SBR/RF Series

OPERATION AND INSTALLATION MANUAL

R-20

Single Band Repeater
(Indoor Coverage)

June 2007

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1. Document History

Document Number	Document Name	Document date	Author	Edited by	Approved by	Revision
As per code wizard document	R20 Repeater	June 2007				

Revision Revised Section Date/Sign

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.

Product name(s) 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 should remain within the input range to the repeaters for warranty purposes.

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

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

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 R20 repeater conforms to ETSI requirement of the inter modulation and spurious emission. It avoids the interference problem.

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 **R20** Repeater for indoor application.

4.2. Scope

This document is the product description of the Shyam **R20** Repeater for indoor application.

4.3. Definitions

AGC	Automatic Gain Control
ALC	Automatic Level Control
APC	Automatic Power Control
BTS	Base Transceiver Station
BSEL	Band Selective
CDMA	Coded Division Multiple Access
CMC	Configuration & Monitoring Console software
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
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 inducted 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 R20 Repeater

5.1. General Description

The **R20** Repeater System is designed to provide indoor coverage and can handle signals in a pre set single sub band in any one of the service bands, used around the World by various service operators. It provides highly selective amplification in the pre-set band.

- The repeater has been designed to meet the requirement of users who are allocated frequency spectrum in **PCS** service band only for operating a single sub band.
- The repeater adopts duplex mode and bi-directional amplification for U/L & D/L signals between the base station and mobile users. It has been designed for indoor applications to meet the requirements of users in the targeted area.
- It conforms to **ETSI standards & safety requirements**.
- The system can be incorporated with optional Remote Management System (RMS). It enables status monitoring, remote configuration & speedy maintenance.
- The System is incorporated with monitoring facility through USB port with easy **GUI** interface.
- It intercepts signals from the BTS through a **DONOR antenna** (highly directional outdoor antenna) and distributes the signals to mobile users after amplification through **SERVER antennas** (omni directional) system in the D/L.
- In the U/L, the signals from the mobile users are picked up by SERVER antenna and retransmitted to the BTS after processing & amplification in the repeater.
- It provides coverage over an area of 1000 to 2000 sq meters (10,000 to 20,000 sq ft.) tentatively.

The repeater consists of the following modules/units:

LNA
Converters
Power amplifiers
Duplexer filters for transmit/receive directions
Supervisory Module

A metallic case houses the repeater. Arrangement 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.

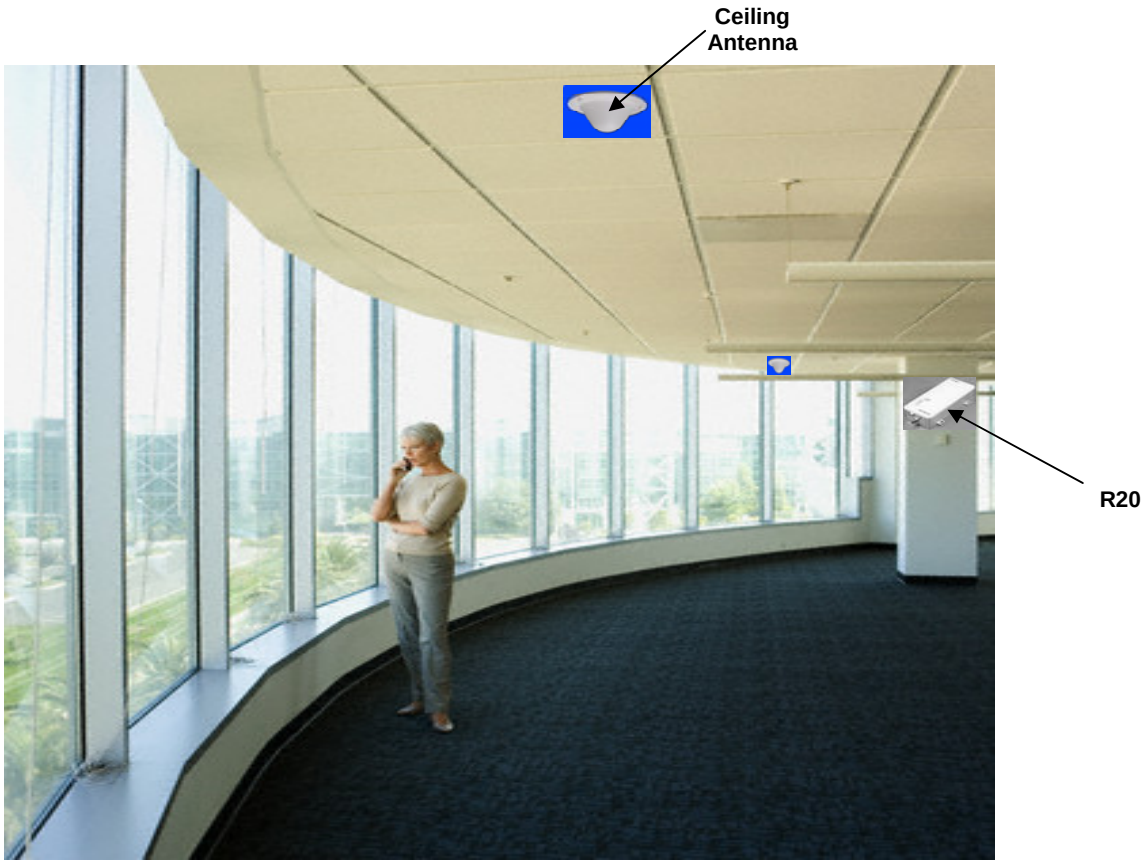

Figure 1: Indoor Coverage (Typical Application)

5.2. Typical In-Building Coverage

The **R20** repeater is designed to provide optimal coverage over an area of approximately 1,000 to 2000 sq. meters (10,000 to 20,000Sq ft.). However, ultimate performance depends on the obstructions blocking/absorbing of the RF signals in side 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 **R20** 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:

- 10-to12dBi-donor antenna. 7dBi indoor directional antenna.

- Installed total cable and connector loss of approximately 5 dB (125feet of typical 1/4" 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.

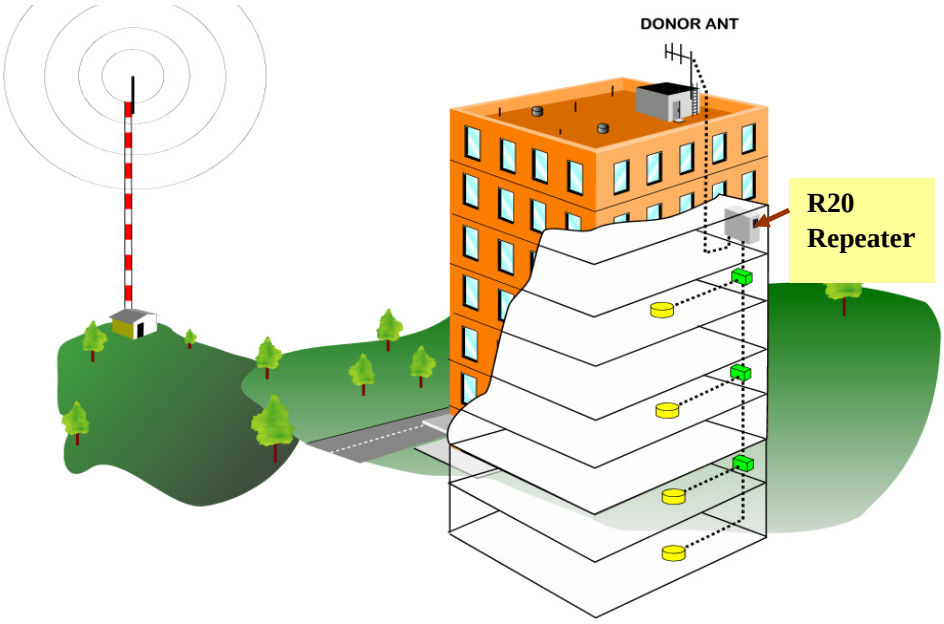

Figure 2: Application of R20 in a multi-storey building

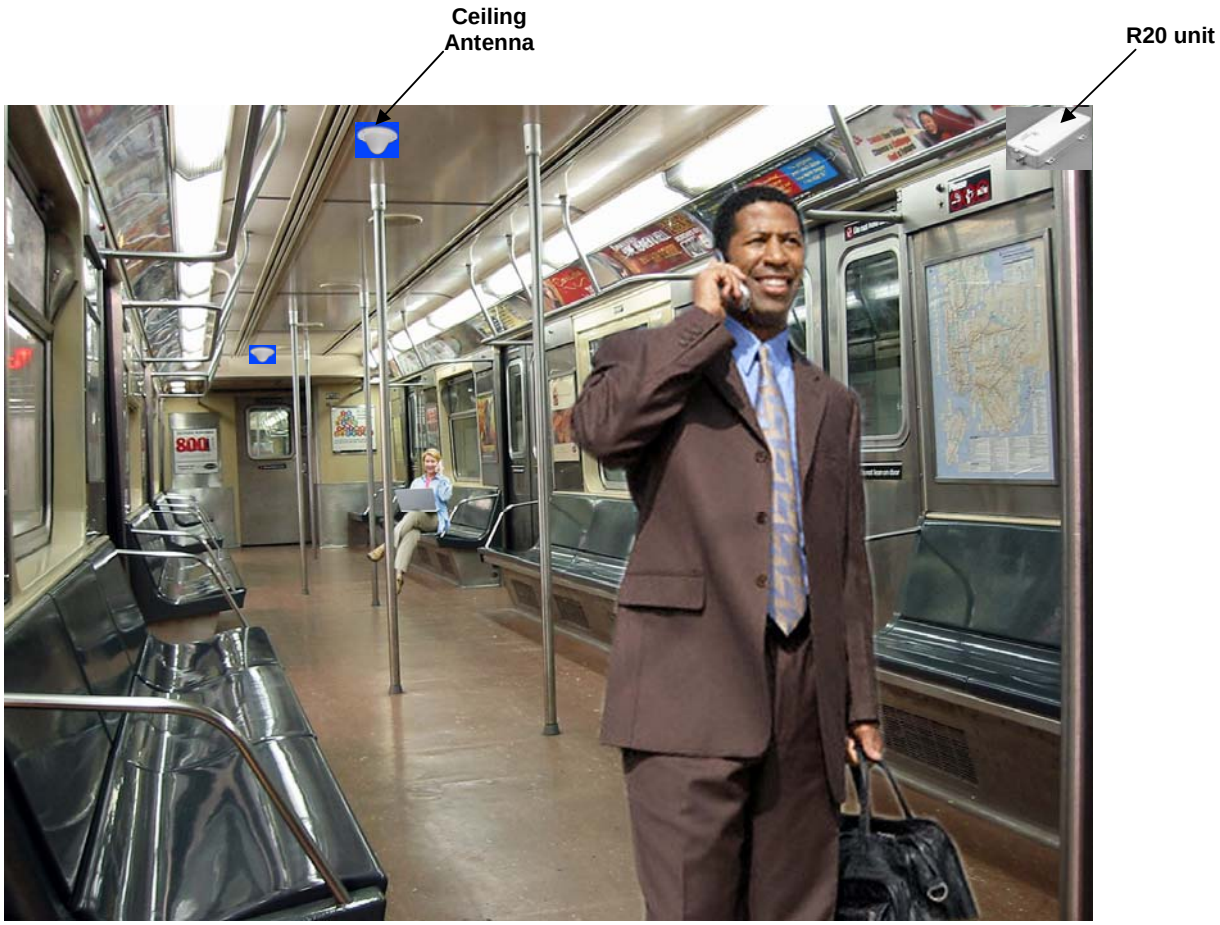

Figure 3: Application of R20 in a Train

6. To Get started-Basic Software Control Of the Repeater

6.1. General

The repeater 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. This way, the parameters can be easily observed and adjusted from the display terminal.

This can be performed either via a terminal (PC/laptop) locally, or via remote login through 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 repeater system is delivered with software loaded in order to perform configuration as per requirement. It also enables monitoring the status. Configuration of parameters can be carried out locally with the help of laptop / PC connected to the repeater by means of local USB serial interface or remotely via wireless modem (Optional) mounted inside the repeater. 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 repeater *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 type of user viz. **ADMINISTRATOR** and **SUPERVISOR**. If user logged in as an ADMINISTRATOR, all the operation through the CMC can be carried out. Default password 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.

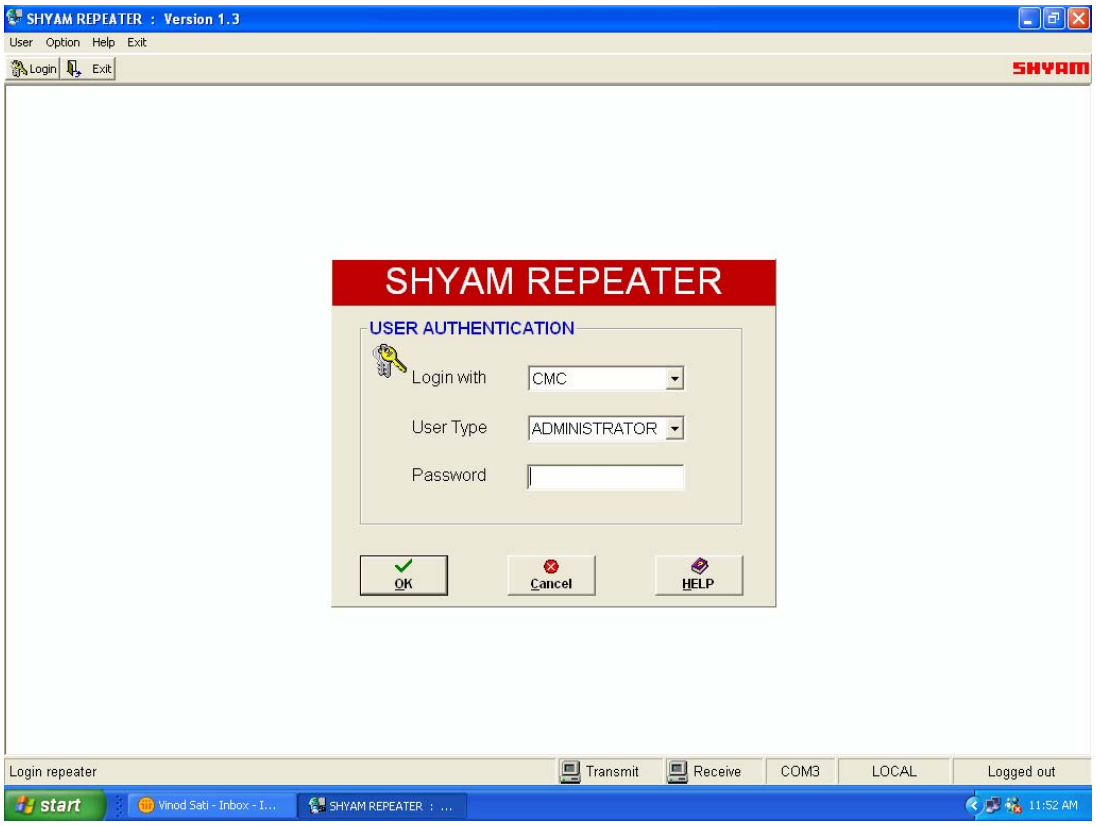

Figure 4: Login Repeater

Administrator can limit the system access authority of the SUPERVISOR.

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 configure 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.

a) Repeater ID (Figure 5)

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

b) Repeater Location (Figure 5)

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

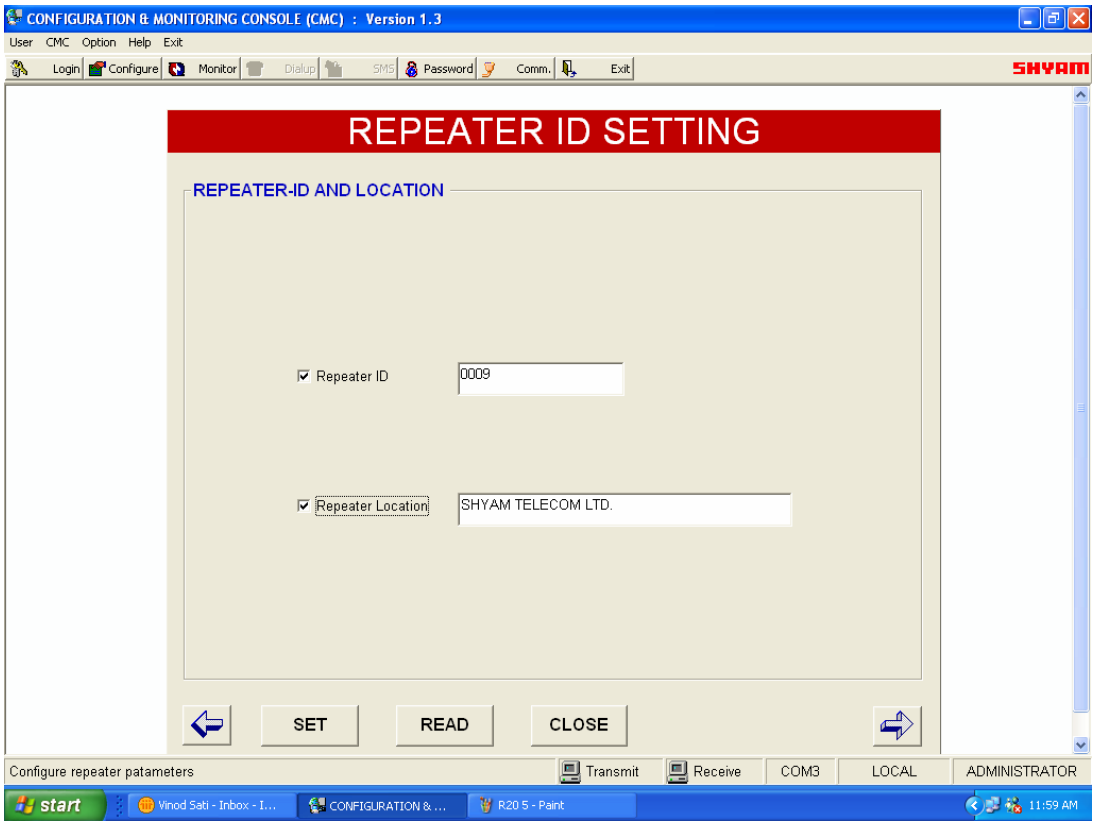

Figure 5: Repeater ID Settings

c) Sub Band ON/OFF Setting (Figure 6)

The sub band equipped can be configured as ON others shall remain OFF.

d) Frequency Settings (Figure 7)

The frequency bandwidth of the sub band equipped is defined for UL & DL paths.

e) PA ON/OFF Settings (Figure 8)

The PA can be set in ON or OFF condition for the purpose of testing & maintenance.

f) RSSI Limits (Figure 9)

RSSI limits in the DL & UL paths are set.

g) PA Power Limits (Figure 9)

Maximum power to be radiated by the PAs in the DL & UL paths, is defined.

h) Attenuation Settings (Figure 10)

If attenuation is to be set manually, the values for DL & UL paths are specified.

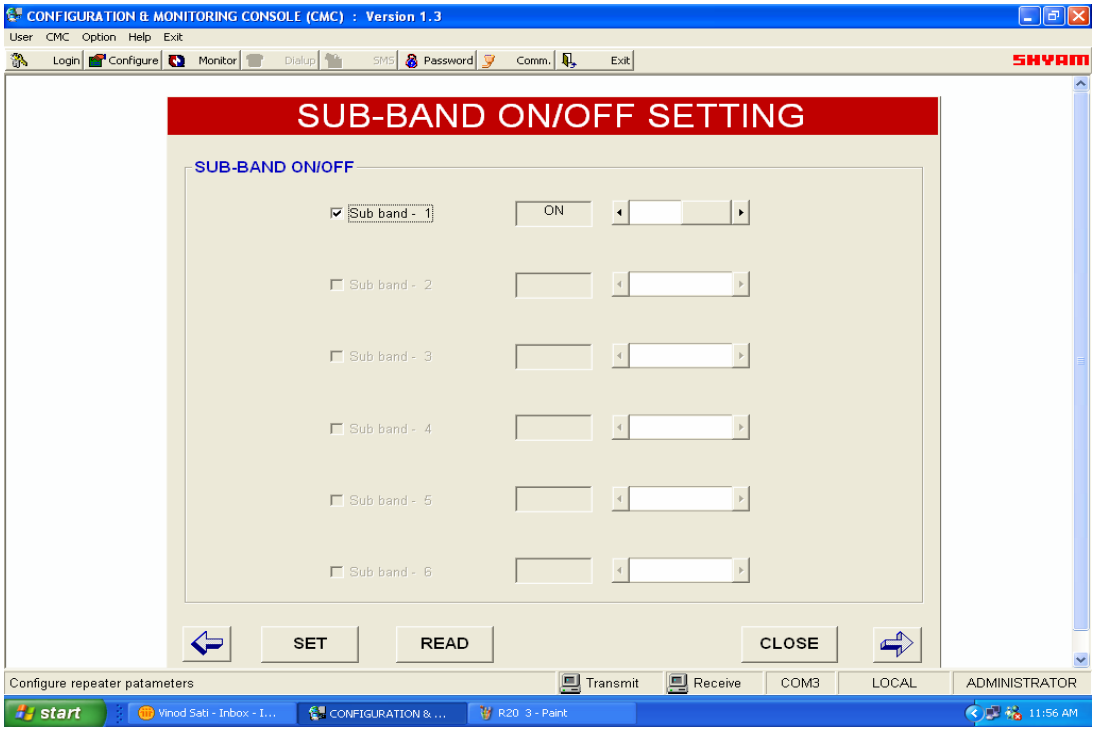

Figure 6: Sub Band ON/OFF settings

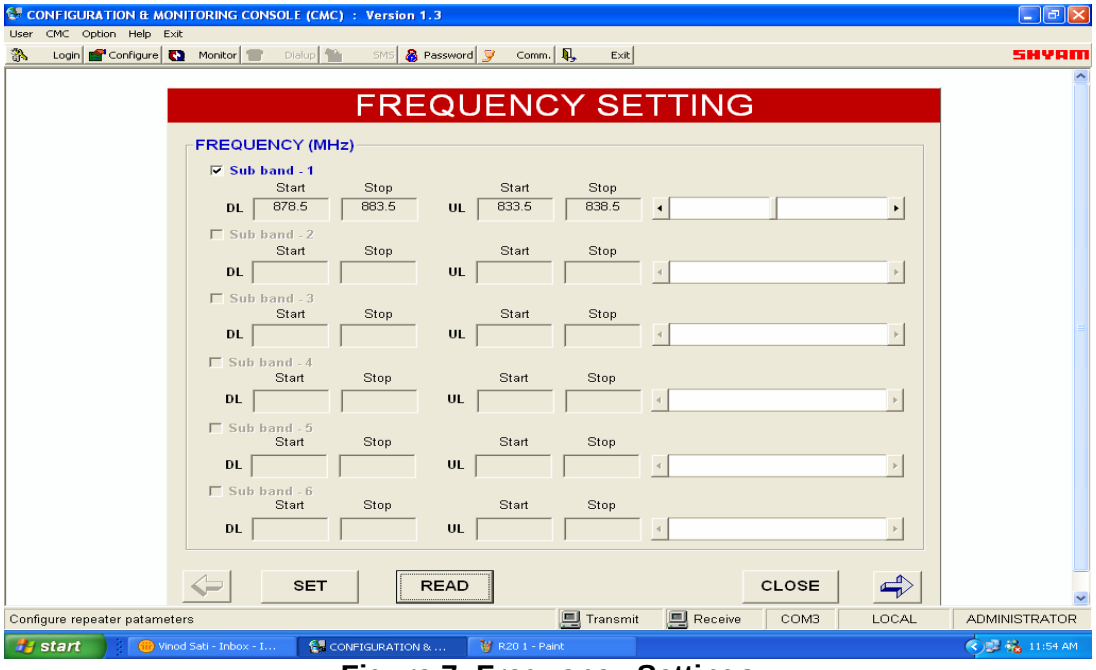

Figure 7: Frequency Settings

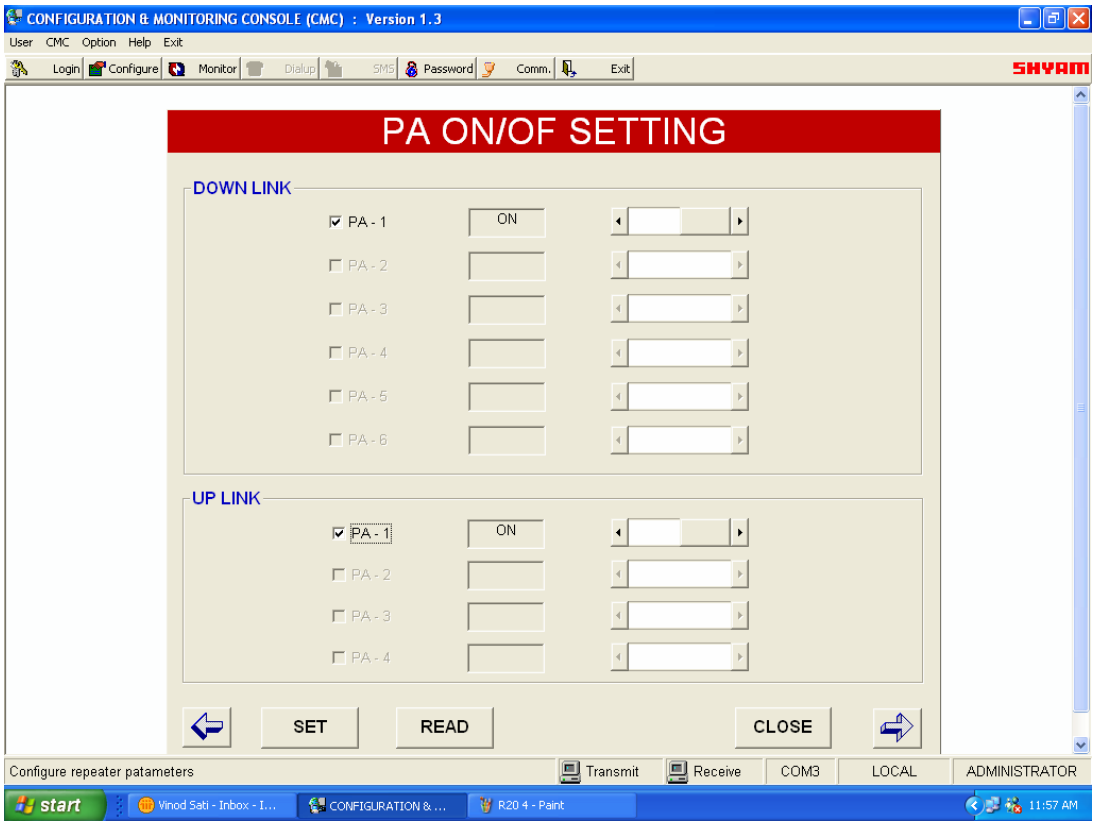

Figure 8: PA ON/OFF Settings

III) Monitoring (Refer Figure11)

Parameter	Remarks
Attenuation	Displays Attenuation inserted in UL & DL in the system.
Output Power	Prevailing PA output power in UL & DL paths.
RSSI DL	Prevailing RSSI DL signal level.
RSSI UL	Prevailing RSSI UL signal level.
APC DL & UL	Effective APC value prevailing in the system.
Location	System location
Serial Number	Serial number (factory settable)
Repeater ID	A unique repeater id set by the user
7.5 V power supply	Value of 7.5 V derived Voltage is displayed
PA Temperature DL & UL	Displays the temperature of PAs in DL & UL
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”.

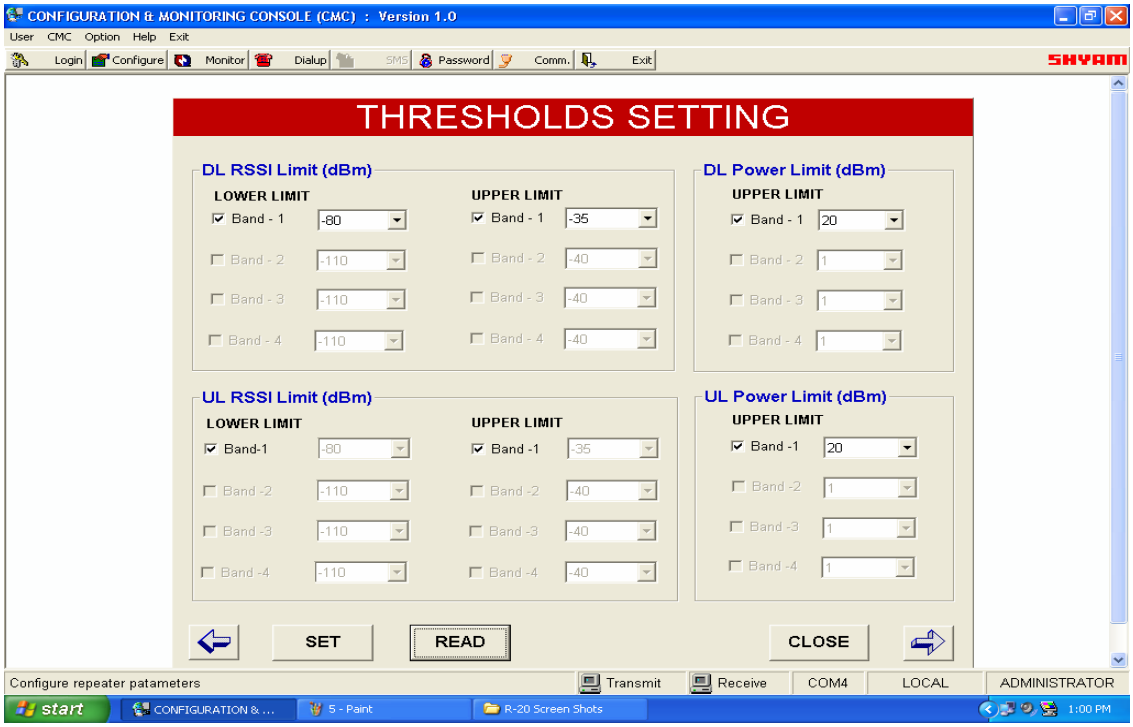

Figure 9: Threshold Settings

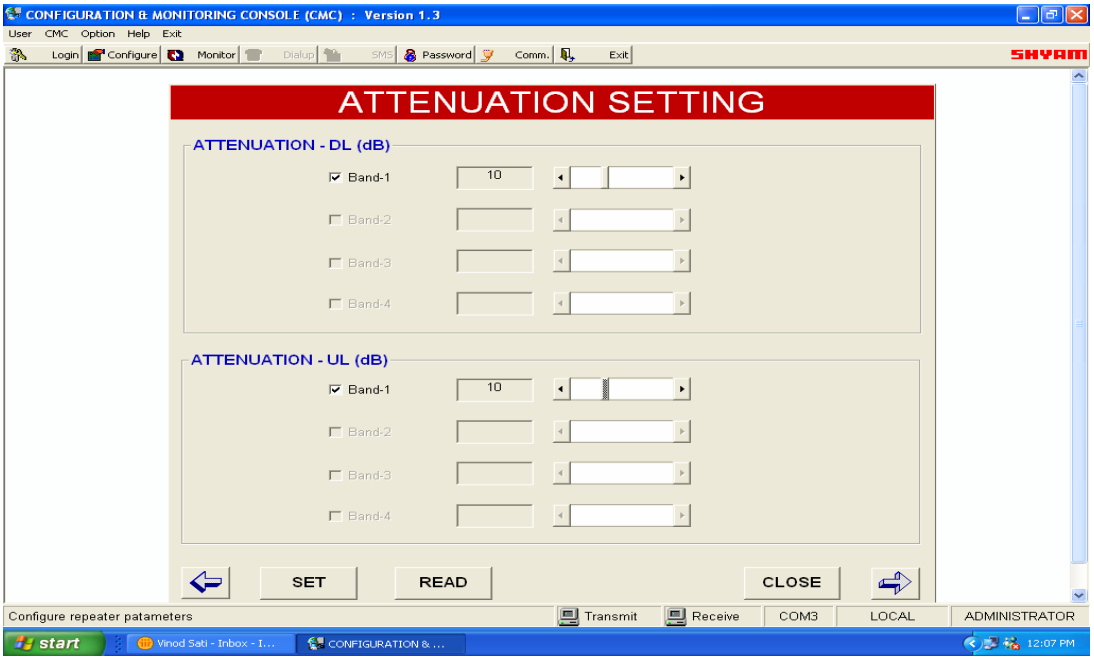

Figure 10: Attenuation Settings

IV) Alarms (Refer Figure 12)

Observation	Remarks
DL synthesizer fail	Failure of synthesizer in DL is indicated.
UL synthesizer fail	Failure of synthesizer in UL is indicated.
PA Off (Auto) DL	Indication draws the attention about the off condition of PA in DL.
PA Off (Auto) UL	Indication draws the attention about the off condition of PA in UL.
PA Off (Manual) DL	Indication draws the attention about the off condition of PA in DL.
PA Off (Manual) UL	Indication draws the attention about the off condition of PA in UL.
PA Power Low -DL	Indicates the PA power becoming lower than the configured condition in DL.
PA Power High -DL	Indicates the PA power becoming higher than the configured condition in DL.
PA Temperature High-DL	Alarm indication draws that the temperature of PA in DL has exceeded the limit.
PA Temperature High-UL	Alarm indication draws that the temperature of PA in UL has exceeded the limit.
RSSI Low-DL	Indication that the RSSI level has gone lower than the pre-set limit in DL.
RSSI High-UL	Indication that the RSSI level has gone lower than the pre-set limit in DL.
LNA-DL	Indicates the failure condition of LNA in DL in the equipped band.
LNA-UL	Indicates the failure condition of LNA in UL in the equipped band.
System Temperature High	Displays that the temperature of the overall system has gone high.

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.

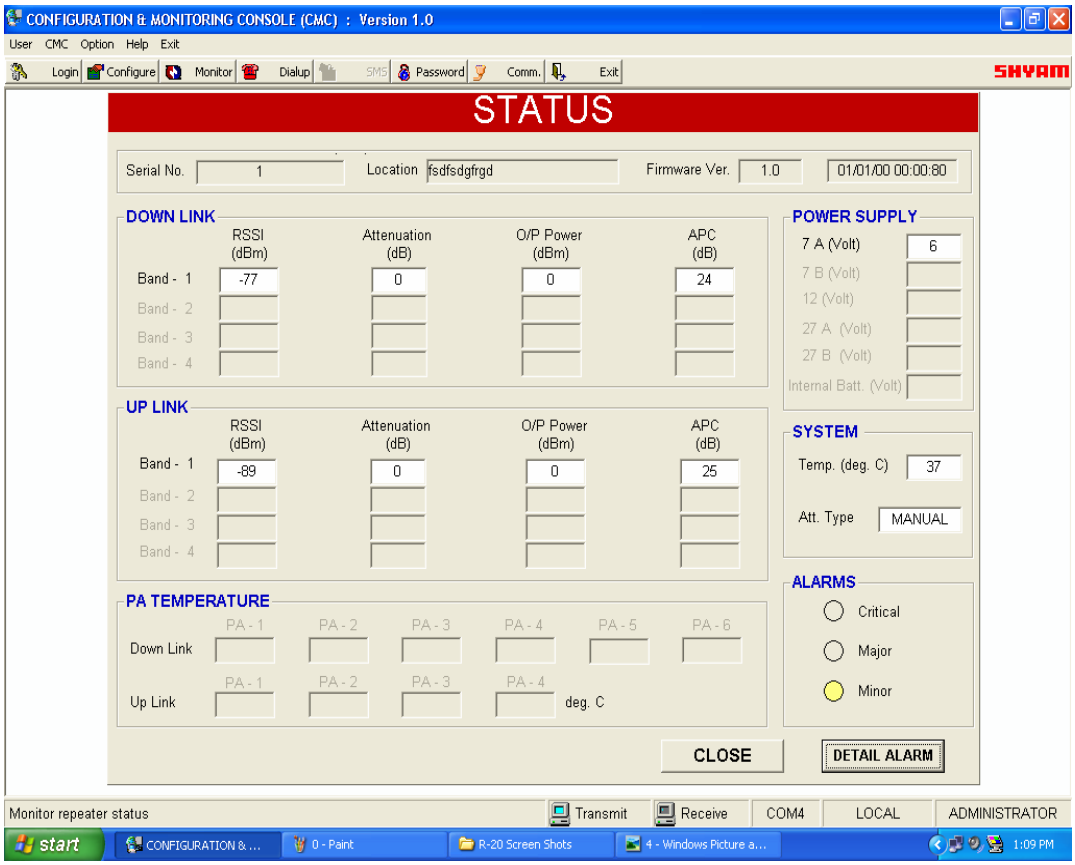

Figure 11: Status Monitoring Window

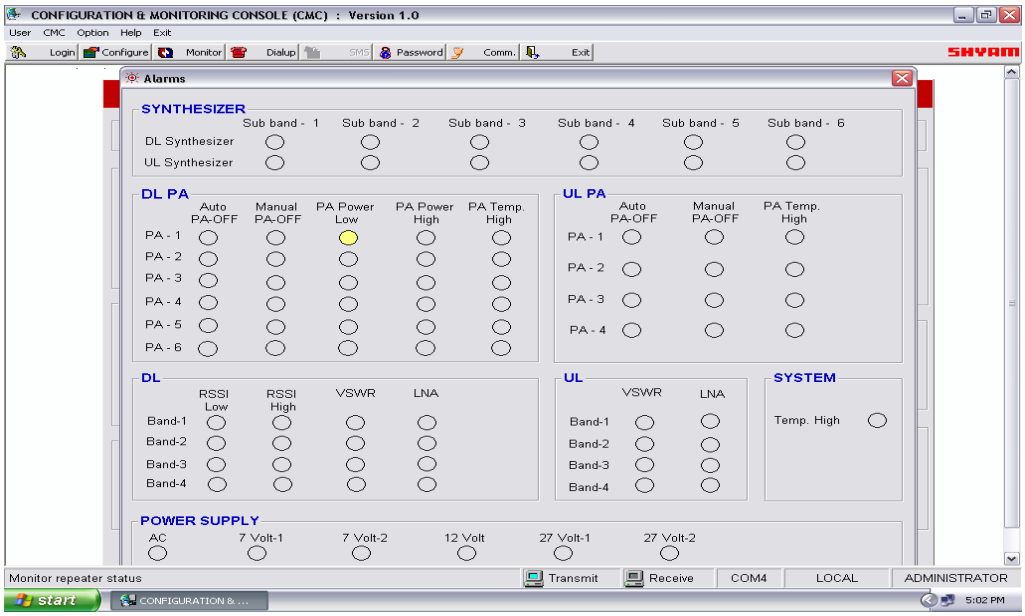

Figure 12: Alarm Display Window

Figure 13: Communication setting

V) Communication (Refer 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. Sequence as indicated below, is 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 GSM Connection is established.

Click the "**DISCONNECT**" on the DIALUP window to disconnect remote communication with 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 SECURITY on the command bar to display SECURITY SETTING window where administrator can change password.

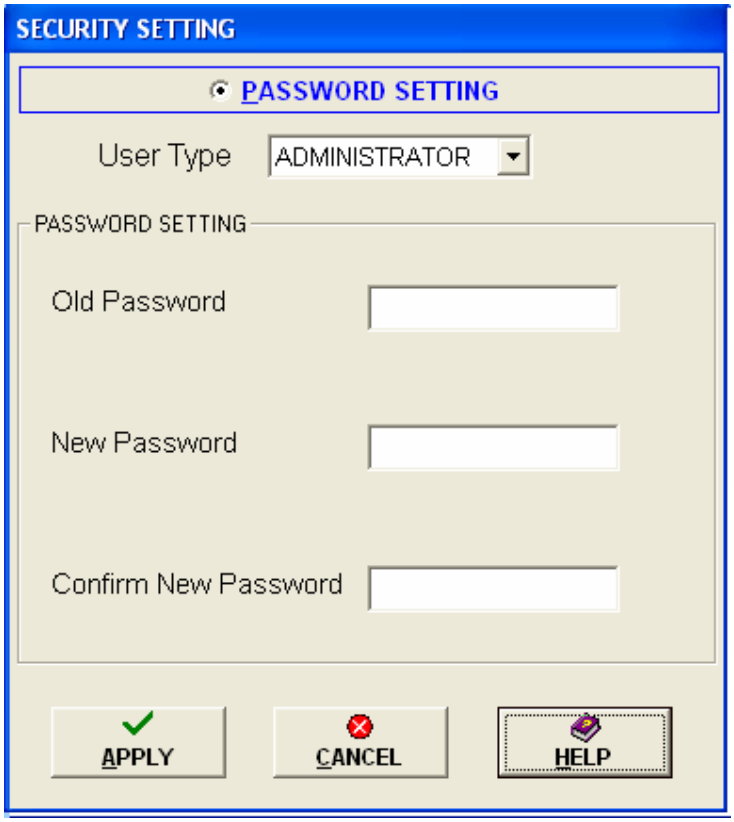

Figure 14: Security Settings

6.3. Technical Description of R-20 Repeater

The **R-20 Repeater** system comprises of high power amplifiers with automatic power control and highly selective amplification in both the UL & DL directions. It is incorporated with a **Donor antenna** (highly directive outdoor antenna) and **Server antenna** (indoor omni directional antenna), specifically designed for interior configurations.

The donor antenna must point towards the cell of the base station from where the signals are proposed to be picked up and is usually mounted on the exterior of the building so as to receive the maximum forward signal level from the base station.

The indoor antenna is specifically designed to blend into the ceiling of a typical office providing RF signals in all directions downward and outward from the installation point. For in-building configurations requiring higher gain or directional RF signal, such as a long hallway or corridor, a medium gain directional antenna may cover the area best by mounting the antenna to the opposing wall, where coverage is required.

Main constituents of R20 repeater are described below:

a. DONOR Antenna

Donor antenna of appropriate bandwidth & gain interfaces the BTS on one side and repeater system on other side through RF cable.

Figure 15: Donor Antenna

It intercepts signals from the base station and switch electromagnetic waves into RF signals in the DL and vice versa in the UL. The antenna with more than 10-12 dB gain transfers intercepted signals to the repeater and transmits uplink signals amplified by the repeater.

b. Duplexer

The main function of **duplexer** is to isolate the uplink frequency from the downlink frequency, i.e. isolate transmit path from receive path. Two duplexer units are provided in the repeater, one in the Donor antenna side and other in the server antenna side. Each duplexer transfers/receives signals from respective antenna for further connectivity to low noise amplifier. The bandwidth of the duplex filter **depends on the operator's frequency band** (25MHz, 15MHz, 10MHz, 9MHz, or full Band etc.).

c. Low Noise Amplifier (LNA)

This module is provided after duplexer before the converter. The **LNA** provides compensation for the losses suffered by the stream of weak signals as it passes through splitter/combiner & duplexer (passive devices). Two LNAs are provided, one each in the UL & DL directions.

d. Converter Module

The basic block of **converter** module comprises 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. Two numbers of converters are equipped, one in the DL & one in the UL.

e. 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. Two power amplifiers with specific frequency bandwidths & gain are provided, one each in the UL & DL directions.

f. Controller Module (Supervisory)

The man-machine communication between the cellular operator 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.

g. 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 panel antenna having 60°, 65°, 90° or 120° vertical polarizations with N type

connecters are installed at spots as per the coverage area requirements.

7. R20 Repeater Specifications

7.1. Electrical Specifications-RF

S.NO.	Parameter	Specified limits/Remarks
1.	Frequency band in DL path.	1930 MHz to 1990 MHz
2.	Frequency band in UL path.	1850 MHz to 1910 MHz
3.	Number of RF Sub bands	One, the bandwidth of the sub band in DL & UL paths is set as per user's requirement.
4.	RF composite power	+19dBm
5.	Spurious Emission	≤ 36 dBm from 9 KHz to 1 GHz ≤ -30 dBm from 1 GHz to 12.75 GHz
6.	Automatic Power Control	15 dB
7.	Repeater Gain	70 dB
8.	Attenuation range for gain adjustment in DL & UL (Automatic/manual by GUI switch)	31 dB in 1 dB step
9.	Gain flatness over band	±2 dB
10.	Gain variation with temperature	± 1.5 dB
11.	Total delay in the signal path/direction	5.5 microseconds.
12.	Noise figure	5 dB Max.
13.	Impedance	50 Ohms
14.	Return loss	16 dB
15.	RMS interface	Wireless modem (optional), USB port

7.2. Electrical Specification Power Requirement

Parameters	Specified/Limits
Input AC Voltage Range through AC/DC adapter.	100-240 V, 47/63 Hz
Power Consumption	24 watts

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)	312x141x54 mm (12x5x2 inches)
Weight	2 Kg.(4.4 lbs.) approx.

Housing	Indoor application (aluminum)
Grounding Connection	Bolt
Housing Color	Grey
Cooling	Convection

7.5. Environmental Specification

Conditions	Specification
Operating Temperature	-5^{0}C to +55 ^{0}C (23^{0}F to +131^{0}F)
Storage Temperature	-30^{0}C to +75^{0}C (-22^{0}F to +167^{0}F)
Enclosure	In accordance with Indoor application requirement

7.6. Contents of Delivery

ITEMS	QUANTITY
Repeater R20	1
PC interface cable for USB port	1
AC/DC Power supply adapter	1
Operation & Installation manual	1
CD containing the application software	1
Wireless Modem (Optional)	1
Mounting Clamps with Nuts-bolts	1 set

8. Installation

8.1. Preparation Sheet- Pre Installation

Before the installation commences, particulars of requirement must be compiled in the preparation sheet as indicated below:

1. General

Application: Indoor
Service Band: Frequency Band DL-
Frequency Band UL-

Number Of Sub band: One
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 DL RF power to the input to the repeater	
4.	Desired RF Power in DL	
5.	Proposed gain settings in DL path	
6.	Estimated attenuator to be 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.	Estimated 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 from the donor site in order to maximize the repeater's output and performance, a signal strength greater than or equal to -75dBm is desired.

Examples of repeater (and accompanying antenna) locations include (but are not limited to): the roof of a building adjacent to the affected area, with the antennas mounted to the penthouse or building sides; 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; an existing utility pole with equipment and antennas mounted below any existing power lines; a newly installed pole or tower.

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 to receive maximum signal strength and at the same time is located in the vicinity of area where coverage is desired. In addition, the donor antenna associated should have line of sight with BTS site to reduce the effects of fading.

Another important issue when choosing a repeater location is the availability of commercial power. If commercial power is unavailable, solar power may be an option. 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. Good antenna characteristics help to provide proper isolation between the server (coverage) and donor antennas, which helps to prevent feedback. An isolation of at least 15dB more than the gain setting of the repeater is required. If the isolation is less than the repeater gain, oscillations are likely to occur.

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 dBi, while server antennas are with gain of 7 dBi.

The coverage antenna normally has a horizontal beam width of 60 to 120 degrees. The donor antenna should have a horizontal and vertical beam

width of less than 30 degrees so as to correctly select the donor base station instead of other nearby base stations.

- 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:

  Isolation (dB) = 28 + 40 log (D/ʎ in m)

  Horizontal Separation:

  Isolation (dB) = 22 + 20 log (D/ʎ in m) – (Gain of donor antenna + gain of server antenna)

  D-Distance between donor & server antennas in m

  ʎ - wavelength in m

  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 reduce isolation requirements.

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

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 the various signal levels and antenna gains needed to form a properly functioning repeater system.

Received Signal Level	-72	dBm
Donor Antenna gain	12	dBi
Cable loss (100 ft. of 7/8 inch)	2	dB
Input to Repeater	-62	dBm
Gain of Repeater set	95	dB
Output of Repeater	+33	dBm
Cable loss (100 ft. of 7/8 inch)	2	dB
Server Antenna Gain	7	dBi
Repeater ERP	+38	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 users 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 R20 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 **R-20** Unit and antennas. (Refer to the manufacturer's recommendations for installing the antennas).
b. RF coaxial cable connection tools for installing connectors.
c. Multi-meter.
d. Mobile handset loaded (e.g. Nokia) with Net engineering software to be used for signal level measurement.
e. Magnetic compass for measuring the azimuth of the BTS and repeater site.

8.4. Installation Procedure

1. RF coaxial cable installation must comply with local or National Electrical Codes and must be with nominal 50-Ohm impedance. Pull and route the RF coaxial cables as per the site installation plan.
2. Fix the supplied connectors to the RF coaxial cable and verify the following:
   - The center conductor to outer shield of RF coaxial cable indicates an "Open Circuit" condition.
   - Check for any short circuit between center conductor and outer shield.
   - Short one end of the conductor between center conductor and outer shield by piece of wire temporarily and check the other end of conductor for any break in the RF cable.
3. Record the **R-20** serial number for use when contacting SHYAM customer service for support.
4. Mount the **R-20** unit on the intended wall surface using the appropriate screws.
5. Install the indoor coverage antenna according to the antenna manufacturer's instructions. Connect the RF coaxial cable between the indoor antenna and the "MS" port on the **R-20** unit.
6. Install the donor antenna (Outdoor Yagi antenna) according to the antenna manufacturer's instructions. Connect the RF coaxial cable between the donor antenna port and the "BTS " port on the R-20 unit. Connections as indicated below may be carried out:

   - RF cable from Donor antenna to "BTS" port.
   - RF cable from Server antenna to "Mobile" port.
   - AC mains through power supply adopter.

8.5. Gain Settings

The **repeater gain setting** is a vital parameter since it ultimately decides the area required to be provided with RF coverage. The noise contribution has to be minimum while setting the gain hence it should be set with utmost care. The variation in gain up to 31 dB in steps 1 dB is possible to

be achieved with the help of attenuator provided in the system. The gain setting for Uplink and Downlink path is independent of each other.

For example, If repeater has a maximum gain of 70 dB and the required repeater gain is 60 dB, the attenuation of 10 dB is required to be incorporated by inserting attenuator of this value.

Note: Repeater gain should be at least 15 dB less than the antenna isolation.

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

a. Forward Gain Setting

The process of setting the forward gain is very simple. Forward signal level strength can be measured using NET engineering software in any NOKIA handset e.g. NOKIA 6210 or any other engineering mobile handset.

Alternatively, RF output power of repeater can be measured using the visual indication shown on the display panel of the 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. Through (optional) wireless modem.

b. Reverse Gain Setting

For reverse gain setting, a 31 dB variable attenuator is provided; the required value can be inserted for the desired gain. The gain is set to such a value so as to cause minimum interference at the base station but high enough to ensure a strong signal.

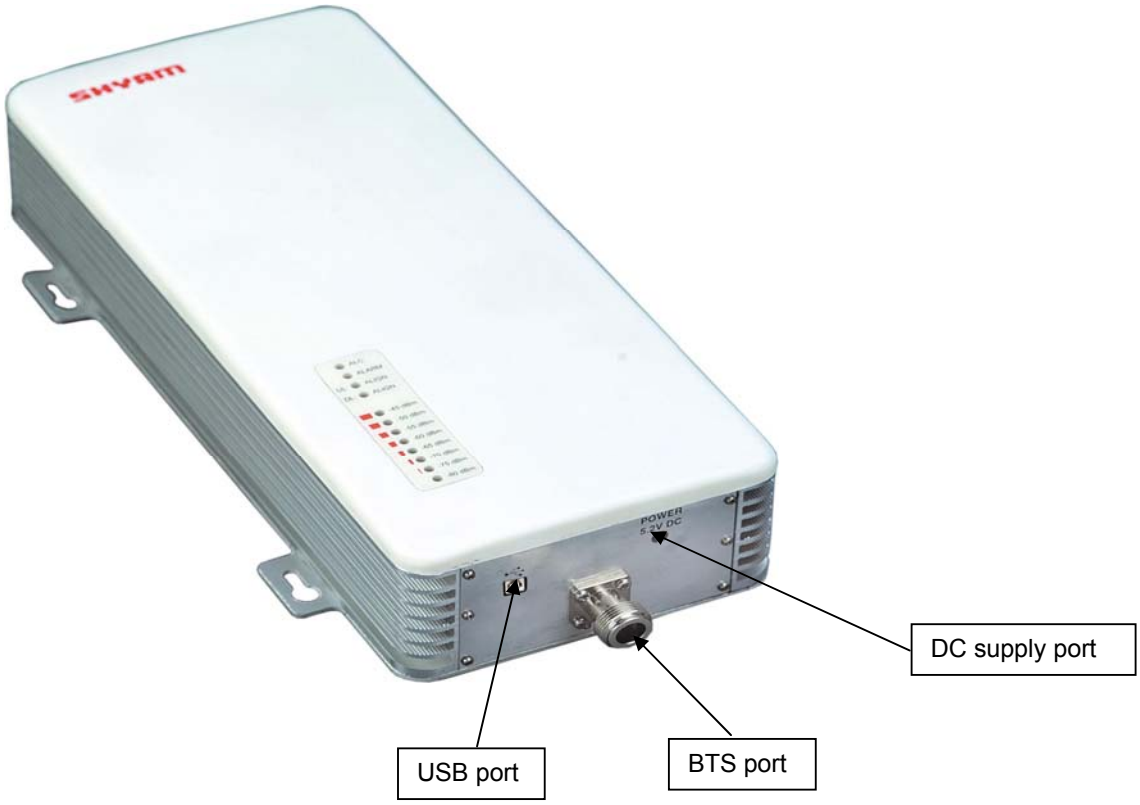

Figure 16: R20 Repeater ports

8.6. Commissioning

1. Plug the AC/DC power adaptor to the Repeater 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. Using a mobile NOKIA handset loaded with NET engineering software and the SIM card of cellular operator, measure and monitor the signal level at various points within and around the perimeter of the coverage area.

8.7. Dos & Don't Dos

1. The site should be accessible for the maintenance team.
2. Arrangement is to be made to avoid unauthorized access to the repeater.
3. Proper earthing of the repeater is required to be done to avoid damage to the system.
4. The housing should be kept away from direct exposure to the Sunlight, chemical fumes & excessive moisture.
5. Stable power supply for repeater unit should be ensured.
6. The route of Cables to/from antennas should be short to limit the cable losses and should be free from sharp bends & kinks.
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. There should be adequate separation of antenna system from power lines to avoid damage to system.
10. The selection of BTS should be made taking other BTSs in the same vicinity in to consideration to avoid interference.
11. Gain of the repeater should be set after taking antenna isolation in to consideration.
12. The estimation of coverage area should be confirmed.
13. 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
14. Feedback regarding performance of the system must be obtained from the user.

8.8. LED Display On R-20 Unit

In order to facilitate the maintenance team, a set of LEDs are provided on the top cover of the unit which display some of the important events in the system, the detail is given below:

Figure 17: Display Details of R-20

- The UL Align LED will blink when system is in Uplink Alignment mode.
- The DL Align LED will blink when system is in Downlink Alignment mode.
- SHUT Down LED will Glow when the system goes out of order due to (poor isolation) or excessive input signal. The system will check for the normal state after 30 seconds continuously. If the system senses the right condition it will be ON automatically and start functioning.
- Downlink RSSI is continuously monitored and level prevailing at a particular instant is displayed through 8 LED's.

Clicking in Alarm window can carry out the detail analysis.

8.9. Checklist – Post Installation

Service Band:
Frequency Band (DL):
Frequency Band (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.	Bandwidth for sub bands set	
3.	Repeater switched ON	
4.	Any error (alarms) observed	
5.	BCCH Channel **(Applicable for GSM based technology)**	
6.	Power level in DL	
7.	Attenuation in DL	
8.	Power level in UL	
9.	Attenuation in UL	
10.	Observation on CMC software & GUI	
11.	Repeater secured & locked	

Any Other Remark/Comment:

Date Of Installation:---------- Repeater ID:----------
Site Address:----------

Name of the Installer:----------

9. System Maintenance

9.1. General

The system normally operates without any operator intervention or maintenance. If, in the unlikely event of a unit failure, the field replaceable units (antenna unit, cables) should be checked for faults and the system restored. A failed unit can be removed and replaced with a spare while the rest of the system (other repeaters) is still operating. Soldering or local repair of the modules should be avoided from better maintenance point of view. Faulty module/unit should be replaced with genuine spares only.
However, the power supply of the failed repeater should be isolated from AC mains and DC power before any module is replaced. In the event of a system malfunction, 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 **R20** 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. R20 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 – 20 feet (4 – 5 m) 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 R20 unit.

III) R20 Defective – Replace the R20 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 R20

may be required to cover the additional area. If R20 unit is found to be defective, please contact our Technical support team. The R20 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 R20 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.

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