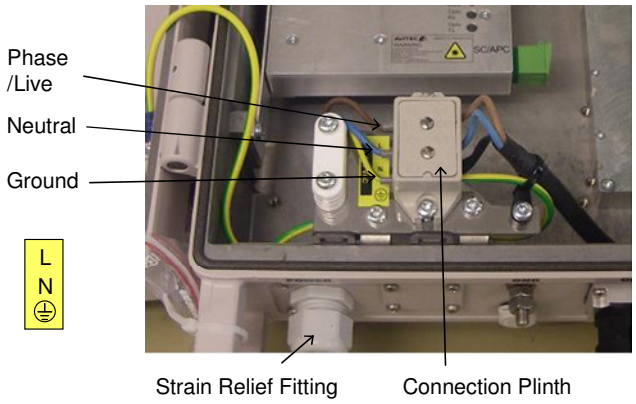
Connect the repeater to the power supply

Power is connected to the repeater via a plinth inside the repeater.

The strain relief fitting is a Pg 13.5 suitable for a 6-12 mm cable diameter.

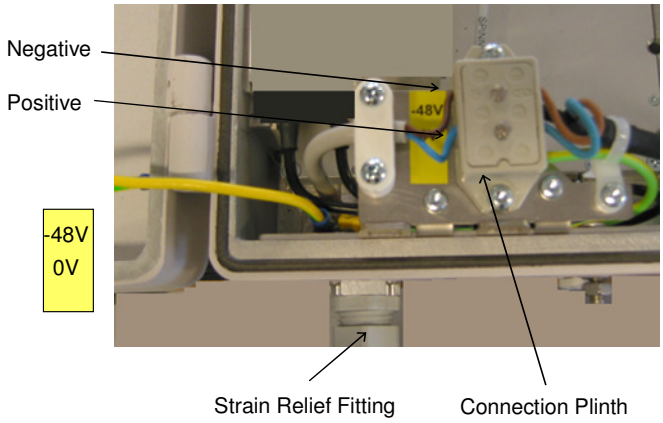
230 VAC Power Supply

Connect the power cable to the plinth with the phase linked to the brown cable, neutral linked to the blue and ground to the yellow/green. See illustration below.



-48 VDC Power Supply

Connect the power cable to the plinth with negative (-48V) to the uppermost connection and positive (0V) to the lower connection. Leave the middle connection empty. See illustration below.



Recommended cable areas for 48VDC

0 - 10 meters between repeater and power supply	2,5 mm²
10 – 50 meters between repeater and power supply	4 mm²
Over 50 meters between repeater and power supply	Recommendation is to reconfigure the installation, or to make special arrangements to increase cable area

Requirements on 48 V DC power supply

The 48VDC power supply must comply with SELV requirements, as defined in EN60950, which implies double isolation. The output power needs to be 48VDC +25%/-15%. The maximum input current is 8A.

Turn Off level

The -48VDC version of the power supply is designed to turn off if the supply voltage falls below -36V (±1V), not to drain the feeding battery. It will turn on again as the supply voltage reaches -43V (± 1V).

Back-up battery

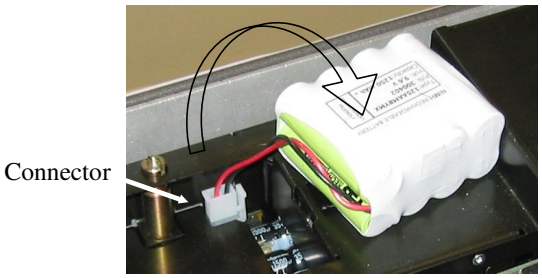
Backup Battery

There is a back-up battery installed in connection with the power supply. If there is a power failure the battery will supply enough power to the Control Module and the Fibre Optic Converter in the repeater to send information about the power failure.

The backup battery can be switched on and off separately. The switch is placed adjacent to the main power switch on the power supply.

At delivery the back-up battery is connected.

The battery is replaced by lifting the battery pack out of the crate and disconnecting the cable.



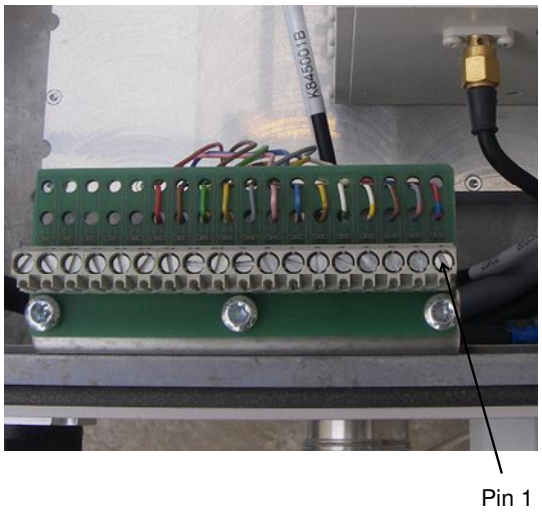
5.2.7 Connect External Alarms

Connect external alarms

The repeater is equipped with an external alarm interface card. The connector plinth for the external alarms is located at the bottom of the repeater.

The strain relief fitting in is a Pg 13.5 suitable for a 6-12 mm cable diameter.

Connect the alarm cords to the plinth according to the pin layout below (in the standard version pins 14 – 18 are not used).



Pin #	Signal
1	External alarm 1A
2	External alarm 1B
3	External alarm 2A
4	External alarm 2B
5	External alarm 3A
6	External alarm 3B
7	External alarm 4A
8	External alarm 4B
9	Alarm +15V
10	Alarm 0V
11	Relay Output 1A
12	Relay Output 1B
13	GND
14	NC
15	NC
16	NC
17	NC
18	NC

External Alarm

Four external alarm sources can be connected to the repeater. These alarms operate on a voltage between 12 and 24VDC. The presence or absence of this voltage will trigger the alarm depending on how the alarm polarity has been configured.

The alarms can be configured active-low or active-high, so that the alarm is given either in the presence or absence of applied power. Active high means that an applied voltage of between 12 and 24 V will cause the external alarm indicator to turn red. Active low means that when there is no voltage the alarm indicator will turn red. The repeater can supply +15 VDC to an external alarm source through pin 9 and 10. The maximum allowed load is 100mA.

The repeater contains a relay (pin 11 and 12) that can be connected to an external device to indicate an alarm. The relay can be configured to trigger on any number of internal and external alarms. The maximum current that can be supplied is 100mA.

5.2.8 Close Repeater

Close repeater	Close lid and lock repeater, or continue with the next section: Start-up the Repeater. **Note!** The two screws must be fully tightened. Failure to do so may affect the IP65 compliancy and therefore any warranty.

5.3 Start-up the Repeater

Caution!

Make sure the antenna cables or 50 ohm terminations are connected to the repeater's antenna connectors before the repeater is turned on.

Switch the repeater on

Switch the repeater on by using the power switches on the power supply.

Note! See caution above!

There are two switches. One is for the battery and one is for the power

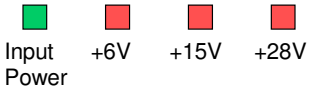
The rightmost switch is the one that switches the main power. The leftmost is for turning the battery on/off.

Note! The power switch has two positions; "on" and "stand by". In the stand by position the repeater is still connected to the power supply but not operational.

Note! On repeaters mounted in an extended box with two power supplies, both power supplies needs to be switched on.

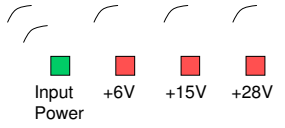
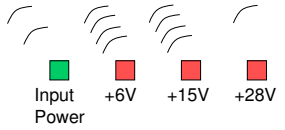
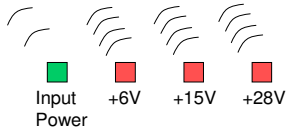
Check power supply LEDs

Check the LEDs on the Power unit to ensure that normal operation conditions have been attained.



Slow flash	Power supply unit operating on AC or DC
OFF	Power supply unit not operating
LED 2, +6V, Red	
Slow flash (every 10 seconds)	+6V power supply operating
Quick flash	+6V power supply not operating or operating with malfunction
LED 3, +15V, Red	
Slow flash (every 10 seconds)	+15V power supply operating
Quick flash	+15V power supply not operating or operating with malfunction
LED 4, +28V, Red	
Slow flash (every 10 seconds)	+28V power supply operating
Quick flash	+28V power supply not operating or operating

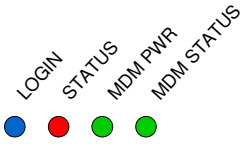
	with malfunction

	LED 1 is flashing slowly, LED 2 – 4 are flashing slowly (once every 10 seconds) => power supply unit is operating without problem
	LED 1 is flashing slowly, one or two of the red LEDs are flashing quickly => Input power is operating but there is a problem with some of the other voltages
	LED 1 is flashing slowly, all of the red LEDs are flashing quickly => Input power is out and unit is operating on backup battery

Check Control Module LEDs

The Control Module has four LEDs which give information regarding the status of the repeater and if someone is logged on to the repeater.

If the repeater is configured as a system slave the two LEDs MDM Power and MDM Status do not fill any function and can be disregarded.



	Quick flash	Control Module switched on, someone logged in locally and/or remotely
	Off (except for a quick flash every 10th second)	Control Module switched on, no one logged in
	Off (permanent)	Control Module switched OFF

	Quick flash	Control Module switched on, one or more errors/alarms detected
	Off (except for a quick flash every 10th second)	Control Module switched on, status OK
	Off (permanent)	Control Module switched off

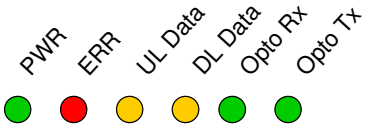
●	On	Modem Power is on
○	Off	Modem Power is off

●	On	Depending on type of call: Voice call: Connected to remote party Data call: Connected to remote party or exchange of parameters while setting up or disconnecting a call
●	Flashing (irregular)	Indicates GPSR data transfer. When a GPRS transfer is in progress the LED goes on within 1 second after data packets were exchanged. Flash duration in approximately 0.5s.
●	75ms on/75ms off/75ms on/3s off	One or more GPRS contexts activated
●	75ms on/3s off	Logged to network (monitoring control channels and user inRadio Modulections). No call in progress
●	600ms on/600ms off	No SIM card inserted, or no PIN entered, or network search in progress, or ongoing user authentications, or network login in progress
○	Off	Modem is off

Check the LEDs on the Fibre Optic Converter

The Fibre Optic Converter contains two optical alarm sources. These are alarms for transmitted and received optical signal level. The levels of the received optical signals can be monitored on-line via the RMC. This is convenient during installation and tuning of the system.

There are 6 LEDs on the module to indicate the status.



On	Unit is powered on
Off	Unit has no power
LED 2, Error, Red	
On	Error detected
Off	No error
LED 3, UL Data, Yellow	

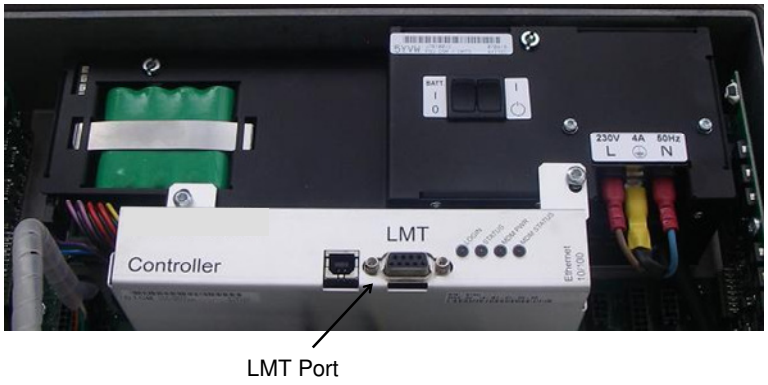
On	Communication via the opto module is ongoing in the uplink direction
Off	No communication
LED 4, DL Data, Yellow	
On	Communication via the opto module is ongoing in the downlink direction
Off	No communication
LED 5, Opto Rx, Green	
On	Input opto level OK
Off	Input opto level below threshold
LED 6, Opto Tx, Green	
On	Output opto level OK
Off	Output opto level below threshold

5.4 Initiate Local Communication

5.4.1 RMC Communication

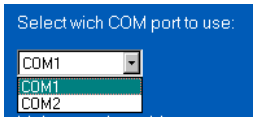
Connect to the LMT port

Connect the computer to the LMT port via a DB9 male connector with serial RS232 interface.

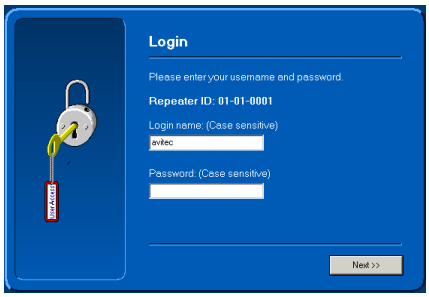


The communication parameters are set automatically by the RMC

Select “Cable” connection and communication port



Enter user name and password



Several users at a time can be logged on to a Repeater, for instance one locally via the RS232 interface and one remotely via modem or Ethernet.

There is one default user name and password defined for the repeater..

avitec	AvitecPasswd

Note! Both the user name and the password are case sensitive.

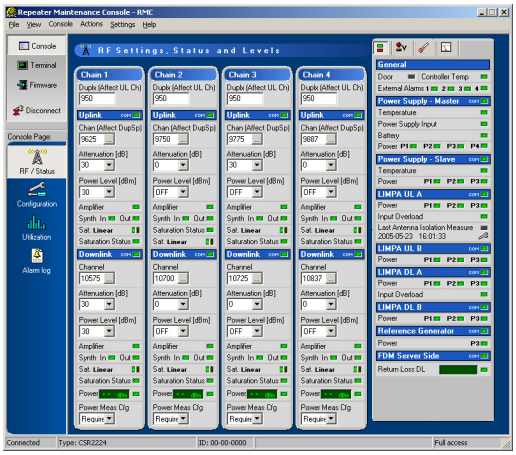
Note! Do not use the number pad when entering numbers.

Note! Failed login attempts are logged. Default maximum number is 8. It is decremented by one every hour, which means that it takes one hour after the last failed attempt before a new try can be made.

5.4.2 RMC Work Views

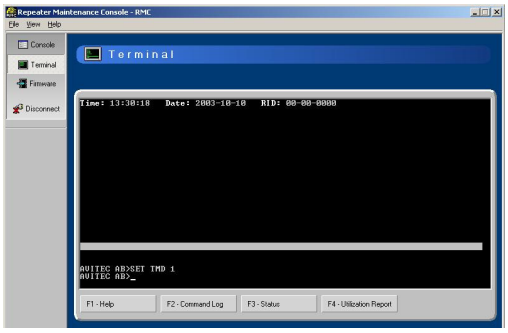
There are three different work views to choose from in the RMC

Console mode



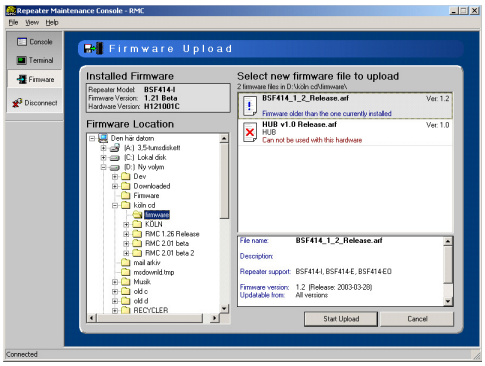
The console mode displays a large number of repeater parameters and contains a number of console pages. It adjusts its user interface to adapt to the features of the connected repeater.

Terminal mode



The terminal mode is used for communication with the repeater using its native command line interface. This interface follows the VT100 standard. For some special actions and error tracing, this mode gives an enhanced availability of the repeater.

Firmware mode



The firmware mode is used for monitoring the currently installed software and for uploading new software to the repeater.

Note! The description in this manual is based on using the Consol work view.

5.5 Install the OMU and Set up OMU-Repeater System

For information about how to install the OMU which will supply the input signal to the repeater please refer to the OMU Manual. In the OMU Manual there is also information about how to calculate link budgets for a whole OMU-Repeater system.

5.6 Configure the Repeater

The following pages will guide you through the configuration of a repeater utilizing the Repeater Maintenance Console (RMC) software. Configuration of a repeater is made partially on site and partially remotely through the AEM. At site the RF parameters are set and verified, the repeater is given a name (a tag) and the remote communication is set and verified. All other configuration can, and should be made from the AEM.

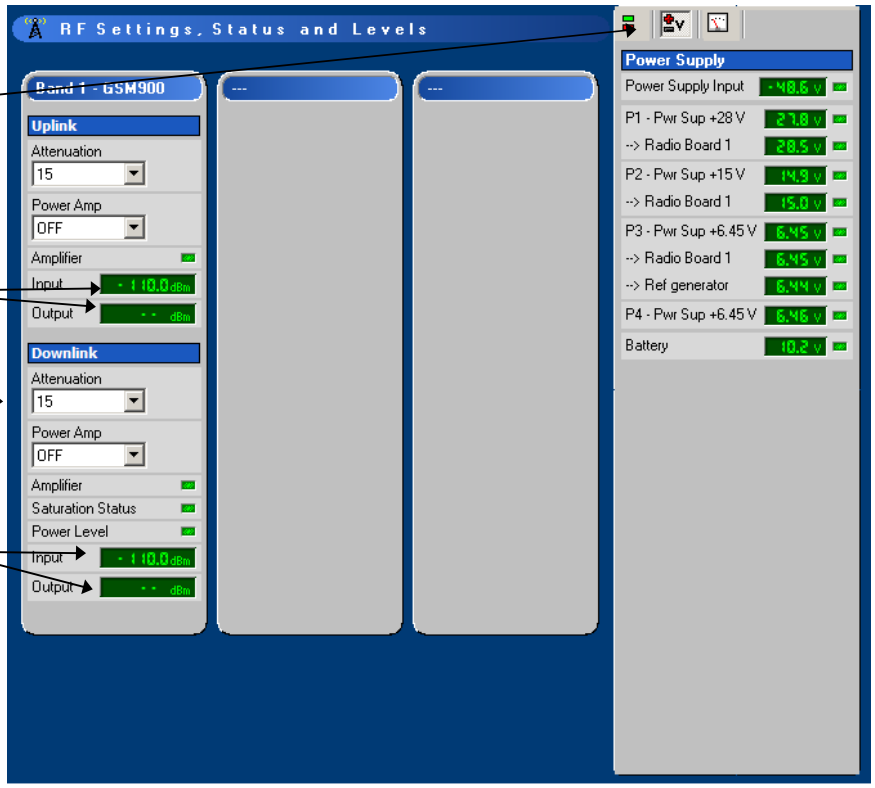
5.6.1 Set up RF Configuration

Configuration of the repeater amplification can be made locally. If the repeater is connected to an OMU the configuration can also be made via this OMU. See *OMU User's Manual*.

Note! This is an example from a single band repeater. Other repeaters will have similar features.

Ensure online communication with the repeater

Select "RF/Status" window



Alarms and general information

Uplink attenuation

Uplink input and output power

Downlink attenuation

Downlink input and output power

This shows a single band repeater with no RF signals

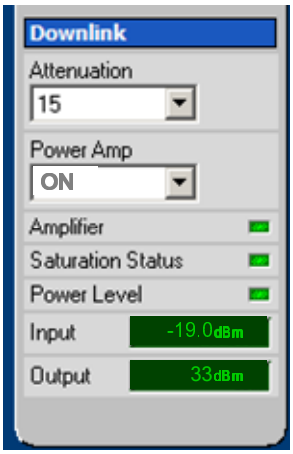
Check that the fibre is OK

Make sure there are no alarms relating to the fibre.

Set attenuation level in uplink and downlink to a maximum

Choose the maximum attenuation value from the drop down menu.

Configure the downlink



Lower the attenuation level step by step until the desired output power level is reached. In this example +33 dBm. Zero attenuation is the same as maximum gain.

Note! Please also consult the OMU User's Manual.

Initiate a fibre loss elimination

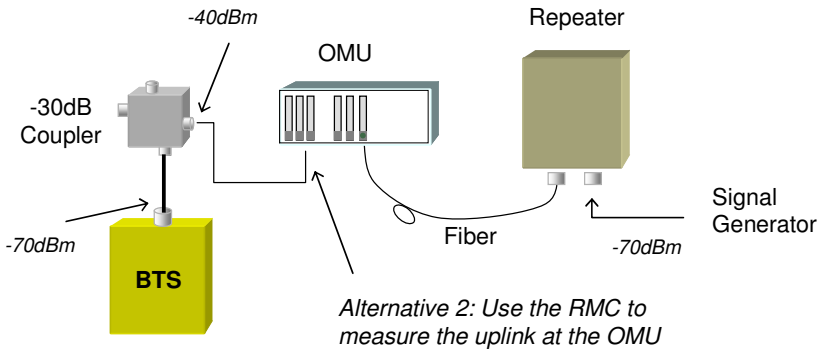
This is done from the OMU by sending a pilot tone to the repeater and calculating the loss in the fibre link. This loss is compensated for automatically. The system will behave as if there is no loss at all in the fibre link.

Configure the uplink

In the uplink direction the attenuation needs to be set based on a measurement of a known signal which is transmitted through the repeater and the OMU as well as the fibre. There are two ways of performing this measurement.

Alternative 1

Use a signal generator to insert a signal of approximately -70dBm into the repeater's server antenna port. Measure the signal level on the BTS or on the coupler and adjust the attenuation so that the total gain in the uplink is close to 0dB. (At 0dB gain the signal level at the coupler should be -40dBm and on the BTS -70dBm in this example.)



Alternative 2

Use a signal generator to insert a signal of approximately -70dBm into the repeater's

server antenna port. Log into the OMU and monitor the uplink via the RMC. This measurement is not as accurate as alternative 1.

Note! If several repeaters are connected to the same OMU the total gain in each chain should be slightly lower than 0dB not to insert too much noise into the BTS.

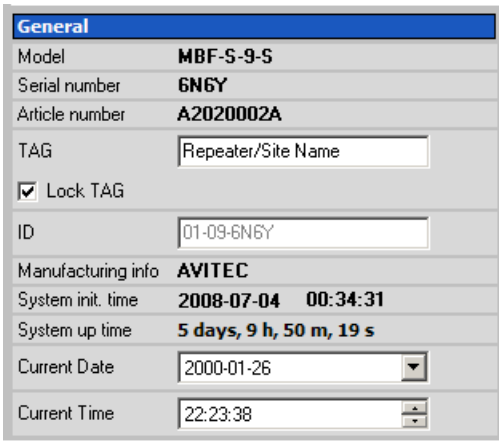
Note! For in-depth instructions for commissioning of an OMU-Repeater system please contact your Axell Wireless representative.

5.6.2 Set Repeater Name (TAG)

The TAG can be chosen freely to give the repeater a name that is linked to the location, the site name, etc. The TAG may contain up to 30 characters including spaces.

Select "Configuration" and "Product"

Insert the repeater's name (TAG) in this box. →



Note! Do **not** assign an ID. The AEM will do this automatically when the repeater is integrated in the AEM.

5.6.3 Configure Alarms

See section *4.4.7Alarm Configuration.*

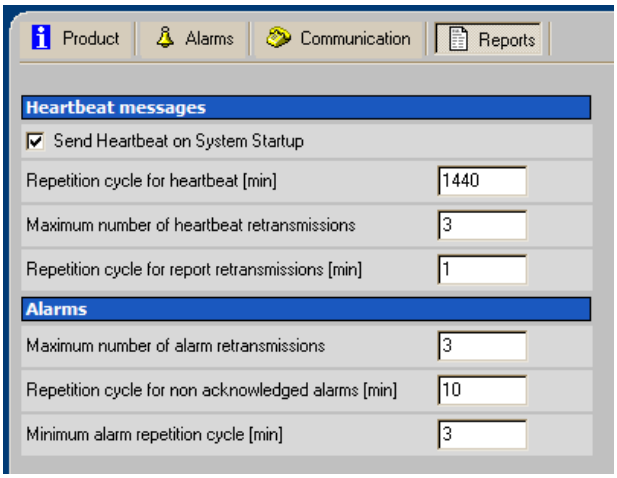
5.6.4 Configure Reports

Select "Configuration" and "Reports"

Set report data

Heartbeat →

Alarms →



Note! For repeaters that are to be used as slaves in an OMU-Repeater system all report configurations are done from the OMU.

5.7 Set Up Remote Communication

Note! If the repeater is fibre fed and is set up as a slave- this section is not relevant since the remote communication is handled by the node master – in most cases an OMU.

The repeaters can be configured with a wireless modem, a PSTN modem or Ethernet for the remote communication.

5.7.1 Communication via Modem

The Control Module is responsible for enabling the power to the modem, unlocking the SIM-card, using the configured PIN-code and making sure the modem is logged in to the network correctly. Depending on network configuration and modem usage, the modem might require different modem initialization strings to work properly. This modem initialization string is set and verified during repeater setup.

5.7.1.1 Modem Initialization

After a power failure, or upon user request, the Control Module performs a full initialization of the modem. This consists of three steps:

- If the SIM-card in the modem has the PIN code enabled, the Control Module unlocks the PIN code. In case wrong PIN-code is configured, the Control Module will not try to unlock the SIM again until the PIN-code is changed. This avoids the SIM card being locked by a Control Module repeatedly trying to unlock the SIM with the wrong PIN code.
- Once the SIM is unlocked, the Control Module waits for the SIM to log in to the network. Depending on signal quality and network configuration this might take a while. The Control Module will wait a configurable number of seconds (default 50 seconds) for the modem to login to the network. In case no network is found, a modem power cycle will be initiated.

When the modem is successfully logged in to the network, the Control Module configures the modem with the modem initialization string as configured when setting up the remote configuration. The modem initialization string is a network dependent string. The default string is suitable for most networks, but some networks might require some tweaking of this string.

5.7.1.2 Monitoring Modem Connection

The Control Module constantly monitors the status of the modem connection to ensure that it is working properly, and that the modem is logged in to the network.

In case the modem is not registered to the network, or the Control Module cannot properly communicate with the modem, a power cycling of the modem is initiated, after which the modem will reinitialized.

5.7.1.3 Scheduled Modem Power Cycling

In addition to polling the modem to ensure the repeater online status, the Control Module can be configured to perform an automatic power cycling on a scheduled time of the day. Power cycling the modem ensures the latest network configuration for the modem, such as the HLR Update Interval etc.

Note! By default, the scheduled modem power cycling is disabled.

5.7.2 Communication via Wireless Modem

There are two different ways of communication for a wireless (GSM) modem:

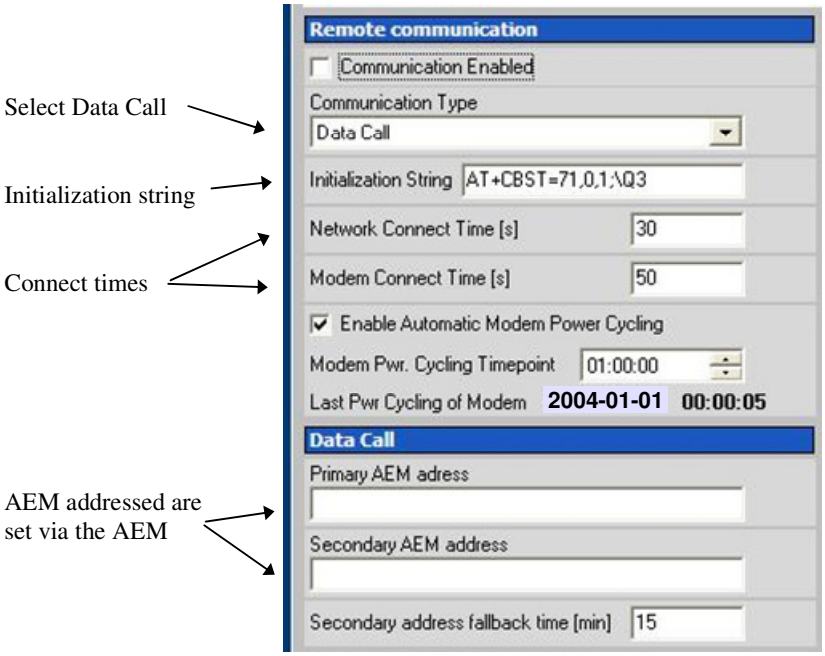
- Using data call / modem connection.
  Note! This requires the SIM-card in the modem to be configured with data service.
- Using SMS to configure the repeater with simple text messages
  Note! SMS functionality is not implemented in this SW release.

The Axell Element Manager always uses data call communication with the repeater, why all repeaters being controlled by the AEM must have data service enabled on the SIM card.

Configuring the repeater to send alarms and reports via SMS it is still possible to establish data calls to the repeater, as long as the SIM card is data service enabled.

5.7.2.1 Modem Configuration, not using GPRS

Select "Configuration" and "Communication"



Select Data Call

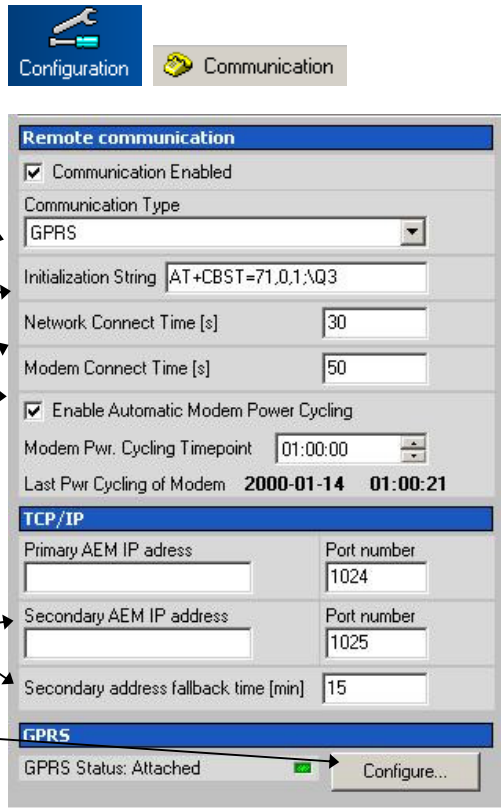
Set the modem initialization string. This string differs between networks. Primary

recommendation is AT+CBST=71,0,1;\Q3. If remote communication cannot be established try 7,0,1 or 0,0,1 or 7,0,3. For more information please refer to the section on Troubleshooting Remote Communication.

Tick “Enable Automatic Modem Power Cycling” for the modem to be power cycled once every 24 hours. Set the time at which the modem should be tested. This function ensures that the repeater always is logged in to the network.

5.7.2.2 Modem Configuration, using GPRS

Select “Configuration” and “Communication”

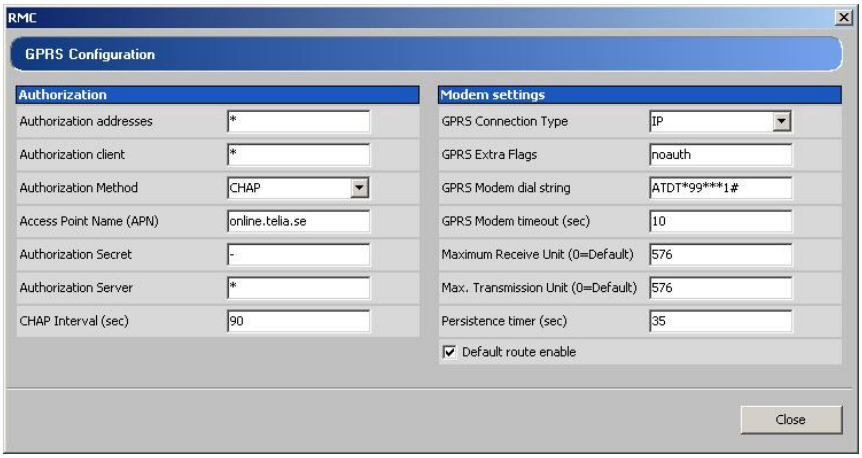


Select GPRS

Set the modem initialization string. This string differs between networks. Primary recommendation is AT+CBST=71,0,1;\Q3

Tick “Enable Automatic Modem Power Cycling” for the modem to be power cycled once every 24 hours. Set the time at which the modem should be tested. This function ensures that the repeater always is logged in to the network.

Click on Configure…



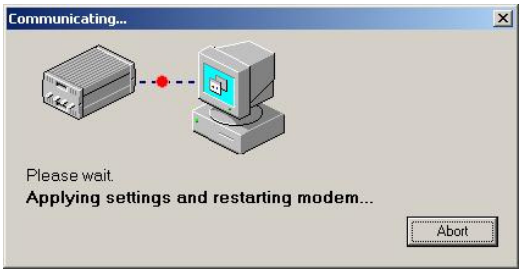
Each parameter is described in *Common Commands and Attributes*, section 14 GPRS Configurations.

Set the Access Point Name. It needs to be defined by the telecom operator

Set Maximum Receive Unit and maximum Transmission Unit. These differ depending on access type: 576 for GSM, 1476 for EDGE and 1500 for WCDMA.

Click on Close, and then on “Yes”.

Wait for the modem to restart. This can take a few minutes.



When the modem settings are ready the LED turn green.

5.7.2.3 AEM Addresses

The Control Module can be configured with two different addresses (telephone numbers) to which alarms and reports are delivered. In case the repeater cannot deliver alarms and reports to the primary address, the next call will be made to the secondary address.

A fallback functionality is available, which means that the Control Module falls back to the primary address after a configurable number of minutes. If this interval is set to 0, the fallback will not be performed. A user can always force the Control Module to fall back to the primary address.

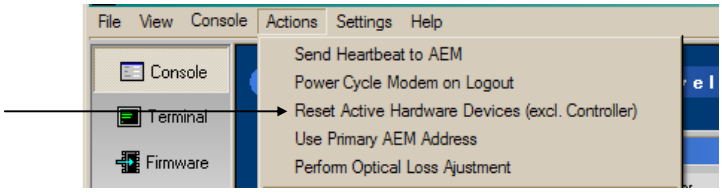
Note! When the repeater is integrated to the Axell Element Manager system, these addresses are set by the AEM, why they need not be configured during site installation.

5.7.2.4 Modem Verification

When the remote configuration has been set up the communication can be verified using the modem feature of the RMC and dialling the data number. The remote communication is verified as soon as a successful remote login to the repeater has been performed.

However, as a first step, it is recommended to verify that the modem is initialized correctly. After configuring the modem using the RMC, make sure to initiate a power cycling of the modem. This is done from the RMC menu.

Click on the drop-down menu Actions, choose Power Cycle Modem on Logout



An immediate power cycling is initiated after which the modem is initialized and registered onto the network. The modem is now ready for remote access.

Ensure a successful configuration by observing the modem LED as described below.

Note! This LED behaviour is valid only for GSM modems. Other modem types will be added in later editions.

●	On	Depending on type of call: Voice call: Connected to remote party Data call: Connected to remote party or exchange of parameters while setting up or disconnecting a call
●	Flashing (irregular)	Indicates GPSR data transfer. When a GPRS transfer is in progress the LED goes on within 1 second after data packets were exchanged. Flash duration in approximately 0.5s.
●	75ms on/75ms off/75ms on/3s off	One or more GPRS contexts activated
●	75ms on/3s off	Logged to network (monitoring control channels and user interactions). No call in progress
●	600ms on/600ms off	No SIM card inserted, or no PIN entered, or network search in progress, or ongoing user authentications, or network login in progress
○	Off	Modem is off

Verify the remote communication either by having someone attempting to integrate the repeater from the Axell Element Manager, or by dialling the repeater using the Repeater Maintenance Console.

Note! It is very important to dial the data number of the SIM. In case the voice number is dialled, the call is answered, but almost immediately the call will be hung up.

5.7.2.5 SIM-card Using Single Numbering Scheme

If the network is configured using Single Numbering Scheme (SNS), some special considerations apply.

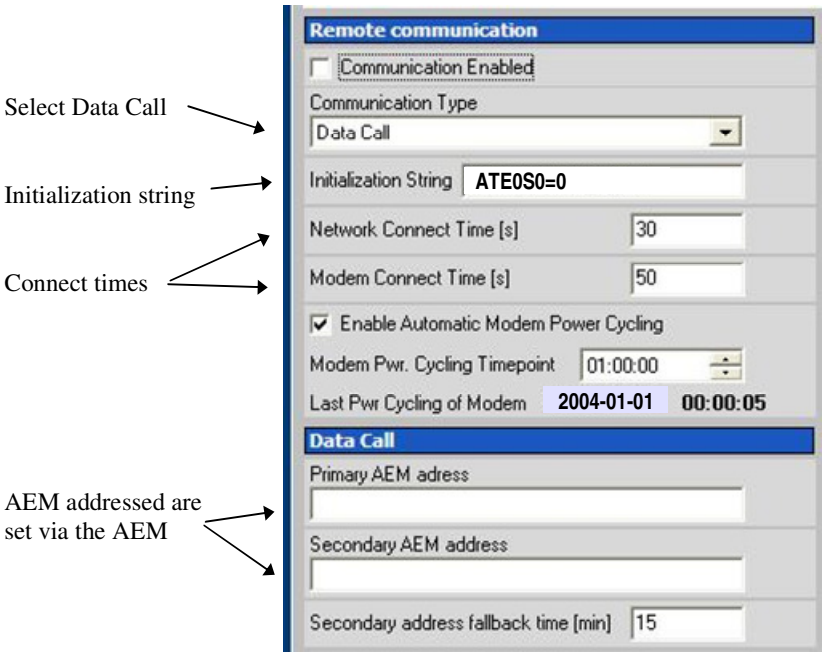
The repeaters are by default configured so that networks using SNS always will have calls routed to the data service in the modem. When dialling from within the network to a repeater having an SNS-configured SIM will operate normally, since the call originator informs the system that the bearer is of type DATA. However, when dialling from outside the network trying to connect to the repeater can be difficult. Depending on the interface to the roaming network or to the PSTN network if an analogue modem is used, the bearer type can default to voice. If the bearer is set to voice, the data service cannot be converted to DATA, and a call setup cannot be completed.

Note! This is not a repeater related problem; the solution is to verify how the external network interfaces handles the VOICE vs. DATA bearer type.

5.7.3 Configuration via PSTN (Fixed) Modem

Also for PSTN modems data call shall be used.

Select "Configuration" and "Communication"



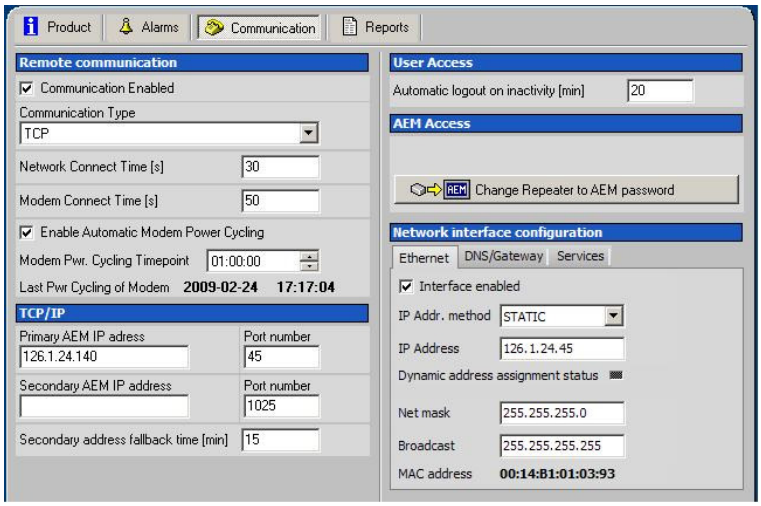
Tick "Enable Automatic Modem Power Cycling" for the modem to be power cycled once every 24 hours. Set the time at which the modem should be tested. This function ensures that the repeater always is logged in to the network.

5.7.4 Communication via TCP/IP and Ethernet

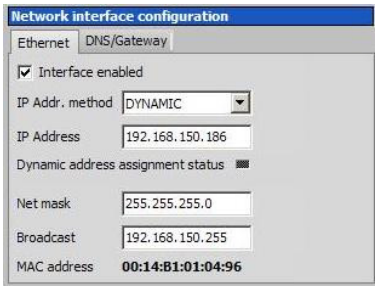
A TCP/IP communication is run over a company's network. Therefore each company needs to define the details regarding the configuration, IP addresses, etc. For more information please refer to *Common Commands and Attributes*, section 13 Network Configurations.

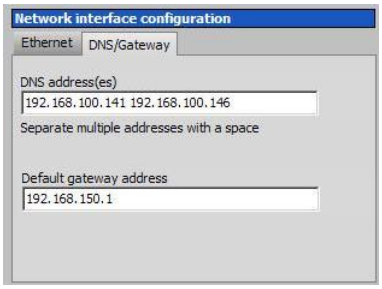
Select "Configuration" and "Communication"

Set IP address and other relevant information here



In these screens the Ethernet and/or DNS Gateway parameters can be set





5.7.5 Troubleshooting Remote Communication

Please also refer to the document *Common Command and Attributes* for guidance.

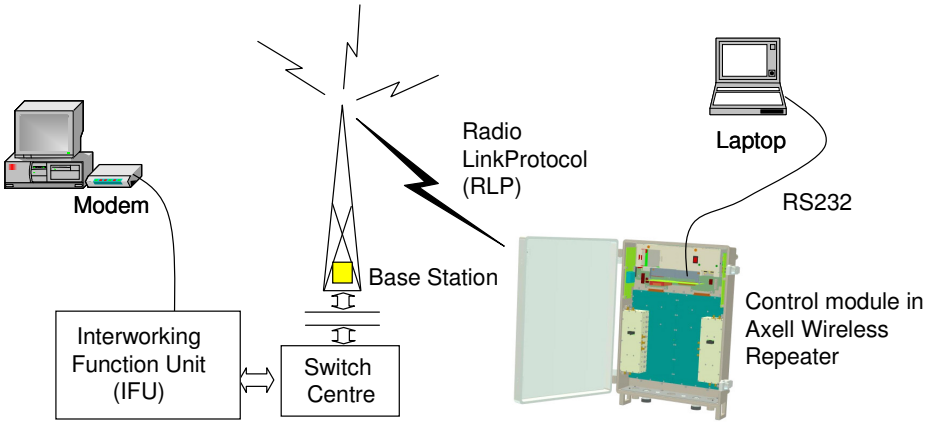
Since many networks have their own "personality", performing first time configuration of the remote communication sometimes requires tweaking of the modem parameters.

This section describes some trouble shooting techniques if configuring the repeater for remote access fails.

The illustration below is a simplified schematic of the remote communication between a GSM modem in a repeater and an analogue modem. The analogue modem in the computer communicates with the Interworking Function Unit (IFU), which is the GSM network analogue network interface. The call is routed via the switch centre over the air interface to the data call number in the SIM-card of the GSM module.

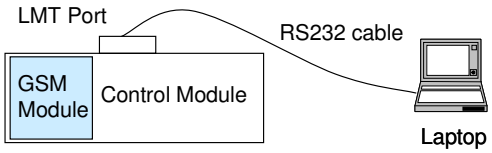
The Control Module is responsible for establishing connections with the Axell Element Manager, and to answer incoming calls to the repeater.

As described in previous sections, the Control Module only accepts one login at a time, either via Local Maintenance port (LMT) or modem connection. Hence, when verifying the remote access of the repeater, it is important to log out from the repeater locally before trying to access the repeater remotely.



5.7.5.1 Direct Modem Access

To allow for advanced trouble shooting of the communications, it is possible to access the modem directly via the Control Module from a laptop computer.



Log in to the repeater, either with RMC, or with a terminal emulation program, such as HyperTerminal™. When the login is completed, select Terminal Mode, this will give access to the repeater command prompt in the same way as with HyperTerminal.

When the repeater prompt is accessible, type in the command

```
ACCESS MODEM <Enter>.
```

When typing ACCESS MODEM, the controller will send all the characters that are typed directly out to the modem port. All characters replied back from the modem will go directly to the LMT port and back to the computer.

To abort an ACCESS MODEM session, press three '-' in a row (all three within one second) to come back to the repeater command prompt.

Note! When accessing the modem port the modem might be configured with "echo off", meaning that the characters entered will not be echoed back to the screen. In order to enable "echo", press Enter.

Type

```
ATE1 <enter>
```

(invisible)

The modem replies with

```
OK
```

indicating that the echo is enabled. All characters entered will now be echoed back to the terminal program.

5.7.5.2 Trace Modem

For troubleshooting purposes it is possible to trace the actual progress of initializing the modem. This trace is useful when having problems with the modem initialization.

Go to Terminal Mode and type

```
TRACE MODEM
```

To end session type CTRL-Z

5.7.5.3 Manually Answering Incoming Calls

It is possible to manually answer incoming calls without involving the repeater software at all, to verify that the remote access and the network itself works as intended. In order to verify the remote communication, make sure to have someone stand by to dial up the repeater with a terminal emulation program, for example HyperTerminal™.

Go in to Direct Modem Access as described earlier. When in direct access mode, ask the person standing by to dial up the repeater.

As soon as a call is received, the text

```
RING
```

will repeatedly be displayed on the screen.

Type

```
ATA <enter>
```

This will inform the modem to answer (ATtention Answer).

When the connection is established, a connect message will be displayed including the connection speed. Sometimes the information comes together with some miscellaneous information, such as error correction protocols etc.

Note! Make sure the remote peer dials the Data Call number

If the voice number is dialled instead of the data number, or if the modem contains an illegal modem initialization string, the message

```
OK
```

or

```
NO CARRIER
```

will be displayed almost immediately.

Try to change the modem initialization string. The modem initialization string mainly used to configure the remote communication is AT+CBST.

Successful modem initialization strings used by Axell Wireless includes (most common first):

```
AT+CBST=71,0,1;\Q3
AT+CBST=7,0,1;\Q3
AT+CBST=0,0,1;\Q3
```

```
AT+CBST=0,0,1;\Q3
AT+CBST=7,0,3;\Q3
```

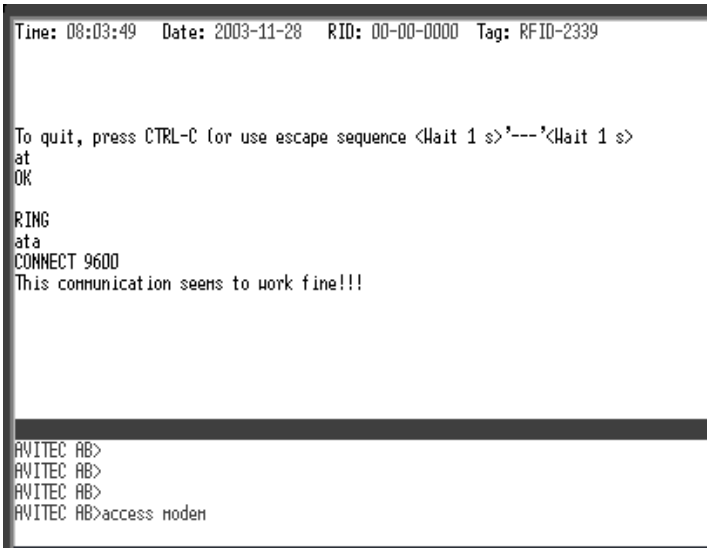
Once the modem initialization string is entered, try again to dial up the repeater. For details on the different modem initialization strings, please refer to the modem's user guide.

If the setup is successful, the connect message will be brought up;

```
CONNECT 9600
```

This means that an online connection is established to the remote peer. From now on, all characters typed on the keyboard will end up on the remote peer's screen. Similarly, all characters typed by the remote peer will be displayed on the screen.

In the example, the incoming call was successfully answered, and the remote user entered the text message.



In order to come back to modem command mode, press +++ (three pluses) rapidly (within one second).

Receiving

```
OK
```

means that the modem is back in command mode.

Type

```
ATH <enter>
```

This terminates the connection to the remote peer. The message

```
NO CARRIER
```

will be displayed.

5.7.5.4 Common Problems

Problem 1

When enabling the remote access for the repeater, the modem fails to log in to the network.

Solution

Signal strength from the donor site is too low. The signal strength can be read directly from the modem. Go in to Direct Modem Access as described earlier. Use the command AT+CSQ (documented below) to read out the signal strength.

In order to have good signal quality, Axell Wireless recommends that the signal strength should be better than -95 dBm. If signal strength is lower, try to adjust the antennas to get a better signal strength from the donor.

6.1 Signal Quality +CSQ

6.1.1 Description :

This command is used to know the *received signal strength indication* (<rssi>) and the *channel bit error rate* (<ber>) with or without any SIM card inserted.

6.1.2 Syntax :

Command syntax : AT+CSQ

Command	Possible responses
AT+CSQ	+CSQ: <rssi>,<ber> OK *Note : <rssi> and <ber> as defined below*

6.1.3 Defined values :

<rssi> :
0 : -113 dBm or less
1 : -111 dBm
2...30 : -109 to -53 dBm
31 : -51dBm or greater
99 : not known or not detectable

<ber> :
0...7 : as RXQUAL values in the table GSM 05.08
99 : not known or not detectable

Documentation of +CSQ command from a modem's manual.

In the example the reply to AT+CSQ is 0,7 meaning 7*2 dB above -113 dBm; the modem detects a signal level of -99 dBm.

```
Time: 07:57:46   Date: 2003-11-28   RID: 00-00-0000  Tag: RFID-2339



To quit, press CTRL-C (or use escape sequence <Wait 1 s>'---'<Wait 1 s>
at+creg?
+CREG: 0,1

OK
at+csq
+CSQ: 7,0

OK
```

```
AVITEC AB>
AVITEC AB>
AVITEC AB>
AVITEC AB>access modem
```

Problem 2a

Repeater is configured properly, and answers the incoming call, but when trying to dial the repeater using an analogue mode, no modem handshaking is heard from the dialling modem.

Problem 2b

When dialling the repeater, the repeater answers the incoming call, but no connection is established, and after a while the repeater disconnects the call.

Solution

The most common cause is that the number called is the voice number of the SIM, not the data number. Therefore, make sure to dial the data number.

If data call is used, the problem probably is an illegal modem initialization string.

In order to change the modem string, go to the repeater command prompt. Try changing the modem initialization string and log out to let the controller reinitialize the modem.

If problem remains, try a few different modem initialization strings. Axell Wireless has been successful with the following modem initialization strings:

```
AT+CBST=71,0,1;\Q3
AT+CBST=7,0,1;\Q3
AT+CBST=0,0,1;\Q3
AT+CBST=0,0,1;\Q3
AT+CBST=7,0,3;\Q3
```

Please refer to the modem manual for detailed description of the modem initialization strings.

Problem 3

It is possible to call the repeater from another GSM mobile, but not from an analogue modem.

Solution

This problem is most likely related to the modem configuration and/or the configuration of the IFU unit. Try to decrease the communications speed and make sure that the modem error correction is supported by the IFU. Verify the IFU configuration to see if there are any known problems with the modem connections.

Problem 4

When dialling the repeater, or when the repeater is dialling the Element Manager, the connection is terminated before the handshaking is completed.

Solution

When a repeater is answering an incoming modem call, or calling up the OMC to deliver an alarm or a report, the repeater will wait a configurable number of seconds for the call to be established. If no communication is established within this time, the call will be hung up. If this interval is set too low, the handshaking is terminated too fast. In the RMC, verify the Modem Connect Time to see that it is set to at least 30 seconds.

5.8 Integration into the AEM

When the repeater has been installed at site and the remote communication has been enabled, the repeater can be integrated to the Axell Element Manager. This is done by the operator of the AEM. After entering the telephone number to the repeater, the AEM dials up the repeater, downloads all the repeater parameters and statuses into a database. When all parameters have been downloaded, the AEM configures the repeater with the telephone number where alarms and reports should be sent, and optionally with a secondary telephone number where the repeater can dial in case connection to primary number fails.

When heartbeat reports and alarms are sent from the repeater to the AEM also the latest information about the status and RF-configuration is included. This means that the AEM operator always has information about the current status in the AEM database (and do not need to call the repeater to find this out).

Note! Once the repeater is integrated to the AEM, all changes to the repeater should preferably be done from the Axell Element Manager in order to ensure that the database always contains correct information.

6 Maintenance

Caution
Please be aware that the equipment may, during certain conditions become very warm and can cause minor injuries if handled without any protection, such as gloves.

Caution
Risk of explosion if battery is replaced by an incorrect type.
Dispose of used batteries according to local laws and instructions.

This product is equipped with class 1 lasers, as per definition in EN 60825-1.

Caution
Un-terminated optical receptacles may emit laser radiation. Do not stare into beam or view with optical instruments.

6.1 General

The system normally operates without any operator intervention or maintenance. If in the unlikely event of any unit failure, the faulty repeater should be replaced. A failed unit can be removed and replaced with a spare while the rest of the system (other repeaters) is still operating. However, the power supply of the failed repeater should be isolated from the power before anything is replaced.

In the event of a malfunction in the system, the status of the antenna systems as well as the continuity of the cabling should be checked before replacing any modules within the repeater.

6.2 Preventative Maintenance

The repeater does not require preventative maintenance apart from changing the battery once every three years.

6.3 Trouble Shooting

In the event of a failure Axell Wireless's support service should be contacted for advice on a possible module replacement or other action to be taken.

Caution!
If a shipment of a repeater back to Axell Wireless is made within the period of guarantee the original packing must be used.

6.4 Component Replacement

None of the modules in the repeater can be replaced without removing the repeater from its mounting and opening the cover of the repeater.

6.5 Product Disposal

Disposal of this product must be handled according to all national laws and regulations. For detailed information regarding materials, please refer to Axell Wireless.

7 Specifications

Note! All data is subject to change without prior notice.

7.1 Single Band Repeater MBF-S-7/8/9/17/18/19/22

Electrical Specifications

	LTE 700	GSM/WCDMA 850	E-GSM	GSM1800	GSM/WCDMA 1900	AWS	WCDMA2100
UL	698-716MHz and 777-787MHz	824 – 849 MHz	880 – 915 MHz	1710 - 1785 MHz	1850 - 1910 MHz	1710-1755 MHz	1920 - 1980 MHz
DL	728-756MHz	869 – 894 MHz	925 – 960 MHz	1805 - 1880 MHz	1930 - 1990 MHz	2110-2155 MHz	2110 - 2170 MHz
Operational bandwidth	28MHz/18MHz/ 10MHz	25MHz	35 MHz	75MHz	60 MHz	45MHz	60 MHz
Composite Output Power DL	+37dBm	+37 dBm	+37 dBm	+37 dBm	+37 dBm	-39 dBm (for PAR of 8.5 dB)	+39 dBm (for PAR of 8.5 dB)

Ripple in pass band (all bands)	< 2 dB
Noise figure UL (all bands)	3 dB typical (maximum gain)
Propagation delay (all bands)	< 2 µs
Modulation Accuracy at nominal output power	
LTE	<3%EVM RMS
GSM / GMSK	< 2.5 ° RMS and < 10 ° peak
EDGE / 8-PSK	< 3 % EVM RMS
WCDMA/EVM	< 12.5% RMS (composite according to ETSI TS 25.106 with TM 1/64 DPCH)
WCDMA/PkDCE	< -33 dB (according to ETSI TS 25.106 with TM 1/64 DPCH and spreading factor 256)
Gain UL/DL (all bands)	Adjustable in 1 dB steps
System Impedance	50 ohm
Return Loss at Antenna Connection	> 14 dB
Antenna connectors	DIN 7/16
Electrical ratings	230 VAC, 50 Hz or -48 VDC
Power Consumption	140 W

Optical Module Electrical Specification

Laser class	Class 1
Optical power level	+3dBm ±2dBm

Optical Wavelength

	Two colour system	Three colour system	Four colour system
Master	1310 ± 10 nm	1310 ± 10 nm	1310 ± 10 nm
Slave 1	1550 ± 3 nm	1550 ± 3 nm	1530 ± 3 nm
Slave 2	NA	1510 ± 3 nm	1510 ± 3 nm
Slave 3	NA	NA	1550 ± 3 nm

Mechanical Specifications

Dimensions	540 x 350 x 150 mm
Enclosure	Aluminium (IP 65)
Weight	20 kg

Environmental Specifications

Cooling	Convection*
EMC	See compliance below
Operating Temperature	- 25 to + 55 ° C
Storage	- 30 to + 70 ° C
Humidity	ETSI EN 300 019-2-4 (see compliance below)
MTBF	> 100 000 hrs

Complies in applicable parts, relevant on different markets, to:

R&TTE Directive including
ETS EN 301 502 (ETS EN 300 609-4/GSM 11.26)
ETSI TS 25.106, ETSI 25.143
ETSI EN 301 908-11
ETS EN 301 498-8
EN 60 950
EN 50 385

* The MBF repeaters are designed primarily for multi carrier purposes. If the repeaters are run at full output power over a longer period the convection cooling might not be enough. The repeaters have a power management function implemented that will step down the power and if needed fully shut down the amplifier chains until temperature has reached normal values. In situations where a repeater will be run in such a manner extra cooling can be provided for instance by putting the repeater in a temperature controlled environment or via external fans.

7.2 Dual Band Repeater MBF-D-9-22/8-19/7-17

Electrical Specifications

	LTE 700	GSM/WCDMA 850	E-GSM	GSM/WCDMA 1900	AWS	WCDMA2100
UL	698-716MHz and 777-787MHz	824 – 849 MHz	880 – 915 MHz	1850 - 1910 MHz	1710-1755 MHz	1920 - 1980 MHz
DL	728-756MHz	869 – 894 MHz	925 – 960 MHz	1930 - 1990 MHz	2110-2155 MHz	2110 - 2170 MHz
Operational bandwidth	28MHz/18MHz/ 10MHz	25MHz	35 MHz	60 MHz	45MHz	60 MHz
Composite Output Power DL	+37dBm	+37 dBm	+37 dBm	+37 dBm	-39 dBm (for PAR of 8.5 dB)	+39 dBm (for PAR of 8.5 dB)

Ripple in pass band (all bands)	< 2 dB
Noise figure UL (all bands)	3 dB typical (maximum gain)
Propagation delay (all bands)	< 2 µs
Modulation Accuracy at nominal output power	
LTE 700	<3% EVM RMS
GSM / GMSK	< 2.5 ° RMS and < 10 ° peak
EDGE / 8-PSK	< 3 % EVM RMS
WCDMA/EVM	< 12.5% RMS (composite according to ETSI TS 25.106 with TM 1/64 DPCH)
WCDMA/PkDCE	< -33 dB (according to ETSI TS 25.106 with TM 1/64 DPCH and spreading factor 256)
Gain UL/DL (all bands)	Adjustable in 1 dB steps
System Impedance (all bands)	50 ohm
Return Loss at Antenna Connection	> 14 dB
Antenna connectors	DIN 7/16
Electrical ratings	230 VAC, 50 Hz or -48 VDC
Power Consumption	220 W

Optical Module Electrical Specification

Laser class	Class 1
Optical power level	+3dBm ±2dBm

Optical Wavelength

	Two colour system	Three colour system	Four colour system
Master	1310 ± 10 nm	1310 ± 10 nm	1310 ± 10 nm
Slave 1	1550 ± 3 nm	1550 ± 3 nm	1530 ± 3 nm
Slave 2	NA	1510 ± 3 nm	1510 ± 3 nm
Slave 3	NA	NA	1550 ± 3 nm

Mechanical Specifications

Dimensions	540 x 350 x 150 mm
Enclosure	Aluminium (IP 65)
Weight	22 kg

Environmental Specifications

Cooling	Convection*
EMC	See compliance below
Operating Temperature	- 25 to + 55 ° C
Storage	- 30 to + 70 ° C
Humidity	ETSI EN 300 019-2-4 (see compliance below)
MTBF	> 100 000 hrs

Complies in applicable parts, relevant on different markets, to:

R&TTE Directive including
ETS EN 301 502 (ETS EN 300 609-4/GSM 11.26)
ETSI TS 25.106, ETSI 25.143
ETSI EN 301 908-11
ETS EN 301 498-8
EN 60 950
EN 50 385

* The MBF repeaters are designed primarily for multi carrier purposes. If the repeaters are run at full output power over a longer period the convection cooling might not be enough. The repeaters have a power management function implemented that will step down the power and if needed fully shut down the amplifier chains until temperature has reached normal values. In situations where a repeater will be run in such a manner extra cooling can be provided for instance by putting the repeater in a temperature controlled environment or via external fans.

7.3 Tri Band Repeater MBF-T-9-18-22/8-17-19

Electrical Specifications

	GSM/WCDMA 850	E-GSM	GSM1800	GSM/WCDMA 1900	WCDMA 2100	AWS
UL	824 – 849 MHz	880 – 915 MHz	1710 - 1785 MHz	1850 - 1910 MHz	1920 - 1980 MHz	1710-1755 MHz
DL	869 – 894 MHz	925 – 960 MHz	1805 - 1880 MHz	1930 - 1990 MHz	2110 - 2170 MHz	2110-2155 MHz
Operational bandwidth	25MHz	35 MHz	75MHz	60 MHz	60 MHz	45MHz
Composite Output Power DL	+37 dBm	+37 dBm*	+37 dBm*	+37 dBm	+39 dBm (for PAR of 8.5 dB)	+39 dBm (for PAR of 8.5 dB)

* In repeaters that share a common downlink fibre for 900MHZ and 1800MHz a minimum of 4 carriers in each band is required for the full composite output power to be attainable maintaining full ETSI compliance

Ripple in pass band (all bands)	< 2 dB
Noise figure UL (all bands)	3 dB typical (maximum gain)
Propagation delay (all bands)	< 2 µs
Modulation Accuracy at nominal output power	
GSM / GMSK	< 2.5 ° RMS and < 10 ° peak
EDGE / 8-PSK	< 3 % EVM RMS
WCDMA/EVM	< 12.5% RMS (composite according to ETSI TS 25.106 with TM 1/64 DPCH)
WCDMA/PkDCE	< -33 dB (according to ETSI TS 25.106 with TM 1/64 DPCH and spreading factor 256)
Gain UL/DL (all bands)	Adjustable in 1 dB steps
System Impedance	50 ohm
Return Loss at Antenna Connection	> 14 dB
Antenna connectors	DIN 7/16
Electrical ratings	230 VAC, 50 Hz or -48 VDC
Power Consumption	350 W

Optical Module Electrical Specification

Laser class	Class 1
Optical power level	+3dBm ±2dBm
Optical Wavelength	

	Two colour system	Three colour system	Four colour system
Master	1310 ± 10 nm	1310 ± 10 nm	1310 ± 10 nm
Slave 1	1550 ± 3 nm	1550 ± 3 nm	1530 ± 3 nm
Slave 2	NA	1510 ± 3 nm	1510 ± 3 nm
Slave 3	NA	NA	1550 ± 3 nm

Mechanical Specifications

Dimensions	540 x 350 x 220 mm
Enclosure	Aluminium (IP 65)
Weight	33 kg

Environmental Specifications

Cooling	Convection*
EMC	See compliance below
Operating Temperature	- 25 to + 55 ° C
Storage	- 30 to + 70 ° C
Humidity	ETSI EN 300 019-2-4 (see compliance below)
MTBF	> 100 000 hrs

Complies in applicable parts, relevant on different markets, to:

R&TTE Directive including
ETS EN 301 502 (ETS EN 300 609-4/GSM 11.26)
ETSI TS 25.106, ETSI 25.143
ETSI EN 301 908-11
ETS EN 301 498-8
EN 60 950
EN 50 385

* The MBF repeaters are designed primarily for multi carrier purposes. If the repeaters are run at full output power over a longer period the convection cooling might not be enough. The repeaters have a power management function implemented that will step down the power and if needed fully shut down the amplifier chains until temperature has reached normal values. In situations where a repeater will be run in such a manner extra cooling can be provided for instance by putting the repeater in a temperature controlled environment or via external fans.