User's Manual

ALR Compact Repeater

VD203 67/EN - English

Future on Demand.

User's Manual

ALR Compact Repeater

Low Power Band Selective Repeater

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English

This document describes installation, commissioning and the design of the Allgon ALR Compact Repeater.

Communication between the Allgon ALR Compact Repeater and an operator is carried out either by using Allgon OMT32 (Operation and Maintenance Terminal), or Allgon OMS (Operation and Maintenance System). OMT32 is described in the *AR Repeaters and OMT32, User's Manual*. OMS is described in the *Advanced Repeater OMS, User's Manual*.

Hardware and software mentioned in this document are subjected to continuous development and improvement. Consequently, there may be minor discrepancies between the information in the document and the performance and design of the product. Specifications, dimensions and other statements mentioned in this document are subject to change without notice.

In this document, the '<>' brackets are used to indicate function keys contrary to a series of key strokes '<Del>' = the Del(ete) key, 'Del' = D, e, l.

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Allgon Systems AB, SE-187 80 Täby, Sweden
Phone: +46 8 540 822 00 – Fax: +46 8 540 834 80 – Internet: www.allgon.com

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Abbreviations

Abbreviations used in this manual, in the software, and in the repeater:

AGC	Automatic Gain Control
AMPS	Advanced Mobile Phone Service
BCCH	Broadcast Control Channel (GSM broadcast channel time slot)
BS	Base Station, BS antenna = towards the base station
BSC	Band Selective Compact repeater board for adjustable bandwidth
CDMA	Code Division Multiple Access
CW	Continuous Wave
DCC	Directional Coupler, Compact
DAMPS	Digital Advanced Mobile Phone Service
DCS	Digital Communication System (same as PCN)
DL	Downlink signal direction (from base station via repeater to mobile station)
DPX	Duplex filter
EEPROM	Electrical Erasable Programmable Read Only Memory
EGSM	Extended Global System for Mobile communication
ETACS	Extended Total Access Communication System
ETSI	European Telecommunications Standard Institute
GSM	Global System for Mobile communication
HW	Hardware
LED	Light Emitting Diode
MS	Mobile Station, MS antenna = towards the mobile station
MSC	Mobile Switching Center
NMT	Nordic Mobile Telephone system
OMS	Operation and Maintenance System
OMS/PC	Desktop or notebook with installed OMS software
OMT32	Operation and Maintenance Terminal
OMT32/PC	Desktop or notebook with installed OMT32 software
PCN	Personal Communication Network (same as DCS)
PCS	Personal Communication System
PSM	Power Supply Module
PTFE	Polytetrafluoro Ethylene (Teflon)
RCC	Remote Control unit for Compact repeater
RF	Radio Frequency
RSSI	Received Signal Strength Indication
RTC	Real Time Clock
SW	Software
TACS	Total Access Communication System
TDMA	Time Division Multiple Access
UL	Uplink signal direction (from mobile station via repeater to base station)
UPS	Uninterruptible Power Supply

1. Safety

Any personnel involved in installation, operation or service of Allgon repeaters **must** understand and obey the following:

- Allgon repeaters are designed to receive and amplify signals from one or more base stations and retransmit the signals to one or more mobile stations. Also, the repeaters are designed to receive signals from one or more mobile stations, amplify and retransmit to the base stations. The repeaters must be used exclusively for these purposes and nothing else.

- Repeaters supplied from the mains must be connected to grounded outlets and in conformity with any local regulations.

- The power supply unit contains dangerous voltage that can cause electric shock. Disconnect the mains prior to any work in the repeater. Any local regulations are to be followed when servicing repeaters.

  Authorized service personnel only are allowed to service repeaters while the mains is connected.

- The repeater cover must be secured in opened position, e.g. by tying it up, at outdoor repeater work. Otherwise, the cover can be closed by the wind and cause your fingers getting pinched or your head being hit.

- When working on a repeater on high ground, e.g. on a mast or pole, be careful not to drop parts or the entire repeater. Falling parts can cause serious personal injury.

- Any repeater, including this repeater, will generate radio signals and thereby give rise to electromagnetic fields that may be hazardous to the health of any person who is extensively exposed to the signals at the immediate proximity of the repeater and the repeater antennas.

BERYLLIUM OXIDE

- Repeaters equipped with an optional remote communication control unit (RCC) have a dummy load in the directional coupler (DCC) that contains beryllium oxide (BeO). Beryllium oxide is poisonous if present as dust or smoke which can be inhaled. Do not file, grind, machine, or treat this part with acid.

HYDROGEN FLUORIDE

- The coaxial cable insulation is made of PTFE, polytetrafluoro ethylene, that gives off small amounts of hydrogen fluoride when heated. Hydrogen fluoride is poisonous. Do not use heating tools when stripping off coaxial cable insulation.

  No particular measures are to be taken in case of fire because the emitted concentration of hydrogen fluoride is very low.

- A lithium battery is permanently mounted on the repeater board. Due to the risk of explosion, this battery must only be removed from the board by an Allgon authorized service technician.

Static Electricity

Static electricity means no risk of personal injury but it can severely damage essential parts of the repeater, if not handled carefully.

Parts on the printed circuit board as well as other parts in the repeater are sensitive to electrostatic discharge.

Never touch the printed circuit board or uninsulated conductor surfaces unless absolutely necessary.

If you must handle the printed circuit board or uninsulated conductor surfaces, use ESD protective equipment, or first touch the repeater chassis with your hand and then do not move your feet on the floor.

Never let your clothes touch printed circuit boards or uninsulated conductor surfaces.

Always store printed circuit boards in ESD-safe bags.

2. Introduction

Figure 2-1. Allgon ALR Compact Repeater

Allgon repeaters are used to fill out uncovered areas in cellular mobile systems, such as base station fringe areas, road tunnels, business and industrial buildings, etc.

A repeater receives signals from a base station, amplifies and retransmits the signals to mobile stations. Also it receives, amplifies and retransmits signals in the opposite direction. Both directions are served simultaneously.

To be able to receive and transmit signals in both directions, the repeater is connected to a donor antenna directed towards the base station and to a service antenna directed towards the area to be covered.

Control of the repeaters is performed using a desktop or notebook loaded with the Allgon OMT32, *Operation and Maintenance Terminal*, which can communicate with the repeaters, either locally or remotely via modem. Remote operation can be performed either via a traditional telephone line or via a mobile phone that can be installed inside the repeater.

To be able to control many Allgon AR repeaters in common, there is an Allgon OMS, *Operation and Maintenance System*.

The compact repeater is described in this manual. OMT32 is described in the *AR Repeaters and OMT32, User's Manual*. OMS is described in the *Advanced Repeater OMS, User's Manual*.

Repeater Type

The following repeater type is currently available:

- Band selective repeater with adjustable bandwidth

Band selective repeater with adjustable bandwidth

The band selective compact repeater has filters that can be set to various bandwidths. This repeater type is used for analog or digital systems, such as NMT, GSM, TACS/ETACS, AMPS, DAMPS and CDMA.

Using Repeaters

In areas where the radio signal propagation is poor repeaters can be used to fill out those areas which are not covered by the base station.

The following scenarios are examples on this:

- Sports arenas
- Fair halls
- Large shopping centres
- Road and railway tunnels
- Indoors in buildings with metal or concrete walls

Other examples where repeaters can be used to increase the coverage are:

- Shaded areas
- Fringe coverage areas

In areas where the traffic intensity is low, it is not cost efficient to install a base station. An Allgon repeater, which can be installed with a minimum of investments, is a much better solution. You save installation costs as well as operational costs.

Examples of using repeaters

Two examples are described in the following sections. An outdoor example in a shaded valley and an indoor example in a sports arena.

Shaded Area

A valley is shaded by hills. There is a base station 5 kilometers away, but the lowest signal strength in the valley is less than –100dBm. A mast used for other purposes is available for a repeater installation. The mast height is 42 meter and it is located on a hill. The scenario is illustrated in Figure 2-2.

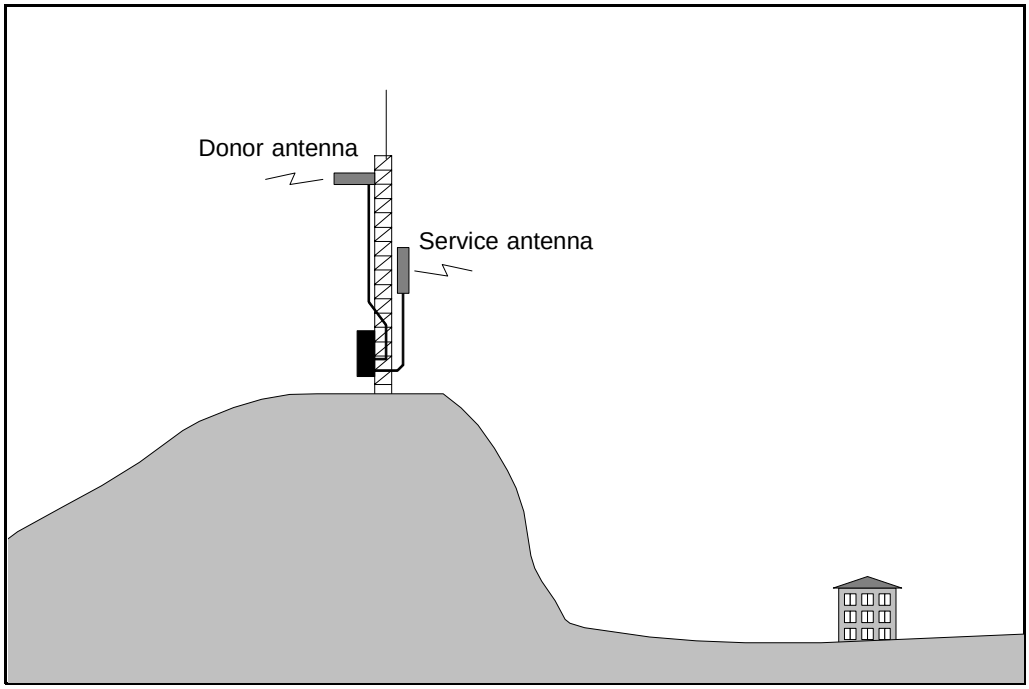


Figure 2-2. Repeater coverage of shaded area

The donor antenna of the repeater was mounted at the top of the mast and the service antenna was mounted at the half mast. The antenna isolation was measured to over 100dB. The repeater was set to 70dB gain.

Measured levels:	Received signal level	– 60.0 dBm
	Donor antenna gain	15.0 dBi
	Cable loss	– 5.0 dB
	Repeater input level	– 50.0 dBm
	Adjusted repeater gain	70.0 dB
	Repeater output level	20.0 dBm
	Cable loss	– 5.0 dB
	Service antenna gain	8.0 dBi
	Radiated output level	23.0 dBm

The measured result in the valley was better than –90dBm.

Sports Arena

A 2000 spectators sports arena with metallic roof had an indoor signal strength too low to provide a fair service in most parts of the arena. The nearest base station was 8 kilometers away and it was equipped with one carrier only.

A donor antenna directed towards the base station was mounted on a mast outside the building and a repeater was installed inside the building with the service antenna on the arch vault. The scenario is illustrated in Figure 2-3.

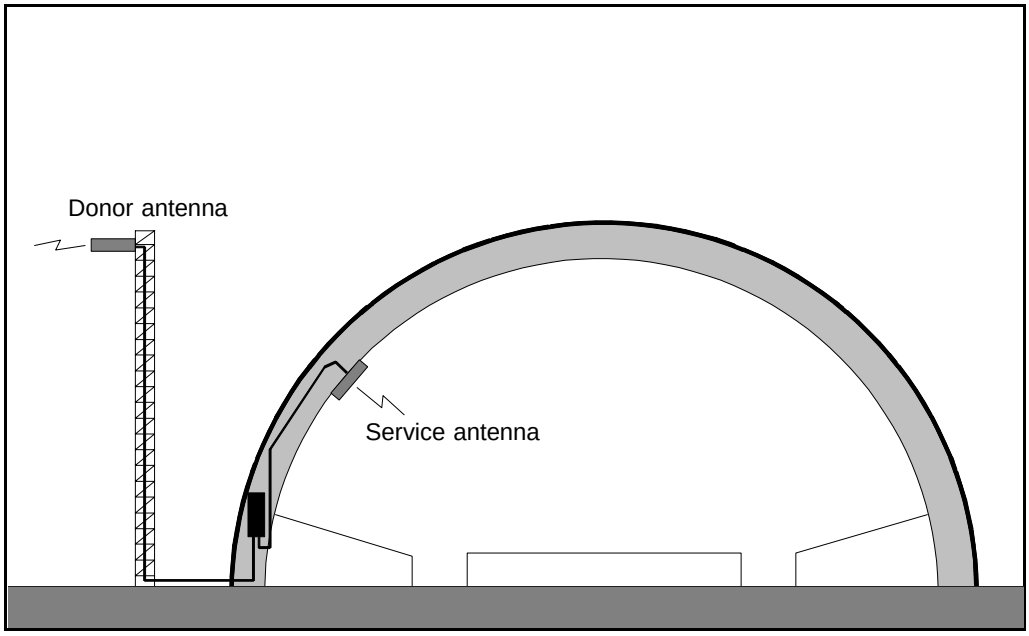


Figure 2-3. Repeater in sports arena

The antenna isolation was measured to over 85dB.

Measured levels:	Received signal level	– 80.0 dBm
	Donor antenna gain	15.0 dBi
	Cable loss	– 5.0 dB
	Repeater input level	– 70.0 dBm
	Adjusted repeater gain	70.0 dB
	Repeater output level	0.0 dBm
	Cable loss	– 2.0 dB
	Service antenna gain	7.0 dBi
	Radiated output level	5.0 dBm

The signal strength was fair for service in the entire arena.

3. Installation

Before installation, read carefully Chapter 1, *Safety*.

Siting the Repeater

Allgon repeaters are designed for outdoor usage. However, humidity and temperature changes may have affect on the reliability. A preferable site for the repeater is thus indoor, in a tempered and ventilated room.

Sunshine

If a repeater is placed outdoor and can be exposed to direct sunshine, it is essential that the air can circulate around the repeater with no obstacle.

The operating temperature must not exceed +55°C. A shelter can be used to shade the repeater from direct sunshine.

Shelter

Allgon repeaters are designed with a weather proof outdoor case that can be mounted without any kind of shelter from rain, snow or hail.

If a repeater is to be opened on the site when raining, snowing, or hailing there must be some kind of permanent or temporary shelter. This is applicable to gentle rainfall, snowfall or hail. Limitations for very bad weather is found in the next section.

Outdoor Installation and Service Limitations

Sited outdoors, the repeater **must not be opened** for installation or service at bad weather, such as:

- Intense rainfall, snowfall or hail
- Storm or high wind
- Extremely low or high temperature
- High humidity of the air

Dimensions and Weight

The dimensions of the repeater, including the mounting bracket, is shown in Figure 3-1. The repeater chassis consists of two main parts, a **cabinet** in which the circuitry is housed, and a **cover**.

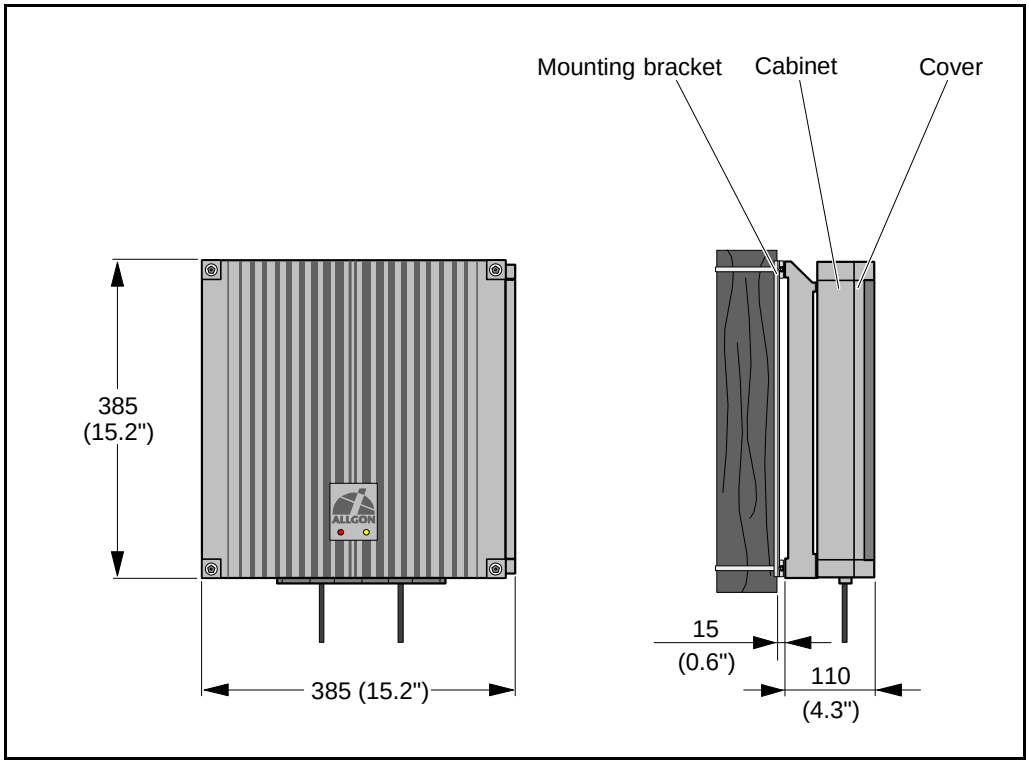


Figure 3-1. Repeater dimensions

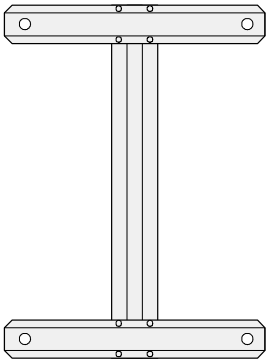
Approximately repeater weight

Repeater with cover ..... 10Kg (22 lbs)

It is not recommended to remove the cover from the cabinet at the site.

However, if the cover, for some reason, has to be removed from the cabinet, then disconnect the interconnection cables, close the cover, remove the hinge shafts, and remove the cover.

Mounting



The ALR repeater is easy to mount, either by anchoring the repeater in the fixing holes, or by using the EA101 57/1 *Pole Mounting Bracket* kit, containing a mounting bracket, clamps for 40mm – 110mm round pole, and fixing screws for fastening the repeater to the mounting bracket.

The mounting bracket is shown in the figure. The holes are threaded (M6) and correspond to the mounting holes in the repeater.

1. Mount the repeater.

Normally, the repeater is mounted on a wall, pole, or mast. These mounting cases are shown below.

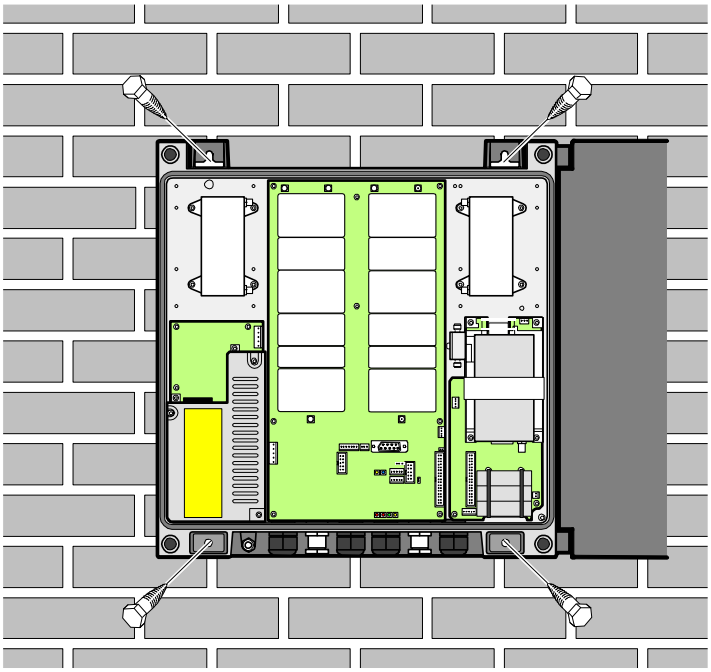


Figure 3-2. Attaching the repeater to a wall

Figure 3-2 shows how to mount the repeater to a wall using four fixing screws. You can use screws for maximum 13mm (1/2") hexagon socket wrench, e.g. 6mm (1/4") bults.

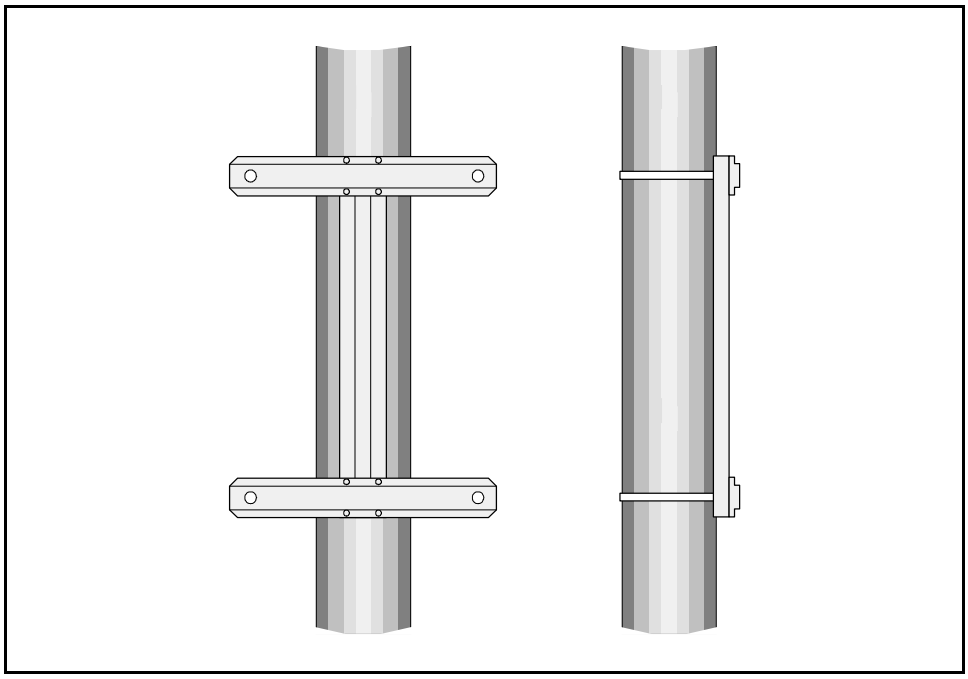


Figure 3-3. Attaching the bracket to a pole

Figure 3-3 shows a bracket attachment to a pole using the mounting bracket and the clamps provided with the bracket.

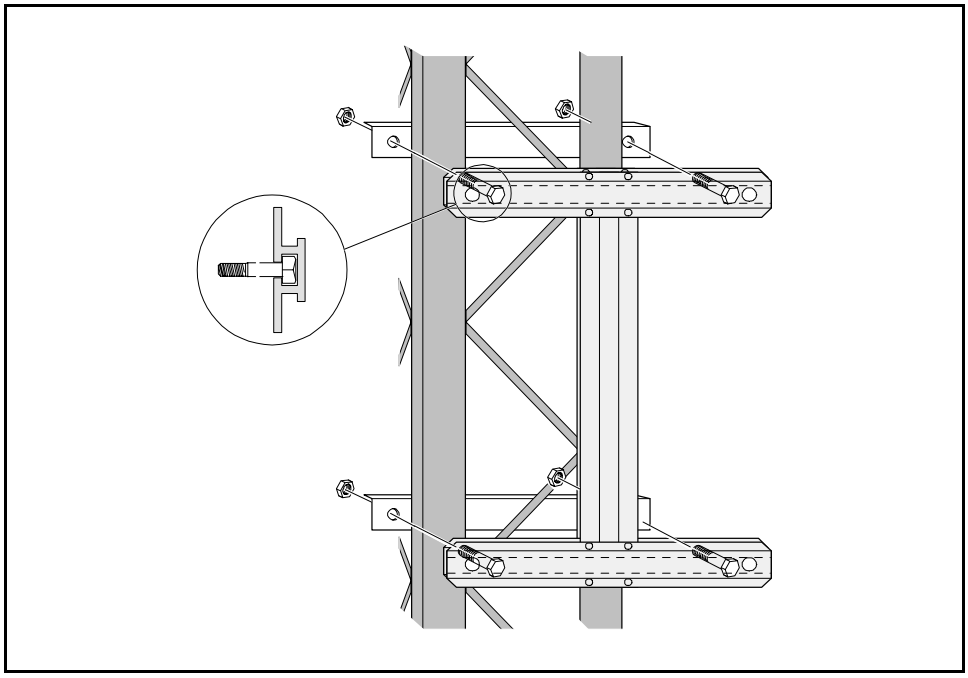


Figure 3-4. Attaching the bracket to a mast

Figure 3-4 shows a bracket attachment to a mast using two angle irons and four M6 (1/4") screws. The screw heads can be slided into the bracket profile as shown in the figure.

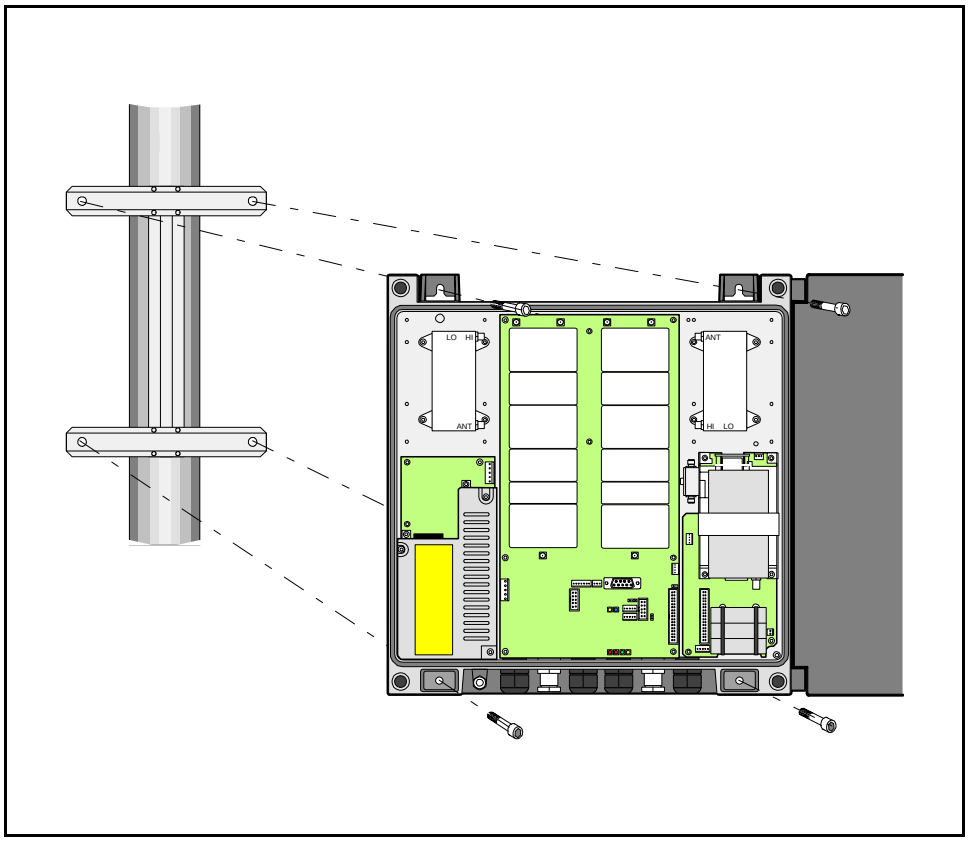


Figure 3-5. Attaching the repeater to the bracket

If the mounting bracket is used, then mount the repeater on the bracket using the four fixing screws provided with the mounting bracket kit (see Figure 3-5).

2. Mount the donor antenna directed towards the base station antenna.

3. Mount the service antenna directed towards the area to be covered by the repeater.

Connection

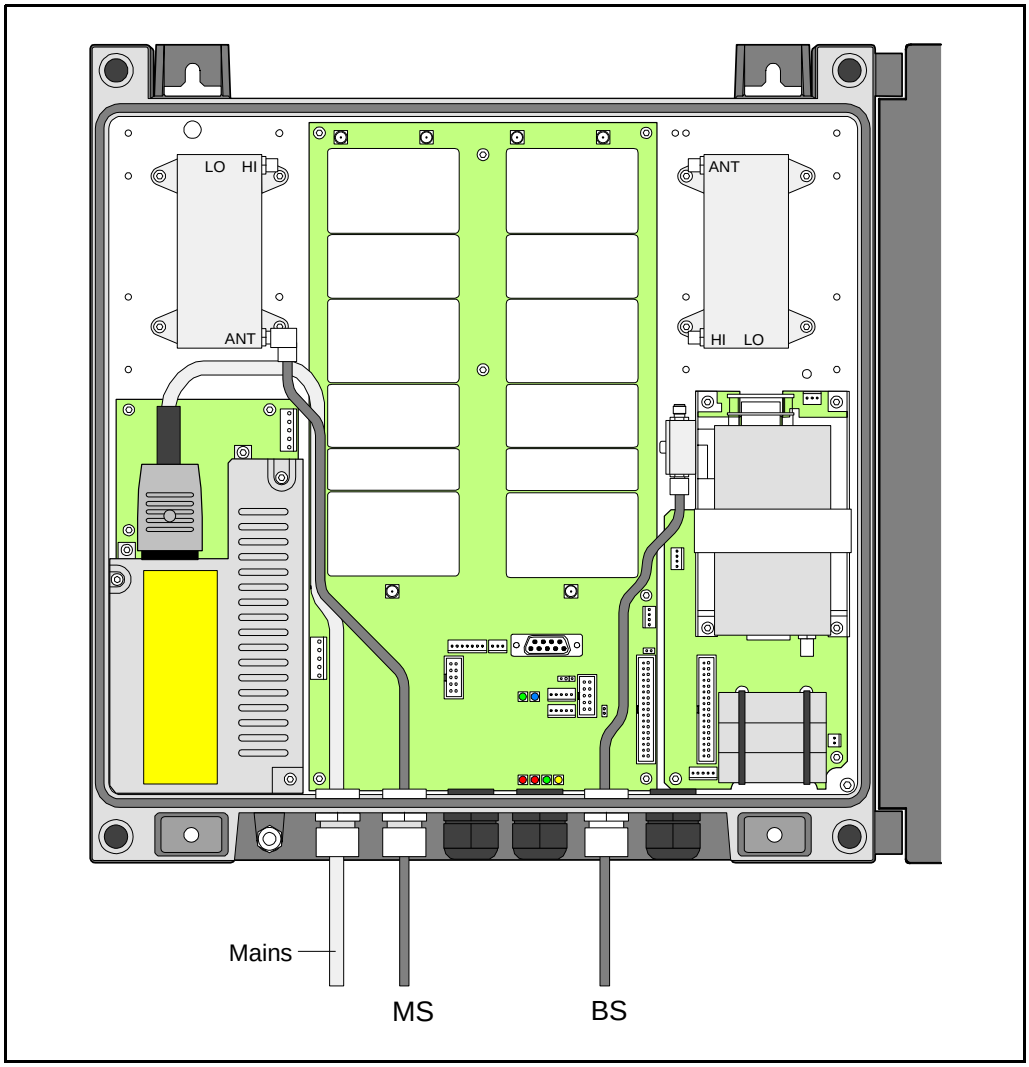


Figure 3-6. MS and BS antenna connections

1. Connect the service antenna (MS) and donor antenna (BS) coaxial cables (see Figure 3-6). N type female connectors are used in the repeater.

   The donor antenna (BS) is connected to the right in the cabinet.

   The service antenna (MS) is connected to the left in cabinet.

2. Connect the mains to the repeater Power Supply Module, PSM, in the PSM connector.

☞ *The Compact repeater is approved in accordance with EN and UL/cUL regulations. This is, however, only valid if a classified power cord is used.*

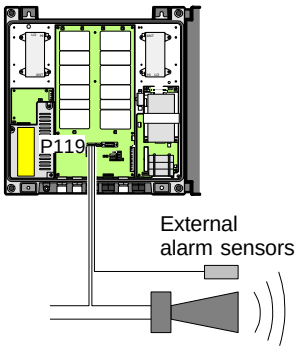
To get the repeater to meet these regulations, select one of the following classified and approved cord types:

EN - H 05 W5 - F HMR
UL - AWM Style 2587
CSA - AWM 1 A/B 11 A/B

For outdoor use the power cord should meet at least IP65 encapsulation requirements.

The repeater PSM must be grounded. Make sure the ground cable part is connected to ground in the PSM connector.

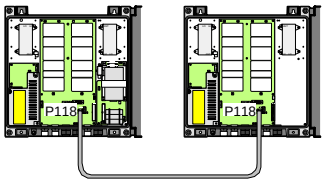
Ground is marked with the following symbol: ⏚



3. Connect external alarm sensors (burglary, fire, etc.) and other external alarm equipment (optical or acoustic signal, etc.), if any. Cables for this installation is taken through a free strain relief bushing at the bottom of the repeater, in the same way as the mains cable and the antenna cables.

External alarm is connected to the P119 alarm port located in the center of the cabinet (see Figure 3-7 on page 3-9). Use a 7 pole female connector.

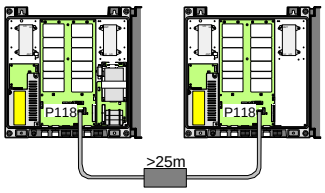
The P119 port is described on page 3-11.



4. Connect the *Repeater to Repeater Link* cable, if this feature is to be used. The R2R net cable is connected to the P118 or P124 Repeater to Repeater Link ports to the right in the repeater. Connection and termination is described on page 3-10.

Any cable type can be used for indoor installation.

The following cable type is recommended for outdoor installation: Li 2YC11Y, 2x2xAWG24/222, non-halogen, Metrofunkkabel-Union.



If the link cable between two repeaters in an R2R net is longer than 25 meters, then an RS-485 repeater is required, see the figure.

Free strain relief bushings at the bottom of the repeaters are used for the external net cables.

The P118 and P124 Repeater to Repeater Link ports are described on page 3-10 and page 3-12.

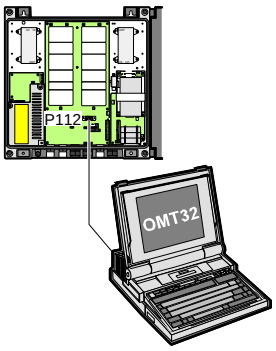
Not used RCC unit:

5. This step is applicable only if the repeater has an RCC unit which is not used (or has been removed).

If the P130 cable connector has been removed, then pin 1 and 2 of the P130 port must be interconnected with a jumper. Do not interconnect any other position than between pin 1 and 2 of the P130 port.

The jumper is found in the P113 parking device if not used in the P130 port.

The P130 port is described on page 3-12 and the P113 parking device is described on page 3-10.



6. Set up a PC with OMT32 to the repeater by connecting a standard RS-232 serial cable between a COM port on the PC and the P112 PC port located to the right in the repeater cabinet (see Figure 3-7 on page 3-9).

Port P112 is described on page 3-10.

Now, you can commission the repeater as described in Chapter 4.

Connection Ports and Station Ground

Connectors involved in the installation are described below.

Station ground is also detailed below.

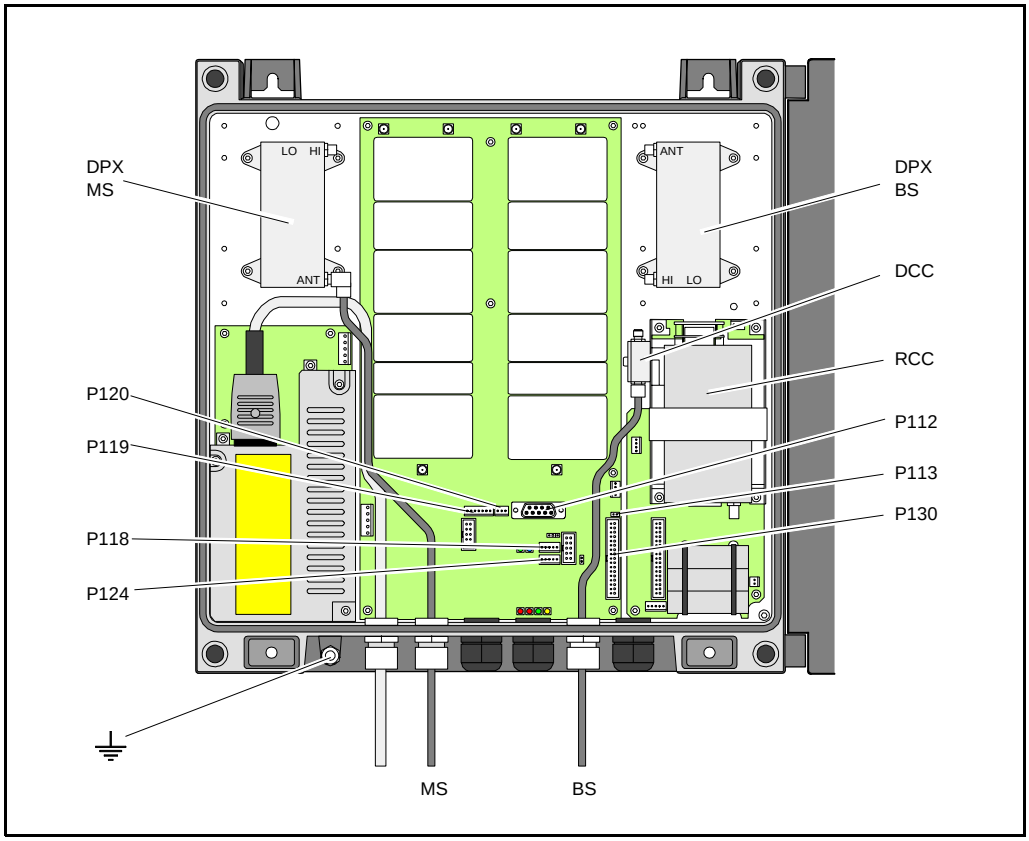
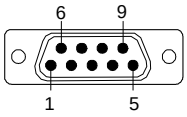


Figure 3-7. Connection ports and station ground

Station Ground

There is a ground screw (M6) on the repeater that is intended for station ground (see Figure 3-7). This screw must be used only for station grounding.

P112 PC Port



PC port P112 is a RS-232 port used for local PC communication.

P112 is a 9 pole D-sub female connector located to the right in the cabinet (see Figure 3-7).

Connector pinning

Pin 1	Not used
Pin 2	Data from repeater to OMT32
Pin 3	Data from OMT32 to repeater
Pin 4	DTR from OMT32 to repeater
Pin 5	GND
Pin 6	DSR from repeater to OMT32
Pin 7	RTS from OMT32 to repeater
Pin 8	CTS from repeater to OMT32
Pin 9	Not used

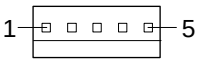
P113 Parking Device

P113 is a parking device for a jumper used for the P130 port. The jumper is used to interconnect pin 1 and pin 2 of the P130 port when there is no RCC remote communication control unit connected to the repeater.

When an RCC unit is connected to the repeater, then the jumper can be placed in P113.

P113 is an unconnected 2 pole male connector located to the right in the cabinet, adjacent to the P130 connector (see Figure 3-7).

P118 Repeater to Repeater Link Port



P118 is used for the *Repeater to Repeater Link* feature (R2R net).

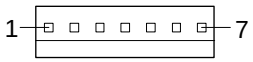
P118 is a 5 pole male connector located to the right in the cabinet, adjacent to the P124 connector (see Figure 3-7).

The P118 and P124 ports are identical an connected in series. One of the connectors are intended to be used from the previous repeater in the net chain, and the other connetor to the next repeater in the net chain. Either of P118 or P124 can be used for the first and the last repeater in the net chain.

Use straight connection between P118 and P124 connectors.

No termination is required for the outermost repeaters in an R2R net.

P119 Alarm Port



Alarm port P119 is used for external alarm sensors and alarm equipment.

P119 is a 7 pole male connector located in the center of the cabinet (see Figure 3-7).

The port has four alarm inputs, EAL1 - EAL4.

The four alarm inputs

The inputs are low-level inputs with common ground (AIC).

Use insulated switch or relay to initiate alarms (open switches in normal operating mode, closed switches cause alarm).

The alarm switch connection can be toggled between being active open or active closed. This is further described in the *AR Repeaters and OMT32, User's Manual*.

The alarm input voltage ratings, related to ground, are:

Vin_{max} = 5.5V
Vin_{min} = –0.5V

Connector pinning

Pin 1	AIC	Ground
Pin 2	AIC	Ground
Pin 3	AI1	External alarm input 1 – EAL1
Pin 4	AI2	External alarm input 2 – EAL2
Pin 5	AI3	External alarm input 3 – EAL3
Pin 6	AI4	External alarm input 4 – EAL4*
Pin 7	Not used	

*EAL4 can also be configured as door alarm with settable alarm level.

P120 Door Switch

P120 is used for repeater door alarm. An internal door switch is connected to this port to activate door alarms.

P120 is a 3-pole male connector located in the center of the cabinet, adjacent to the P119 alarm connector (see Figure 3-7).

The alarm level for this input is always *Warning w ceasing*.

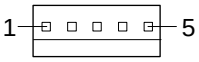
This alarm input is separated from the alarm inputs in the P119 alarm connector. The EAL4 in the P119 alarm port (pin 6) can also be configured as door alarm input with settable alarm level.

The door switch alarm is activated 30 seconds after the door switch has been activated.

Connector pinning

Pin 1 Ground
Pin 2 Alarm input
Pin 3 Power (5V, 10mA for the door alarm circuitry)

P124 Repeater to Repeater Link Port

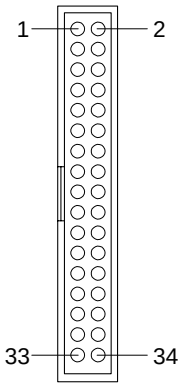


P124 is used for the *Repeater to Repeater Link* feature (R2R net).

P124 is a 5 pole male connector located to the right in the cabinet, adjacent to the P118 connector (see Figure 3-7).

The usage of P118 and P124 is described on page 3-10.

P130 RCC Port



The P130 RCC port is used for connecting an RCC mobile phone/modem remote control unit.

P130 is a 34 pole 2 line male connector located to the right in the cabinet (see Figure 3-7).

The P130 connector contains modem/telephone line connection, RCC power supply, etc.

If there is no RCC remote communication control unit connected to the P130 port, then pin 1 and pin 2 must be interconnected with a jumper (see P113 on page 3-10).

Pin 1 and 2 of the P130 port MUST ALWAYS be interconnected to provide voltage supply to a part of the repeater circuitry.

Mains Breakdown Relay

To be able to distinguish PSM faults from power failure, a mains breakdown relay must be used on the repeater mains supply.

The mains breakdown relay is not included in the repeater. So, it has to be mounted outside the repeater chassis. The relay intended for this purpose must fulfil the following specifications:

Relay specifications

Closing time: max. 30 milliseconds

Insulation coil/contact: min. 4KV

Mains connected relay must be in compliance with valid local regulations.

Connection

- Connect a normally closed relay contact to pin AI1 and AIC on the P119 alarm connector (closed contact at no current). Alarm is initiated by short circuiting the AI1 and AIC inputs as shown in Figure 3-8. The P119 alarm connector is detailed on page 3-11.

- Connect the relay coil. It must be supplied from the same fuse as the repeater.

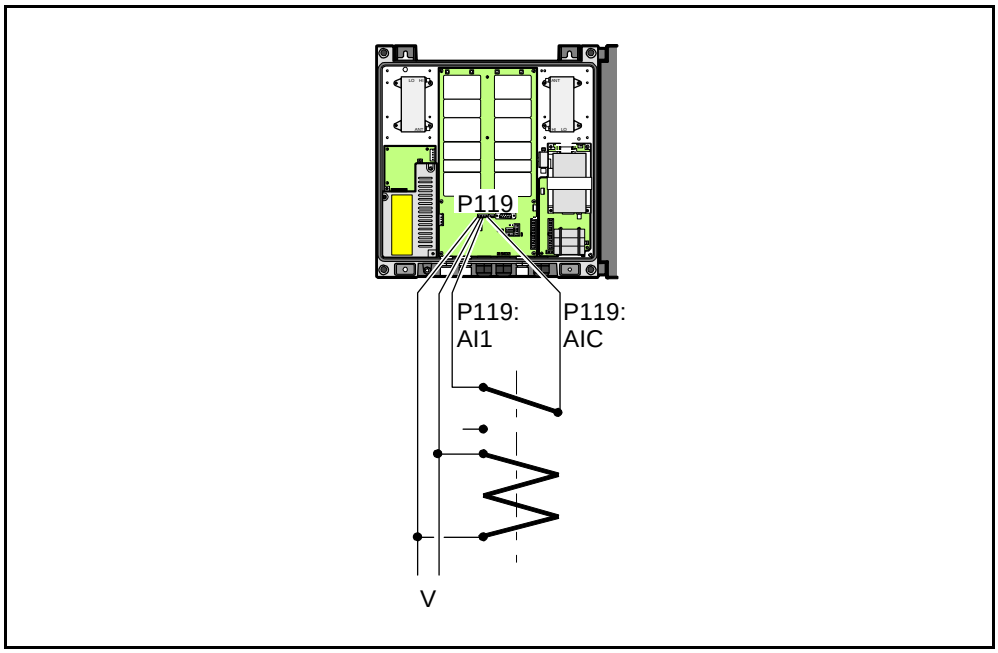


Figure 3-8. Mains breakdown relay connection

- After commissioning, set the mains breakdown feature as described in the *AR Repeaters and OMT32, User's Manual*.

4. Commissioning

Read carefully Chapter 1 *Safety* before commissioning the repeater.

Check all connections made during the installation. Also, ensure that both the mains plugs for repeaters equipped with two power supply units are connected to outlets supplied from the same fuse.

To fulfill the IP65 weather protective requirements, ensure that the cable strain relief bushings are properly tightened. Also, ensure that the gaskets at the cable inlets and on the cabinet are properly fitted and not damaged.

When the installation is checked, commission the repeater as described below.

Starting the Repeater

1. Connect the repeater to the mains.
2. Check the four LEDs downmost in the repeater (see Figure 4-1). A correct power-up is indicated as follows:

   BOOT
   Red LED that is lit with a steady light when the system boots, i.e. for 10 - 15 seconds after the mains is switched on. Then, it flashes for the next 5 - 10 seconds. After that, if no error is detected, the LED is off.

   FAULT
   Red LED that flashes 15 - 20 seconds after the mains is switched on. Then, it flashes for less serious alarms (ERROR) and is lit with a steady light for fatal alarms (CRITICAL).

   OPER
   Green LED that lights up approx. 20 seconds after the mains is switched on. It shows, with a steady light, that the repeater is ready for operation.

   PWR
   Yellow LED which is lit with a steady light after the mains is switched on. Indicates present power.

External indicators on the repeater front

Yellow
Operation LED which lights up approx. 20 seconds after the mains is switched on. At steady light the repeater is ready for operation.

Red
Alarm LED which indicates ERROR alarms with flashing light and CRITICAL alarms with steady light.

When the indicators show operational mode, the repeater can be configured for operation by using an OMT32/PC. This is further detailed in the *AR Repeaters and OMT32, User's Manual*.

Indicators

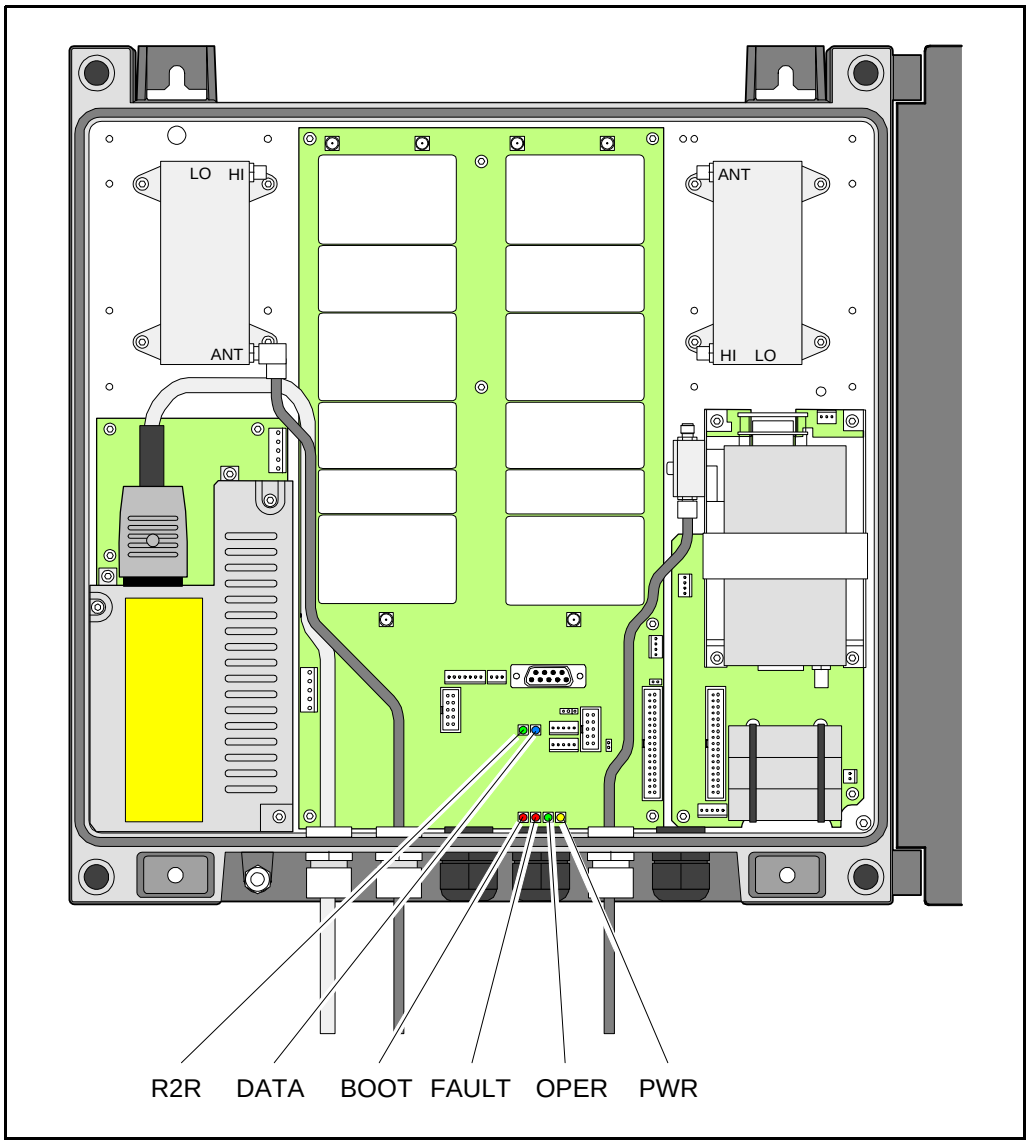


Figure 4-1. Indicators in the cabinet

Figure 4-1 shows the repeater indicators . There are also two external indicators on the repeater front cover.

Repeater to Repeater Link indicators

The two upper indicators, R2R and DATA, indicates the following R2R status:

R2R
Green LED that indicates, with a flashing light, that the repeater currently is a R2R *Control Station*. A steady light indicates that the repeater is not currently a *Control Station*, or there is no more repeater in the net. Only one repeater in an R2R net can show a flashing green LED at the same time.

DATA
Blue LED that indicates data transmission in the net.

Repeater Configuration

The repeater is now ready to be configured in accordance with the site conditions and system performance requirements. Pay especial attention to the antenna isolation described in the *AR Repeaters and OMT32, User's Manual*.

5. Functional Description and Design

Allgon repeaters work as bi-directional on-frequency amplifiers.

A repeater receives, amplifies, and retransmits signals downlink and uplink simultaneously, i.e. from the base station via the repeater to the mobile stations and from the mobile stations via the repeater to the base station.

The repeater is connected to a BS antenna, directed towards the base station, and to a MS antenna directed towards the area to be covered. These antennas are connected to the repeater with N type male connectors.

To prevent instability due to poor antenna isolation, a built-in antenna isolation supervision feature reduces the gain level automatically when poor antenna isolation is detected.

The Allgon repeaters are controlled by powerful microprocessors.

Alarm and operational LEDs are visible on the repeater front.

The repeater works with convection cooling without fan.

Operational parameters such as gain, power levels, etc. are set using a desktop or notebook and the Allgon OMT32, which communicate, locally or remotely via modem, with the repeater. Remote operation is performed using a telephone line or a built-in mobile phone equipped with a data interface.

Repeater Design

The repeater is housed in a cast aluminium chassis that is waterproof, class NEMA4/IP65, for outdoor use. The chassis has a design suited for outdoor use as well as indoor use.

The chassis consists of a cabinet and a cover joined with hinges. The cabinet contains the repeater circuitry.

The cover has two external LEDs for operation and alarm indication.

Both the uplink and downlink circuitry is built up on a single BSC board inside the repeater. The various amplifiers and RF modules are individually shielded by metal covers.

The BSC band selective compact repeater board

The band selective compact repeater board can handle one wide band repeater channel, uplink and downlink. The band width is adjustable.

Other units

In addition to the BSC repeater board, the repeater contains:

- DPX Duplex filter, located on the upper part of the repeater.
- DCC Directional Coupler for Compact, located on the RCC unit in repeaters with an RCC unit that works in the same cell system as the repeater.
- RCC unit (optional), see Chapter 6, *Optionals*. This is located to the right in the cabinet.
- PSM Power Supply Module, located to the left in the cabinet.
- The repeater is equipped with an *R2R, Repeater to Repeater Link* feature that can be used to communicate with several repeaters.

The Main Repeater Units

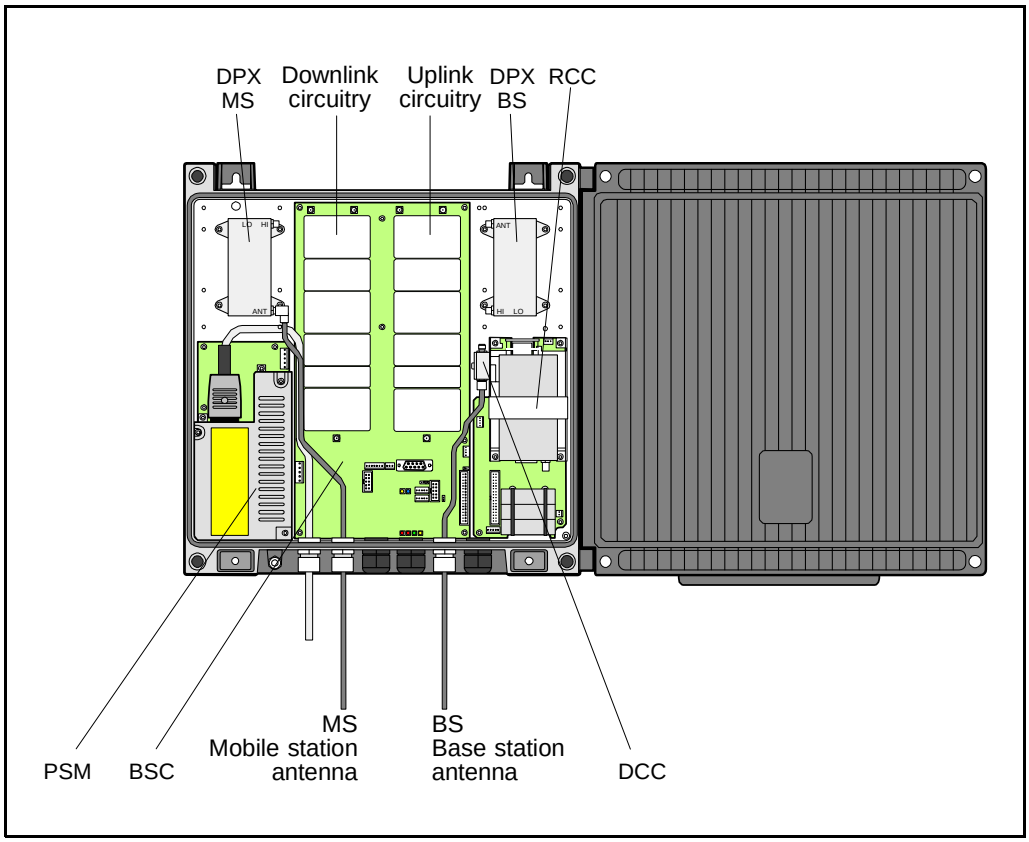


Figure 5-1. The main repeater units

A cabinet (the left part in Figure 5-1) for the band selective Compact repeater is equipped with a BSC board including the downlink and uplink circuitry. The described cabinet is equipped for bi-directional band selective operation and RCC remote control.

There are BSC boards with adjustable bandwidth for 800MHz – 900MHz and 1800MHz – 1900MHz band selective systems.

Main units:

BSC	Band Selective Compact board, adjustable bandwidth
DCC	Directional Coupler for Compact RCC antenna
DPX	Duplex filter
PSM	Power Supply Module
RCC	Repeater Communication Control unit

Block Diagram

A band selective compact repeater block diagram is found on page 5-5.

The signal path and some of the most important features are described after the block diagram.

Downlink Signal Path

The downlink signal path (HI), i.e. from the base station through the repeater to the mobile station, is described after the block diagram.

Uplink Signal Path

The uplink signal path (LO), i.e. from the mobile station through the repeater to the base station, is identical to the downlink path the other way round. Only some levels and component values differ.

Band Selective Compact Repeater Block Diagram

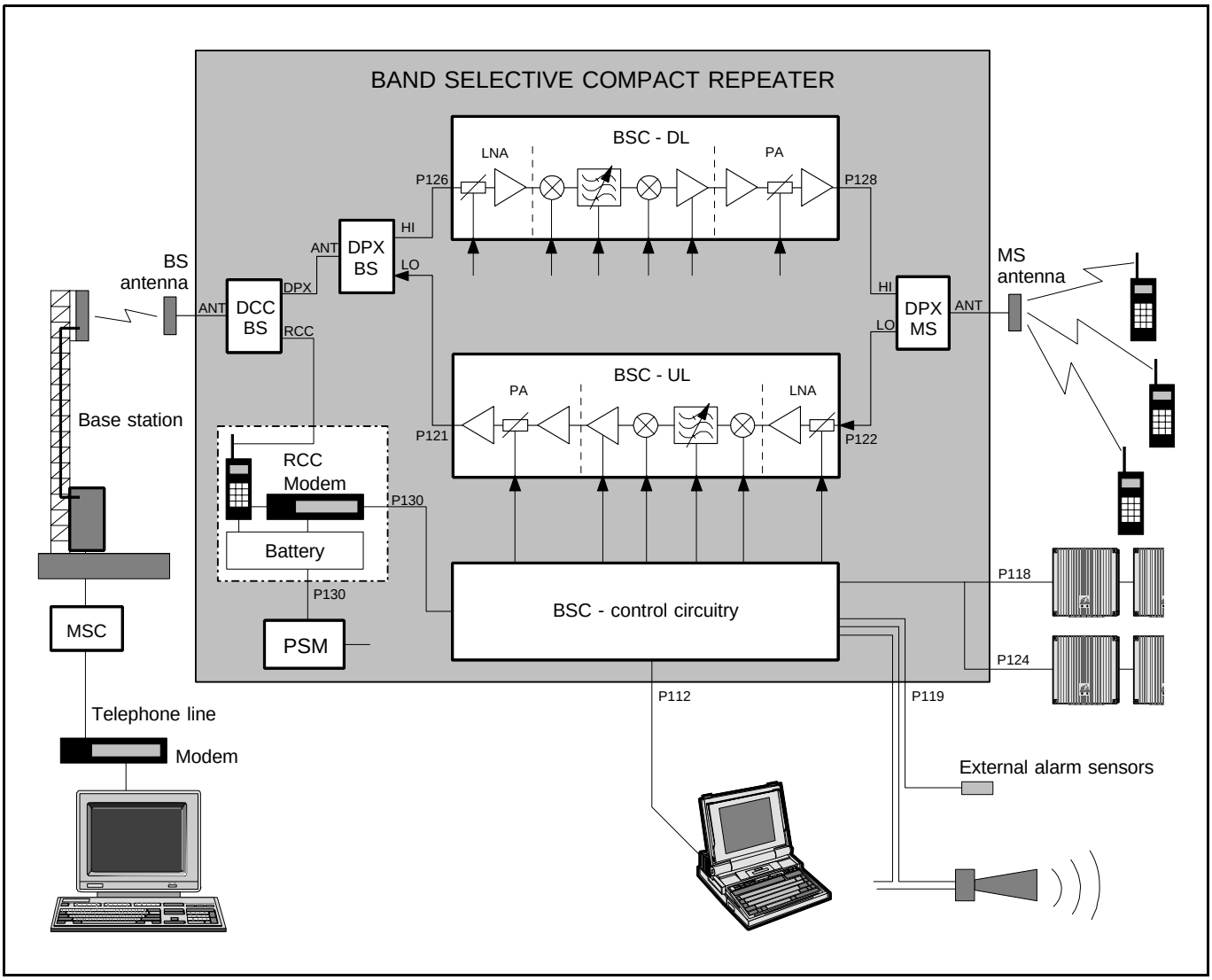


Figure 5-2. Block diagram

Figure 5-2 shows a block diagram of the band selective compact repeater. This diagram is applicable to repeaters for e.g. NMT, GSM, TACS/ETACS, AMPS/DAMPS and CDMA systems.

Downlink signal path

The signal from the base station is received via the repeater BS antenna and is forwarded through a directional coupler (DCC) to the ANT input of a duplex filter (DPX). The signal from the HI output of the duplex filter is, via the P126 port, fed to the BSC board. On the BSC board, the signal is amplified in a low noise amplifier (LNA) and is then entered the band selective amplifier circuitry.

The first mixer stage in the BSC amplifier, which is controlled by a synthesizer, converts the received frequency down to the IF frequency. The signal is then filtered by SAW bandpass filters and, not shown in the

figure, amplified before it is fed to the second mixer stage for conversion back to the original frequency.

The SAW filter combination is adjustable and can be software changed from within OMT32 (or OMS) to cover various band widths.

The following power amplifier (PA) is controlled by the BSC control circuitry. The amplifier gain will be reduced to avoid instability due to poor antenna isolation.

A detector in the PA stage measures continuously the output level. The signal from this detector is used by the automatic gain control, AGC, to supervise and, if necessary, reduce the output power to keep it under a maximum level. The AGC gain control affects several of the amplification stages.

The output signal from the BSC board is taken from the P128 port and it is fed to the HI port of a duplex filter (DPX). The output signal from the ANT port of the duplex filter is fed to the repeater MS antenna.

RCC

The optional RCC Remote Communication Control unit, if used, is located inside the repeater, see Figure 5-1 on page 5-3.

Communication with the base station is performed by means of a built-in mobile feature that has the antenna connected to the BS directional coupler (DCC). Data is transferred between the repeater and the built-in RCC unit via the P130 port.

The RCC unit is powered via the P130 port and the unit has a battery with capacity to send a number of alarms if a mains power failure occurs.

R2R

The *Repeater to Repeater Link* feature makes it possible to communicate with a number of repeaters via one RCC unit in one of the repeaters in an R2R net. Several RCC units can also be used in the same net.

The repeaters in the R2R net are connected to the P118 port and to the P124 port.

The R2R feature is further described on page 5-17.

Alarm

Alarm signals from external sensors are received via the P119 alarm port.

The software on the BSC board is able to activate acoustic or visual alarm or direct the alarm to the P130 PCC port to be forwarded, via the RCC unit (or modem and telephone line) to OMT32 (or OMS) located in an operation and maintenance central.

Alarms can be configured from OMT32 (or from OMS).

Repeater Setup

The repeater parameters can be set locally by means of a desktop or notebook loaded with the OMT32 software (or the OMS software). The PC or notebook is connected to the repeater via the P112 PC port.

The repeater parameters can also be set remotely by means of an RCC Remote Communication Control unit (or via a telephone line and a modem) connected to the repeater via the P130 PCC port.

Board and Unit Descriptions

Cabling between boards and units is found on page 5-15 (with RCC unit) and page 5-16 (without RCC unit).

DCC - Directional Coupler for Compact

There is one BS directional coupler in a repeater equipped with an RCC Remote Communication Control unit.

This unit connects the RCC radio modem antenna to the base station antenna.

Connection

To the right in the cabinet DCC/BS

Port	Connected to
ANT	BS antenna.
DPX	ANT on the DPX/BS duplex filter.
RCC	RCC radio modem antenna.

DPX - Duplex Filter

The DPX duplex filters on the BS and MS sides are identical.

Connection

To the left in the cabinet DPX/MS

Port	Connected to
ANT	MS antenna port.
HI	P128 on the BSC board (downlink PA power amplifier).
LO	P122 on the BSC board (uplink LNA low noise amplifier).

To the right in the cabinet DPX/BS

Port	Connected to
ANT	DPX on the DCC/BS directional coupler (BS antenna signal).
HI	P126 on the BSC board (downlink LNA low noise amplifier).
LO	P121 on the BSC board (uplink PA power amplifier).

BSC Band Selective Compact Board

The compact band selective repeater is built up mainly on a single BSC board that contains all the amplification circuitry for uplink and downlink and the control circuitry. This board contains also all the ports for alarm, local control, remot control, etc.

Figure 5-3 shows the BSC board in the compact repeater.

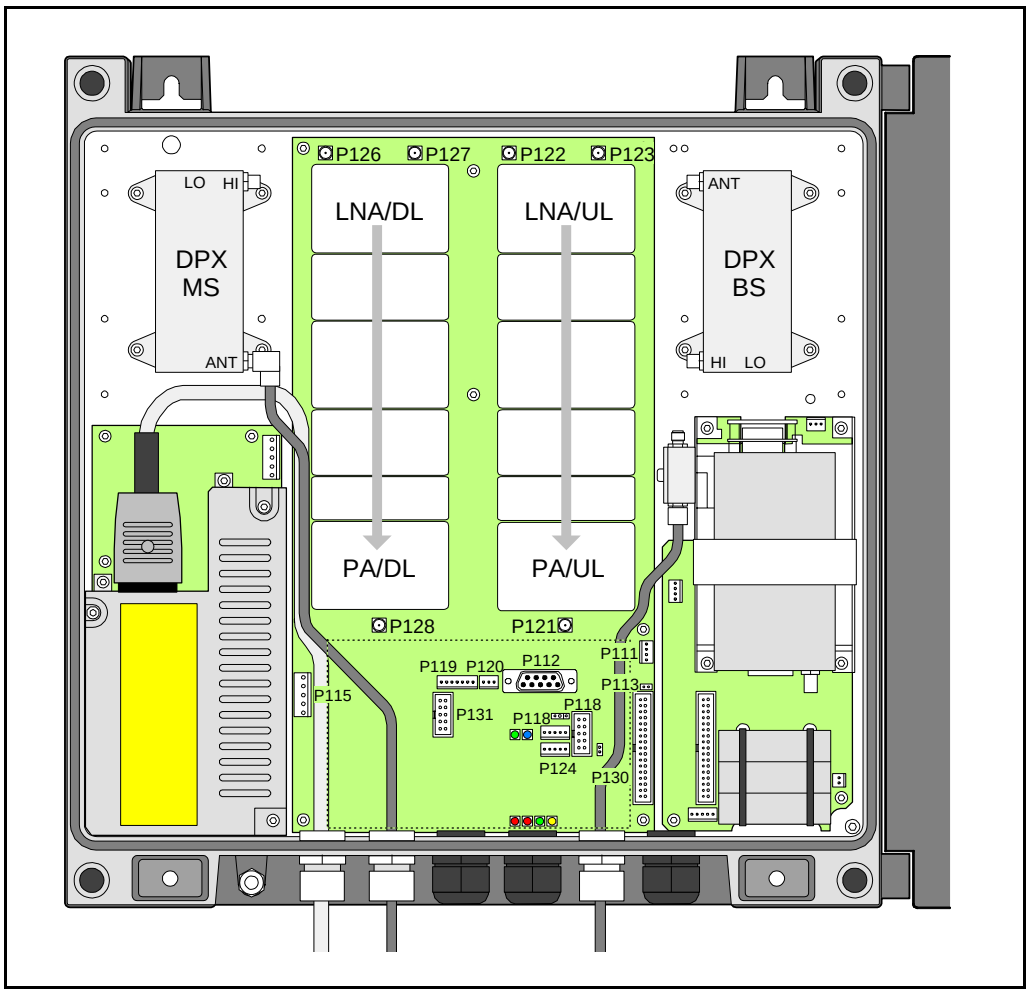


Figure 5-3. BSC, Band Selective Compact board

The left upper part of the BSC board contains the downlink circuitry. The downlink signal path starts from port P126, is fed to the LNA, Low Noise Amplifier, then it passes a number of amplifiers, and is finally fed to the PA, Power Amplifier before it is fed, via port P128, to the DPX/MS HI port to be forwarded to the MS antenna.

The right upper part of the BSC board contains the corresponding circuitry for the uplink signal path, from port P122, via port P121, DPX/BS HI port and to the BS antenna.

BSC control circuitry

The BSC control circuitry is the central part of the repeater, located in the lower part of the BSC board (inside the dotted line in Figure 5-3).

The BSC control circuitry contains a microprocessor, main memory, flash memory for the BSC software, EEPROM memory for parameters, memory for the event log and statistics, a REFO reference oscillator, ports for local and remote communication, battery powered real-time clock, etc.

The BSC control circuitry supervises and controls operational parameters such as gain control, etc. The BSC control circuitry takes also care of alarms and the event log, password, logon, and many other tasks.

The BSC control circuitry is also an interface when communicating with an OMT32 or OMS, locally or remotely.

The BSC software can be downloaded from OMT32 or OMS either locally or remotely.

The real-time clock in the BSC control circuitry is used for alarm and for the event log.

BSC software

The BSC board can be run with the SA102 04 software. The board can store two software versions, located in segment 1 and segment 2 of the flash memory as *Application 1* and *Application 2*. The repeater will boot on that software which is set as *Primary* (a description of the *Primary* application is found in the *AR Repeaters and OMT32, User's Manual*.

The compatibility between the BSC board and software is detailed in the next section.

Caution

A lithium battery is permanently mounted on the BSC board. Due to the risk of explosion, this battery must only be removed from the board by an authorized service technician.

Connection and connector types

The BSC board is also a distribution board with most of the repeater ports. The connector types are chosen to prevent unintentional mixing up.

Port	Connected to	Connector type
P111	LED board in the cover.	4 pole 1 line male.
P112	PC (serial RS-232).	9 pole D-sub female.
P113	Not connected (jumper parking device).	2 pole 1 line male.
P115	PSM - Power Supply Module	5 pole 1 line male.
P118	R2R connection to P118 or P124 in the next compact repeater, or to the R2R connector board in a standard AR repeater.	5 pole 1 line male.
P119	External alarm sensors and alarm equipment.	7 pole 1 line male.
P120	Door switch (internal alarm).	3 pole 1 line male.
P121	HI on DPX/BS duplex filter (uplink output signal).	Coaxial
P122	LO on DPX/MS duplex filter (uplink input signal).	Coaxial
P123	P122 on another BSC board (currently not used expansion output).	Coaxial
P124	R2R connection to P118 or P124 in the next compact repeater, or to the R2R connector board in a standard AR repeater.	5 pole 1 line male.
P126	LO on DPX/BS duplex filter (downlink input signal).	Coaxial
P127	P126 on another BSC board (currently not used expansion output).	Coaxial
P128	HI on DPX/MS duplex filter (downlink output signal).	Coaxial
P130*	RCC Remote Communication Control unit, or modem for traditional telephone line.	34 pole 2 line male.

*Pin 1 and 2 of the P130 connector must be interconnected with a jumper if the connector is not used.

Testpoints

There are no testpoints intended for field maintenance or calibration. Availalbe testpoints on the board are used for factory calibration only.

LNA - Low Noise Amplifier

Two LNA, Low Noise Amplifiers, are located uppermost on the BSC board in shielded covers. LNA/DL (downlink) is located to the left and LNA/UL (uplink) to the right.

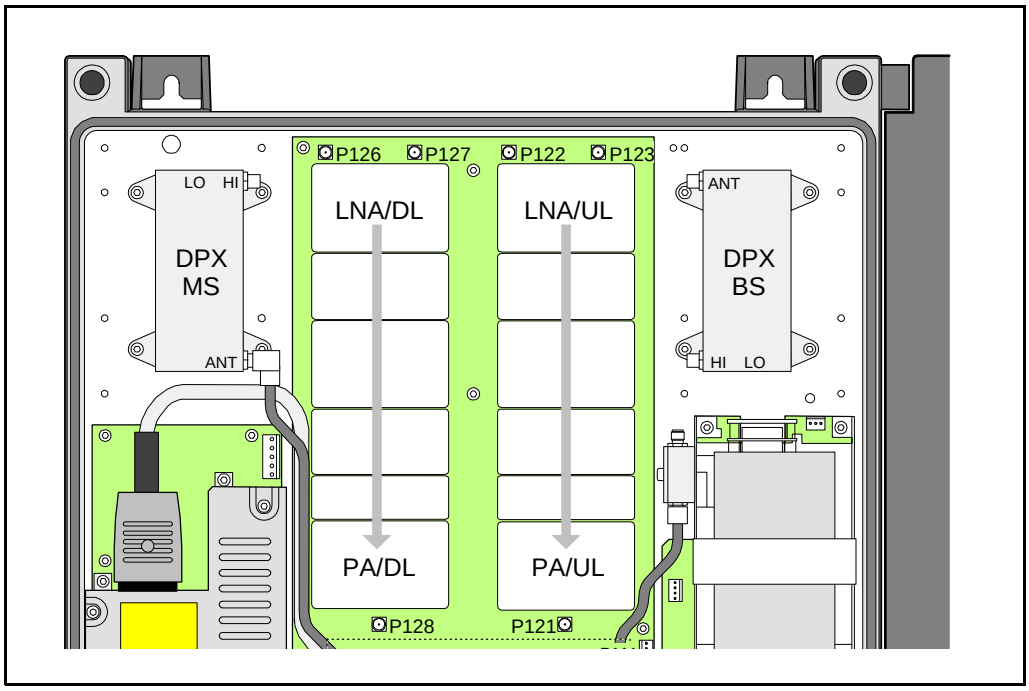


Figure 5-4. LNA, Low Noise Amplifiers

Received signals from the duplex filters are fed to the LNA input connectors P122 (uplink) and P126 (downlink). The output signals from the LNA amplifiers are fed to the next amplifier stages for uplink and downlink on the BSC board.

The P123 and P127 ports are expansion outputs for additional BSC boards (not used in the currently available single band repeaters).

Connection

The P122, P123, P126 and P127 ports are connected as shown on page 5-11.

PA - Power Amplifier

Two PA, Power Amplifier, are located in the middle of the BSC board in shielded covers. PA/DL (downlink) is located to the left and PA/UL (uplink) to the right.

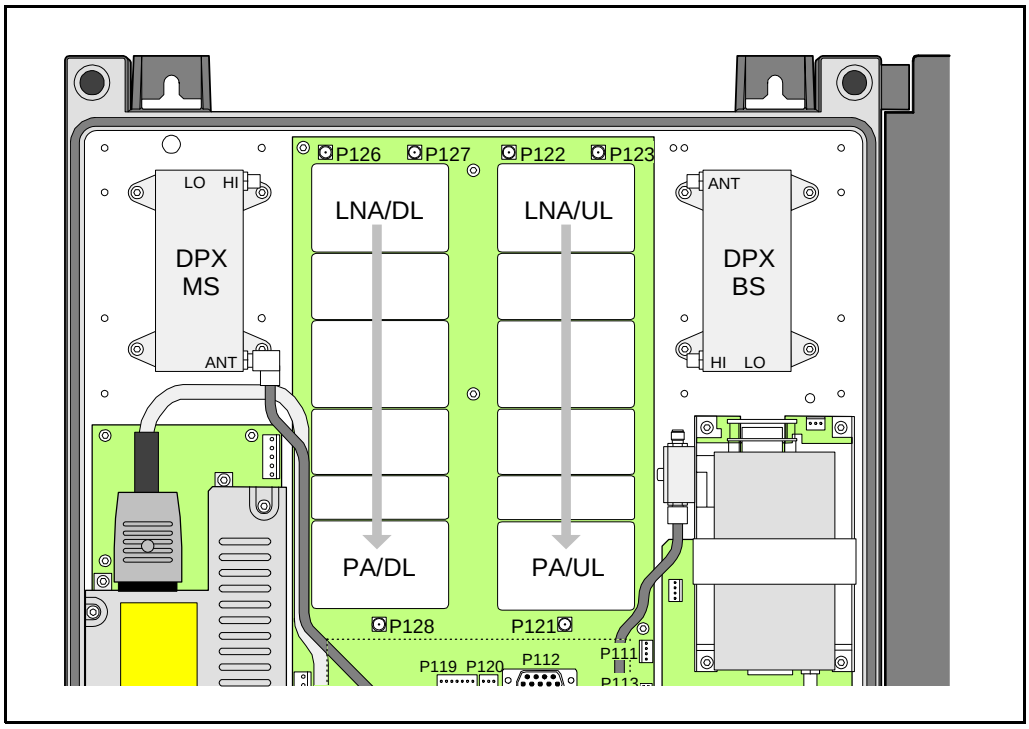


Figure 5-5. PA, Power Amplifiers

The final power amplification for the downlink signal is performed in the PA/DL stage. Then the signal is fed via the P128 port to the HI port of the DPX/MS duplex filter and from this filter to the MS antenna.

The uplink final power amplification is performed in the same way and is fed to the BS antenna via the P121 port and the HI port of the DPX/BS duplex filter.

Connection

The P121 and P128 ports are connected as shown on page 5-11.

Repeater Software and Hardware Compatibility

There may be different versions of the repeater software, which can be combined with boards of various revisions. These have unique part numbers and revision information. Below, you will find a table of repeater software currently available in combination with BSC boards.

BSC Software Part #	Software Revision	Compatible with BSC board	Comments
SA102 04	R1A	K304/x	1800MHz – 1900MHz
		K308/x	800MHz – 900MHz

x = digit indicating frequency and bandwidth

This information is updated 2000-06-20. As new versions of hardware and software are released without prior noticing, contact your Allgon sales representative if in doubt about the latest revision status.

For detailed information, refer to the release notes for the repeater software to be downloaded (normally found in the *readme.txt* file, which is supplied with the program files).

Cabling

On the following pages, you will find cabling information for:

- Compact repeater with RCC unit, this page.
- Compact repeater without RCC unit, page 5-16.

Compact Repeater With RCC Unit

Figure 5-6 shows the compact repeater main cabling with an RCC Remote Communication Control unit.

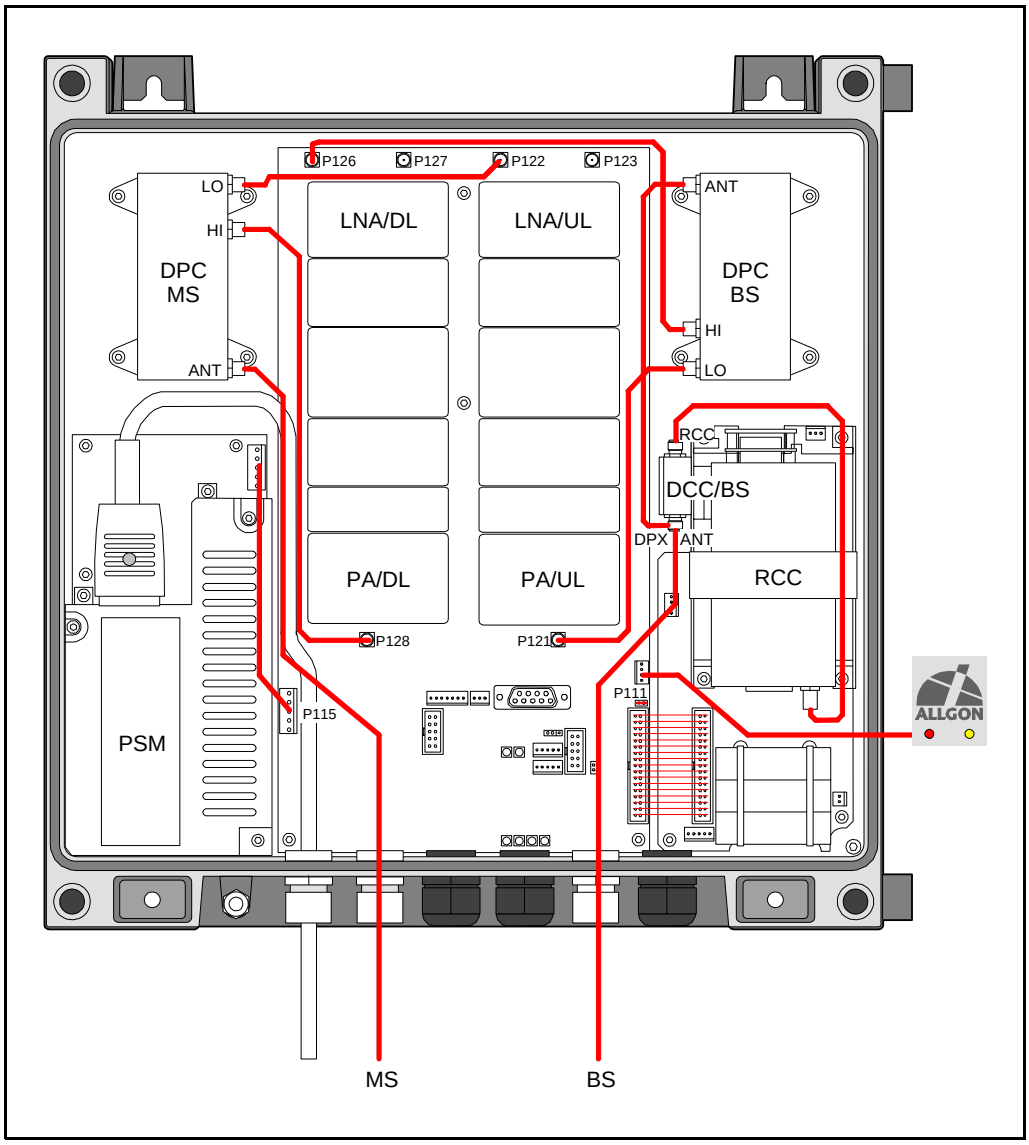


Figure 5-6. Cabling with RCC unit

Compact Repeater Without RCC Unit

Figure 5-7 shows the compact repeater main cabling without an RCC Remote Communication Control unit.

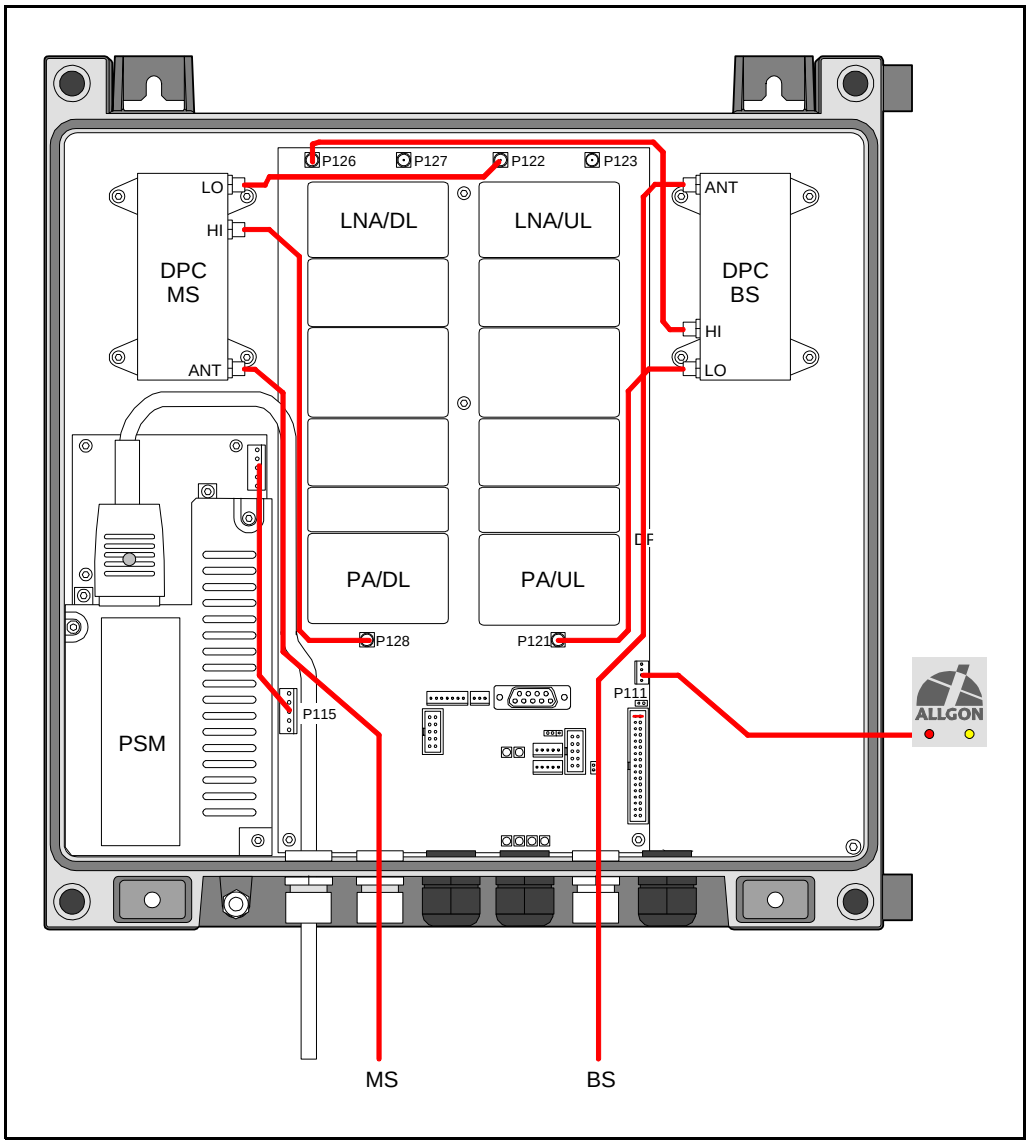


Figure 5-7. Cabling without RCC unit

R2R, Repeater To Repeater Link

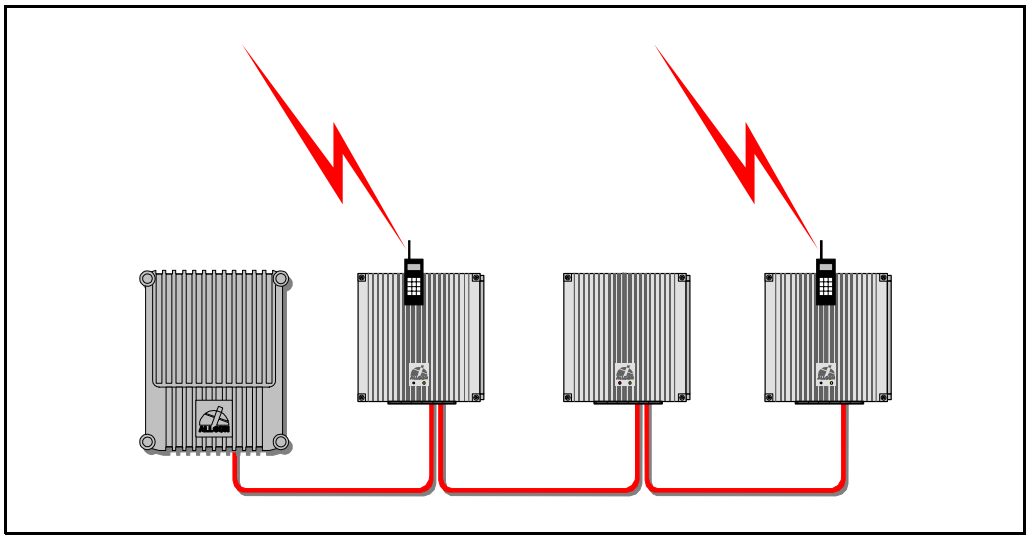


Figure 5-8. Repeater to Repeater Link

The Allgon *Repeater to Repeater Link* can be used in order to establish a repeater network with up to 13 repeaters, one or several of which can contain a phone line for communication with an OMT32 or an OMS.

All Allgon standard Compact repeaters include this feature.

All Allgon repeaters can be mixed in R2R nets (see Figure 5-8). For standard AR repeaters, the R2R *Repeater to Repeater Link* feature is optional and require certain hardware and repeater software versions.

Installation

All required R2R, *Repeater to Repeater Link*, circuitry is included in the compact repeater. Only interconnecting cables are required to set up an R2R net.

At least one RCC unit (or telephone line with modem) is required for the remote communication.

Configuration

Configuration is described in *AR Repeaters and OMT32, User's Manual*.

6. Optionals

This chapter describes the following optional accessories available for the Allgon repeaters:

- RCC, Remote Control Unit for band selective systems, page 6-2.
- OMT32, Operation and Maintenance Terminal, page 6-4.
- OMS, Operation and Maintenance System, page 6-4.
- Battery Backup, page 6-4.
- Fiber Optic Interface, page 6-4.

RCC, Remote Communication Control Unit

As the mobile phone technology is developing very fast, this RCC may be modified after issuing this manual. New types may also have been added. For the latest details, please contact your local Allgon representative.

For remote control of Allgon Compact repeaters in band selective systems an RCC Remote Communication Control unit is available. This unit contains an integrated mobile phone, modem and power supply backup.

The RCC unit for the Compact repeater is mounted to the right inside the repeater cabinet, see Figure 6-1.

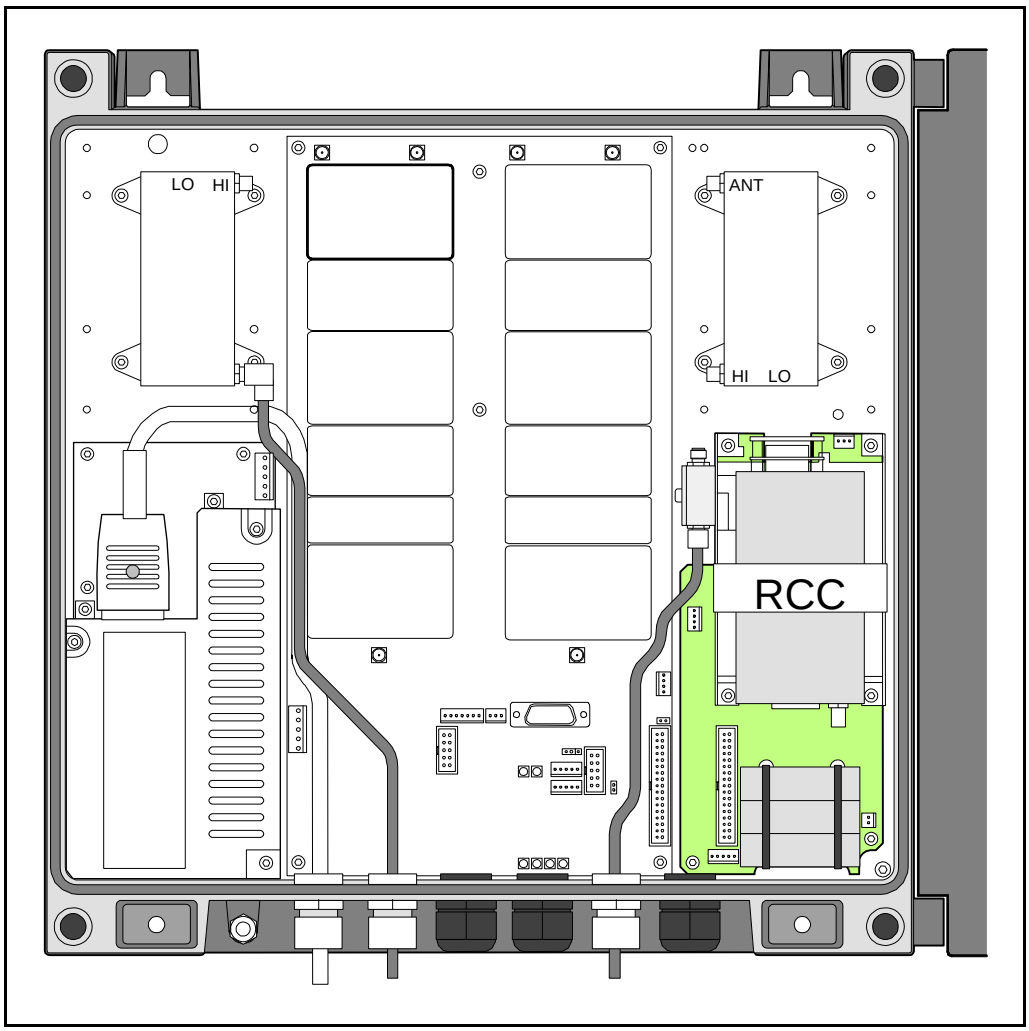


Figure 6-1. The RCC unit

The RCC is connected to the P130 port on the BSC board.

Do not forget to put a jumper between pin 1 and 2 of the P130 connector on the BSC board if the P130 cable connector is removed.

A jumper should be located in the P113 parking device (a 2-pole connector used for this purpose).

RCC For Radio Communication

The RCC antenna for the radio modem is connected to the BS antenna via an uplink directional coupler, DCC, located at the RCC unit to the right in the cabinet, provided that the RCC and the repeater operate in the same cell system.

RCC For Telephone Line Communication

In this unit, the telephone line will be connected to a terminal block on the RCC unit. A free strain relief bushing at the bottom of the repeater is used for the external telephone line cable.

RCC with a telephone line modem is not available when this manual is released. Please, contact Allgon for further information about this optional feature.

OMT32, Operation and Maintenance Terminal

The *OMT32, Operation and Maintenance Terminal* is an Allgon software package for configuration and controlling a repeater by using a computer with Windows 95/98 or NT 4.

The OMT32 can be used either locally, i.e. connected to the repeater, or remotely via an RCC unit or a traditional telephone line and modem.

All repeater parameters and settings can be configured by menas of the OMT32.

OMS, Operation and Maintenance System

The *OMS, Operation and Maintenance System* is an Allgon software package for controlling a large repeater fleet by using computers with Windows NT in networks with a common database.

The OMS is capable of operating a large number of repeaters. Multiple modems can be used for several incoming and outgoing parallel activities, such as polling, radio parameter configuration, software downloading, etc.

Battery Backup

Battery backup can be arranged by completing the repeater with an 25Ah or 50Ah Allgon *BBU, Battery BackUp* unit. The Allgon BBU has an exterior similar to the repeater which means that it can preferably be mounted adjacent to the repeater.

Fiber Optic Unit

A *FOU, Fiber Optic Unit* that includes transmitter, receiver, alarm board and power supply is available for the Allgon Compact repeater. The fiber optic interface can be adapted for separate uplink and downlink fiber as well as for bi-directional one-fiber distribution.

7. Repeater Alarms

This chapter contains a list of those alarms which are initiated in the repeater and generated by the repeater control circuitry.

Critical, *Error* and *Warning* alarms can be sent automatically from a repeater to an OMT32 and OMS and then be stored. These alarms can then be viewed.

The alarm handling and facilities are described in the following manuals:

- *AR Repeaters and OMT32, User's Manual*
- *Advanced Repeater OMS, User's Manual*

The table starting on the following page contains those alarms that can be generated by a Compact repeater.

Alarm Reference List

The following table contains the internal repeater alarms which can occur and be shown in the OMT32 and OMS alarm window (additional alarms may have been added to the system after issuing this manual).

ID	Alarm Text	OMS Ceasing	Alarm Unit	Alarm Level	Description
1	*Power supply*	No	PSM	*Critical*	PSM in the cabinet does not work properly. A sum signal from PSM indicates that at least one voltage output has dropped. If no mains breakdown relay is used, then the alarm will also be sent at mains breakdown.
				Ceasing	PSM in the cabinet works properly again. Ceasing is sent if the PSM works at start-up, and there is a corresponding critical PSM alarm logged in the *Events list*. The repeater will restart when the power is back and this alarm will be sent.
2	*Repeater restart*	No	BSC	*None*	Power on start, or user ordered reboot, Logged to indicate a normal power up, or a restart ordered by operator.
				Warning	Software error restart, 1st – 7th time, Restart 1st to 7th time during a 14 day period. The counter is reset every 14th day, counted from power up.
				Error	SW error restart 8th –10th time, Restart 8th to 10th time during the 14 day period. At the 11th time, the SW bank will be blocked and not used anymore until a user ordered reset is performed, or power is switched off/on.
3	*Mains breakdown*	No	External	*Critical*	The mains power is gone. Used with external relay indicating mains breakdown. The external relay should be connected to External Alarm 1 and the repeater configured to indicate this alarm. If no relay is used, a mains breakdown will be reported as a PSU fault.
				Ceasing	The mains power is back, Sent if there is a corresponding critical mains breakdown alarm logged in the *Events list*. The repeater will restart when the power is back.
4	*Alarm reset*	No	BSC	*None*	Alarm reset by the user. All alarms are reset. The alarm criteria will be re-evaluated and reported, if still active.
6	*Mains bkd w backup*	No	External	*Error*	Used to indicate that the mains is no longer available. Repeater is powered by external battery backup unit. Suggested remedy: Check the mains power.
				Ceasing	The alarm criteria has ceased.
7	*Err in AD-converter*	No	BSC	*Warning*	The analog-to-digital converter on the BSC board does not give reliable values.
8	*New unit detected*	No	BSC	*None*	Compared to last power on, the BSC board has recognized at least one additional hardware unit.
9	*Inst. unit lost*	No	BSC	*Error*	Compared to last power on, the BSC board lacks at least one hardware unit.
10	*EEPROM error*	No	BSC	*Error*	EEP read or write fail. Data cannot be written or read from the EEPROM on the BSC board. User parameters are stored in the EEPROM.

ID	Alarm Text	OMS Ceasing	Alarm Unit	Alarm Level	Description
11	*Log memory fault*	No	BSC	*Error*	Log memory fault. Indicates that the log memory on the BSC board is faulty. The repeater will not work. Not available in all BSC software versions.
12	*High temperature*	No	BSC	*Warning*	The BSC board temperature is higher than 90°C.
				Ceasing	The BSC temperature has fallen below 90°C.
13	*REFO error*	Yes	BSC	*Error*	Low level from REFO is detected.
15	*CU battery fault*	No	BSC	*Warning*	BSC RAM battery fault. The battery for the RAM on the BSC board has a voltage outside the normal 2.7 to 3.5 Volt. An alarm may be initiated at start-up if the repeater has been stored out of power for a long time. Suggested remedy: Ensure the jumper on the BSC board is mounted to charge the battery.
				Ceasing	The alarm criteria has ceased.
16	*SW load error*	No	BSC	*Error*	Software load error. An error has occurred during a software load process. The flash memory does not contain a proper software. Suggested remedy: Check the BSC software using the OMT32 software manager. Do NOT restart the repeater.
17	*Log cleared*	No	BSC	*None*	Log memory has been cleared. The check sum in the *Events list* memory is faulty. The log is cleared. Can be caused by a bad RAM battery backup or low voltage to the RAM.
18	*RTC restarted*	No	BSC	*None*	The time is changed by the operator (logged to keep track of changes made to the RTC).
				Warning	Time reset to 1994-01-01. The RTC was unable to keep track of the time did a reset. Suggested remedy: Ensure the jumper on the BSC board is mounted to charge the battery.
19	*RTC error*	No	BSC	*Error*	RTC does not operate. The BSC has detected an error in RTC operation which makes the time unreliable. Suggested remedy: Replace the BSC board.
20	*Door open alarm*	No	External	Configurable	The door has been open more than 30 seconds without disabling the alarm. EAL4 alarm.
				Ceasing	The door has been closed more than 30 seconds, or the alarm is disabled.
				Warning	The door has been open more than 30 seconds without disabling the alarm. P120 connector alarm.
				Ceasing	The door has been closed more than 30 seconds, or the alarm is disabled.
21	*External alarm 1*	No	External	Configurable	External alarm input EA1 active more than 1 second.
				Ceasing	External alarm input EA1 no longer active.
22	*External alarm 2*	No	External	Configurable	External alarm input EA2 active more than 1 second.
				Ceasing	External alarm input EA2 no longer active.
23	*External alarm 3*	No	External	Configurable	External alarm input EA3 active more than 1 second.
				Ceasing	External alarm input EA3 no longer active.
24	*External alarm 4*	No	External	Configurable	External alarm input EA4 active more than 1 second.
				Ceasing	External alarm input EA4 no longer active.
30	*No modem found*	No	Remote ctrl	*None*	No modem found, i.e. no answer is returned on a poll string to the modem.

ID	Alarm Text	OMS Ceasing	Alarm Unit	Alarm Level	Description
31	*No carrier*	No	Remote ctrl		Not logged or not used.
32	*No answer*	No	Remote ctrl		Not logged or not used.
33	*No connection*	No	Remote ctrl	*None*	No connection at callback. The repeater has tried to call as many times as stated in the alarm call criteria. No connection was established.
				Warning	No connection at alarm call. The repeater has tried to call as many times as stated in the alarm call criteria. No connection was established. This alarm does not generate a new attempt to transfer alarm by alarm call.
34	*Login failed*	No	BSC	*None*	Invalid repeater password.
35	*Remote connection*	No	Remote ctrl	*None*	Modem connection to OMT32 opened. Not logged on BSC2. *Login Registry* gives same function and more information about BSC2.
36	*Modem init failed*	No	Remote ctrl	*None*	Initiation string to modem not OK. The initiation string sent to modem is not Ok. The string may contain commands not recognized by the modem. An alarm might be sent anyway. Suggested remedy: Check the modem using the OMT32 or OMS modem debugger.
37	*Remote timeout*	No	Remote ctrl	*Warning*	The time limit of 20 minutes is exceeded without extending the timer. The modem connection is terminated by the repeater.
38	*PIN code failed*	No	Remote ctrl	*Warning*	The PIN code sent to MS is incorrect. To unlock the MS/SIM card, the PUK code will probably be needed.
				Ceasing	The alarm criteria has ceased.
39	*No phone detected*	No	Remote ctrl	*Warning*	When using a PC-card together with the MS, the alarm indicates contact with the PC-card, but MS is not present or turned off. Note: A Nokia MS does not power-up after power failure. Suggested remedy: Ensure the cellular phone is connected.
				Ceasing	The alarm criteria has ceased.
41	*RF blocking*	No	BSC UL/DL	*Error*	Constant carrier, PA off. Uplink carrier has been constantly above 27dBm for more than 10 seconds.
				Ceasing	The criteria for the alarm has not been detected for 10 seconds.
42	*Antenna isolation*	No	BSC UL/DL	*Warning*	Low antenna isolation. The antenna isolation is lower than the gain set. Gain is reduced by 10 – 13dB below the oscillation point. Suggested remedy: Decrease gain or increase antenna isolation.
				Error	Low antenna isolation at lowest gain. The gain has been reduced as much as possible but the oscillation still remains. The amplifier is turned off. Suggested remedy: Decrease gain or increase antenna isolation.
				Ceasing	Normal operation again, i.e. no oscillation can be detected 13dB above the gain set.
48	*Battery backup fault*	No	External	*Error*	If a battery backup unit alarm is connected to external alarm 2, then the operator can configure the repeater to display this alarm when the battery backup unit indicates alarm.
				Ceasing	The alarm criteria has ceased.
50	*Fiber optical error*	No	External	Configurable	If a fiber unit alarm is connected to external alarm 3, then the operator can configure the repeater to display this alarm when the fiber optical unit indicates alarm.

ID	Alarm Text	OMS Ceasing	Alarm Unit	Alarm Level	Description
55	*R2R queue full*	No	BSC	*None*	The R2R transmitting queue is full and messages are lost. Suggested remedy: Check the R2R configuration and cables.
56	*R2R node lost*	No	BSC	*None*	An R2R node is lost. Suggested remedy: Check if the node is still operating and connected.
57	*R2R HW error*	No	BSC	*Error*	R2R hardware fault. Suggested remedy: Replace the repeater.
70	*Bad table found*	No	BSC	*Error*	A requested table contains information error (software error).
71	*Table not found*	No	BSC	*Error*	A requested table was not found in the database (software or calibration error).
72	*Table database err*	No	BSC	*Error*	The database table is not found (calibration error).
121	*Synthesizer fault*	Yes	BSC UL/DL	*Error*	Unlocked synthesizer. The frequency synthesizer is unlocked and the transmission can take place on unknown frequency.
122	*Volt Reg fault*	Yes	BSC UL/DL	*Error*	A DC voltage to an analog part of the board is missing.
123	*PA fault*	Yes	BSC UL/DL	*Error*	Low power amplifier gain. The PA has too low output power for the RSSI and gain set. Not available in all BSC software versions.
125	*High temperature*	No	BSC UL/DL	*Warning*	The BSC board temperature is higher than 85°C.
				Error	The BSC board temperature is higher than 95°C and the power is turned off.
				Ceasing	The temperature has fallen to below 70°C and the power is turned on again.
126	*High PSU voltage*	Yes	BSC UL/DL	*Critical*	The PA supply voltage is too high. Suggested remedy: Ensure that correct PSM is used.

Remarks

The *Mains breakdown* alarm (3) requires a relay not included in the repeater.
The *Door open alarm* (20) requires an optional door switch.
The *Battery backup fault* alarm (48) requires an optional battery backup unit.
The *Fiber optical error* alarm (50) requires an optional fiber optical interface.

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Questionnaire

The aim of this manual is to guide you when installing and operating the Allgon repeaters, and to answer questions that may turn up. To ensure that we provide appropriate information for these purposes, we would appreciate your views and suggestions on how to improve the manual in this direction. Please, fill out the following questionnaire and send it to us.

1

Have you read entire sections or do you use the manual to look up specific information when needed?

❑ Read entire sections ❑ Look up specific information

Comments: _____

_____

2

Do you think the information is easy to find and understand?

❑ Yes ❑ No

Comments: _____

_____

3

Do you find any function of the Allgon repeater hard to understand, a function which should be subjected to more detailed description?

❑ Yes ❑ No

If yes, which one: _____

_____

4

Do you have any suggestions on how we can improve this manual?

_____

_____

_____

Title (Mr/Ms/Other): _____ Initial: _____

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Thanks for your kind help. It's very valuable to us.

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