RF / SBR Series

OPERATION & INSTALLATION MANUAL

R4-30-SMR800 (Band Selective) Repeater
Single Sub Band Repeater For Indoor Applications (FCC ID: S3CR4-30-S8)

June 2007

Contents

1. Document History

Document Number	Document Name	Document date	Author	Edited by	Approved by	Revision
	R4 Band Selective 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.

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 internal modules, as a result of lightning is not covered by 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 unit with server antenna must be installed to provide minimum 40 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 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 **R4 Band Selective** Repeater.

4.2. Scope

This document is the product description of the Shyam **R4 Band Selective** 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
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
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 R4 Band Selective Repeater

5.1. General Description

The **R4 Band Selective** Repeater System is designed to provide indoor coverage and can handle signals in 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 details of operating service frequency bands are given below:

S.NO.	Service Band	DL Frequency (MHz)	UL Frequency (MHz)
1.	**SMR 800**	851-869	806-824
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 Customer is advised to refer to the packing note giving the details of frequency band set & the bandwidths of different sub bands equipped in the repeater: Only SMR800 Band is subject to this FCC Application w/ FCC ID: S3CR4-30-S8]

- 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 outdoor applications to meet the requirements of large number 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 can be customized to meet the requirement of user for coverage by making provision for radiating required RF power in the DL/UL paths to achieve the coverage. 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.

The repeater consists of the following modules/units:

- LNA
- Converter modules
- Power amplifiers
- Power supply modules
- 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. The housing is not waterproof since it is to be used for indoor application.

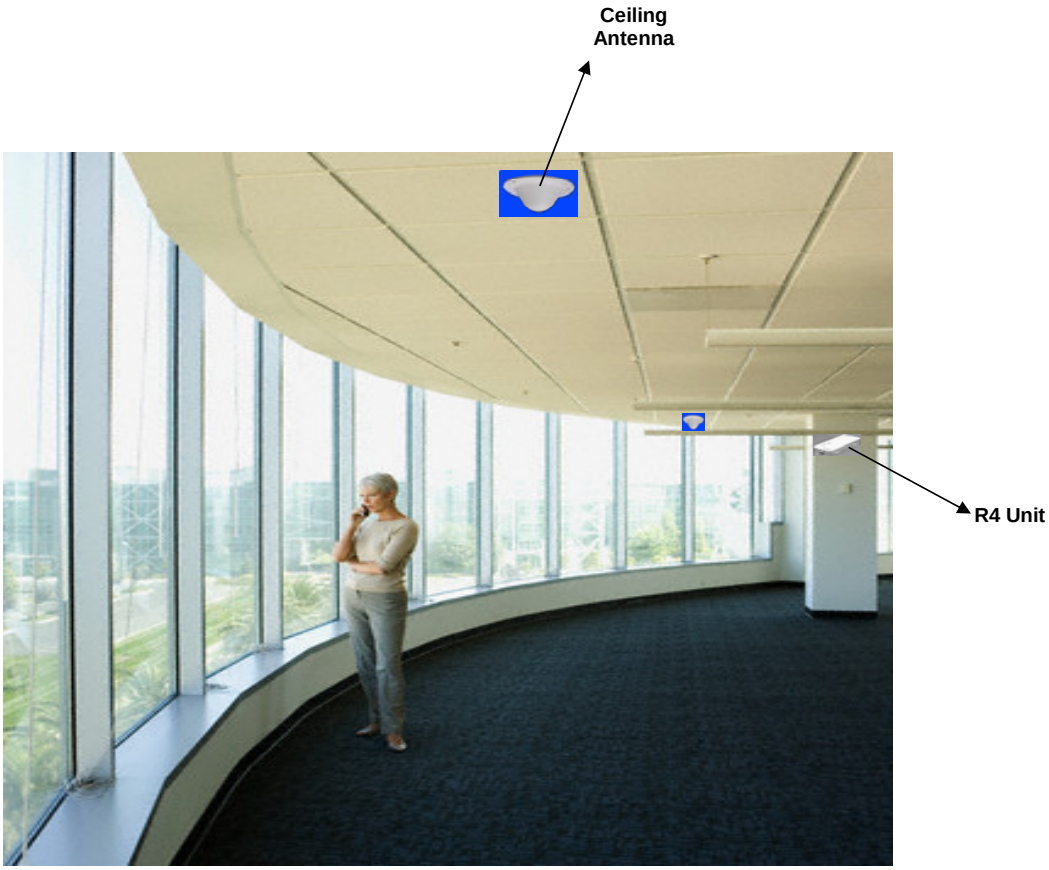

Figure 1: Indoor Coverage (Typical Application)

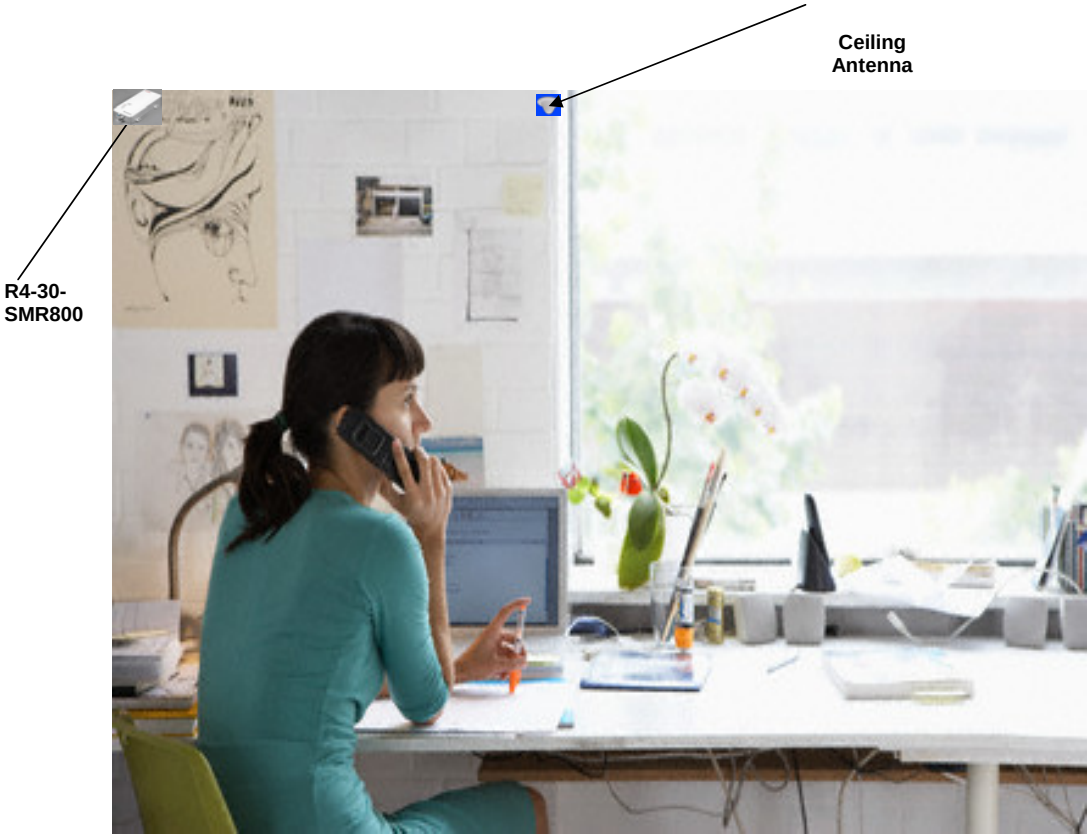

Figure 2: Indoor Coverage In a Office Premises

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. 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 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.

I) LOGIN Repeater

After running the *Configuration & Monitoring Console* (CMC), user needs to login the repeater, sequence as under, may be followed:

- Click the "**LOGIN**" on the command bar.
- Select the user type (ADMINSTRATOR or SUPERVISOR).
- Enter the password.
- Finally click the "**OK**".

A message "**Logged in successfully**" will appear on the screen after successful login. There are two types of users viz. **ADMINISTRATOR** and **SUPERVISOR**. If user logged in as an **ADMINISTRATOR**, all the functions can be performed through the CMC. By default, the password for both users 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.

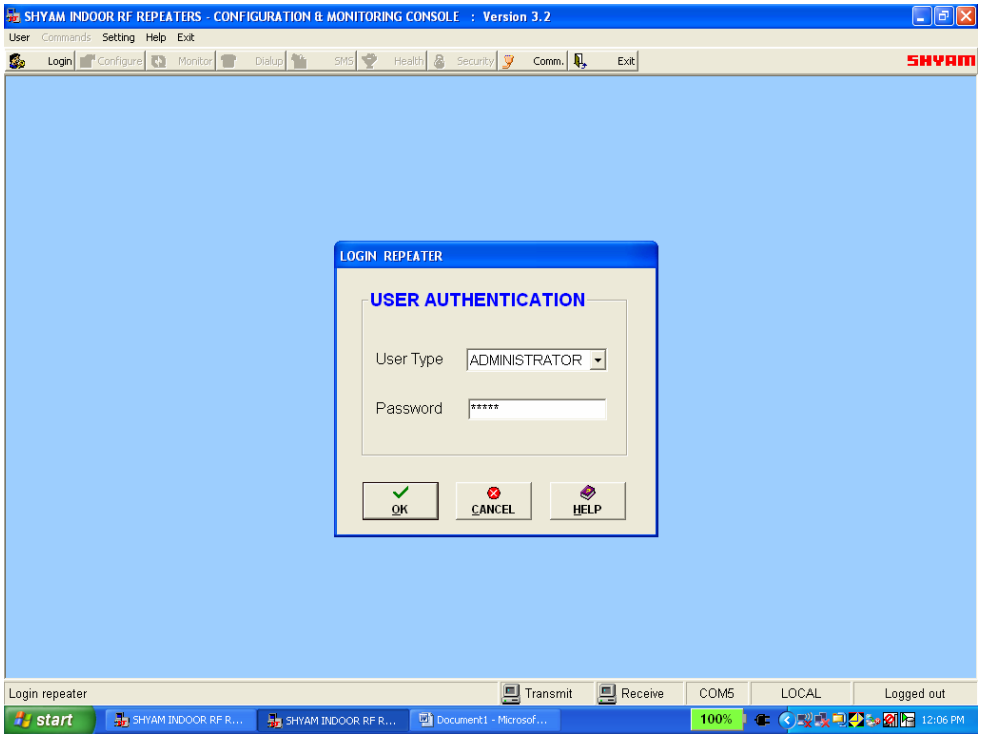

Figure 3: Login Repeater

II) CONFIGURATION (Figure 4)

Configuring system means setting the parameters for operation as per the requirement at site. The configuration is carried out after the physical installation is completed.

Click on the command bar to display the configuration and monitoring window, which allows access to all the configurable repeater parameters. User can login for configuration & monitoring of repeater parameters.

- **START** command is for initiating the dialogue.
- **SET** command is for updating the repeater parameters.

Information as detailed below, is configured after the **"CONFIGURATION"** window is activated:

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

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

iii. Sub Bands (UL/DL Frequency Bands): The frequency bandwidth with frequency details, of the loaded sub band in UL & DL paths are specified.

iv. Output Power: Maximum Output Power limits in UL & DL paths are set. A **"PA Power high"** alarm will be generated when PA power exceeds the upper limit.

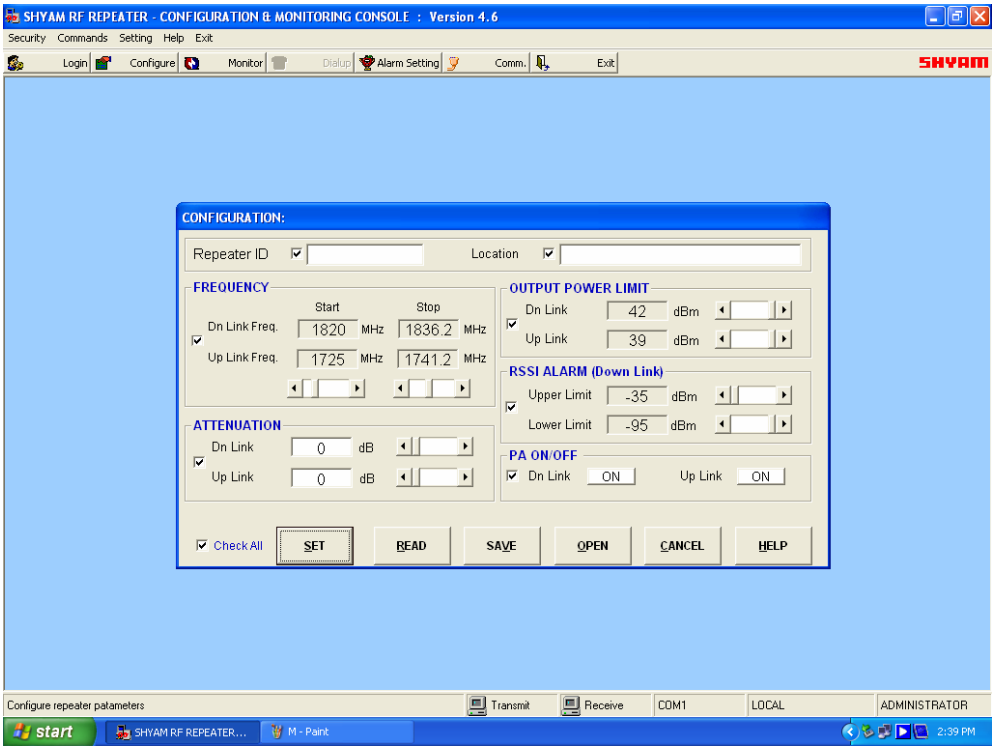

Figure 4: Configuration Window

v. RSSI Alarm (Down Link): Lower and Upper RSSI Limits in DL are set in the factory. A RSSI High alarm will be generated when RSSI exceeds the set upper limit, and a RSSI Low alarm will be generated when RSSI goes below the set lower limit. Upper range can be set from -35 to -55dBm. Lower range can be set from -75 to -95dBm

vi. PA On/Off: User can set uplink and/or downlink PA as ON or OFF independently for testing/maintenance purpose at the time of installation for both the bands.
After completing the installation it must be in ON condition only.

vii. Attenuation: This field is specified with the attenuation inserted in the system, both in the DL & UL directions to set the desired RF power.

viii. Save Parameters as Text File:

- **SAVE:** Configured parameters can be saved as text file by clicking at SAVE for later reference.

ix. Open Text File:

- **OPEN**: Saved configured text file can be opened and displayed on the configuration window by clicking at OPEN.

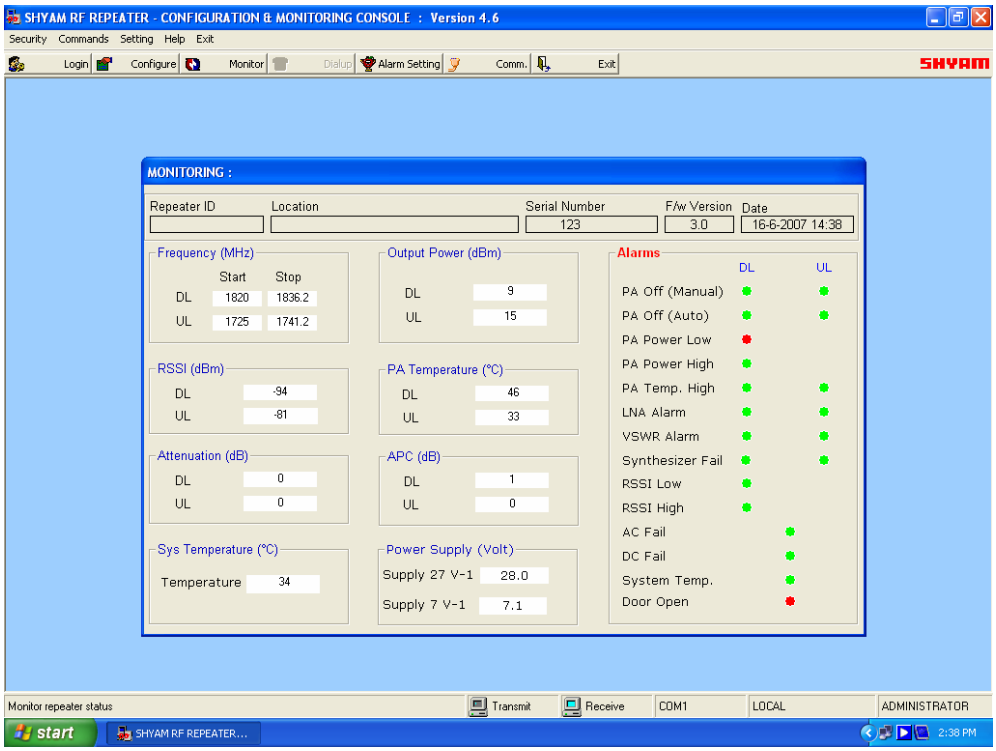

Figure 5: Monitoring/Alarm Window

III) MONITORING (Figure 5)

In this window, the status of the system is monitored for the following parameters/conditions:

STATUS

S.NO.	Parameters/Conditions	Remarks
1.	**Start and Stop Frequency of sub band, equipped.**	The specified frequency bands in DL & UL are displayed.
2.	**RSSI (DL) for the Band**	Real time DL signal level is indicated.
3.	**RSSI (UL) for the Band**	Real time UL signal level is indicated.
4.	**Attenuation DL**	Indicates attenuation inserted in the system in DL path.
5.	**Attenuation UL**	Indicates attenuation inserted in the system in UL path.
6.	**Output Power DL**	RF output power in DL path is displayed.

7.	**Output Power UL**	RF output power in UL path is displayed.
8.	**PA Temperature DL**	Real time value of temperature of PA in DL path.
9.	**PA Temperature UL**	Real time value of temperature of PA in UL path.
10.	**APC (DL)**	The APC action in the DL path is indicated.
11.	**APC (UL)**	The APC action in the UL path is indicated.
12.	**System Temperature**	Real time system temperature is indicated.
13.	**Power supply**	Values of derived voltages are displayed,

IV) ALARMS (Figure 5)

Details of alarms displayed are given below:

S.NO.	Alarm Indication	Remarks
1.	**PA OFF (Manual)**	The alarm indicates the PA OFF (Manual) condition in the DL &/or UL paths.
2.	**PA OFF (Auto)**	The alarm indicates the PA OFF (Auto) condition in the DL &/or UL paths.
3.	**PA Power Low DL**	When PA Power in DL path goes below the set limit, is indicated through the alarm.
4.	**PA Power High DL**	When PA Power in DL path exceeds the upper limit, is indicated through the alarm.
5.	**DL PA Temperature High**	When PA Temperature in DL path exceeds limit, alarm is generated.
6.	**UL PA Temperature High**	When PA Temperature in UL path exceeds limit, alarm is generated.
7.	**LNA Alarm**	The alarm indicates the failure of LNA in DL/UL paths.
8.	**VSWR Alarm**	The alarm indicates the mismatch condition at the DL/UL RF ports resulting in exceeding the VSWR limits (1.5:1).
9.	**Synthesizer fail for the sub band.**	The failure of relevant synthesizer in DL/UL direction is indicated through the alarm.
10.	**RSSI low (DL)**	The alarm indicates that the RSSI strength has gone lower than the set limit in the DL direction.
11.	**RSSI high (DL)**	The alarm indicates that the set upper limit of RSSI in the DL direction has exceeded.
12.	**AC fail**	Indicates the failure of AC mains to the system.

13.	**DC fail**	Indicates the failure of DC derived voltages in the system.
14.	**System Temperature**	Indicates the rise in temperature of the system.
15.	**Door Open**	Indicates the opening of the door of the repeater.

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

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

V) Establishing Communication (Figure 6)

The system has provision of establishing communication on **"LOCAL"** & **"Remote"** basis. In COMMUNICATION window, user can select serial communication port of the computer and type of connection between repeater and computer.

a. LOCAL CONNECTION

In this type of connection, user computer COM Port and repeater's USB port are connected directly using cable. Sequence is as under:

- 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.

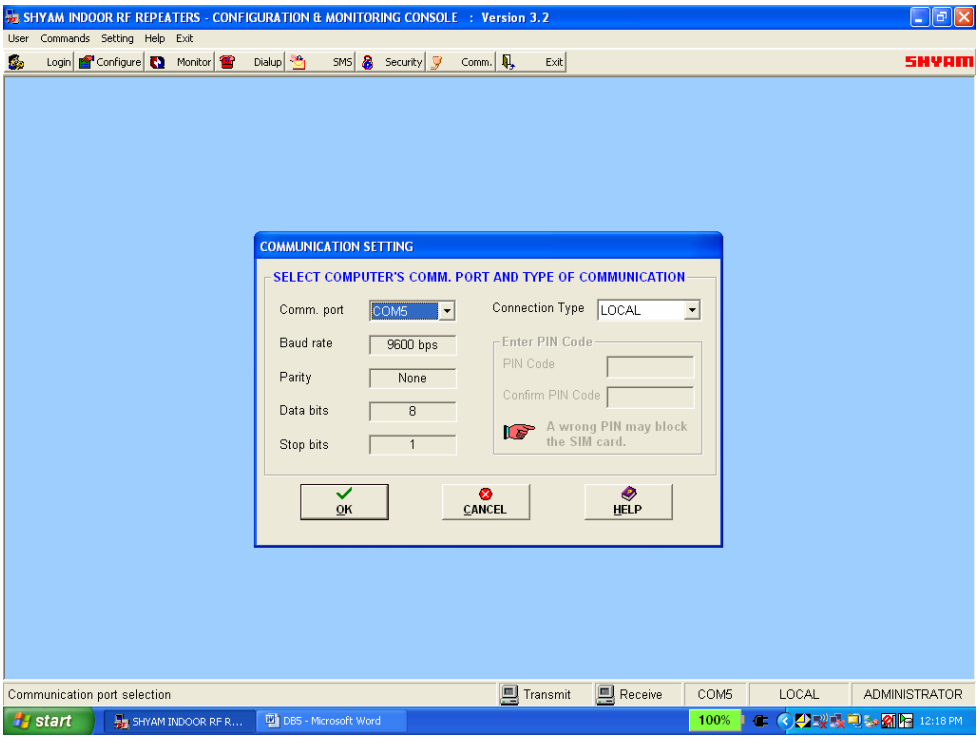

Figure 6: Communication Window

VI) Instant Alarms by SMS (Figure 7)

The provision exists in the system for getting the alarm information through **"Instant Alarms by SMS"** which is carried out by Wireless Modem. Following information is desired to be fed for enabling this facility:

- SMS Service Center Number
- RMS Phone Number
- Maintenance Phone Number

VII) Security Settings (Figure 8)

The system has two levels of permitting Log in to the repeater to avoid unauthorized operation. The levels are: **ADMINISTRATOR & SUPERVISOR.**

Each level has a specific password. The password for each level can be changed at intervals. **ADMINISTRATOR** has rights to perform all functions Viz. Configuration, Monitoring etc. Whereas the **SUPERVISOR** is allowed to perform limited functions like monitoring of alarms, establishing communication etc.

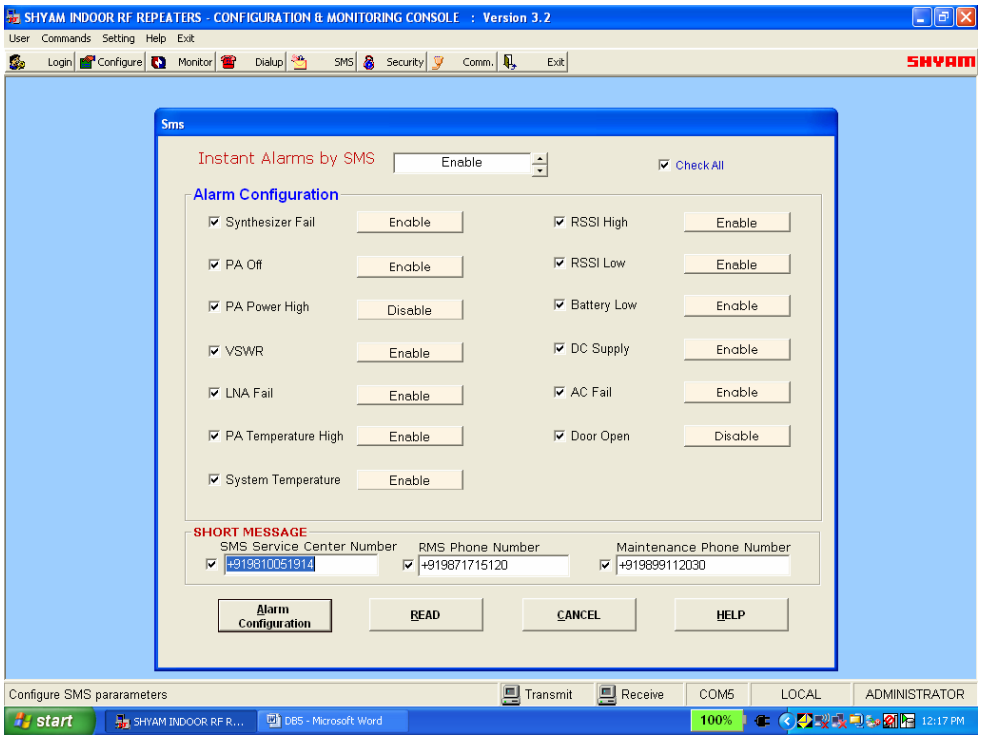

Figure 7: Instant Alarms by SMS

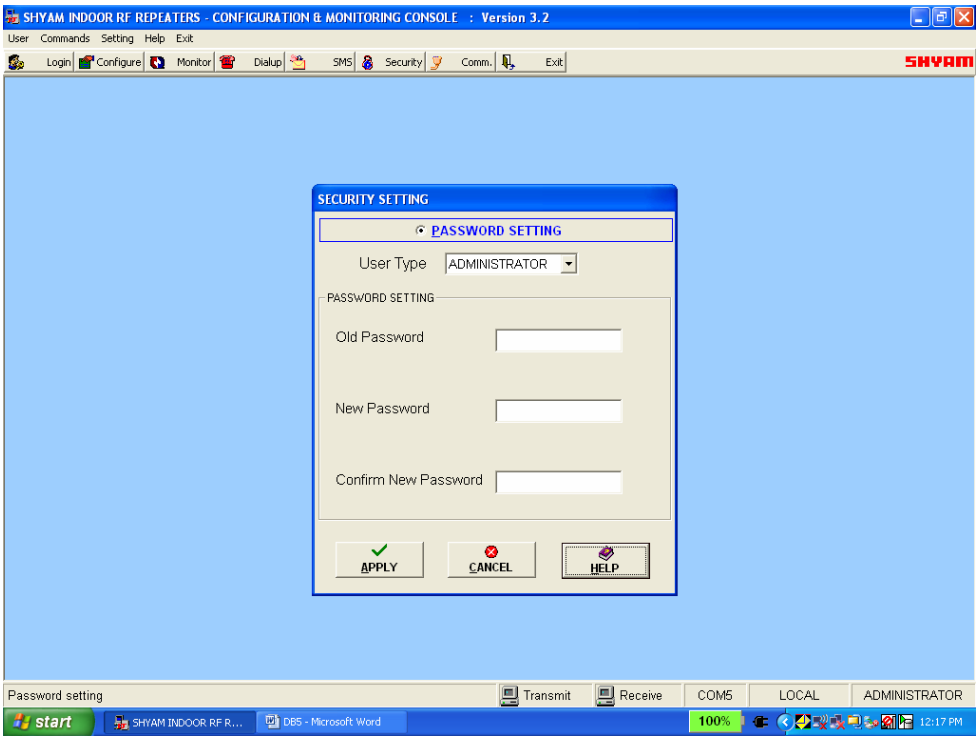

Figure 8: Security Settings

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 10: Donor Antenna (Patch Panel)

It receives signals from the base station and transforms electromagnetic waves into RF signals in the DL and vice versa in the UL. The antenna with more than 10-12 dB gain transfers received 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 converters, one in DL path & other in the UL path are equipped.

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. 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 63Hz, its output DC derived voltages remain constant within 1% of nominal value.

h. 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 antennas with suitable gains & N type connecters is installed at pre-planned spots.

7. R4 Repeater Specifications

7.1. Electrical Specifications-RF

S.NO.	Parameter	Specified limits/Remarks
1.	Frequency band in DL path.	851 MHz to 869 MHz
2.	Frequency band in UL path.	806 MHz to 824 MHz
3.	Number of RF Sub bands	One
4.	RF composite power DL	+30dBm
5.	Spurious Emission	≤ 36 dBm from 9 KHz to 1 GHz ≤ -30 dBm from 1 GHz to 12.75 GHz
6.	Automatic Power Control	25 dB
7.	Repeater Gain	80 dB
8.	Attenuation range for gain adjustment in DL & UL	31 dB in 1 dB step (Software control)
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	100-240 V, 47/63 Hz
Power Consumption +30dBm	100 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)	520x275x180 mm (20x11x7 inches)
Weight	15 Kg. (33 Lbs.)
Housing	Indoor application
Housing Color	Grey
Cooling	Convection

7.5. Environmental Specification

Conditions	Specification
Operating Temperature	-5^{o}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	As per Indoor Application

7.6. Contents of Delivery

ITEMS	QUANTITY
Repeater R4	1
PC interface cable for USB port	1
Power cable 3 pin – 3 meter length	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

1. General

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

Number Of Sub Bands: One
Sub Band: Frequency Band DL- UL-

2. Technical requirements

S.NO.	Requirement	Remarks
1.	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	
7.	Attenuator to be inserted in DL path	
8.	Estimated cable loss from repeater unit to server antenna port	
9.	ERP at server antenna	
10.	Desired RF Power in UL	
11.	Proposed gain settings in UL path	
12.	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 at 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 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 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 AC mains 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 15dB more than the gain setting of the repeater is required 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 proper gains are installed.

- 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	80	dB
Output of Repeater	+18	dBm
Cable loss (100 ft. of 7/8 inch)	2	dB
Server Antenna Gain	9	dBi
Repeater ERP	+26	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 R4 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 **R4 repeater** 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.
f. Magnetic compass for measuring the azimuth of the BTS and repeater site.

Formatted: Bullets and Numbering

8.4. Installation Procedure

The **R4** repeater has been designed for indoor applications. The repeater unit shall be mounted at the place from where it is not exposed to the direct Sunlight & excessive moisture.

In case of wall mounting, minimum physical separation between the repeater housing & the wall should be 50 mm.

Furthermore, the repeater shall be mounted in a way so that there is free access to the individual units, while the cover of the repeater is open.

The repeater is mounted at the pre-selected site firmly placed with clamps and other mechanical accessories. Following connections as detailed below are carried out:

- RF cable routed from DONOR antenna is connected at the BTS port as indicated.
- RF cable routed to SERVER antenna is connected at TX/RX port for signal distribution.
- For energizing the system, the cable from AC mains is connected at AC mains port, range 100-240 V.
- USB port is provided for carrying out configuration and monitoring.

Following points need considerations for laying of RF cable:

1. RF coaxial cable installation must comply with local or National Electrical Codes. The cable shall have 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.
   - 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.

8.5. Gain Setting

The **repeater gain setting** is one of the vital parameters since it also 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 80 dB and the required repeater gain is 60 dB, the attenuation of 20 dB is required to be incorporated by inserting attenuator of this value.

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 is set using software control through local USB serial port or 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.

8.6. Commissioning System

Note:-Repeater should not be connected to Power without termination of the antenna connection. The termination can be performed 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)

After setting the gain, verify the parameters:

1. DL RF power radiated in the set frequency band.
2. Received RF power in the DL.
3. UL RF power radiated in the set frequency band.
4. Received RF power in the UL.
5. Record the value of attenuation introduced for setting the gain.

8.7. Dos & Don't Dos

1. The site should be accessible for the maintenance purposes.
2. Arrangement is to be made to avoid unauthorized access to the repeater.
3. The repeater is designed for indoor applications; the housing is not waterproof. It should be installed from where it is not exposed to direct sunlight & excessive moisture.
4. Stable power supply for repeater unit should be ensured.
5. The route of Cables to/from antennas should be short to limit the cable losses and should be free from sharp bends & kinks.
6. Local standard of cabling should be followed.
7. 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.
8. The selection of BTS should be made taking other BTSs in the same vicinity in to consideration to avoid interference.
9. Gain of the repeater should be set after taking antenna isolation in to consideration.
10. The estimation of coverage area should be confirmed.
11. 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

12. Feedback regarding performance of the system must be obtained from the user.

8.8. Checklist – Post Installation

Before the system is configured for normal traffic, points as indicated in the checklist may be verified for trouble free performance.

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.	Sub band(s)- Bandwidth set	
3.	Repeater switched ON	
4.	Any error (alarms) observed	
5.	Gain set	
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 faulty 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. Faulty module/unit should be replaced with genuine spares from Shyam Telecom Limited only.

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 **R4** 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
   - Repeater gain setting

II) Defective Indoors 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 repeater unit.

III) Repeater Unit Defective – Replace the repeater 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 repeater with more RF power may be required to cover the additional area. If repeater unit is found to be defective, please contact our Technical support team. The repeater 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 DIP switch with the likely compromise to the overall coverage within the building.

TYPICAL PRODUCT APPLICATION

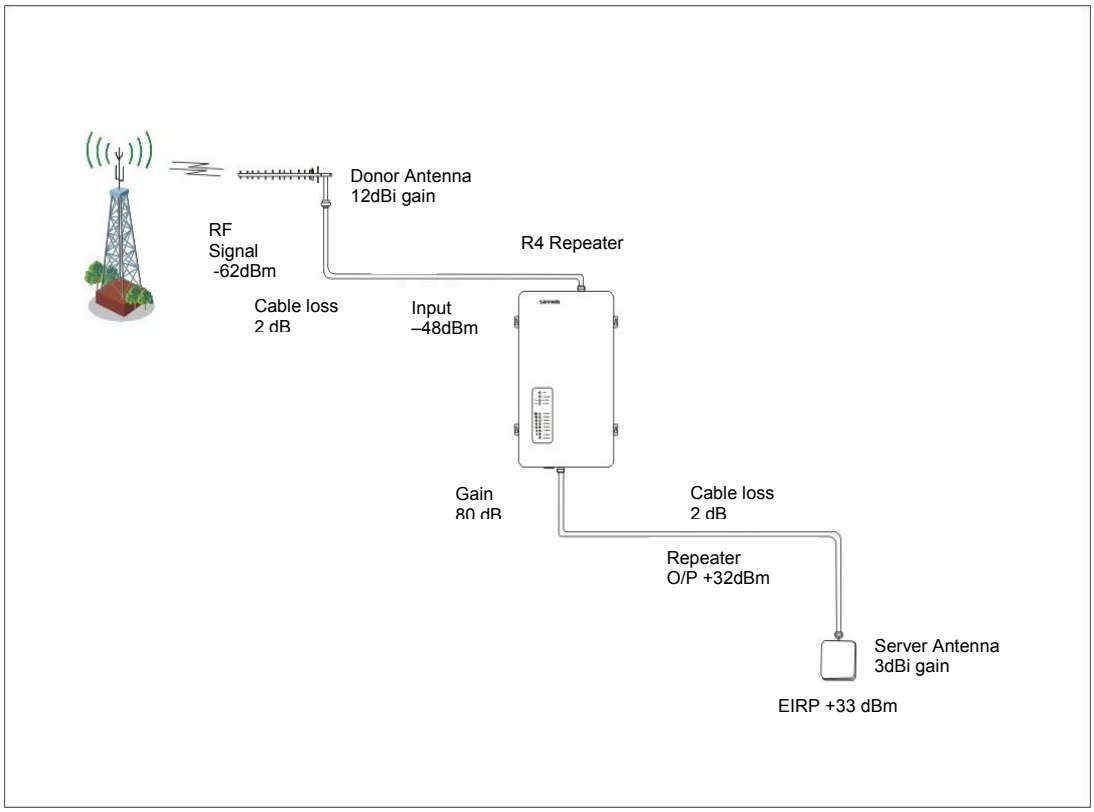

Figure 11: R4 Application Link Budget

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

For Americas

Shyam Telecom Inc.
6, KILMER ROAD, SUIT D,
EDISON, New Jersy-08817 (USA)

For Europe

Shyam Telecom GmbH.
Frohsinnstrasse 16, 63739 Aschaffenburg, Germany
Tel: + 49-6021-45901-0 Fax: + 49-6021-45901-29

For ASEAN & Others

Shyam Telecom Ltd.
246, Phase IV, UDYOG VIHAR,
GURGAON – 122015 (INDIA)
Tel: +91-124-4311600 FAX: +91-124-4018117

Email: contact@shyamtelecom.com

