

RF / DBR Series**OPERATION & INSTALLATION MANUAL****DB6MR20 (Dual Band)
Six Sub-Band Repeaters for In-Door Applications**

FCC ID:S3CDB6MR20 IC: 5751A-DB6MR20

5920 0060 200

December 2008

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1. Document History

Document Number	Document Name	Date	Compiled by	Approved by	Revision
5920 0060 200	DB6MR20 Repeater	December 2008	Inderjit	Ramvir Singh	

Revision**Revised Section****Date****Intentionally Left Blank**

2. Disclaimer

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

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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 should remain within the input range to the repeaters for warranty purposes.

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

All specifications are subject to change without prior notice.

3. Safety Instructions and Warnings

3.1. Personnel Safety

Before installing or replacing any equipment, the entire manual should be read and understood. The user needs to supply the appropriate AC power 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. Equipment Safety

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. **Shyam Telecom Limited** 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

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

WARNING! This equipment complies with FCC & IC radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The signal booster with server antenna must be installed to provide minimum 20 cm separation distance between the server antenna and the body of user or near by person. The donor antenna used for this transmitter must be fixed-mounted on outdoor permanent structures with a separation distance of at least 1.5 meters from all persons during normal operation.

The RF electric performance of the DB6MR20 repeater conforms to FCC requirement of the inter modulation and spurious emission. It avoids interference problems.

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 the intentions of their 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 the 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 **DB6MR20** Repeater.

4.2. Scope

This document is the product description of the Shyam **DB6MR20** Repeater for indoor applications.

4.3. Definitions

AGC	Automatic Gain Control
ALC	Automatic Level Control
APC	Automatic Power Control
BCCH	Broadcast Control Channel
BTS	Base Transceiver Station
BSEL	Band Selective
CDMA	Coded Division Multiple Access
CMC	Configuration & Monitoring Console software
CMB	Combiner Unit
CSEL	Channel Selective
DCS	Digital Communication System
DL	Downlink signal (from base station via repeater to mobile station)
EGSM	Extended Global System for Mobile Communication
ETSI	European Telecommunications Standard Institute
GSM	Global System for Mobile communication
LAC	Location Area Code of the BTS site
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LO	Local Oscillator
MS	Mobile Station
MSC	Mobile Switching Center
NMS	Network Management System
PA	Power Amplifier
PCN	Personal Communication Network
PCS	Personal Communication System
PSU	Power Supply Unit
RF	Radio Frequency
RMS	Remote Management System
RSSI	Received Signal Strength Indication
RTC	Real Time Clock
TACS	Total Access Communication System
TDMA	Time Division Multiple Access
UL (Uplink)	Uplink signal direction (from mobile station via repeater to base station)

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 Communications Systems are planned as cellular systems and each cell of the base station is required to provide RF coverage over a certain geographical area as per defined RF power levels. Due to the RF propagation properties, even using high radiated RF powers or complicated antenna systems, there are zones within the coverage area where the RF signal strength from base station remains inadequate for establishing the desired connectivity to mobile users.

Repeaters traditionally are deployed in the Mobile Communication Network to fill in the "Dead Zones" caused by blocking of signals by geographic topologies such as mountains, valleys, dense foliage, high rising urban landscapes and other man-made structures. The distance from the base station also adversely affects the RF signal strength. The user views repeaters as a means to extend base station coverage so as to reduce the number of base stations and thereby accelerate network availability.

Repeater systems are installed after meticulous planning between BTSs and the mobile users to provide RF coverage in the shadowed regions. Repeater systems are available for different applications and **ultimate choice** shall depend on some of the factors mentioned below:

- Area to be provided with coverage.
- Indoor/outdoor coverage.
- Availability of BTSs in the vicinity.
- Antenna isolation to be achieved.

5. Functional Description of DB6MR20 Repeater

5.1. General Description

The **DB6MR20** Repeater System is a designed to provide indoor coverage and can handle signals in up to six sub bands in two of the service bands, used around the World by various service operators. It provides highly selective amplification in the pre-set bands. The details of operating service frequency bands are given below:

S.NO.	Service Band	DL Frequency (MHz)	UL Frequency (MHz)
1.	SMR 800	851-866	806-821
2.	Cellular	869-894	824-849
3.	SMR 900	935-941	896-902
4.	EGSM	925-960	880-915
5.	GSM 900	935-960	890-915
6.	DCS	1805-1880	1710-1785
7.	PCS	1930-1990	1850-1910
8.	UMTS	2110-2170	1920-1980

*The certification for FCC ID:S3CDB6MR20 & IC:5751A-DB6MR20 is only applied to Cellular and PCS Band applications.

The Customer is advised to refer to the sticker on the repeater unit giving the details of frequency bands set & the bandwidths of different sub bands equipped in the repeater.

Salient Features

- The repeater has been designed to meet the requirement of users who are allocated frequency spectrum in different bands. It is provisioned to be equipped up to six sub bands maximum in both the bands with 3+3 configuration.
- The repeater adopts duplex mode and bi-directional amplification for UL & DL signals between the base station and mobile users. It has been designed for indoor applications to meet the requirements of large number of users in the targeted area.
- It conforms to **ETSI standards & international safety requirements.**
- The system can be incorporated with **optional Remote Management System (RMS)**. It enables status monitoring, remote configuration & speedy maintenance.
- The system is modular in nature & can be customized to meet requirement of user in terms of number of sub bands with the desired

bandwidth of each. The System is incorporated with monitoring facility through USB port with easy **GUI** interface.

- It sucks signals from the BTS through a **DONOR antenna** (highly directional outdoor antenna) and distributes the signals to mobile users after amplification through a set of indoor **SERVER antenna(s)** (omni/ directional) system in the DL.
- In the UL, the signals from the mobile users are picked up by **SERVER antenna** and retransmitted to the BTS after processing & amplification in the repeater.

The repeater consists of the following modules/units:

- LNA
 - Converters
- Power amplifiers
Power supply unit
Quad-plexers filters for transmit/receive directions
Supervisory module

A metallic case houses the repeater. Provision is made for heat dissipation especially for amplifiers, which generate more heat. The choice of suitable metal as the case material gives a lightweight design with good heat conduction. It is not waterproof and therefore, should be installed at indoor locations only.

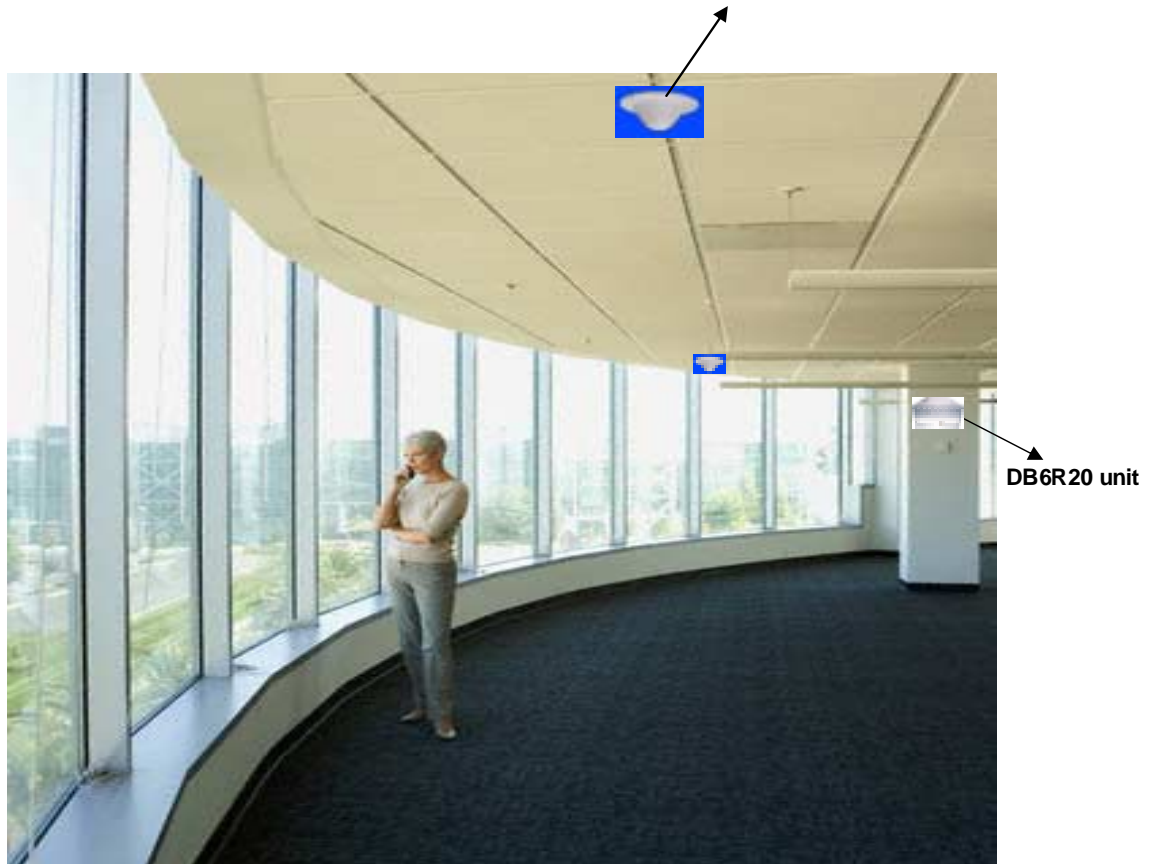


Figure 1: Typical In-building Coverage

5.2. Typical In-Building Coverage

The **DB6MR20** repeater is designed to provide optimal coverage over an area of approximately 1,000 to 2,000 sq. meters (10,000 to 20,000 Sq ft.). However, ultimate performance depends on the obstructions blocking/absorbing of the RF signals inside the building and the available forward signal level at the donor antenna.

Typical coverage is usually planned for relatively small areas such as large conference rooms or several adjacent rooms in smaller office areas.

Coverage is primarily determined by the available forward signal level at the outdoor antenna input, loss due to the RF cable length, type of RF cable installed and achievable isolation for optimum **DB6MR20** performance. Indoor coverage varies greatly due to the nature of various building construction techniques and materials. Approximations of signal level/coverage can be determined with the following assumptions:

- 10dBi to 12dBi-donor antenna. Max. 9dBi indoor omni/directional antenna.

- Installed total cable and connector loss of approximately 5 dB (125 feet of typical 1/2" coaxial foam cable).
- Interior building structure consists of typical vertical stud and drywall composition.
- Isolation between the donor and server antennas should be 15 dB more than the gain of the repeater.

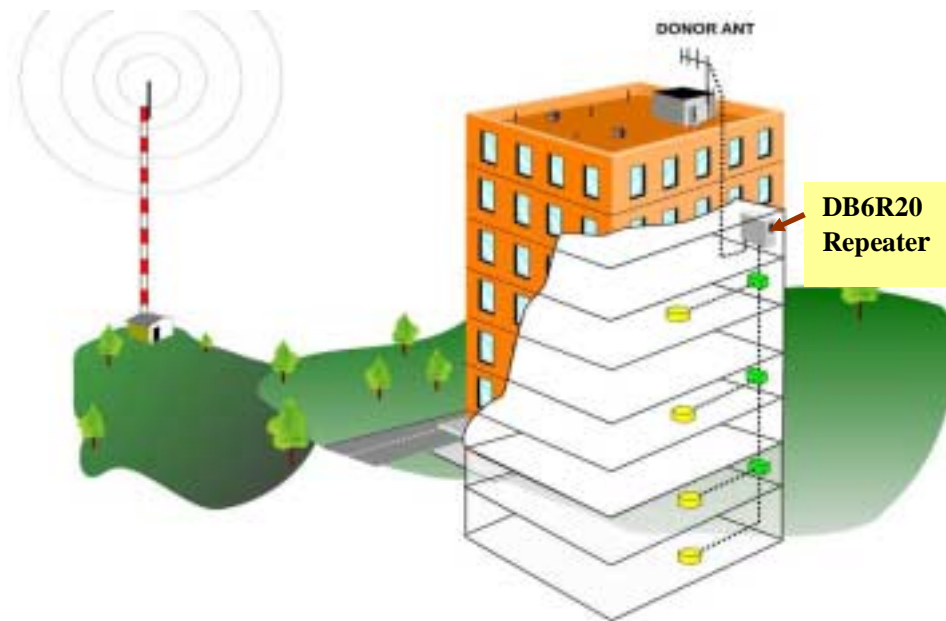


Figure 2: Application of DB6MR20 in a multi-storey building



Figure 3: Typical Indoor Coverage Application in Train

6. To Get started-Basic Software Control of the System

6.1. General

The system is equipped with a supervisory module that allows the monitoring and control of various parameters such as RF power, attenuation, temperature, status of door and alarm conditions etc.

The communication interface between the local terminal and the control module can be set up using the Configuration & Monitoring Console software (CMC), which is an easy to use GUI for simple control and monitoring. It enables monitoring of parameters & subsequent adjustment if required.

This function can be performed either using a terminal (PC/laptop) locally, or through remote login using the wireless modem (Optional) located in the repeater. USB port is provisioned in the equipment for connecting PC/laptop.

6.2. Terminal Set-up

The system is delivered with software loaded in order to perform configuration as per requirement. The laptop/PC should be loaded with the CMC software available on the supplied CD along with the USB driver.

Functions as described below are carried out through CMC software:

I) Login Repeater (Figure 4)

After running the *Configuration & Monitoring Console* (CMC), user needs to login the repeater. To login the repeater:

- Click the “**Login**” on the command bar.
- Select the user type.
- Enter the password.
- Finally click the “OK”.

After successful login, a message “**Logged in successfully**” will be flashed on the screen. Now user can start the operation through CMC.

There are two types of users viz. **ADMINISTRATOR** and **SUPERVISOR**. If user logged in as an **ADMINISTRATOR**, all the operation through the CMC can be carried out. The password by default is “**SHYAM**”.

SUPERVISOR is allowed to perform monitoring of the status & alarms but no change in configuration is permitted. However, the **SUPERVISOR** can change password if so desired.



Administrator can limit the system access authority of the SUPERVISOR



Figure 4: Log-in Repeater

II) Configuration

Configuration means setting different repeater parameters for proper operation. Configuration of Shyam repeaters can be performed locally with a laptop / PC connected to the repeater by means of local USB serial interface cable.

Clicking the **CONFIGURE** on the command bar, displays configuration window. This window allows access to all the configurable repeater parameters.

- **SET**: This is for updating the repeater parameters.
- **READ**: This is for reading configured parameters from repeater.

Repeater ID (Figure 5)

User can assign a unique repeater ID to each repeater installed. Up to 10 characters are allowed for this field.

Repeater Location (Figure 5)

User can assign the address of location where repeater is installed. Up to 30 characters are allowed for this field.

UP Link/ DL Frequency (Figure 6)

The UL /DL frequency ranges are defined for all the equipped sub bands (Maximum up to six) depending on the bands being used.



Figure 5: Repeater ID/Location Settings

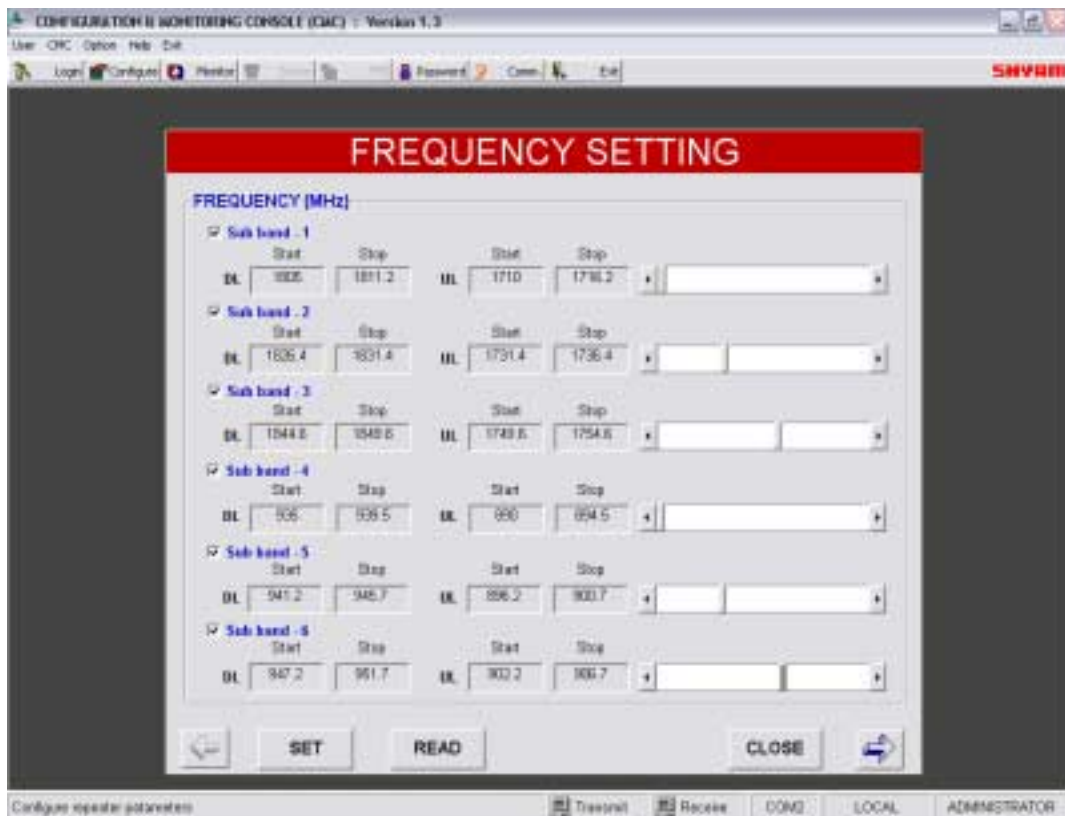


Figure 6: Frequency Settings in sub bands



Figure 7: Sub Band ON/OFF Settings

Sub Band ON/OFF Settings (Figure 7)

Depending on the number of sub bands equipped, particular sub bands can be configured as “ON” & others “OFF”. Maximum six sub bands can be equipped.

PA ON/OFF (Figure 8)

User can set UL and/or DL PA as ON or OFF independently for testing purpose at the time of installation.

After completing the installation it must be in ON condition only.

Threshold Settings for Output Power (Figure 9)

Maximum Output Power limit in DL & UL paths are defined. PA Power “High” alarm will be generated when PA power exceeds the upper limit.

RSSI limits (Figure 9)

Lower & High RSSI Limits in downlink & uplink paths are set in the factory. A RSSI “High” alarm will be generated when RSSI exceeds the upper limit, and a RSSI “Low” alarm will be generated when RSSI goes below the lower limit set by user. Upper and lower ranges that can be set by user vary from -50 to -80dBm.

Attenuation Settings (Figure 10)

Through this setting, the attenuation is inserted in both the bands in UL & DL paths as per the requirement of RF power. It is carried out when the system is set in manual mode. In automatic mode whatever attenuation is inserted, is displayed.



Figure 8: PA ON/OFF Settings

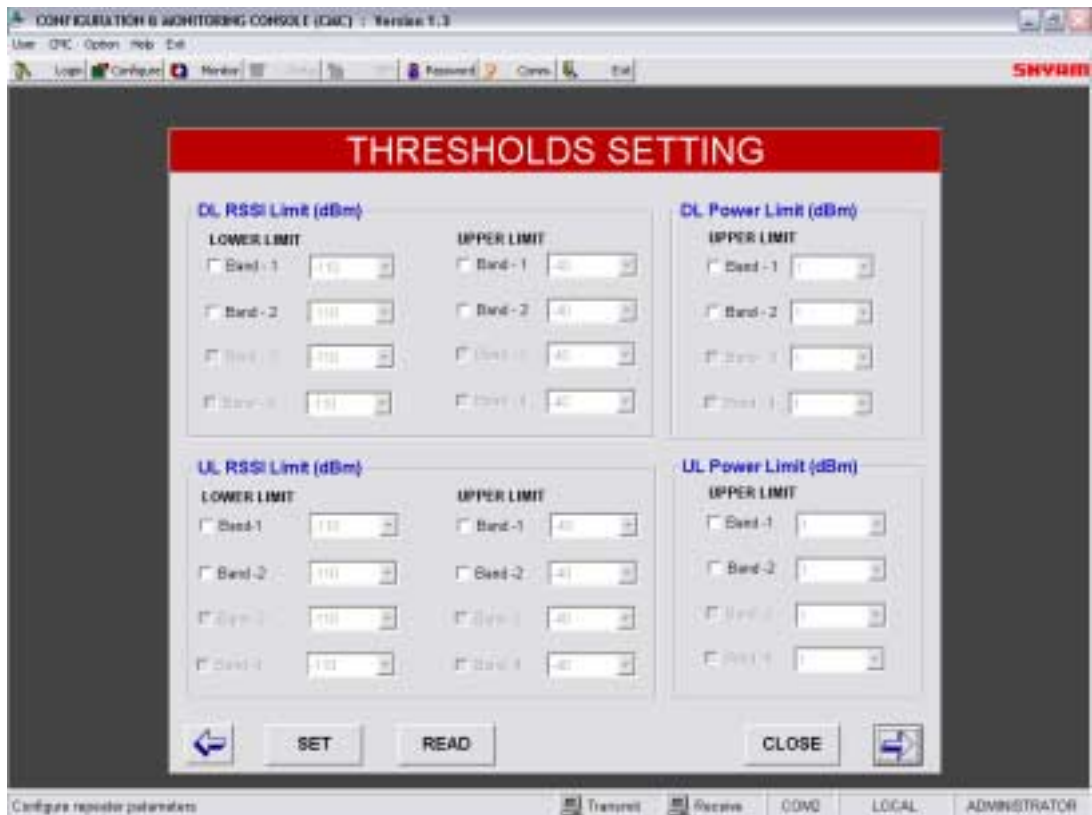


Figure 9: Threshold Settings

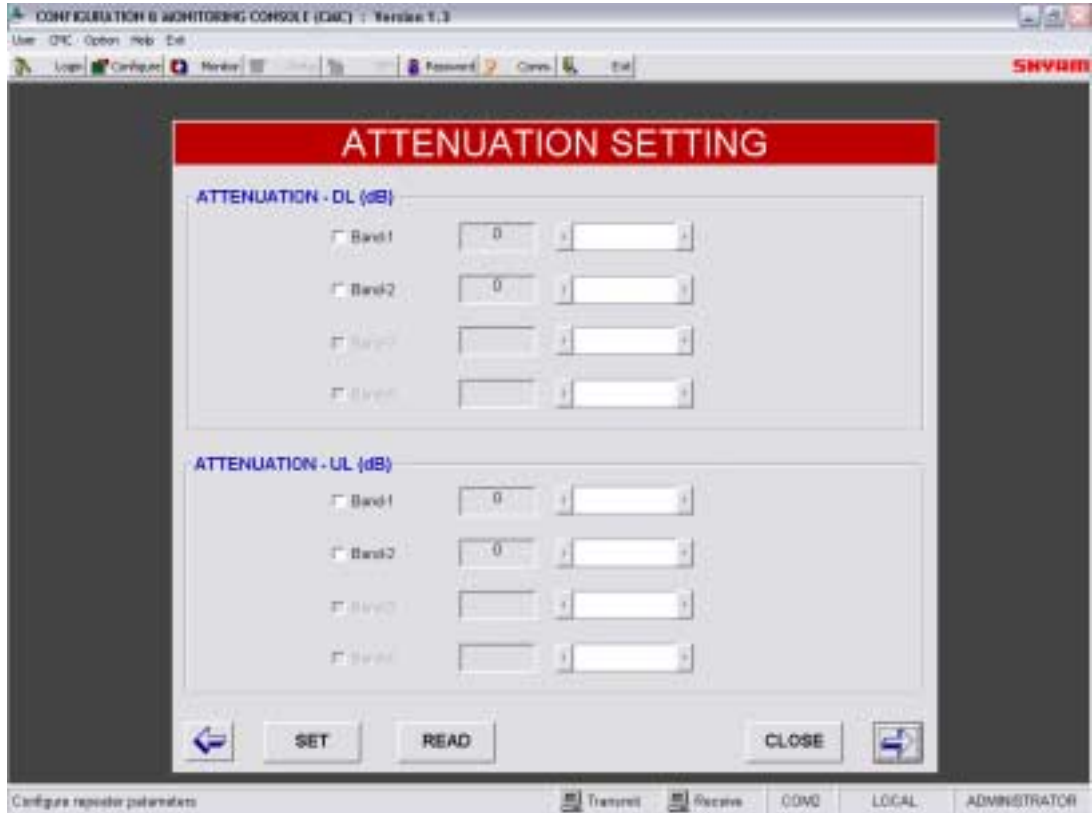


Figure 10: Attenuation Settings

III) Monitoring (Refer Figure 11)

Parameter	Remarks
Attenuation (Band 1 & 2)	Displays UL/DL Attenuation inserted in the system in both the bands.
Output Power	Displays PA output power in UL & DL paths in both the bands.
RSSI DL	Real time RSSI DL signal strength in both the bands is indicated.
Location	System location is displayed.
Serial Number	Serial number (factory settable) is displayed.
Repeater ID	A unique repeater ID set by the user is displayed.
5.5 V power supply	Value of derived Voltage is displayed
PA Temperature DL & UL	Displays the temperature of PAs in DL & UL in both the bands
System Temperature	Displays the temperature of the system
Alarms	Displays if there is any alarm viz. critical, major or minor. Details can be viewed by clicking at "DETAIL ALARM".

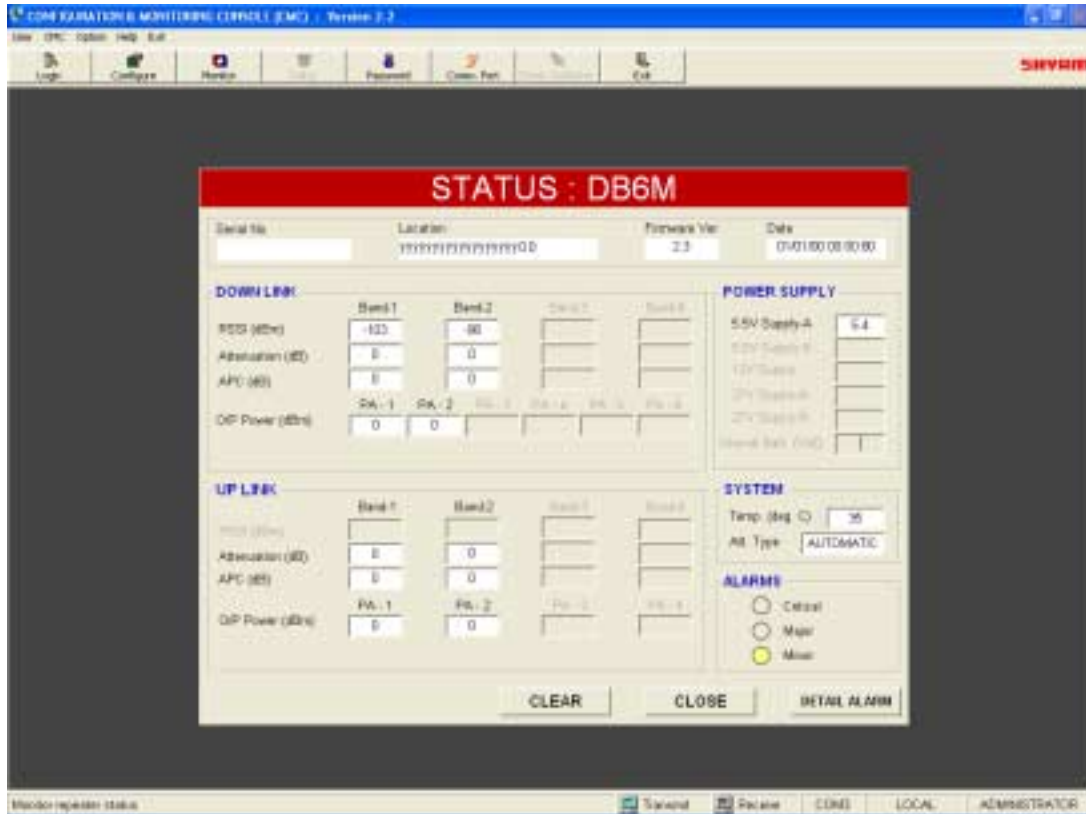




Figure 11: Monitoring Status

IV) Alarms (Refer Figure 12)

Observation	Remarks
Synthesizer Fail (UL & DL)	Failure of synthesizer of a particular sub band either in DL or UL is indicated by this alarm.
PA ON/OFF (DL & UL)	Indicates the status of PA if it is ON or OFF (manual/auto) to draw the attention of the maintenance staff.
RSSI Low (DL)	Indicates that the RSSI has exceeded the lower limit set.
RSSI High (DL)	Indicates that the RSSI has exceeded the higher limit set.
PA Power Low (DL)	When PA Power goes below the lower limit set by the user, this alarm is generated.
PA Power High (DL)	When PA Power exceeds the upper limit set by user, this alarm is generated.
PA Temperature High (DL & UL)	Indicates the rise in temperature beyond the safety limits.
VSWR (DL & UL)	Indicates when VSWR exceeds the specified limits (1.5:1) due to mismatching.
LNA (DL & UL)	Failure of LNA is indicated
System Temperature	Indicates the rise in temperature of system.

Monitoring interval is 3 seconds i.e. after every 3 seconds data on the monitoring window will be refreshed.

-  **A red indication is for Alarm present.**
-  **A green indication is for No alarm.**

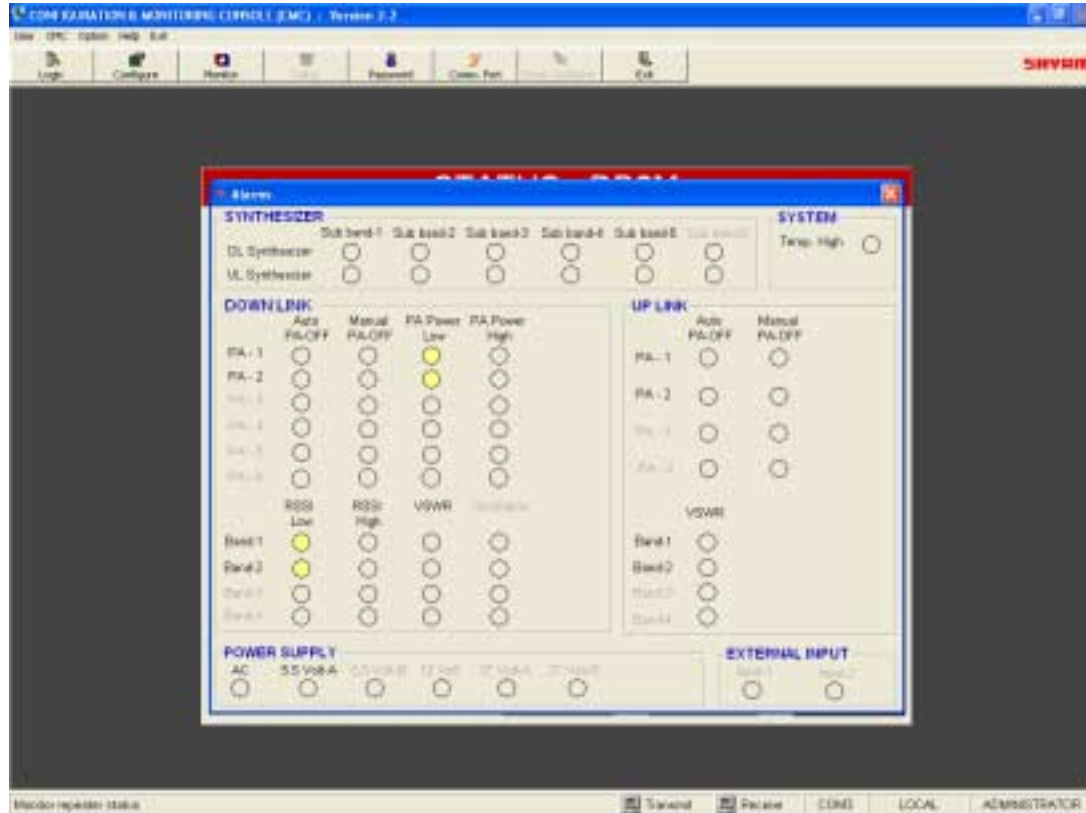


Figure 12: Display of Alarms

V) Communication (Figure 13)

In COMMUNICATION window user can select serial communication port of the computer and type of connection between repeater and computer. There are two types of connections viz. Local and Remote

a) Local Connection

In this type of connection, user computer COM Port and repeater's USB Port are connected directly using cable. Steps as indicated below, are followed:

- Click the **“COMM.”** on the command bar to display the COMMUNICATION window.
- Select the Connection Type as **“LOCAL”**
- Select the computer's Comm. Port where the repeater is connected.
- Click **“OK”**.

b) Remote Connection

In this type of connection, User communicates from/to remote location with the repeater using wireless Modem / Cell phone.

To connect:

- Click the **“COMM.”** on the command bar to display the COMMUNICATION window.

- Select the Connection Type as “**REMOTE**”.
- Select the computer’s Comm. Port where the wireless Modem is connected.
- Click “**OK**”.
- Now click the **DIALUP** on the command bar to display the **DIALUP** window.
- Enter / Select the repeater phone number.
- Click the “**DIAL**” and wait (maximum 60 seconds) for connection.

A message “**CONNECTED**” will appear on the screen after the modem Connection is established.



Click the “**DISCONNECT**” on the DIALUP window to disconnect remote communication with the repeater.

Wireless Modem (Optional) is equipped inside the housing of the repeater and it can be easily located through a sticker provided on the same. It has a groove with SIM cardholder in which the SIM card can be inserted for remote communication.

CAUTION

When the communication between repeater & PC/Laptop is in progress through USB:

1. Do not remove cable from the USB port.
2. Do not switch off the repeater.

In case the communication is not required any more, click at **EXIT** before removing cable from USB port to avoid *hanging* of the PC/Laptop. In case the PC/Laptop goes in to *hanging* mode, it has to be restarted after closing/switching OFF & ON the repeater.

VI) Security (Figure 14)

The system has been incorporated with “**Security**” to protect the settings and to avoid unauthorized access. It is through a Password, which can be set/reset. Click the Password on the command bar to display Password Setting window where administrator can change password.



Figure 13: Communication Setting



Figure 14: Password Settings

6.3. Block Diagram Description

The signals intercepted through the Donor antenna in the DL pass through different devices for further signal processing.

Figure 15: Block Diagram DB6MR20 Repeater (3+3 Configuration)
(see separate document)

a. DONOR Antenna

Donor antenna of appropriate bandwidth & gain interfaces the BTS on one side and repeater system on other side through RF cable. It is used to receive signals from the base station and transforms electromagnetic waves into RF signals in the DL and vice versa in the UL.

The antenna with no more than 10dBi to 12dBi gain transfers received signals to the repeater and transmits uplink signals amplified by the repeater.



Figure 16: A Typical Donor Antenna

b. Quad-plexers

Two Quad-plexers are equipped in the repeater, one on the BTS side & other on the server side. The functions are:

- To isolate frequency bands corresponding to DL & UL paths
- To segregate frequencies corresponding to two service bands equipped in DL & UL paths

Refer to Figure 15

c. Low Noise Amplifier (LNA)

This module is provided after each quad-plexer in the repeater before the converter. The LNA provides compensation for the losses suffered by the

stream of weak signals as it passes through passive devices. Four LNAs are provided, two each for individual bands in the UL & DL directions.

d. Converter

The basic block of **converter** is comprised of L.O., frequency mixer, filter and intermediate amplifier. The low noise amplified signals are converted to IF in frequency mixer with frequency fed from LO. The signals are passed through sharply tuned filters. Number of converters equipped shall depend on the number of sub bands configured in the system. Two converters (one for DL & one for UL) for each sub band are provided.

f. Power Amplifier

It is the core module of repeater. It includes driver stage and final stage. It is installed directly on the heat sink of the repeater. Driver stage and final stage of power amplifier are in the same unit. Four power amplifiers with specific frequency bandwidths & gain are provided, two each for individual bands in the UL & DL directions.

g. Supervisory

The man-machine communication between the user and the repeater is established through this module. One of the two options as given below can be used for achieving this objective:

- USB interface
- Wireless modem (Optional)

Remote controlling function of repeater can be achieved by inserting Wireless modem. This arrangement also enables status of repeaters at different locations to be monitored.

h. POWER SUPPLY

The power supply unit incorporated in the repeater is of high efficiency and reliability. Different DC voltages required for the operation of electronic circuitries are derived in this unit. The standard input voltage is 100 to 240 V AC, 47 Hz to 63 Hz. When the power supply varies in this range and the frequency in 47 to 63 Hz, its output DC derived voltages remain constant within 1% of nominal value.

i. SERVER Antenna

Server antenna transmits signals from the repeater station to mobile users and transport received uplink signals from the mobile users to the base station. Based on the coverage area, a set of select omni/directional antenna(s) having proper gains (less than 9dBi) with connectors may be installed at pre-planned spots.



Figure 17: Typical Server Antennas

7. DB6MR20 Repeater Specifications

7.1 Specification-RF

S.NO.	Parameter	Specified limits
1.	Number of Bands	Two, one each in 800/900 MHz & 1800/1900/2100 MHz frequency bands or as per requirement of the customer.
2.	Frequency band uplink	Customized as per requirement of the user.
3.	Frequency band downlink	Incorporated as per requirement of the customer in accordance with frequency set for uplink.
4.	Number of Sub bands	Six with 3 sub bands in each band with 3+3 configuration or as per requirement.
5.	RF output power in DL	+19dBm±1dBm (P1 +26dBm)
6.	Gain	85.0dB±3dBm
7.	Spurious Emission	<-36dBm @ 9KHz to 1GHz & < -30dBm 1GHz to 12.75 GHz
8.	Gain variation over temperature	± 1.5 dB over normal temperature range
9.	Attenuation range for adjustment of gain in UL & DL paths in both bands	0 to 31dB in steps of 1 dB (Software control)
10.	Noise figure	5 dB
11.	Propagation delay/direction in the signal path	< 5.5 us
12.	Impedance at RF ports	50 Ohms
13.	Return Loss	16 dB
14.	Remote control & management	Through optional wireless modem
15.	Automatic Power Control	10 dB

7.2. Electrical Specification Power Requirement

Parameters	Specified/Limits
Input AC Voltage Range	100-240 V, 47/63 Hz
Power Consumption Approx.	80 watts (Shall vary depending on the number of sub bands equipped)

7.3. External Electrical Interface

Parameters	Specification
RF port UL	N-type (F)
RF port DL	N-type (F)

7.4. Mechanical Specification

Dimensions (w x h x d)	520x400x180 mm (20x15x7 inches)
Weight Approx.	20 Kg. (44 lbs.)
Housing	Indoor application
Housing Color	Grey
Cooling	Convection

7.5. Environmental Specification

Conditions	Specification
Operating Temperature	-5°C to +50 °C (+23°F to +122°F)
Storage Temperature	-30°C to +75°C (-22°F to +167°F)
Enclosure	In accordance with indoor applications

7.6. Contents of Delivery

ITEMS	QUANTITY
Repeater unit DB6MR20 – Model as per requirement	1
PC interface cable for USB port	1
Power cable with 3 pin plug	1
Operation & Installation manual	1
CD containing the application software	1
Wireless Modem (Optional)	1

8. Installation

8.1. Preparation Sheet-Pre Installation

Before the commencement of installation, a preparation sheet is compiled for expected performance & better maintenance.

1. General

Application: Indoor

Service Band 1: Frequency Band DL- UL-

Service Band 2: Frequency Band DL- UL-

Number of Sub Bands: Six

Sub Band 1: Frequency Band DL- UL-

Sub Band 2: Frequency Band DL- UL-

Sub Band 3: Frequency Band DL- UL-

Sub Band 4: Frequency Band DL- UL-

Sub Band 5: Frequency Band DL- UL-

Sub Band 6: Frequency Band DL- UL-

2. Technical requirements

S.NO.	Requirement	Remarks
1.	Estimated RF Power available at site where donor antenna is to be installed	
2.	Estimated Cable loss from donor antenna to the repeater unit	
3.	Estimated Downlink RF power to the input of the repeater	
4.	Desired RF Power in DL	
5.	Proposed Gain settings in DL path	
6.	Proposed Attenuator inserted in DL path	
7.	Estimated Cable loss from repeater unit to server antenna port	
8.	ERP at server antenna	
9.	Desired RF Power in UL	
10.	Proposed gain settings in UL path	
11.	Proposed Attenuator to be inserted in UL path	

3. Proposed site Address: -----

4. User's Address & other particulars: -----

Date:

Prepared by: -----

8.2. Engineering Consideration

a. Site Selection

Site selection is one of the most critical decisions affecting the overall performance of the system. A repeater must be located where it can receive the maximum signal strength from the donor site in order to maximize the repeater's output and performance, signal strength greater than or equal to -75dBm is desired.

Examples of donor antenna locations include (but are not limited to): the roof of a building adjacent to the affected area, with the antennas mounted on the highest point in the building; the top of the hill that is obstructing the donor site's coverage, with the antennas mounted on poles at ground level; a water tower with antennas mounted at the top or as the situation permits.

Distance from both the donor site as well as from the new area to be covered must be taken into consideration. The repeater unit should be located close to the donor site so as to receive adequate signal strength and at the same time it is located in the vicinity of area where coverage is desired. In addition, the donor antenna associated with the repeater unit should have line of sight with BTS site to reduce the effects of fading.

Another important aspect when choosing a repeater location is the availability of AC for operation of the system. Sites where repeater unit is installed should be easily accessible for the maintenance team.

b. Antenna Selection and Placement

Proper selection of the repeater's donor and server antennas is crucial in designing the repeater system. Appropriate antenna characteristics help to provide proper isolation between the server (coverage) and donor antennas, which helps to prevent feedback. An isolation of at least 15 dB more than the gain setting of the repeater is maintained to avoid the possibility of oscillations.

Specific ways to achieve proper isolation include: using high gain directional antennas with good Front to Back ratios (25dB or better); physical separation of the repeater's donor and server antennas; and external shielding between antennas. A high gain antenna will help minimize overall path loss to achieve the desired output power. Donor antenna gains are typically 10 to 12 dB, while server antennas with gains as per requirement are deployed.

- The antennas should have proper frequency band of operation.
- Adequate separation is to be ensured from the power lines to avoid damage to the equipment and humans.

- Antenna with proper characteristics to maintain adequate isolation to avoid oscillations. Normally, isolation should be 15 dB more than the gain set for the repeater. It should have good front to back ratio.
- The beam width for the DONOR antenna should be as small as possible.
- The beam width for SERVER antenna is 60 degree to 120 degree.
- There should be adequate vertical & horizontal separation between the DONOR & SERVER antennas to avoid interference and noise.

Separation can be determined by the mathematical formulas:

Vertical Separation:

$$\text{Isolation (dB)} = 28 + 40 \log (D/\lambda \text{ in meters})$$

Horizontal Separation:

$$\text{Isolation (dB)} = 22 + 20 \log (D/\lambda \text{ in meters}) - (\text{Gain of donor antenna} + \text{gain of server antenna})$$

D-Distance between donor & server antennas in meters

λ- Wave length in meters

The following table is an approximate guide to antenna separation. The use of highly directional antennas with good front to back ratios can help to achieve isolation requirements.

A Typical Example

Vertical Separation

Separation (m.)	Isolation (dB)
5	75.0
10	87.1
20	99.1
30	106.2
40	111.2
50	115.0

Horizontal Separation

Separation (m.)	Isolation (dB)
5	45.5
10	51.7
50	65.5
100	71.5
150	75.1
250	77.6

Vertical and Horizontal Antenna Separation @ 900 MHz

The antenna separation table demonstrates that vertical separation yields better results than horizontal separation. However, when desired isolation cannot be met due to insufficient separation, external shielding can help; for example, mounting the antennas on either side of a rooftop penthouse or

using some type of grounded metal screen or wire mesh (so called chicken wire) between antennas.

The following example illustrates a typical signal level at input of the repeater and other losses with final EIRP:

Received Signal Level	-62	dBm
Donor Antenna gain	12	dB
Cable loss (100 ft. of 7/8 inch)	2	dB
Input to Repeater	-52	dBm
Gain of Repeater set	70	dB
Output of Repeater	+18	dBm
Cable loss (100 ft. of 7/8 inch)	2	dB
Server Antenna Gain	7	dB
Repeater EIRP	+23	dBm

c) Overlapping Coverage

Ideally, the repeater system will be engineered with minimal overlapping coverage between the donor base station and the repeater. However, the mobile will occasionally receive signals from both the donor and the repeater at similar levels. This situation is comparable to a mobile receiving multiple signals at varying times due to multi-path propagation.

The repeater contributes a maximum signal delay of 5.5 microseconds in each direction.

d) Call Processing

The mobile communication system perceives calls handled by the repeater as actually being handled by the donor site (BTS); the repeater is just an extension of the base station's coverage. Therefore, the donor handles call initiation, power control messages, hand-over requests, etc., for mobiles in the repeater area. When the base station assigns a channel to the mobile, that channel is sent through the repeater and then reradiated under the same frequency. Since the repeater is technically part of the base station, no hand-over takes place when a mobile moves from the repeater's coverage area to that of the base station. When the mobile moves from the repeater's area to a neighboring site, the base station handles the hand-off in the same way as for a mobile in the base station area.

8.3. Installation Tools

You will need the following basic tools for installation:

- a. Standard wrenches/screwdrivers/cable stripper/cable cutter/pliers set for installing the **DB6MR20** Unit and antennas. (Refer to the manufacturer's recommendations for installing the antennas).

- b. RF cable connecting tool for installing connectors.
- c. Multi-meter.
- d. Mobile handset loaded with NET engineering software to be used for signal level measurement.
- e. Magnetic compass for measuring the azimuth of the BTS and repeater site.

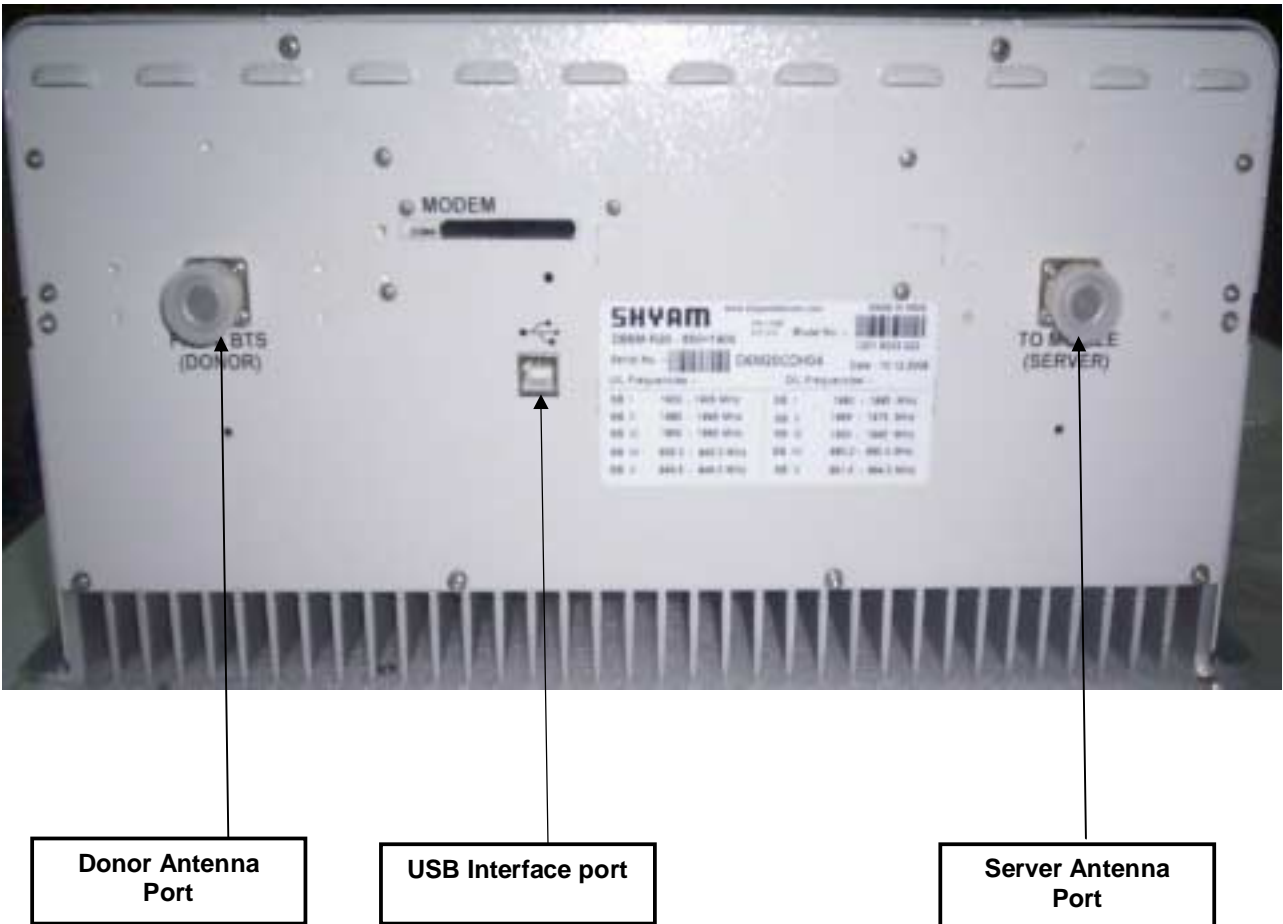


Figure 18: Connections at ports

8.4. Installation Procedure

1. RF cable installation must comply with local or National Electrical Codes. The cable shall have nominal 50-Ohm impedance. Pull and route the RF cables as per the site installation plan.
2. Fix the supplied connectors to the RF cable and verify the following:
 - The center conductor to outer shield of RF coaxial cable indicates “Open Circuit” condition.
 - Check for any short circuit between center conductor and outer shield.

- Place short between the center conductor and outer shield using a piece of wire temporarily and check the other end of conductor for any break in the RF cable.
3. Mount the **DB6MR20** unit on the intended wall surface using the appropriate screws.
 4. Install the indoor coverage antenna according to the antenna manufacturer's instructions. Connect the RF cable between the indoor antenna and the "MS" port on the **DB6MR20** unit.
 5. Install the donor antenna (Outdoor antenna) according to the antenna manufacturer's instructions. Connect the RF cable between the donor antenna and the "BTS" port on the **DB6MR20** unit.

8.5. Gain Settings

The **repeater gain** is one of the vital parameters since it also decides the area to be provided with RF coverage. The noise contribution has to be minimum while the gain is set.

Signals received by DONOR antenna from BTS and transmitted to the repeater are termed as **DL/Forward** signals and the signals originated by mobile users and intercepted by SERVER antenna for application to repeater are termed as **UL/Reverse** signals.

a. Forward Gain Setting

The process of setting the forward gain is carried out automatically (in automatic mode) through software depending on the threshold settings for RSSI & maximum RF power.

In manual mode, the setting is carried out through software by observing the forward signal level strength with any mobile handset loaded with engineering software.

Alternatively, RSSI can also be observed through LEDs provided on the top of the cover of repeater.

Once the RF output power has been determined, the attenuation will have to be modified to reach the desired output signal level.

The gain of repeater can be set using any of the following methods:

- a. Local USB serial interface mode (GUI based)
- b. Remote through (optional) wireless modem.

b. Reverse Gain Setting

For reverse gain setting, 31dB variable attenuator is inserted in accordance with the attenuation inserted in the DL.

8.6. Commissioning

Important:-Repeater should not be connected to Power without termination at the antenna ports. The termination can be carried out either by the antenna connection as well as a dummy load or the 50 Ω terminated connection of a measuring instrument (Power Meter, Spectrum analyzer with appropriate PAD)

1. Plug the power cable to the AC mains and switch ON the unit.
2. Once the repeater is ON, the LEDs will not glow under normal condition.
3. The UL Align indication LED and DL align indication LEDs will blink for adjusting the DL gain and UL gain automatically.
4. Review the intended coverage area according to the site installation plan. Measure & monitor signal level at various points within and around the perimeter of the coverage area with a mobile handset loaded with NET engineering software and the SIM card of cellular operator.

8.7. Checklist – Post Installation

After completion of installation, points as stated in the checklist may be verified to ensure that all aspects have been covered.

Service Bands Particulars:

Frequency Band for Band 1 DL	
Frequency Band for Band 1 UL	
Frequency Band for Band 2 DL	
Frequency Band for Band 2 UL	

A. Repeater Installation

S.NO.	Point(s) To be Verified	Remarks
1.	Ensure isolation between server and donor antennas, it has to be 15 dB + Gain set of the repeater.	
2.	Actual isolation measured	
3.	Ensure proper grounding of the unit	
4.	Cable from donor antenna connected to donor antenna port	
5.	Cable from server antenna connected to the relevant port in the unit	
6.	Mains cable connected to the repeater unit	
7.	Cable protection ensured and outdoor connections are waterproof	

B. Repeater Set Up

S.NO.	Point(s) To be Verified	Remarks
1.	Number of sub bands equipped	
2.	Number of Sub band(s) in Band 1 with frequency bandwidth of each.	
3.	Number of Sub band(s) in Band 2 with frequency bandwidth of each.	
4.	Repeater switched ON	
5.	Any error (alarms) observed	
6.	Gain set	
7.	Power level in DL	
8.	Attenuation in DL	
9.	Power level in UL	
10.	Attenuation in UL	
11.	Observation on CMC software & GUI	

12.	Repeater secured & locked	
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Any Other Remark/Comment:

Date of Installation: ----- Repeater ID & Site Address: -----

Name of the Installer: -----

8.8. Dos & Don't Dos

1. The site should be accessible for maintenance purposes.
2. Arrangement is to be made to avoid unauthorized access to the repeater.
3. For indoor applications, the housing should be kept away from direct exposure to the Sunlight & chemical fumes.
4. Stable power supply for repeater unit should be ensured.
5. The route of Cables to/from antennas should be short to minimize the cable losses and should be free from sharp bends & kinks.
6. There should be adequate separation between antenna system and power lines to avoid damage to system and humans.
7. Local standard of cabling should be followed.
8. The donor antenna should have proper line of sight with the BTS from where the signals are to be intercepted for maximum signal strength and to reduce the effect of fading.
9. The selection of BTS should be made taking other BTSs in the same vicinity in to consideration to avoid interference.
10. Gain of the repeater should be set after taking antenna isolation in to consideration.
11. The estimation of coverage area should be confirmed.
12. The system should be made over for normal traffic after actual measurement of:
 - a) RF power in the DL
 - b) RF power in the UL
 - c) Antenna Isolation
 - d) Gain settings in DL & UL
13. Feedback regarding performance of the system may be sent to Shyam Telecom by the user.

8.9. Display Details of DB6MR20

In order to display the status prevailing in the system, LEDs are provided on the top cover of the housing. These LEDs display the conditions in both the bands.

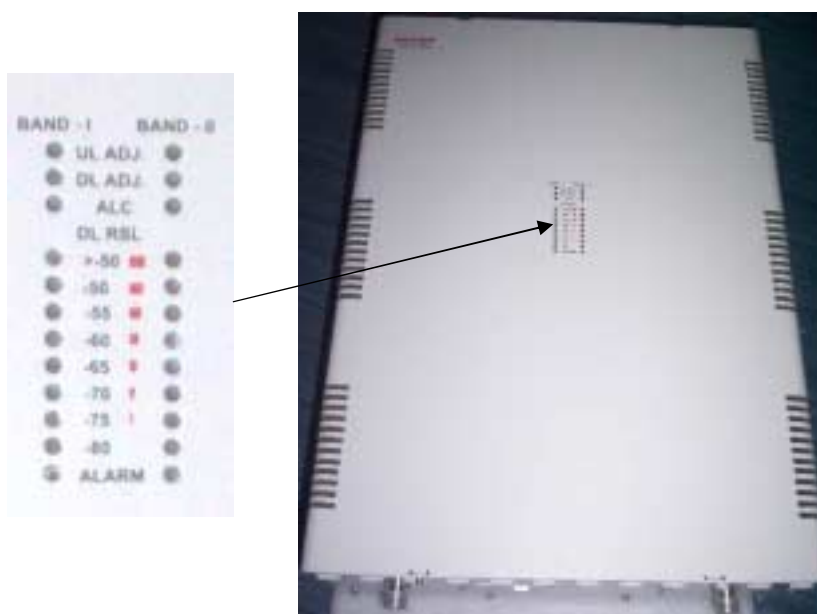


Figure 19: LED Display on DB6MR20

- UL ADJ. will blink when system is in Uplink Alignment mode.
- DL ADJ. will blink when system is in Downlink Alignment mode.
- ALC LED will blink when, when system is in ALC.
- Alarm LED will Glow when the system goes to the shut down mode due to input power going/out put power going high (beyond ALC) in DL path.
- Downlink RSSI is continuously monitored and level is displayed through 8 LED's.

9. System Maintenance

9.1. General

The system normally operates without any operator intervention or maintenance. In the event of fault, the field replaceable units (antenna & cables) should be checked for faults and the system restored if possible. A faulty unit can be removed and replaced with a spare while the rest of the system is still operating. Soldering or local repair of the modules should be avoided. Faulty module/unit should be replaced with genuine spares from **Shyam Telecom Limited** only.

However, the power supply of the faulty unit should be isolated from AC mains and DC power before any module is replaced. In the event of a system malfunctioning, the status of the antenna systems should be checked as well as the continuity of the cabling before replacing any modules within the repeater.

9.2. Preventative Maintenance

The **DB6MR20** repeater does not require any preventative maintenance.

9.3. In-Building Coverage Problems

If the coverage area appears to be smaller than the installation site plan, there are only a few possibilities that limit the signal level in the area.

- I) Physical obstructions degrading the signal level**-Visually inspect the area of weak coverage. If possible, rearrange objects that may be interfering with the signal path. Pay particular attention to large metallic objects that reflect or block the signals to the weak coverage area. If weak coverage area still persists, check the following:
- a. Inspect the indoor RF coaxial cable and its connection with connector
 - b. Indoor antenna direction and its tilting
 - c. **DB6MR20** repeater gain setting

- II) Defective Indoor coaxial cable/Antenna** – Check the RF coaxial cable and antenna. If necessary, replace each individually with a known functional unit, and verify the respective signal level. This can be achieved by observing the signal strength indicator on a mobile handset that has an unobstructed line-of-sight view, 15 to 20 feet (5 to 7 meters) from the indoor antenna. If the signal level increases at this test location, re-verify the signal level in the weak coverage area. If the signal level remains marginal, inspect the unit.

III) Defective Unit – Replace the unit with a known operational unit. Verify the signal level at the unobstructed test location. If the signal level increases, re-verify the weak coverage area. If the weak coverage area remains marginal, an additional indoor antenna or **DB6MR20** may be required to cover the additional area. If the unit is found to be defective, please contact our Technical support team. The unit serial number must be available to establish a return authorization. If replacing any part, Shyam authorized service dealer should replace it and no soldering/repairing of PCBs should be carried out in the field for reliable service thereafter.

IV) Signal Quality Problems

Under certain conditions, the signal level on the mobile handset may indicate adequate signal strength, but the quality of the signal is degraded (i.e. distortion). The signal level at the donor antenna is probably too strong. Under these conditions, the service provider's exterior signal level is adequate, in such condition, reduce the forward path signal using the forward attenuation in the repeater and minimize the forward signal level in step of 1dB until the problem subsides.

But ensure that the In-Building signal level remains adequate for the coverage area.

V) Antenna Isolation

Antenna isolation is defined by the path loss or attenuation, between the donor and server antennas. It is important to ensure that the antennas are sufficiently separated, such that the signal transmitted by donor antenna is not received by server antenna and vice versa. For optimal performance, the separation of the two antennas must provide a path loss of at least 15 dB greater than the set gain of the repeater.

In most cases, isolation will be achieved by properly locating the donor and server antennas, respectively. The optimal location for the donor antenna is high above the roofline, and exterior to the building. The indoor coverage antenna (server) should be installed inside, near or below the ceiling. Following guidelines should ensure adequate isolation between antennas.

- a) Never mount the donor or server antenna near a window, where signals can easily pass through the glass.
- b) Mount the donor antenna as high as physically possible to the exterior of the building, maximizing the vertical separation between the donor and server antennas. The donor antenna should point towards the base station site.
- c) Install the antennas taking advantage of any existing building structure such as brick walls, metal roofs, or multiple wall structures to additionally attenuate the path between them.
- d) Whenever using directional antennas inside the building to cover corridors and hallways, point the indoor antenna away from the donor antenna location.
- e) In extreme cases, the building configuration may not allow for such separation and isolation. If additional isolation is required, coaxial

attenuator may be inserted between the donor antenna and the repeater or reduce the forward path signal using the attenuation control with the likely compromise to the overall coverage within the building.

TYPICAL PRODUCT APPLICATION

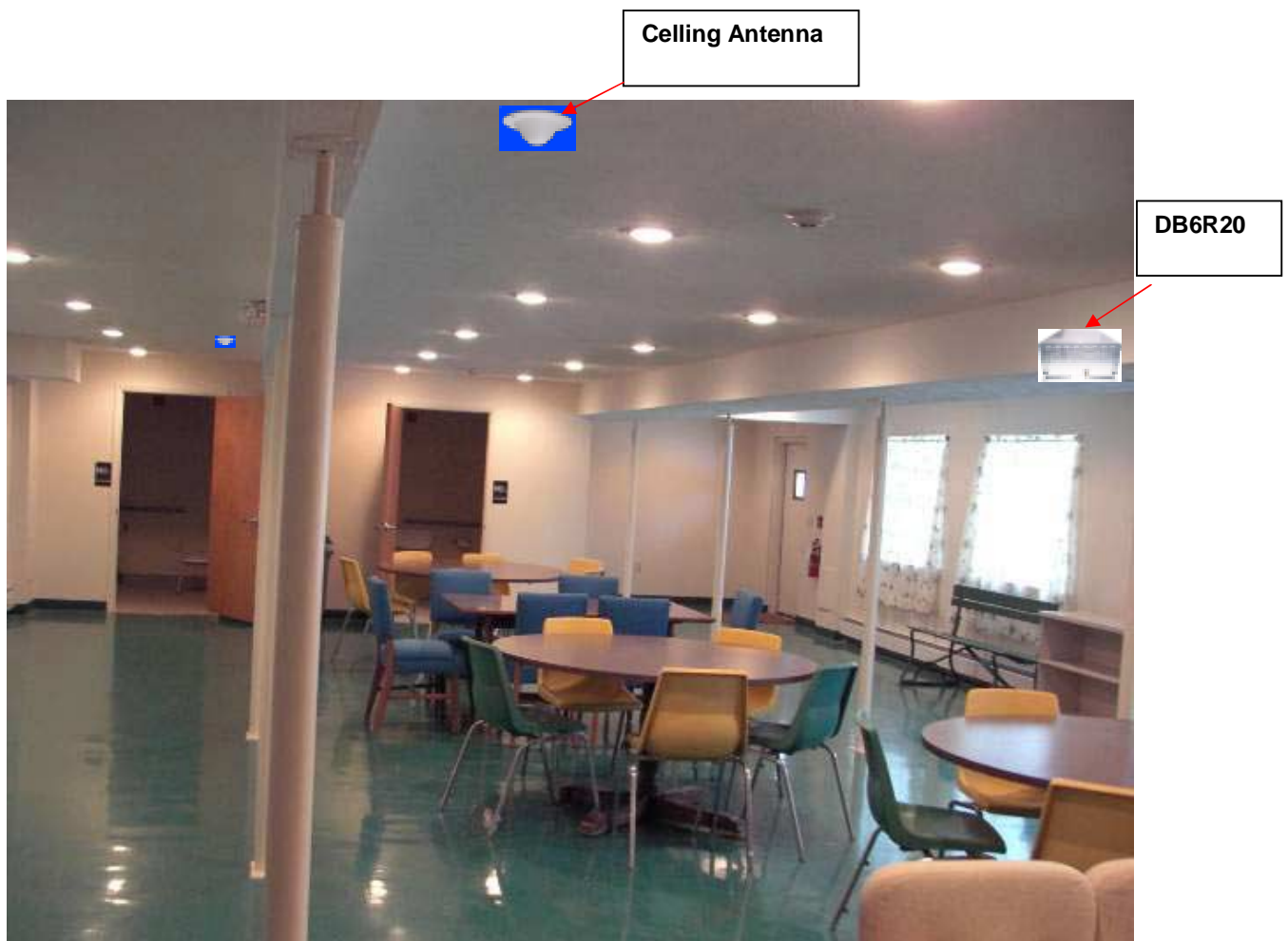


Figure 20: Indoor Application of DB6MR20 in a room

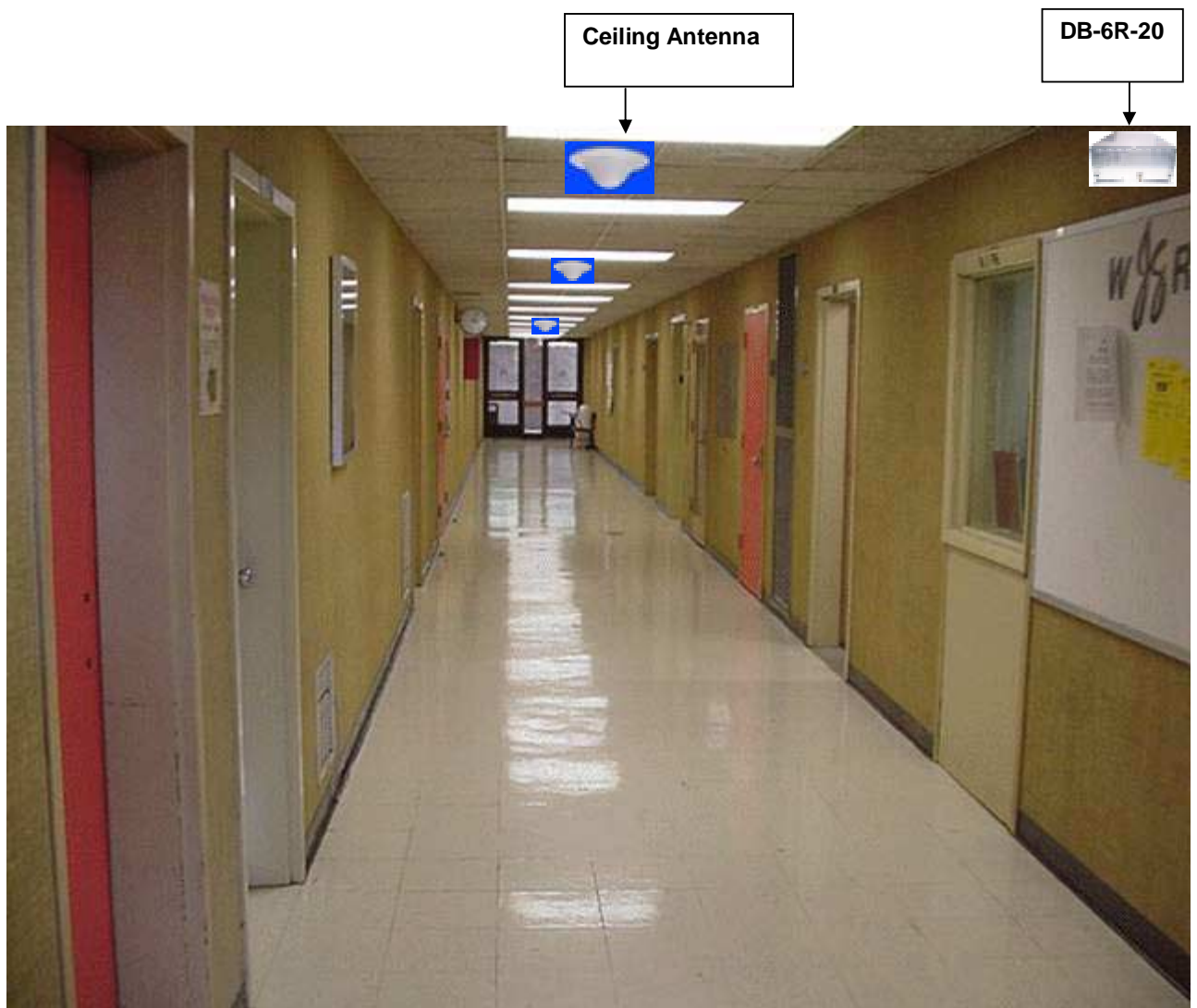


Figure 21: Indoor Application DBR6R20 in a Corridor

FCC Statement:

FCC ID:S3CDB6MR20

This device complies with Part 2, 22,24 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

IC Statement:

Trade Name: SHYAM Dual Band Inddor Repeater

Model No.: DB6MR20

IC: 5751A-DB6MR20

This device complies with RSS-131, RSS-102 of the IC Rules.

Warning

Changes of modifications not expressly approved by the manufacturer could void the user's authority to operate the equipments.

Antenna Information:

This device has been designed to operate with the antennas listed below, and having a maximum gain of 12dBi. Antennas not included in this list or having a gain greater than 16dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Antenna (or equivalent) list:

- 1) Donor Antenna , max. 12 dbi for UPLINK path
- 2) Server Antenna, max. 9 dbi for DOWNLINK path

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

WARNING! This equipment complies with FCC & IC radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. For mobile or fixed location transmitters, the minimum separation distance is greater than 20 cm (indoor server antenna), even if calculations that the MPE distance would be less.

For Technical Support, please contact at any of the following addresses:

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