ATTACHMENT E.

- User Manual -

GRS-825DM-BC
RF Repeater
User Manual

January, 2009

Version 1.0

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1. Summary

GRS-825DM-BC is a In-building repeater, which has been designed to improve signals in blanket/shadow areas inside of buildings to transmit Bell Mobility's signals at nd 800MHz frequencies.

Characteristics

800MHz Band: 80dB Gain with 25dBm maximum composite output power.

Bandwidth:

- Downlink 880MHz~894MHz, Uplink 835MHz~849MHz (14MHz Band)
- See page 11 for more details.

Characteristics

GST's In-buildingrepeater is basically a combination of 800MHz 25dBm repeaters. Functional modules are classified as below:

- Cavity Filters to combine the Duplex input/output signals for: 800MHz.
- LNA (Low Noise Amplifier)
  - Gain Block to transmit output signal to PAM (Power Amplifier Module)
- Cavity Filter
- Converter Modules
- PAM Module to amplify output power linearly in accordance with optimal repeater output power.
- Power Supply Unit
- Controller to monitor each module in repeater.

Abbreviation
PAM: POWER AMPLIFIER MODULE
LNA: LOW NOISE AMPLIFIER
AGC: AUTO GAIN CONTROL
ALC: AUTO LIMIT CONTROL

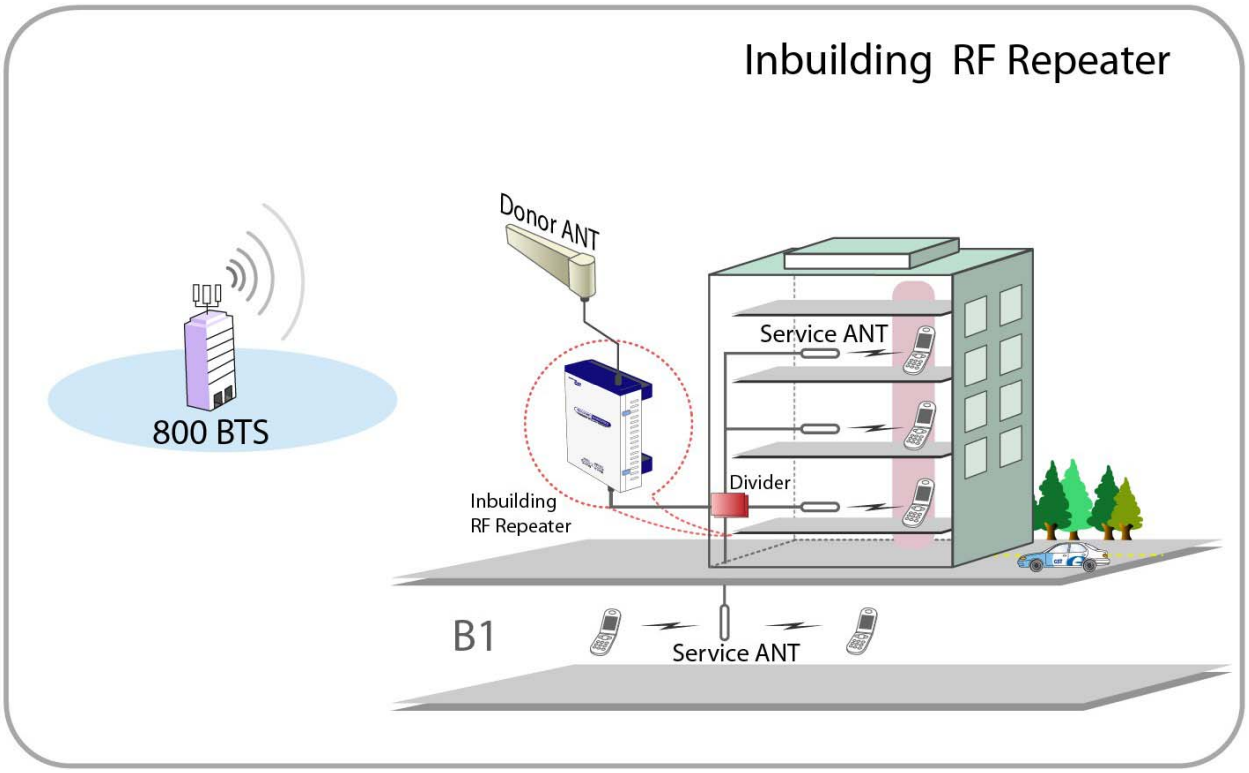
Caution: Risk of explosion if battery on the controller board is replaced by an incorrect type.

- Statement indicating that the socket-outlet shall be installed near the equipment and shall be easily accessible.

- This equipment is indoor use and all thecommunication wirings are limited to inside of the building.

2. System Configuration

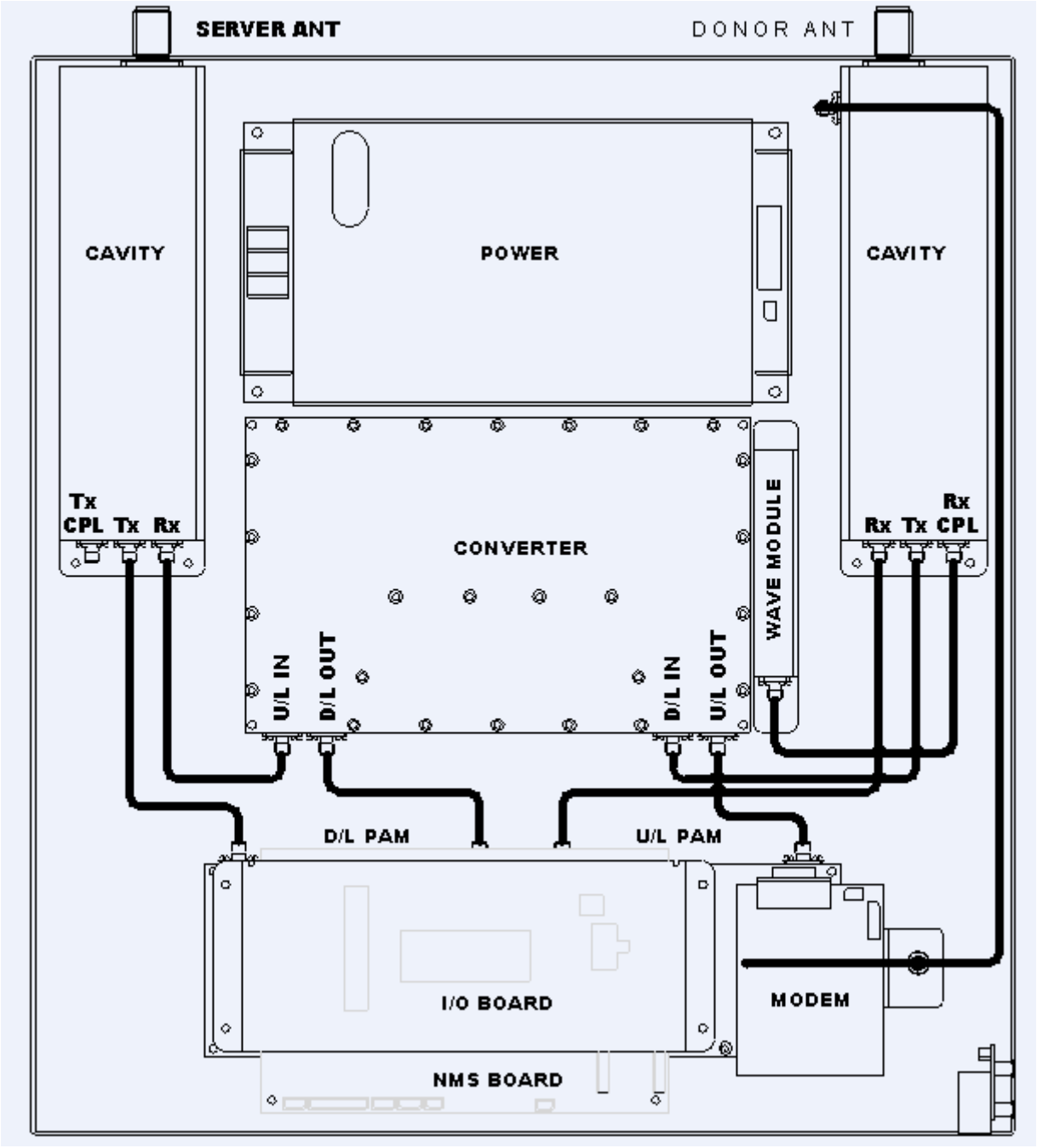
2.1 In-building Repeater Service Network Configuration



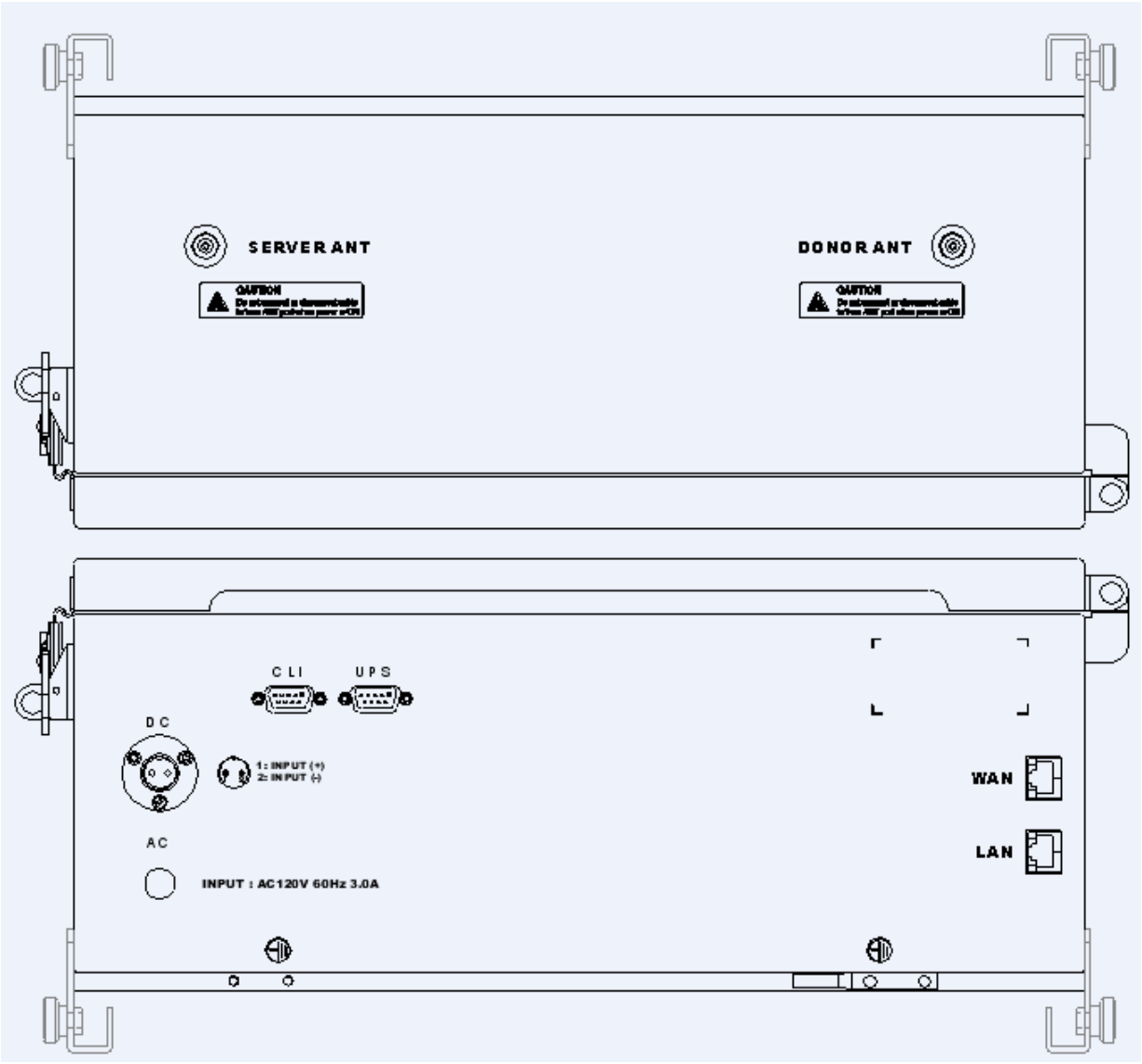
<Pic.1> In-building Repeater Service Organization

2.2 System Design and Operation

2.2.1 System Design



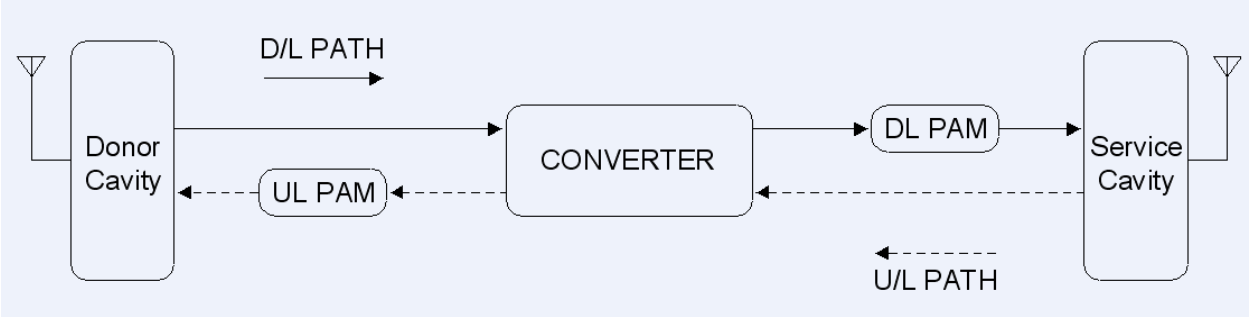
<Pic.2> In-building Repeater Internal Design



<Pic.3> > In-building Repeater Port Design

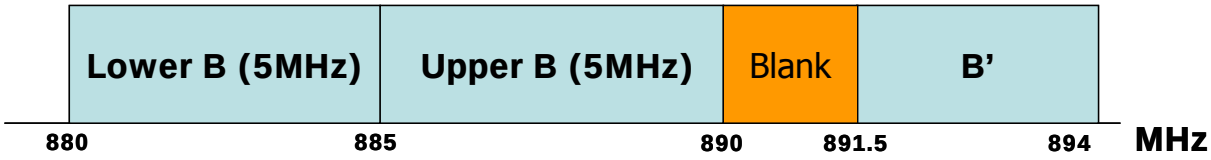
2.2.2 Downlink/ Uplink Path

In-building RF Repeater simutaneously operates at 800MHz frequencies and has one Donor ANT Port for aiming at each BTS, and one Server Port for the In-building coverage. Therefore the Cavity Filters applied to the Front End of Donor ANT Port and Server ANT Port consists of DPX, has DPX which multiplexes all Tx/Rx into one path.

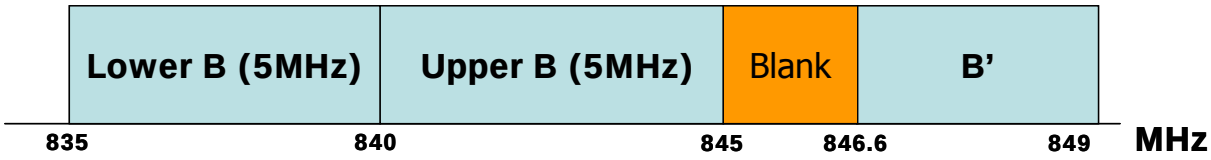


<Pic.4> In-buildingIn-building Repeater Block Diagram

2.2.3 800MHz Frequency Selection



800MHz Downlink Frequency Table



800MHz Uplink Frequency Table

<Pic.6 > 800MHz Band Structure

800MHz Band Select Table

Configuration	B (10MHz)		B' (2.5MHz)
	Lower B (5MHz)	Upper B (5MHz)	
1	O		O
2			O
3	O		
4	O		
5		O	
6	O		O
7		O	O

3. SPECIFICATIONS

3.1 System Capacity

Item		Specification	Remark
Frequency	DOWNLINK	880MHz ~ 894MHz	14MHz
	UPLINK	835MHz ~ 849MHz	14MHz
Port	Donor	Tx / Rx	DPX
	Server	Tx / Rx	DPX
Capacity		OMNI	
Bandwidth		14MHz	
Output Power (ANT Port)		+25dBm / 316mW Total	

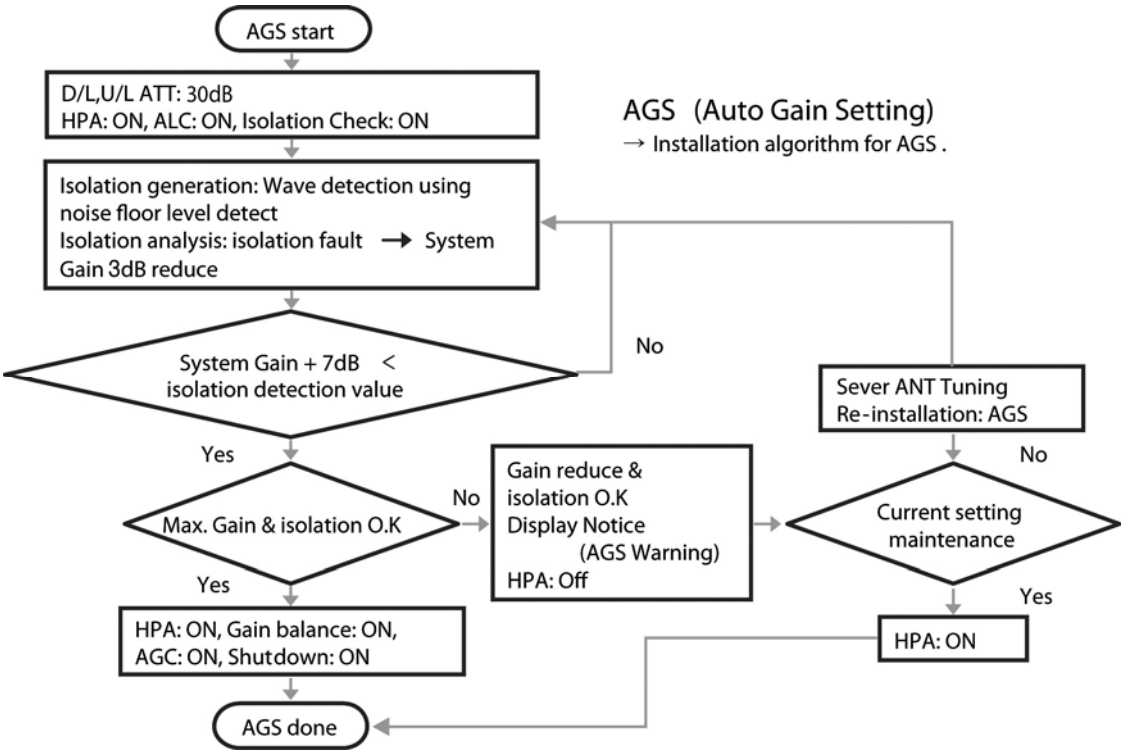
3.2 System Specifications

Parameter		Specification	Remark
Band Select	B+B′	DL: 880~894MHz UL: 835~849MHz	1dB BW
	B	DL: 880 ~ 890MHz UL: 835 ~ 845MHz	
	B′	DL: 891.5 ~ 894MHz UL: 846.5 ~ 849MHz	
	Lower B or Upper B	DL: 880 ~ 885MHz UL: 835 ~ 840MHz Or DL: 885 ~ 890MHz UL: 840 ~ 845MHz	
Gain	Range	50dB ~ 80dB	
	Adjust Step	±1.0dB	
	Adjust Accuracy	±0.5dB	
Propagation Delay	800MHz	< 6.0us	
Spurious Emission	F0±750kHz	< -45dBc	Δmarker: 29dB
	F0±1.98MHz	< -50dBc	Δmarker: 39dB
Out Band Spurious Emission		< -13dBm	RBW: 30MHz
Flatness		< ±1.25dB	
Return Loss / VSWR		> 14dB / < 1.5 : 1	
Uplink Noise Figure		< 5dB @ Max gain < 8dB @ Min gain	
Roll off	±1.5MHz	> 40dBc	Test frequency measured from band edge
	±3MHz	> 50dBc	
Characteristic Impedance		50Ω	

3.3 Electrical and Environmental Specifications

Item		Specification	Remark
RF Connector		N-Type Female	Donor & Server ANT Port
Power Connector	AC	MS3102A-10SL (3Pin)	MIL-C-5015 Type
	DC	SCK-16-2P (2Pin)	Circular Type
AC Supply		AC 120V 60Hz 3.0A	
Out Dimension		450(L)*410(W)*199(H)	cm
Net Weight		17.6	kgs
Material	Module	AL6063S-T5	
	Cabinet	AL5052P	
Operation Temperature		5℃ ~ +45℃	Convection cooling
Humidity		5% ~ 95%	Non-condensing
Dust Resistance		TELCORDIA GR63-CORE	
Vibration Resistance		1G, 10~150Hz 0.1 Octaves/min	
Environmental specifications		NEMA1	
MTBF		100,000 hours	

3.4 Functions

Parameter	Specification
Gain Control	• Adjustable DL and UL Gain range 50~80dB (800MHz) • Display default Gain and current Gain function
AGS Auto Gain Setting	• AGS (Auto Gain Setting) Use for convenient Set-up 
AGC Auto Gain Control	• It always operates in Downlink AGC ON status • To maintain same Downlink output power despite flexible input signal strength. • To add or subtract Attenuation level referring to AGC Power Limit level. • Used with the Automatic Setup (Auto Gain Setting)
ALC Auto Limit Control	• To limit output power as far as default range • Used for DAS configuration and when oscillation/isolation is a concern • Automatic Gain decrement when output power of repeater is higher than default level • Automatic Gain recovery when output power of repeater is reduced. • Shutdown when output power is higher than default level in Minimum Gain • Automatic Recovery Algorithm conversion after Shutdown status
Band Select	• B+B′ Band (14MHz)

Power Monitoring Function	• Monitoring repeater's output level
Oscillation Check	• Isolation Check in initial set up or Reset • Monitoring Oscillation comparing to minimum/maximum Noise Floor level • When Oscillation occurred, repeater attempts to stabilize Isolation through Gain control function. • Shutdown repeater when Oscillation still occurs in Minimum Gain • Automatic Recovery Algorithm conversion after Shutdown status
Spurious Emission Alarm	• Noise Floor Observation in case of ±2.25MHz down at the center • In case of Noise level > –13dBm, Spurious Emission is stabilized automatically • In case of Oscillation Spurious Emission Alarming in Minimum Gain, repeater will be shutdown • Automatically Switch to Recovery Algorithm at Shutdown
DL Input control	• Monitoring Donor ANT input power of DL
Automatic Recovery	• When repeater is shutdown, it periodically recovers output power of repeater then monitors alarming
Security	• Support HTTPS for Web Browser security • User authentication through User ID and Password
Temperature Control	• Monitoring temperature of repeater • Maximum and minimum set up is possible. Shutdown in over temperature • Automatic recovery after temperature becomes normal. (Hysteresis 10degree)
VSWR Monitoring	• Monitoring VSWR of Donor ANT Port (Every 90 seconds) • Reporting VSWR Alarm and Shutdown when the rate is 3:1 • Automatic Recovery Algorithm conversion after Shutdown status
IP address report via E-mail	• When in PPP reconnection, E-mail which includes HTML to connect to newly assigned IP Address, reports to operator.
DHCP Client	• Automatic IP assignment
DHCP Server	• Server function for automatic IP assignment
Web GUI	• Remote and local user browser support through Web Browser
SNMP Agent	• NMS report via SNMPv2 Trap
LED Display	• LED displays power and operation status on front side of repeater system. • Input and Output signal levels are verified by LED bars.

4. SETUP

4.1. Equipment Needed for In-buildingRepeater Setup

Parameter	Item	Quantity	Remark
Major Component	Repeater GRS-DUO24M-BC	1 EA	Provided by GST
Additional Components	Mounting Bracket CD which contains User Manual V.1.0 and Installation Guide V.1.0 Ethernet Cable 6.6ft (2m) Ground Cable 6.6ft (2m) Ground Sems Screw M4 x 8mm Bracket Sems Screw M6 x 16mm Lag Screw 12.7mm x 50.8mm Anchor Bolt Set 12.7mm x 50.8mm	1 EA 1 EA 1 EA 1 EA 4 EA 4 EA 4 EA 4 EA	Provided by GST
Antenna	Donor ANT Server ANT	1 EA 1 EA	Not Included
RF Cable	Antenna connection Cable	TBD	Not Included
Testing and Measuring Equipment	Spectrum Analyzer	1 EA	Not Included

4.1.1 Checkpoints before turning on the Repeater

1) **System Power Check**: AC electrical power to the repeater should be 110V, input electricity only after power verification.
2) **Input RF Signal Range**: Optimal input RSSI into the repeater is -55dBm ~ -25dBm for 800MHz. User should verify input condition of Donor ANT. If the input RSSI exceeds -20dBm, then external attenuators should be used.
3) **Isolation check between DONOR/SERVER ANT**: Isolation condition of this equipment is 87dBc (Gain+7dB) for 800MHz. User should check its condition before installation.

4.1.3 System Setup

1) This equipment is basically wall mountable.
2) Installer will have to connect the power supply (after verifying the input power) and RF cable to the Repeater and then it will be ready to use.
3) For grounding, there is a grounding terminal in main power supply which will be plugged into power outlet. There is also a separate grounding terminal on the repeater which should be connected to the on-site grounding terminal to ensure proper grounding.
4) Mounting of repeater should be done by at least two technicians to ensure a safe and proper installation.

4.1.4 Open for Service

1) Check points before open:

a. Verification of system installation status:

- Electricity, In/Out antennas, cable connection, and equipment mount status.

b. Verification of system accessories:

- User should check all necessary accessories.

c. Check receipt signal level

- Installer should check whether environmental conditions are in accordance with system specification to ensure that system operation will be optimized.

2) Check points after open:

a. Check external LED

1) RUN: Green light ON (Off: all lights off)

2) ALARM: Green light in normal status, Red light in alarming

3) SHUT DOWN: Green light in normal status, Red light in Shutdown status

800MHz 25dBm:

Number of LED bars on front side of repeater will show input signal level.

Less than ~ -85dBm: LED 1bar

-84dBm~-67dBm: LED 2 bars

-66dBm~-49dBm: LED 3 bars

-48dBm~-31dBm: LED 4 bars

More than -30dBm: LED 5 bars

Number of LED bars on front side of repeater will show output power signal level.

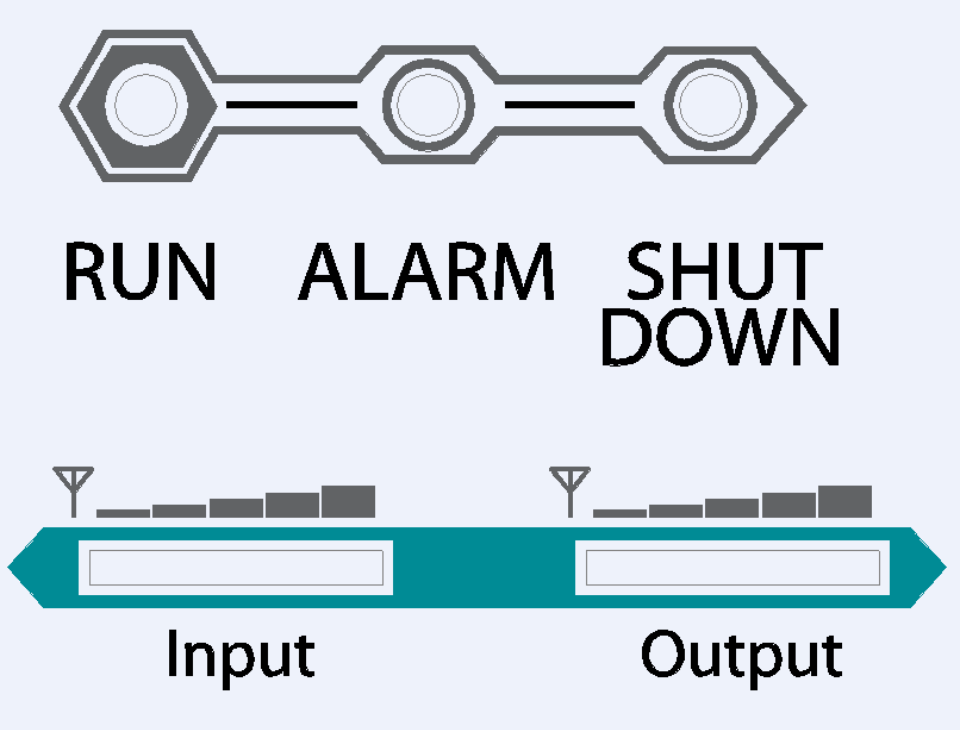
Less than +5dBm: LED 1 Bar

+6dBm ~ +10dBm: LED 2 Bar

+11dBm ~ +15dBm: LED 3 Bar

+16dBm ~ +20dBm: LED 4 Bar

More than +21dBm: LED 5 Bar



<Pic.9> GRS-825DM-BC In-Building Repeater Front LED

b. Verification of operation status

User should verify following status with Output monitoring terminal, which is provided by Spectrum Analyzer:

- Output power generation status, system spurious emission characteristics.

c. Verification of signal quality and strength in service area

User should verify signal strength and quality of in-service coverage area by using cell phone or other measuring device.

d. Verification of upper-level NMS operation status

4.2 Troubleshooting

In case of abnormal operation, technician should diagnose abnormality via remote access or directly connecting to repeater using Ethernet cable. If technician is required to conduct repairs due to major alarm, repeater should first be powered off, and then technician should prepare the proper measurement equipment before trying to fix the problem. In most cases of major repairs, GST will simply replace the unit and conduct repairs at the appropriate facility.

4.2.1 Necessary Testing and Measuring Equipment

a. RF Power Meter: 10Watt Max, 50ohm

b. Signal Generator: 3GHz

c. Spectrum Analyzer: 3GHz

d. Multi-Meter

4.2.2 Notice

a. Troubleshooting should be performed by a trained technician.

b. Parts that seem to be not used should not be disassembled.

c. While troubleshooting, technician should use attenuator to check RF Signal output.

4.2.3 Simple Troubleshooting Method

a. Verify LED Status, both on external LED's as well as internal module LED's

- Normal operation: Green light On. Alarming: Red LED on

b. Technician should check external and internal connectors to ensure that all connections are tightly secure. These connectors should be cleaned regularly.

c. If technician thinks there is a serious problem, call after sales team for over-the-phone technical support. 1-866-9-GST-USA (1-866-947-8872)

4.2.4 Troubleshooting Guide

<table>
<tr><th>Item</th><th>Check Point</th><th>Trouble shooting</th></tr>
<tr><td>Note before system operation</td><td>* System Input power range</td><td>
<table>
<tr><th colspan="2">Input Level</th></tr>
<tr><td>Downlink (800MHz)</td><td>-55dBm/Total ~ -25dBm/Total</td></tr>
<tr><td>Uplink (800MHz)</td><td>-55dBm/Total ~ -25dBm/Total</td></tr>
</table>
</td></tr>
<tr><td>Note before system operation</td><td>* System Gain</td><td>
<table>
<tr><th colspan="2">Gain</th></tr>
<tr><td>Downlink (800MHz)</td><td>50 ~ 80dB</td></tr>
<tr><td>Uplink (800MHz)</td><td>50 ~ 80dB</td></tr>
</table>
</td></tr>
<tr><td>Note before system operation</td><td>* Output power at Server port</td><td>
<table>
<tr><th colspan="2">Output power</th></tr>
<tr><td>Downlink (800MHz)</td><td>25dBm/Total</td></tr>
<tr><td>Uplink (800MHz)</td><td>25dBm/Total</td></tr>
</table>
</td></tr>
<tr><td>Check in Advance</td><td>* Check points before open for service</td><td>* Please check quantity of all accessories with specification before you set up.
* Fit cable length in accordance with field condition.
* Set up 800MHz Donor antenna to secure Isolation (More than 87dBc)</td></tr>
<tr><td>Check after open</td><td>* Check points after open for service</td><td>* Check following status
- Verify that the antennas are securely mounted and pointed in the correct directions
- Connection status between antennas and RF cable
- Verify that the Repeater is securely mounted
- Proper AC power status
- Grounding status of electrical circuit
- Coaxial cable (RF) construction status
- Connectors and combiners connection status
- Cable connection status against leakage of water</td></tr>
</table>

4.2.5 Troubleshooting Guide Related to RF

Symptom	Check Point	Troubleshooting
When repeater does not work properly	* Check Electricity Cord connection status	* Re-plug in AC power cord
When repeater does not work properly	* Checking electricity input to AC power outlet.	* Please verify AC power input by using DVM (Digital Voltage Meter)
When in alarming	* DL over-input alarm	* Please Check following status - Proper maximum output power limit level - BTS input level (Spectrum Level) - Input RSSI value on Status Page - Downlink Attenuation level * Please reset AC power upon completing Alarm troubleshooting
When in alarming	* DL over-output alarm	* Make sure output power is operating normally. * Reset AC power upon completing Alarm troubleshooting.
When in alarming	* UL over-output alarm	* Please make sure output level is operating normally * Please reset AC power upon completing Alarm troubleshooting
When in alarming	* VSWR alarm	* Check following status - Antenna port connection - Verify that cable from I/O filter is secure. * Disconnect all antenna cables from the repeater, terminate all antenna ports with 50Ohm terms and then reboot the repeater. If the VSWR alarm still occurs then equipment should be replaced. If the alarm goes away, then the VSWR issue is somewhere in the cabling or connectors. * Reset AC power upon completing Alarm troubleshooting
When in alarming	* IF Module alarm	* Verify IF Module LED is On. * When LED is Off, module should be defective.

When in alarming	* DL, UL PAM alarm	* Reset AC power upon completing Alarm troubleshooting
When in alarming	* DC matter/Current alarm	* Verify DC power by using DVM (Digital Voltage Meter) * Reset AC power upon completing Alarm troubleshooting.
When in alarming	* UL Oscillation	* Check Isolation between Donor and Server. * Reset AC power upon completing Alarm troubleshooting
When in alarming	* DL / UL LNA alarm	* Check connection status of LNA. * Reset AC power upon completing Alarm troubleshooting
When in alarming	* Temperature alarm	* Check following status: - Setting level of maximum temperature limit - Temperature offset is normal or not. - Circumstances of temperature. * Reset AC power upon completing Alarm troubleshooting
When in alarming	* DL low-input alarm	* Reset AC power upon completing Alarm troubleshooting
When in alarming	* DL low-output alarm	* Check following status - Output power level is normal or not. - Whether minimum output limit level is normal. - Compare RSSI to maximum gain. * Reset AC power upon completing Alarm troubleshooting
When in alarming	* RF OFF	* Verify that the HPA's are On. * Reset AC power upon completing Alarm troubleshooting
When output power is no longer problem	* Technician should verify category of alarm at the front side of repeater.	* When Red light on the Shutdown LED, technician should troubleshoot the alarm via Notebook computer.

When output power is no longer problem	* Technician should connect antenna with output port of repeater. * Please make sure all connectors are fastened	* Reconnect the connector. * Change it if the connector is defective.
When output power is no longer problem	* Check the input level	* Increase output power or check input change of BTS side.
When output power is no longer problem	* Check Gain of the unit	* If the Gain is different from normal level, please contact A/S team.
When output power is no longer problem	* Cable connector loose.	* It is possible for connectors to get too tight and damage the equipment or throughput. * Please contact installer or service provider upon verification.
In case of dropped call or bad signal after set up	* Check input signal strength in the service area	* Increase output power level of repeater by adjusting attenuation level.
In case of drop call or bad signal after set up	* If input signal strength is not a problem, please check delay of calling time.	* Increase output level of Uplink signal, then set to optimal level.
In case of dropped call or bad signal after setup	* Check RSSI signal strength	* Contact network management team or service provider

In case Output Signal wavelength is not shown flat or looks like oscillation	* Check connection fastened between antenna and cable (Signal wavelength should be flat and stable if technicians shake CABLE. If not, it is connection problem.)	* If connection is not proper, reconnect cable and connector and then check the output power again.
Same as above	* Input level change or module overheating.	* Check input level from BTS side. * Check performance of each module. (Diagnosed by A/S team.)
Same as above	* Please check VSWR of the Cable is normal.	* Change to normal Cable.

4.2.6 Troubleshooting Guide Related to NMS

Symptom	Check Points	Troubleshooting
Link Fail	* Communication problem	* In case of Ethernet, verify IP addressing, DHCP function, and that Cookies are deleted. * Verify that a crossover Ethernet cable is being used.
Link Fail	* CLI Connection, Cable status check	* Make sure 1:1 connection. * Follow instructions in the installation guide for this connection procedure.
Link Fail	* CLI connection Check by USB to Serial Cable	* Please verify Port number of PC communication. * Please check Cable connection status.

5. IC Information

General Information

Transmitter Antenna

This device has been designed to operate with the antennas listed below, and having a maximum gain of 80 dB. Antennas not included in this list or having a gain greater that cable loss of Antenna to Repeater than 12 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

User Manual

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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

General Standard Specifications

User Manual

(a) The nominal passband gain (dB); Cellular: 80.0 dB

(b) The nominal bandwidth; Cellular : 15 MHz

(c) The rated mean output power; Cellular : 25.0 dBm

(d) The input and output impedances; 50 ohms

(e) The following notice: "The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device."