CSR904 Repeater

User, Operation and Maintenance Manual

AVITEC

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1. Document History

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	CSR904.DOC	12/09/01	PB	-	TA	1

Revision	Revised section	Date/Sign
1	First edition	12/09/01

2. Disclaimer

Every attempt has been made to make this material complete, accurate, and up-to-date. Users are cautioned, however, that Avitec AB reserves the right to make changes without notice and shall not be responsible for any damages, including consequential, caused by reliance on the material presented, including, but not limited to, typographical, arithmetical, or listing errors.

Product names referenced in this document may be trademarks or registered trademarks of their respective companies, and are hereby acknowledged.

Guarantees

In areas with unstable power grids (mains) all repeaters must be installed with a voltage regulator ensuring a constant voltage level at the repeater power input. A maximum voltage deviation of +/- 10% from the repeaters rated voltage is acceptable for warranty purposes.

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

3. Safety Instructions and Warnings

3.1. 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 power (alt. DC) to the Repeater. Incorrect AC power settings can damage the Repeater and may cause injury to the user.

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 or system component or even the user. Do not perform any procedure preceded by a "Caution" until the described conditions are fully understood and met.

3.2. 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. Avitec AB 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 system.

CAUTION
Calls attention to a procedure or practice,
which, if ignored, may result in personal injury
or in damage to the system or system components.
Do not perform any procedure preceded by a
CAUTION until described conditions are fully understood and met.

3.3. Electrostatic Sensitivity

CAUTION
ESD = ELECTROSTATIC DISCHARGE SENSITIVE DEVICE

Observe electrostatic precautionary procedures.

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 charge 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.

4. Introduction

4.1. Purpose

The purpose of this document is to describe the electrical and mechanical specifications, operation and maintenance of the CSR 904 Repeater.

4.2. Scope

This document is the product description for the Avitec Repeater CSR 904.

4.3. Definitions

ALC	Automatic Limit Control
ARFCN	Absolute Radio Frequency Channel
BTS	Base Transceiver Station
BCCH	Broadcast Control Channel
Band Selective Repeater	A repeater that is designed for operation on a combination of channels within a specified band of frequencies, within the operating band of the repeater.
Broadband Repeater	A repeater, which is designed for operation on any combination of, specified maximum number of channels within the operating band of the repeater.
Channel Selective Repeater	A repeater, which is designed for operation on a specified subset of channel within the operating band of the repeater. The subset of channels may be determined during the manufacture of the repeater, or may be programmable.
Downlink (DL)	RF signals that are transmitted from the BTS and relayed to mobile radio equipment.
EMC	Electromagnetic Compatibility
GND	Ground
LED	Light emitting diode
LNA	Low Noise Amplifier
MTBF	Meantime between failures

Definitions Continued

NA	Not Applicable
NC	No Connection
NF	Noise Figure
Repeater	A bi-directional Radio frequency (RF) amplifier that can amplify and transmit a received Mobile Station (MS) signal in the MS transmit band. In addition, simultaneously it can amplify and transmit a received Base Transceiver Station (BTS) RF signal in the BTS transmit band.
RF	Radio Frequency
RS232	Serial Interface Protocol
SN	Serial Number
SDCCH	Stand Alone Control Channel
TCH	Traffic Channel
Uplink (UL)	RF signals that are transmitted from mobile radio equipment to the BTS

4.4. References

[1] ETS 300 086.

Radio Equipment and Systems Land mobile service Technical characteristics and test conditions for radio equipment with an internal or external RF connector intended primarily for analogue speech

[2] ETS 300 609-4.

Digital cellular telecommunications system (phase 2): Base Station Systems (BSS) equipment specification: Part 4 : Repeaters.

[3] 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.

4.5. General

Mobile Communication systems transmit signals in two directions, between base station and mobile radio equipment. If weak radio transmissions occur within the coverage area, and they are due to topological conditions or distance from the transmitter, a repeater system is used to extend the transmission range.
In the downlink path the repeater will pickup the signal from an existing coverage area via a donor antenna, it then amplifies it and re-transmits it into the desired poor coverage area. In the uplink direction the repeater will receive signals from the mobile radios in the covered area and re-transmit them to the corresponding base station.

5. Functional Description of CSR 904 Repeater

5.1. General Description

The channel selective repeater is a 4-channel repeater for GSM systems, which has a minimum output power of 2W per carrier. The repeater is designed to have a small form factor with separate modules for each channel in both transmit and receive directions.

The frequency and amplification can be individually controlled via two alternative methods of communication. The monitoring and control of the system can be conducted either with a direct connection via an RS232 cable to a laptop computer or via the Data Call function (wireless interface) of the network operator.

An aluminium case houses the repeater. Cooling fins for the amplifiers are located on the rear of the unit. Aluminium is chosen as the case material, which gives a lightweight design with good heat conduction and protection against the elements. The housing conforms to IP65 and NEMA 4 standards.

Connections are made with 7/16” and type-N connectors that are located on the underside of the repeater. The external connections on the bottom are protected from unauthorised access with a cover, which can be opened only from the inside of the repeater.

The repeater units can be divided into the following modules:

- Channel Modules
- Power Amplifier Modules
- Power Supply Module
- Duplex Filter Module
- Control Module
- Reference Generator
- Low Noise Amplifier Module
- Combiners

Internal View of Repeater

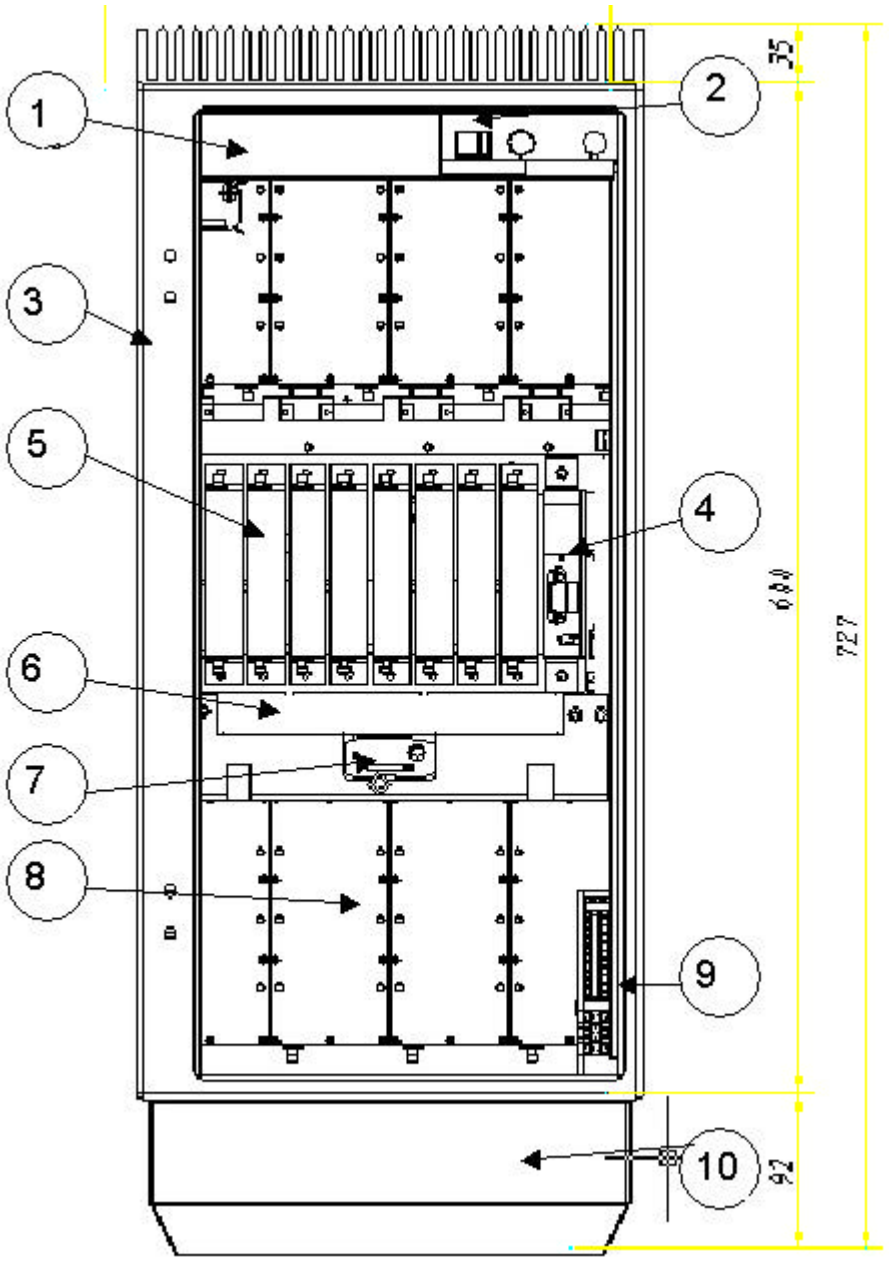


Figure 1

1	Battery	6	Splitter(x2)
2	Power Supply	7	Modem
3	Combiner (x2)	8	Amplifier (x8)
4	Control Module	9	Mains RFI filter
5	Channel Modules (x8)	10	Cable Protector

Signal path through the Repeater for a signal in the DL passing through channel 1

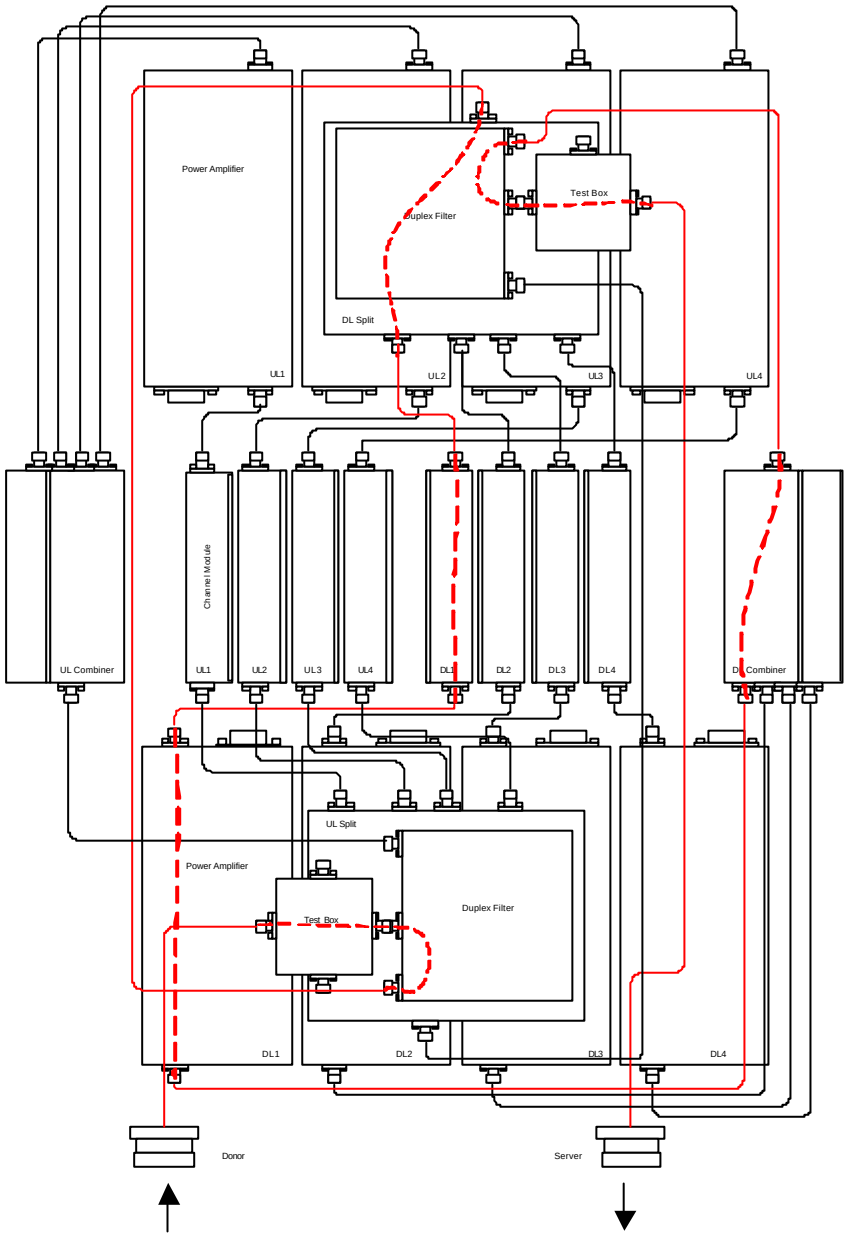


Figure 2 -

The signal enters the antenna port from the donor antenna. It then passes through the test box and duplex filter before passing through the splitter and then being selected by the assigned channel unit from where the selected channel passes on to the power amplifier before being combined and transmitted via the server antenna after having passed through the duplex filter closest to the server antenna connector.

6. To Get Started - Basic Software Control of the Repeater

6.1. General

The repeater is equipped with a control module that allows the monitoring and control of various parameters such as channel number, attenuation, temperature, status of door, etc.

The communication interface between the local terminal and the control module is set up as a self-explanatory menu for simple manual control and monitoring. This way, the parameters can easily be observed and set up from the terminal display.

This can be performed either via a terminal (PC) locally, or via remote login through the built in wireless interface.

To get the repeater operating on-air, you only have to set-up three parameters:

1: ARFCN to be repeated.
2: Desired attenuation (gain) in each signal path.
3: Desired ALC levels in each signal path

NOTE: This procedure is simplified with the built in input and output power monitoring functions of the repeater.

6.2. Terminal Set-up

The easiest way to perform set-up is to use the user-friendly Repeater Maintenance Console(RMC) software package to configure the repeater.
(Please refer to the Repeater Software Manual for more detail)

Connect a straight 9PIN RS232 cable to the 9PIN DSUB female connector located on top of the control module in the repeater. Any VT-100 compatible terminal unit can be used, one example is the "Hyper Terminal" terminal emulation software included in Windows 95/98/NT4/Windows 2000.

The terminal parameters should be set as follows:

Baud rate 9600, Parity None, 8 Data bits, 1 Stop bit, and “no flow control”.

When the repeater is switched on, it will start its initialisation procedure, and information will be displayed on the terminal screen. Wait for 10-20 seconds and the press the 'Enter' key. This brings up the AVITEC Login screen, which asks for the Username and Password. Different user accounts may have different authorities. The default login parameters are

Username	Password	Authority
USERNAM1	PASSWRD1	Read/write
USERNAM2	PASSWRD2	Read/write
USERNAM3	PASSWRD3	Read only
USERNAM4	PASSWRD4	Read only

Type **USERNAM1** followed by Enter. Repeater now prompts for Password.

Type **PASSWRD1** followed by Enter. You are now logged in.

Type **STATUS** followed by Enter. This displays the current repeater settings and status.
(This screen can also be viewed by pressing F3.)

NOTE 1: Login activation may take several seconds if the control module is busy with remote communication.
NOTE 2: The username and password should be changed during installation.

The control module logs the allowable number of failed login attempts. If this count exceeds the user defined maximum (default = 8), then future login attempts are no longer allowed. The false login count value is decremented by one every hour. This means that it takes one hour after reaching the maximum number of failed login attempts, before a successful login can be initiated.

6.3. Commands Necessary to Set up Remote Access

When the repeater is delivered, the back-up battery will be disconnected. The battery cable connector is placed at the telephone on the inside of the repeater door. Before starting with the set-up of the telephone, please connect the cables together. In a case of power disruption this battery will supply the wireless interface and the control module with power. The battery is fully charged after the repeater has been connected to external power for 24 hours.

Configuring for DATACALL: Insert the SIM-card into the Wireless interface and type the following four commands on the terminal:

SET PIN xxxx	Where xxxx is the PIN code of the SIM card. NOTE: ensure the SIM card has a DATACALL number and is activated. If PIN-code is disabled, leave XXXX blank.
SET MTP Wavecom	Sets the modem type: Wavecom
SET ASC **SET MIS AT+CBST=0,0,3** **or** **SET MIS AT+CBST=7,0,3**	Clears any old telephone number the repeater calls on alarm Sets the modem initialisation string. Note! These strings work in most networks, but might have to be adjusted from network to network.
SET DEV DTC **ACT RCD** **LOGOUT**	Set up for datacall (modem) communication. Resets the communications device after next logout Exits the terminal mode

After entering the commands, logout by using the command **LOGOUT.** Observe the display that the modem has been successfully initialised.

During this procedure the wireless interface will try to register into the GSM network, which will only be possible if the repeater is connected to antennas. For lab tests with 50 Ω attenuators on repeater ports, it is possible to temporary disconnect the wireless interface antenna cable SMA connector from the box and connect it to a small whip antenna.

One can now remotely log in to the repeater by dialling the DATA CALL number of the SIM card.

NOTE:
Do not try to enable the wireless interface for DATA CALL traffic if it has not registered any GSM radio signal. If an attempt to enable the wireless interface is done when a very weak GSM radio signal is detected, the communication between the repeater and the terminal will be extremely slow.

6.4. Commands to Control RF Parameters

The best method of controlling RF parameters is by using the 'user-friendly' Maintenance Console software. One may control RF parameters when in Terminal mode by using the following commands followed by the 'enter' key:

SET CHA 1 xxx 2 yyy 3 www 4 zzz	Sets repeater channel 1 to ARFCN xxx and channel 2 to ARFCN yyy etc.

It is also possible to set only one channel at a time, for example:

SET CHA 1 30

SET ATD 1 xx 2 yy 3 zz 4 ww	Sets attenuation to xx in downlink channel 1, yy in channel 2, zz in channel 3 and ww in channel 4
SET ATU 1 xx 2 yy 3 zz 4 ww	Sets attenuation to xx in uplink channel 1,yy in channel 2, zz in channel 3 and ww in channel 4

NOTE: Attenuation is set in 2 dB steps from 0 to 30dB.

Ex: SET ATU 1 22 2 22

Attenuation Table

Gain dB	Attenuation
85	0
83	2
81	4
79	6
77	8
75	10
73	12
71	14
69	16
67	18
65	20
63	22
61	24
59	26
57	28
55	30

To shorten the command to only control one channel, see above.

SET LVU 1 xx 2 yy 3 zz 4 ww	Sets ALC Uplink to xx for channel 1, yy for channel 2, zz in channel 3 and ww in channel 4
SET LVD 1 xx 2 yy 3 zz 4 ww	Sets ALC Downlink to xx for channel 1, yy for channel 2 zz in channel 3 and ww in channel 4

Valid ALC levels are 33, 30, 27 and 0. Setting to 0 means that the output power is switched off.

Example:

```
SET LVU 1 30 2 30 3 0 4 0
```

6.5. Functional Description of Repeater Modules

6.5.1. Channel Modules

Every channel module consists of an IF down-converter with SAW filters, an IF up-converter, and a post amplifier. The module contains a power level control unit.

6.5.2. Power Amplifier Modules

The power amplifiers are composed of temperature-compensated gain blocks. The power transistors are designed to minimize inter-modulation products. The power amplifier has four watts of output power.

6.5.3. LNA/Power Splitter Module

The LNA/Power Splitter Module consists of a low noise amplifier in front of a power splitter. The module provides the initial gain for a good noise figure and also splits the received power between the four channels of the repeater.

6.5.4 Power Supply Module

The power supply module is connected to all other electronic modules. The AC input is equipped with an EMI, EMC and surge suppression filter.

6.5.5 Duplex Filter Module

The transmit antenna is combined with a duplex filter operating in the appropriate band. The filter consists of band-pass filters that provide isolation from out-of-band signals.

6.5.6 Control Module

The surveillance and control of the repeater are carried out with the help of the Control Module. This module determines the status of all channel modules and identifies error conditions. When an error occurs, the control module will send an alarm via DataCall to the Element Manager at the operator's monitoring centre. The control module sends and receives all channel and amplification data for the addressed channel modules.

Examples of monitored parameters are:

Status of synthesizers
Amplifier Chain Gain Alarm
BCCH alarm
Temperature alarm
Etc….

7. CSR 904 Repeater Specification

7.1. General

7.1.1. Frequency Hopping and Repeaters

The CSR904 four channel repeater is fully compatible with base band frequency hopping, as long as only four frequencies are being used for hopping by the BTS, and the repeater is configured for exactly those four frequencies.

7.1.2. Antenna Isolation

Avitec recommends that the isolation between the donor and server antennas is15 dB greater than the maximum gain in the repeater (85 dB gain => 100dB isolation). This is to make sure that feedback problems are minimised.

7.1.3. Minimum Channel Spacing

The minimum recommended spacing between the two amplifier chains is **four GSM channels** (0.8MHz).

7.2. Electrical Specification RF

Frequency range	890 - 915 MHz in Uplink 935 - 960 MHz in Downlink
Impedance	50 Ω
Number of channels	1 - 4
Channel programming	In 200 kHz Channel spacing, individually programmable
Channel bandwidth	200 kHz
Selectivity	> 35 dB at 400 kHz > 45 dB at 600 kHz
Ripple	< 1 dB in Passband
Sensitivity	< -105 dBm at S/N 9 dB
Max. Input level	Up to + 10 dBm
Gain	85 dB nominal in both signal directions
Propagation delay	<7 us
Gain adjustment	55 - 85 dB in 2 dB-Steps, individual for both signal paths
Output power	> 33 +0/-1,5 dBm per carrier in Downlink > 33 +0/-1,5 dBm per carrier in Uplink
Intermodulation	< -36 dBm (2 carriers, +33 dBm, 600 kHz)
Spurious responses	< -36 dBm for 9 kHz - 1 GHz < -30 dBm for 1 GHz - 13 GHz
Return loss at the antenna connections	> 16 dB
Output Connectors	7/16 Female
External earthing connection	Negative pole of DC supply connected to the case
External alarms	High logic level: 12 V - 24 VDC Low logic level: 0 VDC

7.3. Electrical Specification Power Requirements

200 - 260 VAC, 50 Hz +/-2 Hz, < 200 W

or 48Vdc option available on request.

7.4. Mechanical Specification

Housing (w x h x d)	300 x 637 x 213mm
Weight	30 kg
Housing material	Aluminum
Grounding connection	In connecting panel, threaded M6 size bolt
Connection panel	Protected against unauthorized access
Color	Grey (painted)
Anchor screws	≤ M8 screws
Cooling	External convection (no ventilation slots or fans)

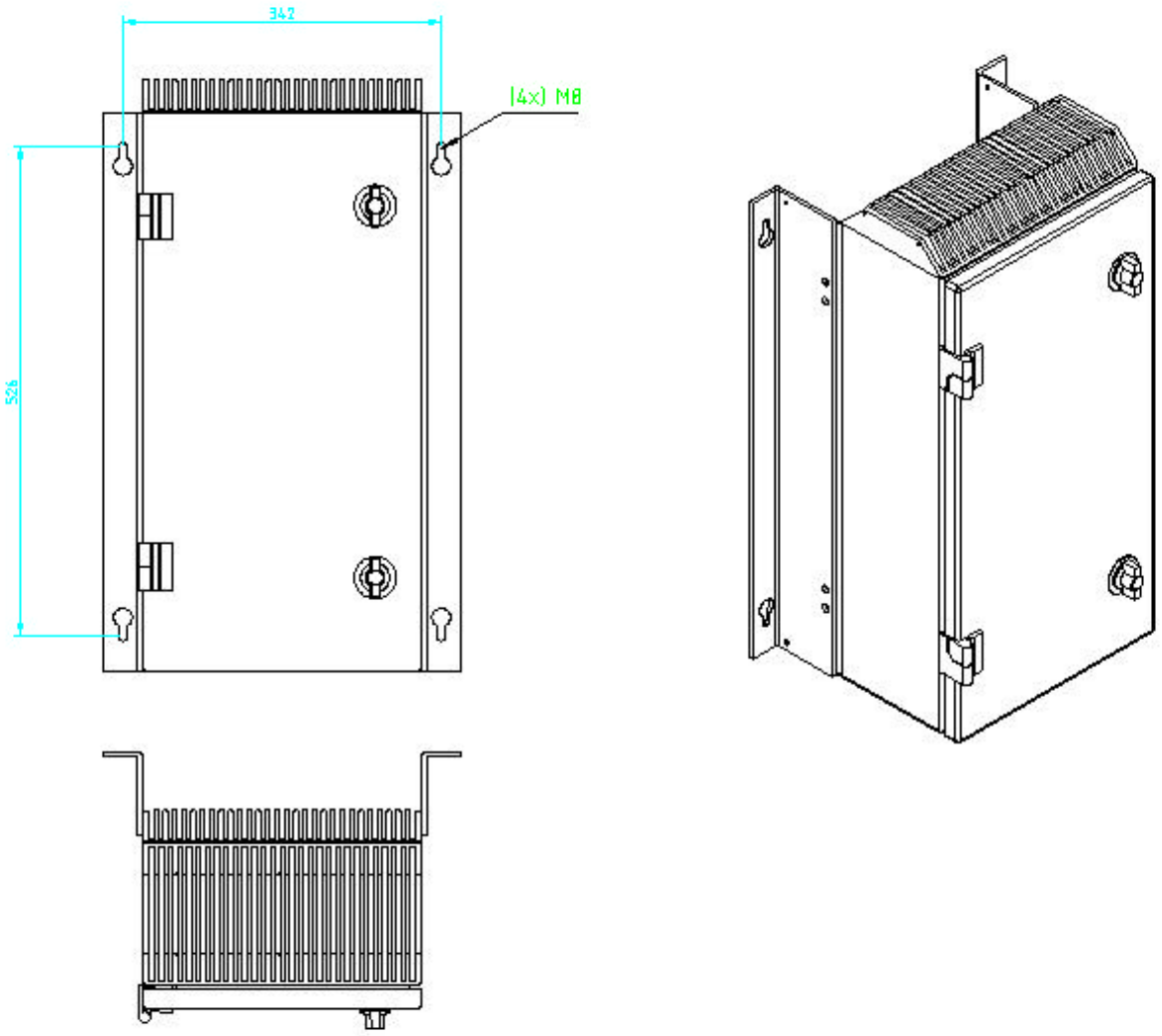


Figure 3

7.5 Block Diagram CSR904

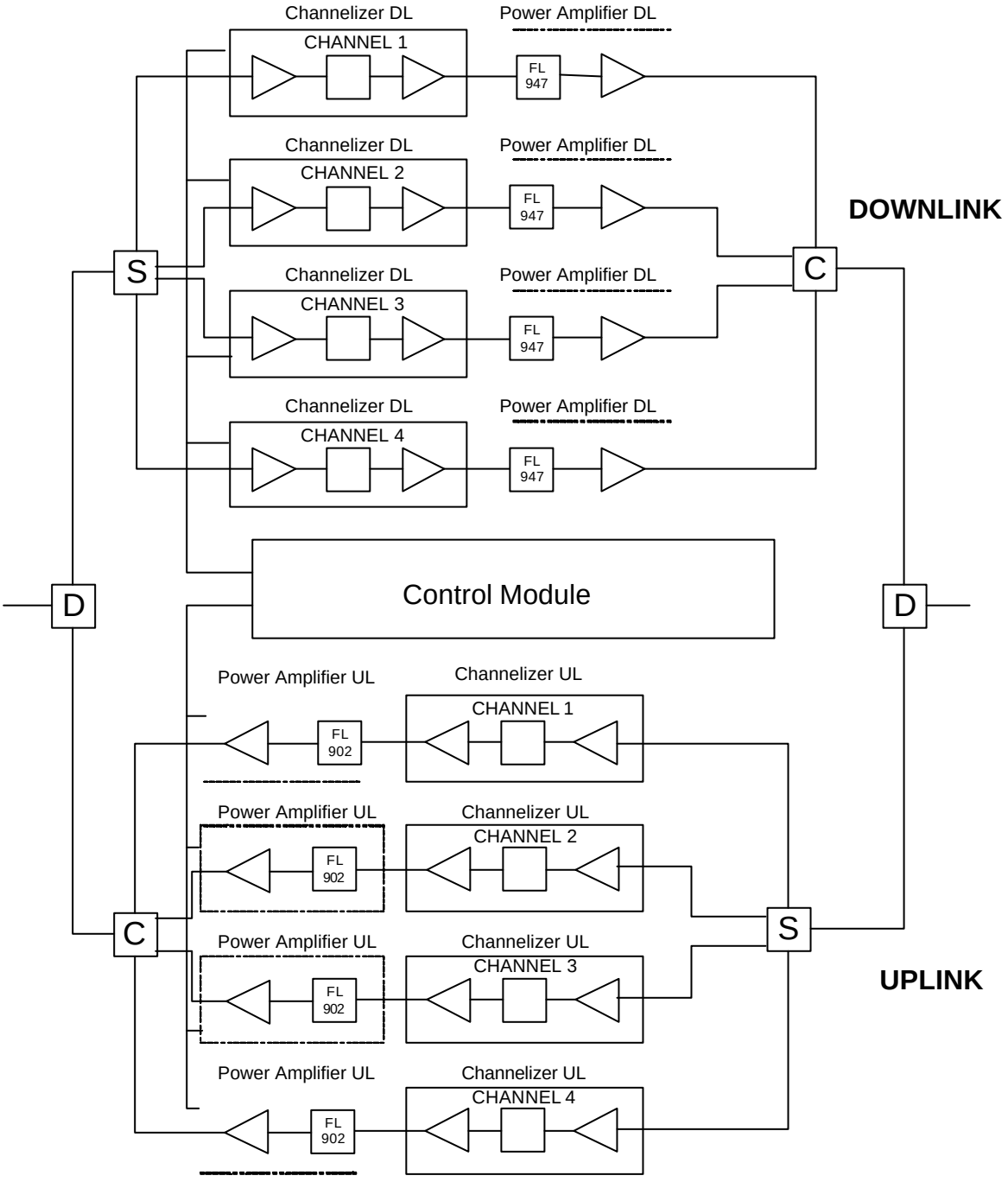


Figure 4

7.6 Environmental Specification

EMI	Meets the specifications for influx of an electromagnetic field of 10V/ between 100kHz - 1GHz, excluding the band of operation
Acoustic noise floor	< 50 dB (acoustic) relative to 1pW transmitted volume
Operating temperature	-25° C - +55° C, class T 4.1 conforms to ETS 300 019-1-4
Storage temperature	-30° C - +75° C
Humidity	100 %, class T 4.1 conforms to ETS 300 019-1-4
Static charge	Antenna connections DC-coupled to ground reduces static charge
Enclosure	NEMA 4, protection class IP65 after DIN 40 050, designed for external mounting
Storage	Class1.2 conforms to ETS 3000 19-1-1

7.7 Other Specifications

MTBF	>50,000hrs
EMC	ETS 300 342-3
Electrical Safety	EN 60 950

8. Control Module

8.1. General

The repeater is equipped with a control module that facilitates the monitoring and control of various parameters such as channel number, attenuation, temperature, status of door, etc. The communication interface between the local terminal and the control module is set up as an easy to follow menu for simple manual control and monitoring. This way, the parameters can easily be observed and set from the terminal.

This can be performed either via a terminal (PC) locally, or via remote login through the built in wireless modem located on the inside of the repeater door.

8.2. Commands

A complete list of all commands and other software related information is found in the Command and Attribute Summary supplied together with this users manual.

8.3. Command log

A command log, kept in the control module, stores the last ten commands entered. Use the up and down arrow keys to browse stored commands. The right and left arrow keys may then be used, along with the backspace and clear buttons, to edit the command.

8.4. Quick commands

Four quick commands are available with the function keys when using the Terminal Mode:

F1:	help menu
F2:	shows a list with the last ten entered commands
F3:	status screen
F4:	traffic data.

8.5. Configuring the external alarms

The external alarms can be configured active-low or active-high.
Active high means that an applied voltage of between 12 and 24 Volts will cause the external alarm indicator to turn red.
Active low means that when there is no voltage the alarm indicator turns red.

Examples of Software Commands for the external alarms are shown below:
`SET EXT X Y Z W` (X is configuration of alarm 1 and Y of alarm 2 etc…)
If X is set to 1 and Y to 0 then alarm 1 is active low and alarm 2 is active high.

To set the delay before the alarm is activated the following command is used:
`SET ALA EX1 X Y Z LLL UUU TTT`
The letters represent digits. The delay in seconds takes the place of `TTT`.
e.g. `SET ALA EX1 0 1 0 030 030 002`. This indicates a delay of 2 seconds.
All software commands are described in the Command and Attribute Summary.

8.6 LED indicators

The LED on the control module is tricolour, where each colour has a distinct meaning:

Green	Repeater is functioning properly
Red	Repeater is not functioning properly
Amber	User logged in to control module, either locally or remotely.

NOTE: Depending on alarm configuration, the door alarm may go off a few seconds after the door has been opened; in this case, the LED will turn red.

9. System Maintenance

9.1. General

The system normally operates without any operator intervention or maintenance. If' in the unlikely event of any unit failure, the field replaceable units (antenna unit, cables) should be checked and the system restored. A failed unit can be removed and replaced with a spare while the rest of the system (other repeaters) are still operating. However, the power supply of the failed repeater should be isolated from AC mains and DC power before any module is replaced.

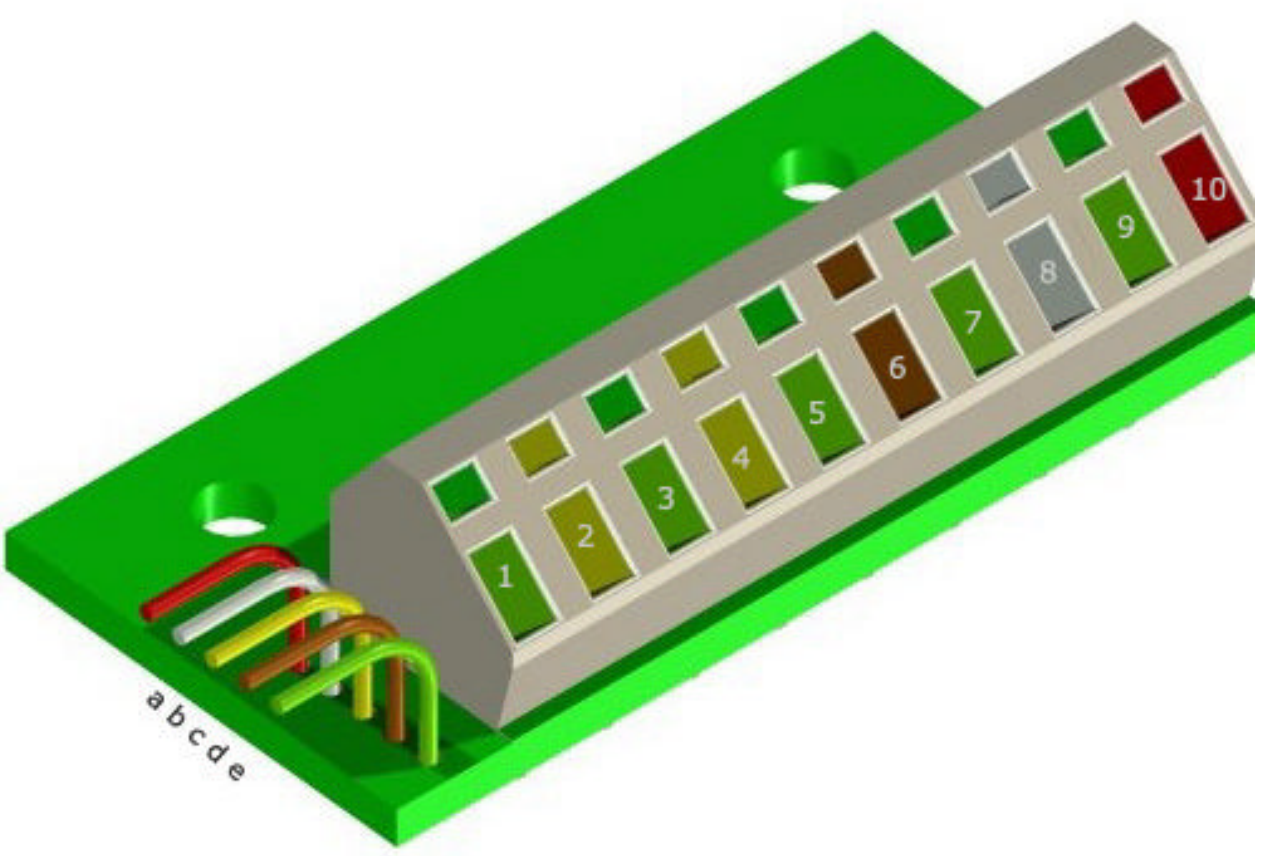
9.2. Preventative Maintenance

The CSR 904 repeater does not require any preventative maintenance.

10. Frequency and Channel List

GSM Ch	Uplink MHz	Downlink MHz	GSM Ch	Uplink MHz	Downlink MHz	GSM Ch	Uplink MHz	Downlink MHz	GSM Ch	Uplink MHz	Downlink MHz
1	890,20	935,20	32	896,40	941,40	63	902,60	947,60	94	908,80	953,80
2	890,40	935,40	33	896,60	941,60	64	902,80	947,80	95	909,00	954,00
3	890,60	935,60	34	896,80	941,80	65	903,00	948,00	96	909,20	954,20
4	890,80	935,80	35	897,00	942,00	66	903,20	948,20	97	909,40	954,40
5	891,00	936,00	36	897,20	942,20	67	903,40	948,40	98	909,60	954,60
6	891,20	936,20	37	897,40	942,40	68	903,60	948,60	99	909,80	954,80
7	891,40	936,40	38	897,60	942,60	69	903,80	948,80	100	910,00	955,00
8	891,60	936,60	39	897,80	942,80	70	904,00	949,00	101	910,20	955,20
9	891,80	936,80	40	898,00	943,00	71	904,20	949,20	102	910,40	955,40
10	892,00	937,00	41	898,20	943,20	72	904,40	949,40	103	910,60	955,60
11	892,20	937,20	42	898,40	943,40	73	904,60	949,60	104	910,80	955,80
12	892,40	937,40	43	898,60	943,60	74	904,80	949,80	105	911,00	956,00
13	892,60	937,60	44	898,80	943,80	75	905,00	950,00	106	911,20	956,20
14	892,80	937,80	45	899,00	944,00	76	905,20	950,20	107	911,40	956,40
15	893,00	938,00	46	899,20	944,20	77	905,40	950,40	108	911,60	956,60
16	893,20	938,20	47	899,40	944,40	78	905,60	950,60	109	911,80	956,80
17	893,40	938,40	48	899,60	944,60	79	905,80	950,80	110	912,00	957,00
18	893,60	938,60	49	899,80	944,80	80	906,00	951,00	111	912,20	957,20
19	893,80	938,80	50	900,00	945,00	81	906,20	951,20	112	912,40	957,40
20	894,00	939,00	51	900,20	945,20	82	906,40	951,40	113	912,60	957,60
21	894,20	939,20	52	900,40	945,40	83	906,60	951,60	114	912,80	957,80
22	894,40	939,40	53	900,60	945,60	84	906,80	951,80	115	913,00	958,00
23	894,60	939,60	54	900,80	945,80	85	907,00	952,00	116	913,20	958,20
24	894,80	939,80	55	901,00	946,00	86	907,20	952,20	117	913,40	958,40
25	895,00	940,00	56	901,20	946,20	87	907,40	952,40	118	913,60	958,60
26	895,20	940,20	57	901,40	946,40	88	907,60	952,60	119	913,80	958,80
27	895,40	940,40	58	901,60	946,60	89	907,80	952,80	120	914,00	959,00
28	895,60	940,60	59	901,80	946,80	90	908,00	953,00	121	914,20	959,20
29	895,80	940,80	60	902,00	947,00	91	908,20	953,20	122	914,40	959,40
30	896,00	941,00	61	902,20	947,20	92	908,40	953,40	123	914,60	959,60
31	896,20	941,20	62	902,40	947,40	93	908,60	953,60	124	914,80	959,80

12 Connecting the External Alarms



The CSR 904 is designed for four external alarms per unit.
External alarms are connected to terminals[(3),(4) alarm 1],
[(5),(6) alarm 2], [(7),(8) alarm 3] and [(9),(10) alarm 4].

Wire e is electrically connected to slots 1,3,5,7and 9. These are grounded.

The flat cable from the terminal board is connected to the distribution board that is part of the back plane.

The external alarms shall have a voltage between 12 and 24 VDC.
Terminals (3,4), (5,6), (7,8) and (9,10) shall be used.

Please refer to section 8.5 on how to configure the external alarms.

13. Quick Installation Guide-CSR 904

A basic knowledge of repeater systems is recommended before starting an installation. We will therefore begin with a brief description of the products covered in this guide and explain in general terms how a channel selective repeater system works.

Figure 1 illustrates a typical channel selective repeater system.

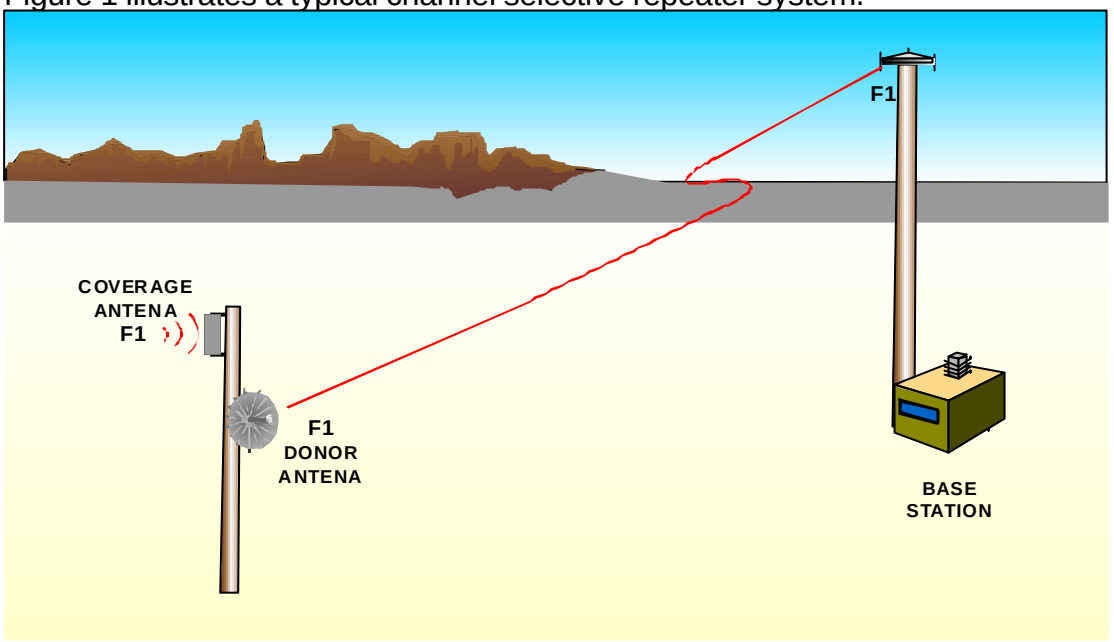


Figure 1.

The Channel Selective Repeater

The channel selective repeater system consists of a remote unit with one antenna facing the donor BTS and the other facing in the direction of the area requiring coverage.

The repeater is a bi-directional amplifier and transmitter relaying signals from the base station to the MS and vice versa.

Channel selective means that a single GSM carrier is filtered amplified and retransmitted per channel module in the repeater.

The maximum output power per carrier in Avitec's CSR 904 channel selective repeaters is 2 Watts (33Bm)

The channel selective repeater systems manufactured by Avitec have been designed for flexibility and ease of installation.

Modules can be combined in different ways to suit customer preferences.

Avitec has 3 basic units available for the GSM 900 system.

- CSR902 (Up to two carriers, 900MHz)
- CSR904 (Up to four carriers, 900MHz)
- CSF902 (Up to two carriers, Fibre optic link, 900MHz)

Site Selection

The repeater site shall be located where the BTS signal strength is at least –67dB. This is assuming a pick-up antenna gain of 15 dBi. The max repeater gain is 85dBm. At these levels the maximum repeater output of 33dBm would be achieved. In practice therefore the signal strength should be a little higher than –67dB in order to compensate for cable losses and pick-up antennas that perhaps have a gain less than 15dBi. It may not always be necessary or desirable to get full output from the repeater especially if the area requiring coverage is not too large or limited in some way. Antenna gain and prices go hand in hand.

Antennas

Proper selection of the repeater's pick-up and server antennas is crucial in designing the repeater system, High gain directional antennas with good front to back ratios (25 dB or better) should be used. The front to back ratio is not to be confused with antenna gain. The front to back ratio is an indication of the front lobe signal in relation to the back lobe signal

Antenna Isolation

Antenna isolation is one the most important factors influencing the performance of a channel selective repeater. This is because bad isolation can lead to oscillation. This will occur as soon as the isolation is less than the gain. The recommended isolation is 10-15dB greater than the repeater gain.
There is however no definitive figure for antenna isolation. Sometimes distances of 20 meters or more might be needed and in other cases a distance 6 or 7 meters might suffice. This is due to all the difficult to predict variables associated with wave propagation. All sites have their own special requirements and the numbers used in this guide are for relatively average sites.

Example:

If repeater gain is 75dB then antenna isolation should be 85-90dB
Isolation between the server and pick-up antennas can be achieved using one of several different methods or a combination of methods.

Vertical Antenna separation.
Grounded metal shield between antennas.
Horizontal Antenna Separation

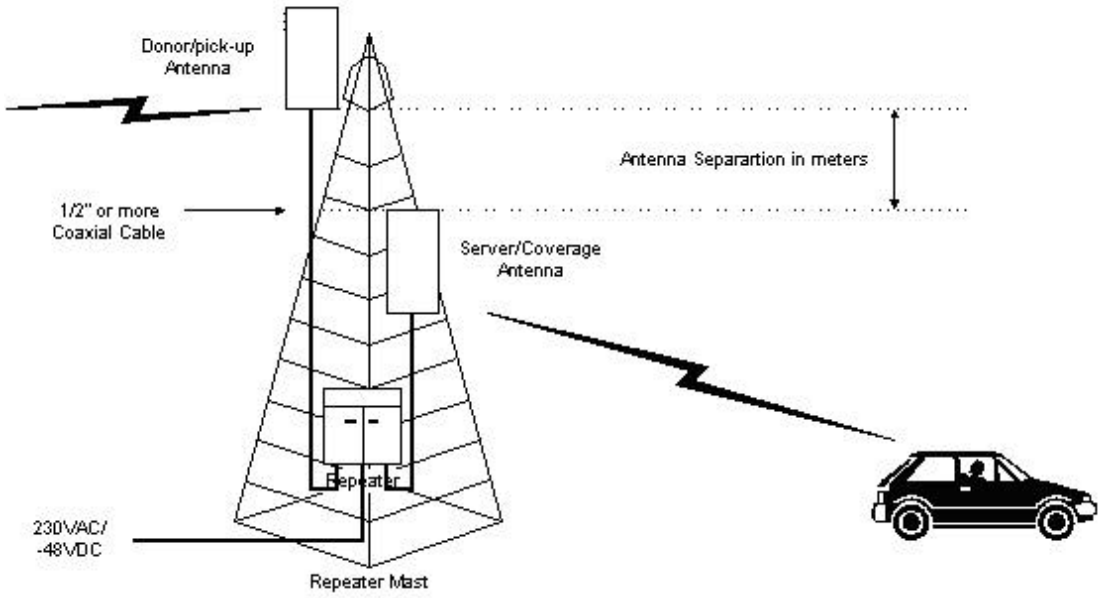


Figure 2.

The following table can be used as a guideline for antenna separation.

Using shielding and highly directional antennas with good back to front ratios can substantially reduce the distance between antennas.

VERTICAL ANTENNA SEPARATION		HORIZONTAL ANTENNA SEPARATION	
Separation (m)	Isolation (dB)	Separation (m)	Isolation (dB)
5	75.0	5	45.5
10	87.1	10	51.7
20	99.1	50	65.5
30	106.2	100	71.5
40	111.2	150	75.1
50	115.0	250	77.6

Figure 3

The table in figure 3 demonstrates that vertical separation is more effective.
The physical separation between the donor and server antennas has been calculated using the following formulas.

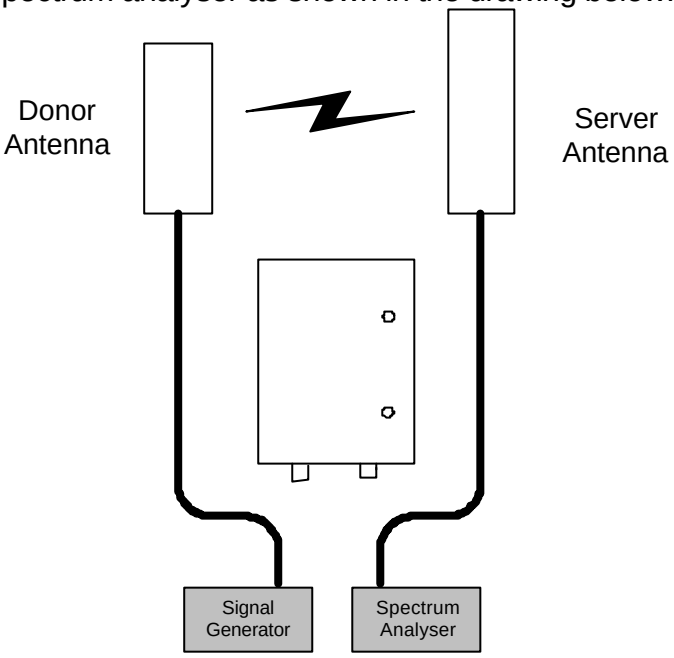
Vertical Separation: $I(dB)=28 +40 \log(D/\lambda)$
Horizontal Separation: $I(dB)=22 + 20\log(D/\lambda)$

I = Isolation
D = Distance between donor and server antennas
λ =Wavelength (m)
Gd =Gain of donor antenna facing server antenna (dB)
Gs =Gain of server antenna facing donor antenna (dB)

When the desired isolation cannot be achieved through vertical or horizontal separation shielding can be used. Mounting antennas on either side of a building is a commonly used form of shielding. A mast with two antennas is however more difficult to deal with. In this case metal screening with wire mesh or similar screening material needs to be used.

How to measure Isolation between Server and Donor/Pick-up antennas.

There are several ways of measuring the isolation between antennas, some more accurate than others. The recommended method is to use a signal generator and a spectrum analyser as shown in the drawing below.



Measure the signal generator output with a spectrum analyser.
Disconnect the antenna cables from the repeater and make sure the repeater is switched off. Connect one antenna cable to the signal generator and one to the spectrum analyser. Measure the signal strength and subtract the figure gathered during the first measurement. The difference is the antenna isolation.

Installation

To consider before installation

- What type of power does the repeater require?
    - Mains AC (230V) or –48VDC
- Is there adequate grounding and lightning protection (EMP)?
    - Earth cable should be Min. 16mm″
- Is there adequate antenna isolation?
- What kind of repeater system is being installed?
- Is there a clear line of sight between the BTS antenna and the Repeater's Donor (Pick-up) antenna?
- Try to mount the repeater unit where it is easily accessible.
- It is important that the antennas at the repeater site are as far as possible aligned in opposite directions.
- Make sure that cables and connectors are compatible. Using cables and connectors from the same manufacturer is one way of doing this.
- If the BTS has different sectors always choose to use the carriers used in the sector facing away from the remote site in order to avoid coverage overlap.
- A sealing compound such as silicone or vulcanizable tape should be used to waterproof all joins as moisture and dust can impair RF characteristics.

Remember: The antenna cables or 50Ω terminators must be connected to the repeater before mains power is switched on.

The Repeater site

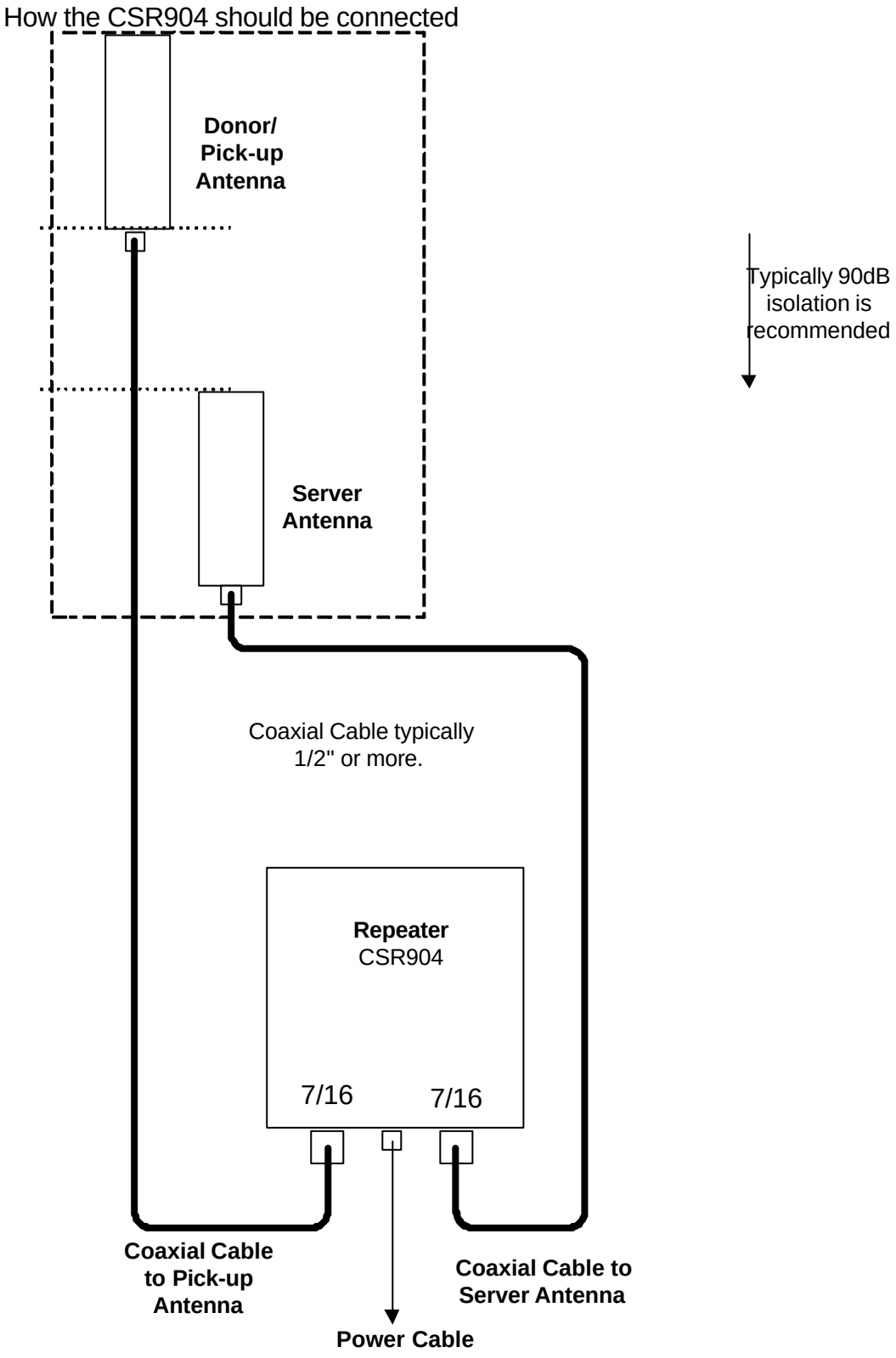
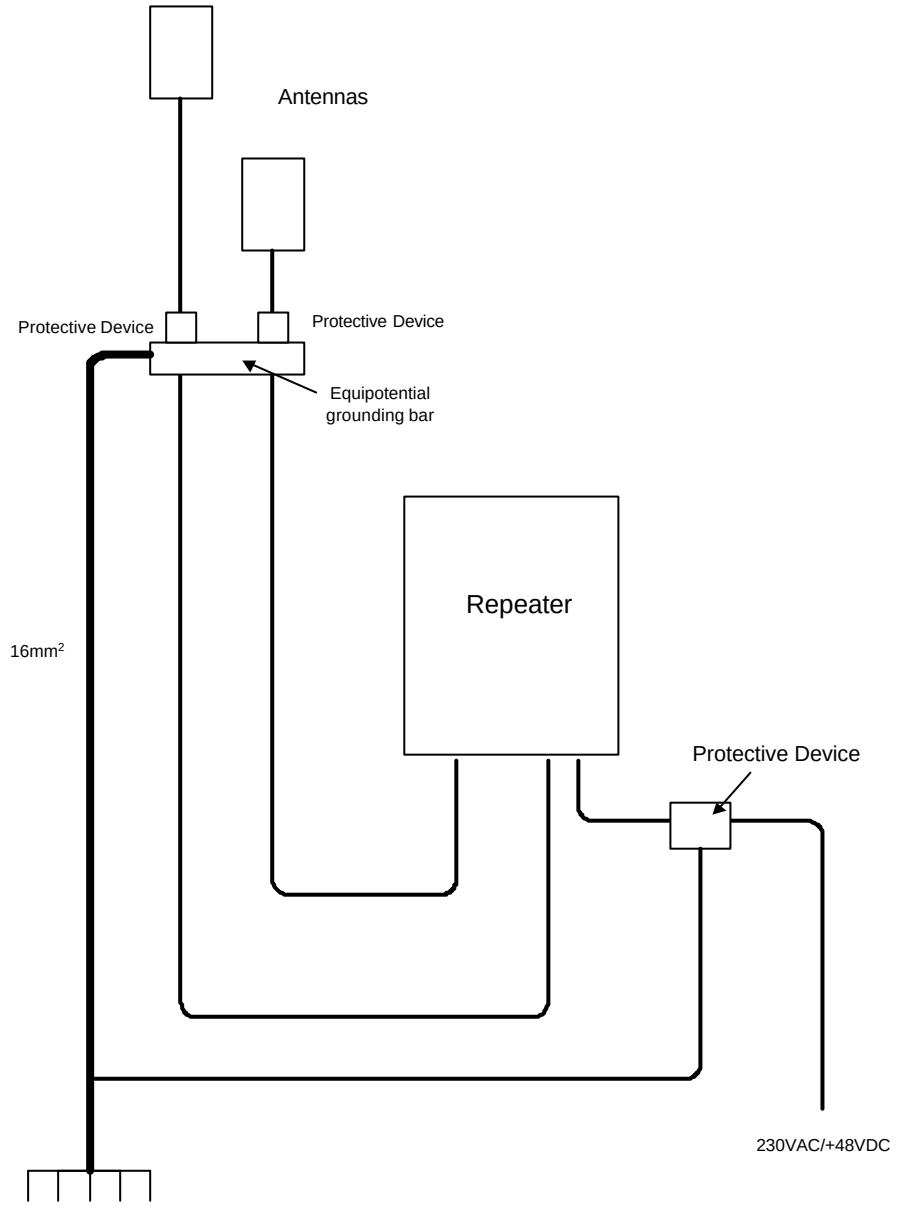


Figure 3.

EMV Protection (Lightning)



Grounding and lightning Protection measures are also essential ingredients in the construction of a reliable repeater site. All cables should be fitted with suitable Lightning protection devices that should in turn be connected to an adequately dimensioned grounding cable. The minimum recommended conductive area for such a Cable is 16mm″.

All coaxial cables and power cables need to be protected from the transients that lightning can cause.
If all the paths into the repeater and base station are protected with protective devices the chances of damage by lightning are reduced. Sometimes several lightning protection devices are used in series with declining threshold voltages. This helps attenuate the part of the pulse that breaches the first layer of protection.

Getting the Repeater started

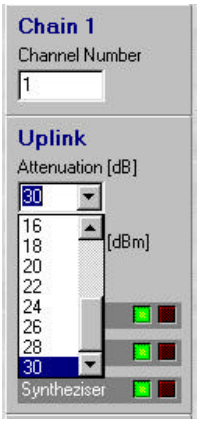
Once the repeaters, their antennas and cables have all been mounted and connected it is time to start testing the system. Avitec's Remote Maintenance Console (RMC) is an essential tool in this process.

In order to use the RMC you will need the following:

- A PC with operating system Windows 95/98, NT or Windows 2000.
- The program in the form of diskettes or CD.
- A modem and telephone line or a suitable cable if direct connection to the repeater is desired.
- The Data Call number to the repeater.(Looks like a telephone number but is for data transfer only)

How the RMC is installed is explained in a separate instruction sheet available from Avitec.
Before the RMC can establish contact with the repeater the power must be switched on.
The default window in the RMC is BASICS. From this window most of the parameters can be set.

Screen Dumps from the RMC



Attenuation menu

Power Limit menu

When commissioning a repeater for the first time it is important to set the attenuation levels at a maximum and then slowly reduce them until the desired output signal strength is reached. (Start with 30 and lower this figure to raise the output power)
Zero attenuation is the same as maximum amplification.
Attenuation tables are available in the manual supplied with the product.

If the gain is set too high, feedback may result.

The power limit menu limits the output power to the figure chosen or the channel can be switched off completely by clicking on **off.**