

**ATTACHMENT E.**

**- USER MANUAL -**

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# **3G Indoor Repeater GRS-1924R-SPR User Manual**

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**Version 0.1**

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## 1. SUMMARY

GRS-1924R-SPR is an Digital RF repeater, which improves PCS network.

GRS-1924R-SPR receives RF signal from BTS and transmits it to the blanked and shadowed area, thus providing and improving voice and image data services. GRS-1924R-SPR's goal is to support BTS's functions proportionately.

GRS-1924R-SPR communicates with BTS wirelessly, thus saving additional costs for its maintenance.

GRS-1924R-SPR consists of RF/IF part module, Digital Filter module, and I/O & Control module divisions, which are supplied with Alarm LED, thus providing quick and easy maintenance and troubleshooting of the repeater.

This manual describes in general structure of GRS-1924R-SPR, its application, maintenance and troubleshooting, installation and operation etc.

### **Abbreviation**

PCS : Personal Communication System

RF: Radio Frequency

BTS: Base Transceiver Station

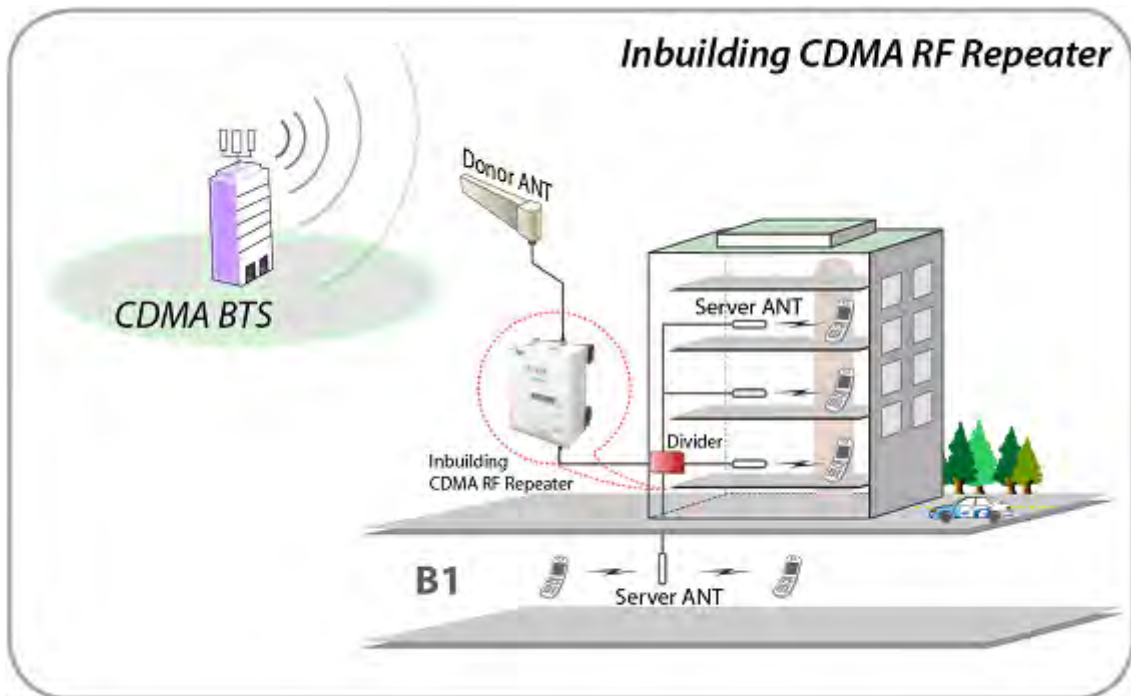
IF: Intermediate Frequency

I/O : Input/Output

## 2. System Configuration

### 2.1 GRS-1924R-SPR Service Organization

GRS-1924R-SPR decreases blanked and shadowed areas and extends cell coverage by re-transmitting signal. The signal is received from BTS via Antenna directly, thus excluding additional expenses for signal transmission (like cabling). Service organization of CDMA In-building RF repeater is shown at the picture below. Donor Antenna is directed to BTS, and being divided at Service Antennas are installed in the building and parking place. Pass Loss should be taken into consideration while dividing and cabling.



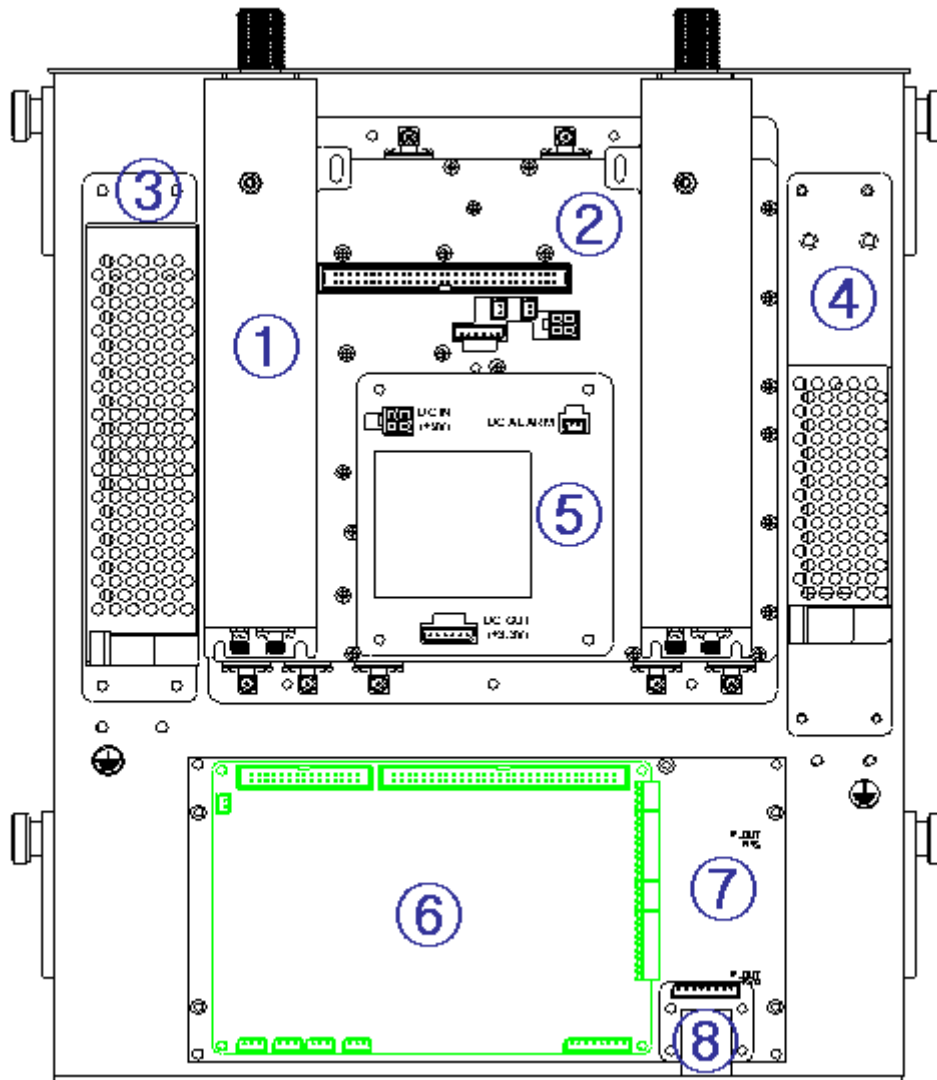
<Pic.1> US PCS 1900 Service Organization

## 2.2 System Design and Operation

### 2.2.1 System Design



<Pic.2> GRS-1924R-SPR Repeater



<Pic.3> Internal Design

NO	DESCRIPTION
①	CAVITY FILTER - (Frequency Filtering)
②	CONVERTER MODULE - (Frequency Conversion)
③	PSU MODULE(RS-100-9) - (Converter, LED, NMS Power Supply)
④	PSU MODULE(RS-35-12) - (EMB Power Supply)
⑤	I/O BOARD - (Input/Output Board)
⑥	NMS BOARD - (System Control Board)
⑦	DIGITAL FILTER - (Digital Filtering)
⑧	ETHERNET BOARD - (Web UI Board)



<Pic.4> Outside Port Design

NO	DESCRIPTION
①	DONOR ANT PORT
②	SERVER ANT PORT
③	POWER SWITCH PORT
④	AC POWER PORT
⑤	CLI MONITOR PORT
⑥	ETHERNET PORT
⑦	DC POWER PORT

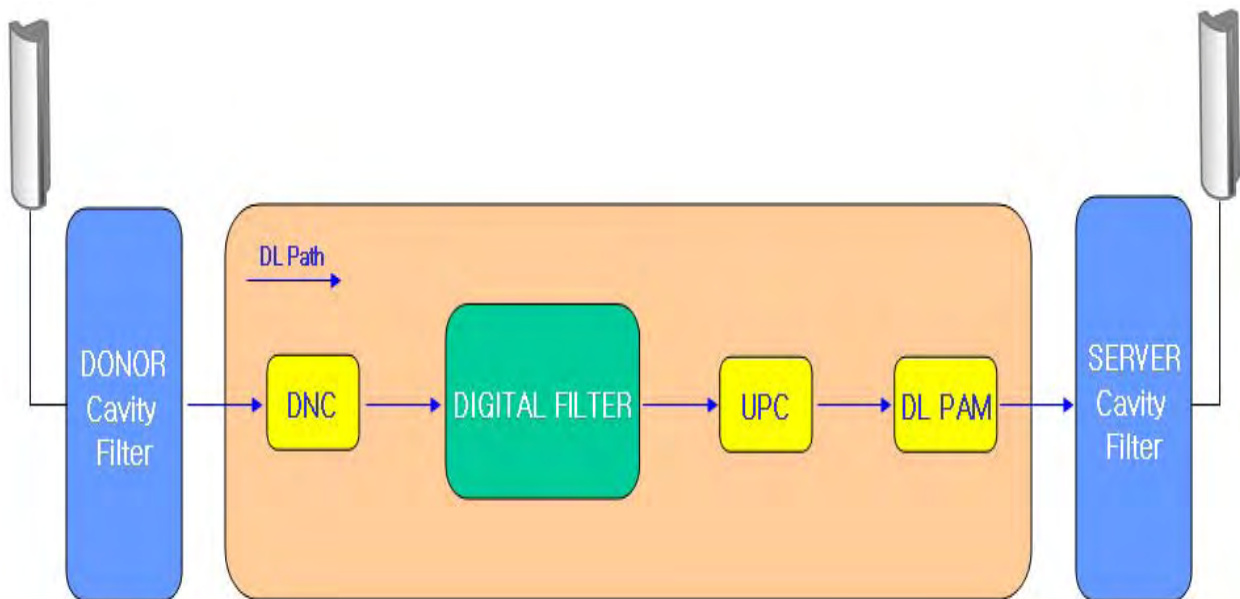


### 2.2.2 Downlink Path

Downlink and Uplink Gain Budgets have similar structure.

In case of Downlink Path, RF signal is received from Donor Antenna, and through FWD division, then the signal is transferred to IF division, where desirable Band is selected by Digital Filter. Selected Band is transferred to RF division again, and through FWD PAM, after that the signal is transmitted to User through Server Antenna.

Two attenuators use for AGC compensation. AGC attenuation range is 40dB.



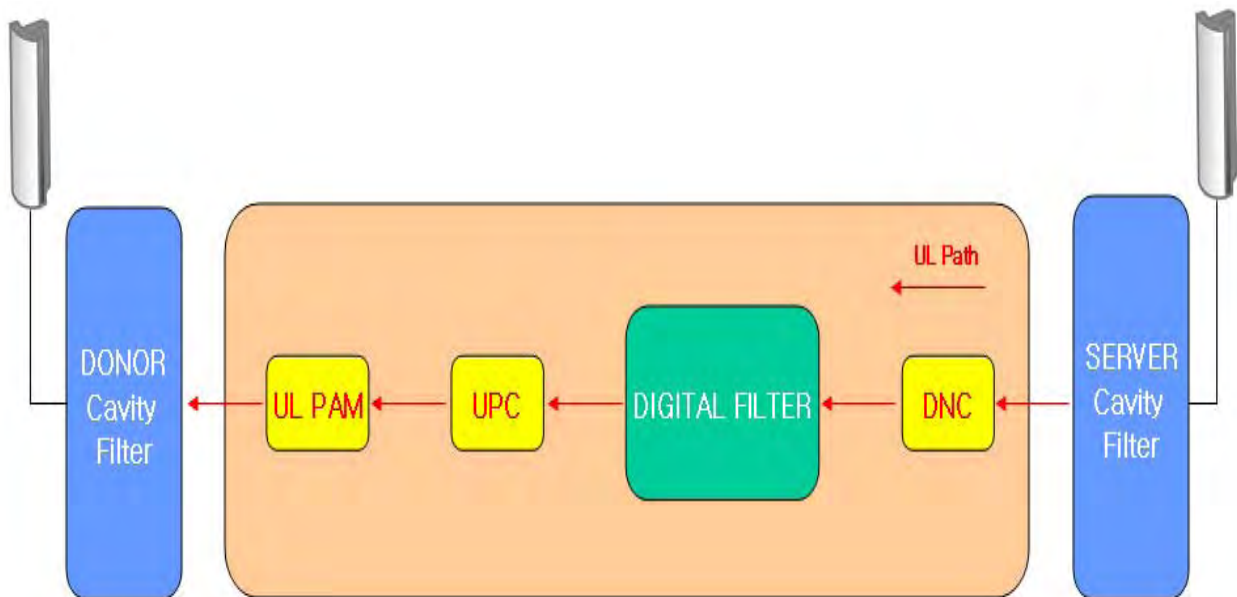
<Pic.5> Downlink Block Diagram

### 2.2.3 Uplink Path

Uplink Path is similar in structure to Downlink Path.

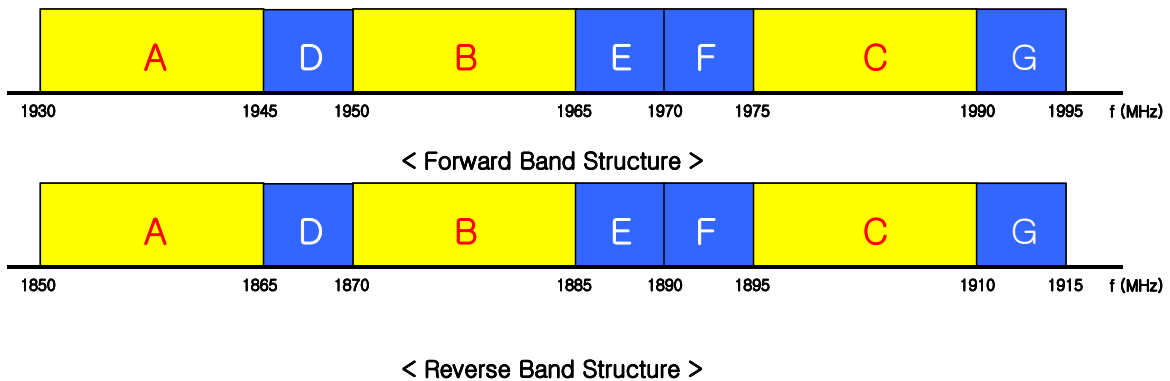
In case of Uplink Path, RF signal is received from Server Antenna, and through RVS division, then the signal is transferred to IF division, where desirable Band is selected by Digital Filter. Selected Band is transferred to RF division again, and through RVS PAM, after that the signal is transmitted to BTS through Donor Antenna.

Two attenuators use for ALC compensation. ALC attenuation range is 40dB.



<Pic.6> Uplink Block Diagram

### 2.2.4 US PCS Frequency Selection



<Pic.7> 1900MHz PCS Band Structure

GRS-1924R-SPR has 5MHz, 10MHz, 15MHz, 20MHz Paths in IF division, so any of these bandwidths can be chosen for providing service.

ITEM	BANDWIDTH	NOTE
Band Select	5MHz	Any of these bandwidths from A to G can be chosen
	10MHz	
	15MHz	
	20MHz	
	5MHz + 5MHz	
	5MHz + 5MHz + 5MHz	
	10MHz + 5MHz	
	15MHz + 5MHz	

Also, by adding Channel Select Function, it enables users to select bands sophisticatedly. Each band has 1.25MHz Bandwidth and if users select all the 15 bands, GRS-1924R-SPR can serve 18.75MHz bandwidth to users.

A1				A2				A3				D			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
B1				B2				B3				E			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800
F				C1				C2				C3			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
825	850	875	900	925	950	975	1000	1025	1050	1075	1100	1125	1150	1175	1200
G															
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>													
1225	1250	1275													

### 3. SPECIFICATIONS

#### 3.1 System Specifications(Applicable to both Uplink & Downlink)

ITEM		SPECIFICATION	REMARK
Transmit Power		24dBm ± 2.0dBm	
Frequency Range	Downlink	1930MHz ~ 1995MHz	
	Uplink	1850MHz ~ 1915MHz	
Gain Range		42dB ~ 82dB	DL/UL both
Roll Off		≥ 50dBc	@ F(edge)±1MHz
VSWR		1.5 : 1	
Delay		8us	
In Band Spurious Emission	@ Fc±885kHz	≥ 45dBc	marker to marker 29dB
	@ Fc±1.98MHz	≥ -52dBc	marker to marker 36dB
OUT Band Spurious Emission		< -13dBm	
Flatness		2.5dB	
Band Select		5MHz	Non-contiguous Band (Maximum 3-band) Adding Channel Select Function
		5+5MHz or 10MHz	
		5+5+5MHz or 10+5MHz or 15MHz	
		15+5MHz or 20MHz	
Noise Figure		5dB @ Max Gain 12dB @ Min Gain	
ALC Range		40dB, 1dB step	
Frequency Stability		±0.05ppm	
Waveform Quality Factor		> 0.912	
Output Power Variation over Temperature		±2.0dB	

### 3.2 Electrical and Environmental Specifications

ITEM	SPECIFICATION	REMARK
Power & Consumption	100 ~ 240 VAC,60Hz	
Connector Type	N-type female	
Size	289X385X180	
Weight	max 40 lbs	
Reliability, MTBF	100,000 hours	
Enclosure	NEMA4	
Operating Temperature	-10°C ~ +50°C	
Rel. Humidity	0% ~ 90%	
Industry Standards	TIA-97, TIA-98, IS-98D, IS-2000	
Regulatory Approvals	FCC, Part24 CDN-IC	
Safety Approvals	UL1950 or Equiv	

### 3.3 Functions

ITEM	FUNCTIONS
Gain Control	<ul style="list-style-type: none"> <li>Adjustable DL and UL Gain range 42~82dB</li> <li>Display default Gain and current Gain function</li> </ul>
AGC (Auto Gain Control)	<ul style="list-style-type: none"> <li>It always operates in Downlink AGC ON status</li> <li>To maintain same Downlink output power despite flexible input signal strength</li> <li>To add or subtract Attenuation level referring to AGC Power Limit level.</li> <li>Used with the Automatic Setup (Auto Gain Setting)</li> </ul>
ALC (Auto Level Control)	<ul style="list-style-type: none"> <li>To limit output power as far as default range</li> <li>Used for DAS configuration and when oscillation/isolation is a concern</li> <li>Automatic Gain decrement when output power of repeater is higher than default level</li> <li>Automatic Gain recovery when output power of repeater is reduced</li> </ul>

	<ul style="list-style-type: none"> <li>• Shutdown when output power is higher than default level in Minimum Gain</li> <li>• Automatic Recovery Algorithm conversion after Shutdown status</li> </ul>
AGS (Auto Gain Setting)	<ul style="list-style-type: none"> <li>• Operate when User control (Only system initialize)</li> <li>• Decrease attenuator value for 3dB from minimum gain</li> <li>• In case of attenuator value is from 0dB to 3dB when AGS ended                             <ul style="list-style-type: none"> <li>- AGC on (DL)</li> <li>- Gain balance on</li> <li>- PAM on</li> <li>- Shutdown on</li> </ul> </li> <li>• In case of attenuator value is over 3dB when AGS ended                             <ul style="list-style-type: none"> <li>- AGC off (ALC on)</li> <li>- Gain balance on</li> <li>- PAM on</li> <li>- Shutdown on</li> </ul> </li> </ul>
Gain Balance	<ul style="list-style-type: none"> <li>• Downlink ATT is applied to Uplink during AGC state</li> <li>• Setting and maintenance of output level</li> <li>• Additional attenuation to ALC Level</li> </ul>
Band Select	<ul style="list-style-type: none"> <li>• To select either 5MHz/10MHz/15MHz/20MHz</li> </ul>
Power Monitoring Function	<ul style="list-style-type: none"> <li>• Monitoring repeater's output level</li> </ul>
DL Input control	<ul style="list-style-type: none"> <li>• Monitoring Donor ANT input power of DL</li> </ul>
Automatic Recovery	<ul style="list-style-type: none"> <li>• When repeater is shutdown, it periodically recovers output power of repeater then monitors alarming</li> </ul>
Security	<ul style="list-style-type: none"> <li>• Support HTTPS for Web Browser security</li> <li>• User authentication through User ID and Password</li> </ul>
Temperature Monitoring	<ul style="list-style-type: none"> <li>• Monitoring temperature of repeater</li> <li>• Maximum and minimum set up is possible</li> <li>• Shutdown in over temperature</li> <li>• Automatic recovery after temperature becomes normal (Hysteresis 10 degree)</li> </ul>

VSWR Monitoring	<ul style="list-style-type: none"> <li>• Monitoring VSWR of Donor ANT Port (Every one and half minute)</li> <li>• Reporting VSWR Alarm and Shutdown when the rate is 3.5:1</li> </ul>
IP address report via E-mail	<ul style="list-style-type: none"> <li>• When in PPP reconnection, E-mail which includes HTML to connect to newly assigned IP Address, reports to operator.</li> </ul>
DHCP Client	<ul style="list-style-type: none"> <li>• Automatic IP assignment</li> </ul>
DHCP Server	<ul style="list-style-type: none"> <li>• Server function for automatic IP assignment</li> </ul>
Web GUI	<ul style="list-style-type: none"> <li>• Remote and local user browser support through Web Browser</li> </ul>
SNMP Agent	<ul style="list-style-type: none"> <li>• NMS report via SNMPv2 Trap</li> </ul>
LED Display	<ul style="list-style-type: none"> <li>• LED displays power and operation status on front side of repeater system</li> <li>• Input and Output signal levels are verified by LED bars</li> </ul>

## 4. SET UP

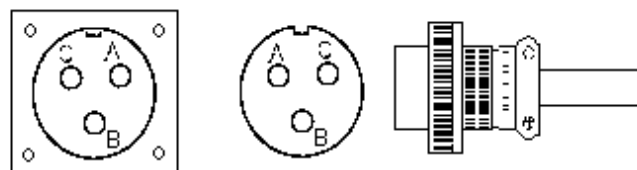
### 4.1 System Set up

#### 4.1.1 Constitution (Based on 1 set)

PARAMETER	ITEM	QUANTITY
Major Accessory	US PCS 24dBm case	1 EA
Additional Components	Main power input cable	1 EA
	Fixable screw	1 SET
	Mountable brackets	1 EA
User Manual	Manual	1 EA

#### 4.1.2 Notice

- 1) **System Power check:** Major electricity is AC110V, therefore please input electricity after power verification.
- 2) **Input condition optimization:** DL input condition is -58 ~ -18dBm. User should verify input condition of Donor ANT.
- 3) **Isolation check between DONOR/SERVER ANT:** Isolation condition of this equipment is 89dBc (Gain+7dB). User should check its condition before installation.



Wall Mount  
Receptacle

AC Plug

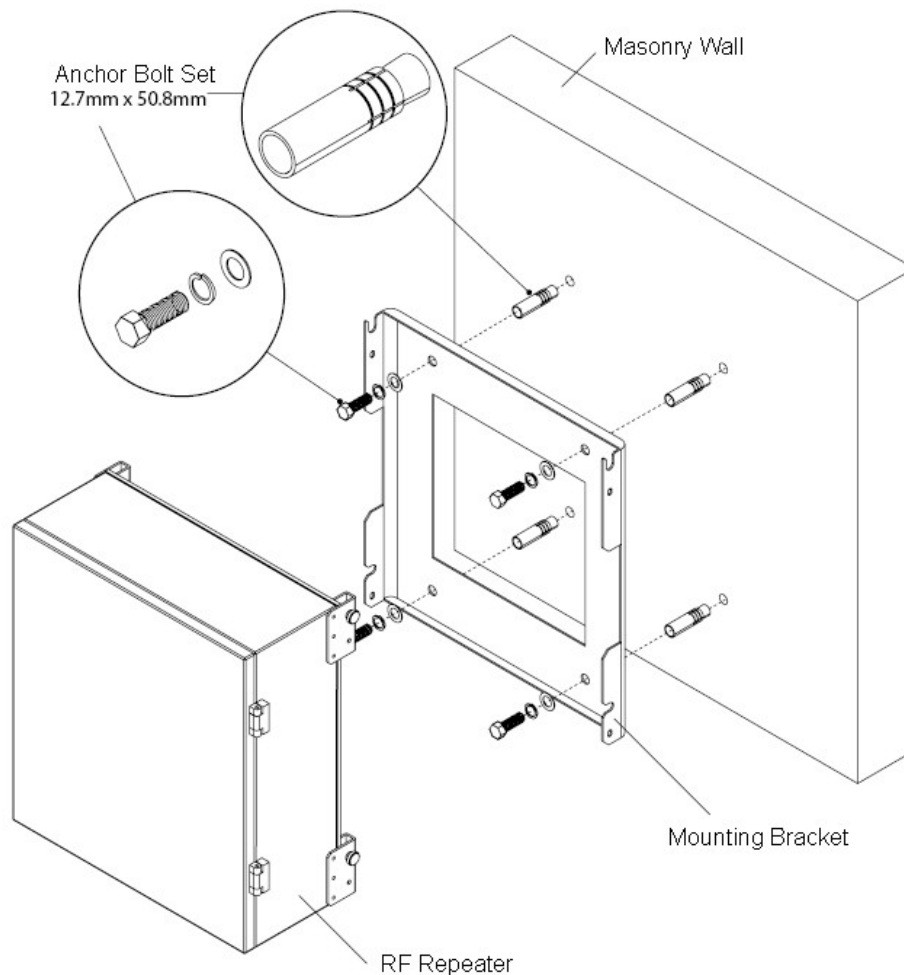
A: AC 110V
B: AC 110V
C: GND

<Pic.8> MS 3100 A 10SL-3 (Wall Mount Receptacle) & MS3010 A 10SL-3(Plug)

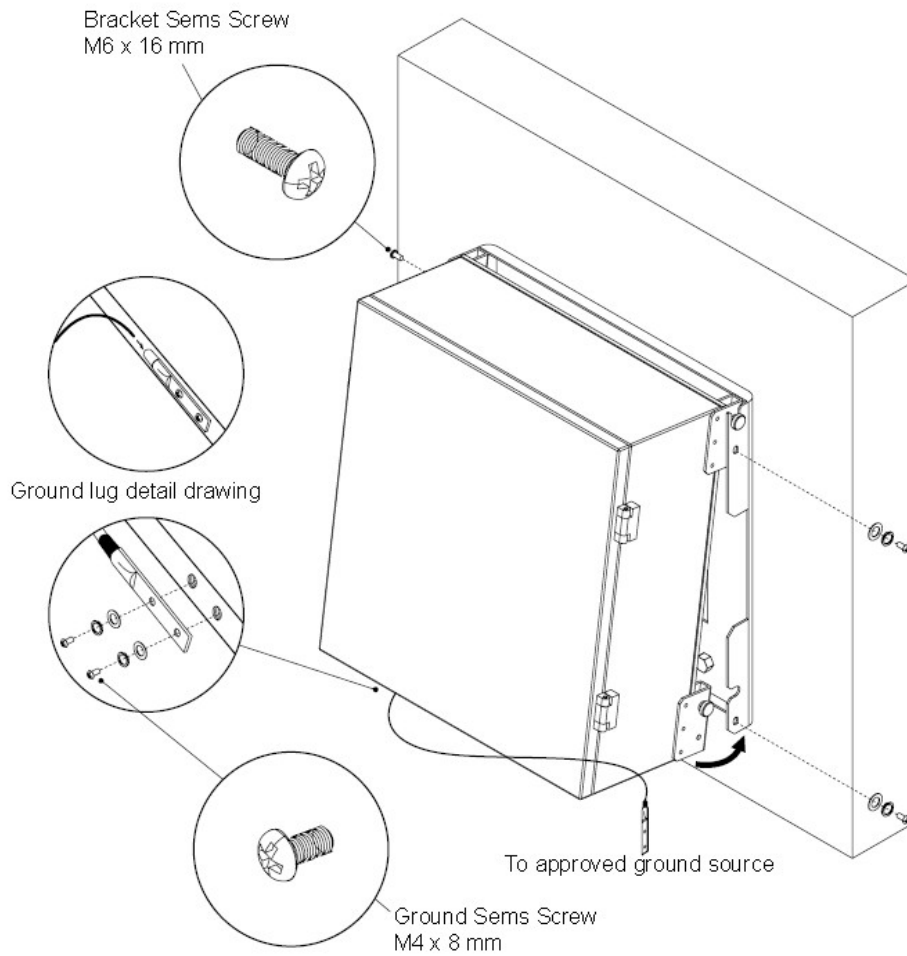


### 4.1.3 System Set up

- 1) This equipment is basically wall mountable installation.
- 2) Once aforementioned process is done, open for service get ready.
- 3) For grounding, there is a grounding terminal in main power supply side and the grounding terminal on a site and unit should be connected same.
- 4) System installation work is basically performed more than two people and should be careful for unexpected accident.
- 5) The socket-outlet shall be installed near the equipment and shall be easily accessible.
- 6) Round terminals located on the side of a 0.75 mm<sup>2</sup> (18 AWG) or more wires Using permanently connected to earth.



**<Pic.9> Case Mounts - Step 1**



**<Pic.10> Case Mounts - Step 2**

#### 4.1.4 Open for Service

##### 1) Check points before open

###### a. Verification of system installation status

- Electricity, In/out antenna, coaxial cable connection, equipment mounts status.

###### b. Verification of system accessories

- User should check whole necessary accessories.

###### c. Check receipt signal level

- User should check whether receipt environmental condition is in accordance with system specification, so that system operation will be optimized.

##### 2) Check points after open

###### a. Check by external LED

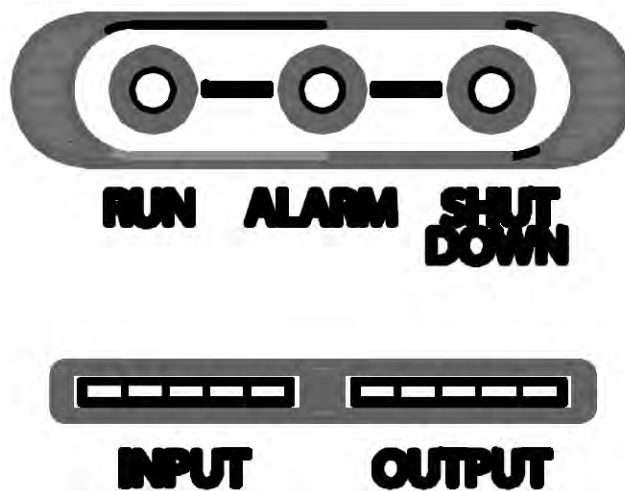
- ① RUN: Green light ON (Off: Green light off)

- ② ALARM: Green light in normal status, Red light in alarming
- ③ SHUT DOWN: Green light in normal status, Red light in Shutdown status
- ④ Number of LED bar on front side of repeater will show input power signal level

Less than -86dBm: LED 1 bar  
 -85dBm ~ -70dBm: LED 2 bar  
 -69dBm ~ -54dBm: LED 3 bar  
 -53dBm ~ -41dBm: LED 4 bar  
 More than -40dBm: LED 5 bar

- ⑤ Number of LED bar 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.11> 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**

- 1) RF Power Meter: 10Watt Max, 50ohm
- 2) Signal Generator: 3GHz
- 3) Spectrum Analyzer: 3GHz
- 4) Multi-Meter

### **4.2.2 Notice**

- 1) Troubleshooting should be performed by a trained technician.
- 2) Parts that seem to be not used should not be disassembled.
- 3) While troubleshooting, technician should use attenuator to check RF Signal output.

### **4.2.3 Simple Troubleshooting Method**

- 1) Verify LED Status, both on external LED's as well as internal module LED's
  - Normal operation: Green light on. Alarming: Red LED on.
- 2) Technician should check external and internal connectors to ensure that all connections are tightly secure. These connectors should be cleaned regularly.
- 3) 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

Item	Check Point	Troubleshooting
Check before system operation	System input power range	-Downlink: -58dBm ~ -18dBm -Uplink: -58dBm ~ -18dBm
	System gain	-Downlink: 42dB ~ 82dB -Uplink: 42dB ~ 82dB
	Output power at server port	-Downlink: 24dBm ± 2dB -Uplink: 24dBm ± 2dB
	Check points before open for service	-Please check quantity of all accessories with specification before you set up -Fit cable length in accordance with field condition -Set up 1900MHz CDMA Donor antenna to secure Isolation. (More than 89dBc)
Check after system operation	Check points after open for service	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

#### 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 Adapter cord

When in alarming	DL VSWR alarm	Please Check following status; -Make sure Server Antenna Port is disconnected. -Please reset Adapter upon completing Alarm troubleshooting
	DL over-output alarm	-Make sure output power is operating normally -Please Reset Adapter upon completing Alarm troubleshooting
	UL over-output alarm	-Please make sure output level is operating normally -Please reset Adapter upon completing Alarm troubleshooting
	Temperature alarm	Check following status; -Setting level of maximum temperature limit -Temperature offset is normal or not -Circumstances of temperature -Please Reset Adapter upon completing Alarm troubleshooting
	RF off	-Verify that the HPA's are On -Please Reset Adapter 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
	-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
	Check the input level	-Increase output power or check input change of BTS side
	Check gain of the unit	-If the Gain is different from normal level, please contact A/S team

	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
	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.
	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
	Input level change or module overheating	-Check input level from BTS side. -Check performance of each module (Diagnosed by A/S team)
	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
	CLI connection, cable status check	-Make sure 1:1 connection -Follow instructions in the installation guide for this connection procedure
	CLI connection Check by USB to serial cable	-Please verify port number of PC communication -Please check cable connection status



## MPE Information

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Warning: Exposure to Radio Frequency Radiation The radiated output power of this device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna should not be less than 20cm during normal operation. The gain of the antenna is F2 dBi. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.