

Sierra ROU10W

Multi-Operator/Multi-Band DAS User Manual

VER 1.0



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FCC WARNING

This equipment generates or uses radio frequency energy. Changes or modifications to this equipment may cause harmful interference unless the modifications are expressly approved in the instruction manual. The user could lose the authority to operate this equipment if an unauthorized change or modification is made.

INFORMATION TO THE USER

The head end unit must always be connected to the Base Station using a direct cabled connection. This system has not been approved for use with a wireless connection via server antenna to the base station.

Part 27.5

Antennas must be installed in accordance with FCC 27.50. With 17dBi gain antennas the height of the antenna above average terrain (HAAT) must not exceed 915m. For difference gain antennas refer to the relevant rules.

Booster Warning Label

WARNING. This is **NOT** a **CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC LICENSE** or express consent of an FCC Licensee to operate this device. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.

Specification or recommendation about Antennas is not available or not mention in this manual.

As per default antennas, cables or coupling devices, contact www.frtek.net for further information.

1. Overview

1.1 SIERRA Overview

This manual is created for operators who is using or will use Sierra DAS system to give an information and an instructions how to figure out the system.

Operator shall be acknowledged, experienced and properly educated about the overalls of repeater system and the experience of the installation & maintenance of DAS system.

1.2 Use of recommendation and warning



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Warning

Use of unauthorized antennas, cables, and/or coupling devices not conforming with ERP/EIRP and/or indoor-only restrictions is prohibited.



Caution

This symbol indicates cautions which operators shall be careful while installing and managing systems

1.3 System Features

Sierra is an in-building/outdoor DAS system and provides 4 bands of service; 700MHz (LTE, 27MHz), 850MHz (WCDMA, LTE 32MHz), 1.9GHz (WCDMA, LTE 65MHz), 2.1GHz (WCDMA, LTE, 45MHz) at the same time. The system is scalable to extend additional 2 bands services - 2.3GHz and 2.5GHz frequencies. Sierra system is configured and features:

A. ROU : Remote Optic Unit

– Type

1. ROU 10W : 700MHz SISO, 700MHz MIMO, 850MHz SISO, 1.9GHz SISO, 2.1GHz SISO, 2.1GHz MIMO

- 2. SROU 10W : 2.3GHz SISO, 2.3GHz MIMO, 2.5GHz SISO, 2.5GHz MIMO(Future ordering option)
- Conversion and amplification of digital optical signal into an RF signal (Downlink)
- Converting the RF signal into a digital optical signal (Uplink)
- Optic interfaces with MHU
- Node Isolation : Bypass to avoid impact on service of lower nodes in case of failure of upper nodes or power off condition
- System Delay Equalizer (110us)

1.4 System Port Configuration

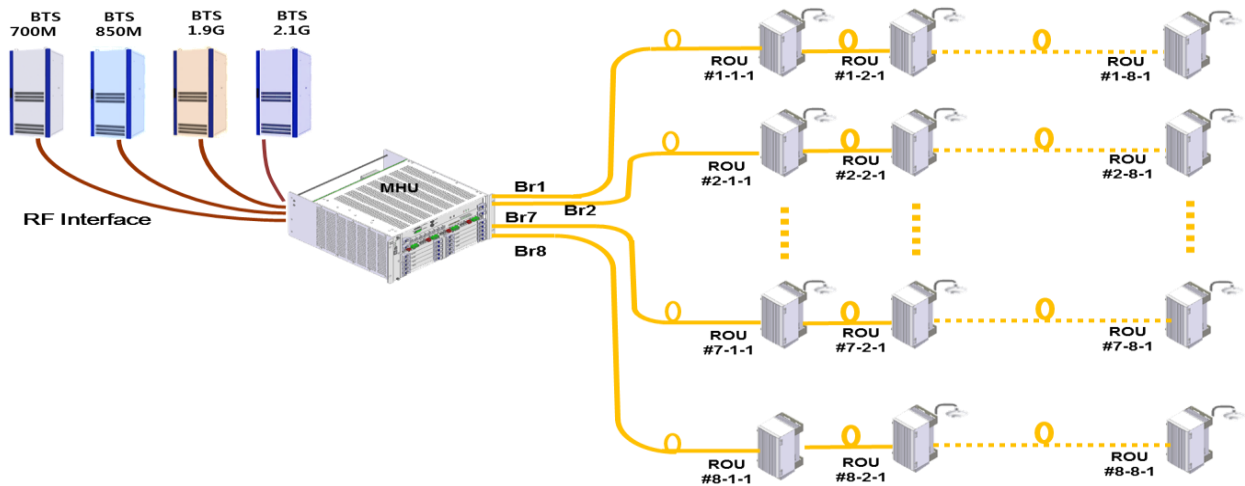
- Unauthorized cables and devices would give damages to the system. Approved devices and cables are recommended to use.

A. ROU 10W Port Configuration

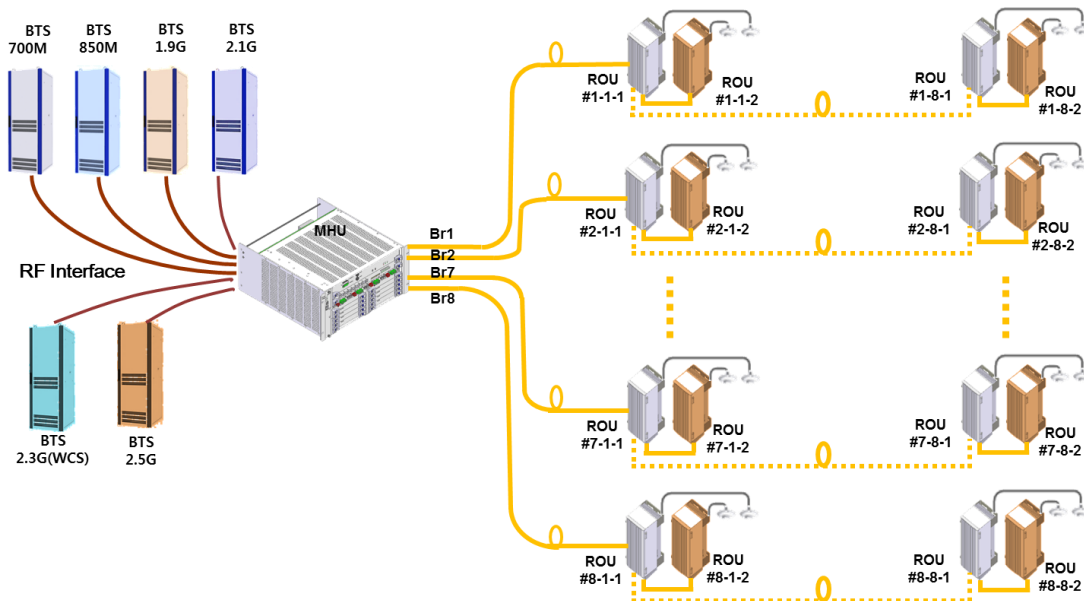
Port Type	Description	Port Location
Input Power	Single AC Power Input	Bottom side
Antenna	6 ports (700MHz SISO, 700MHz MIMO, 850MHz SISO, 1.9GHz SISO, 2.1GHz SISO, 2.1GHz MIMO)	
Optic Cable	Optic Cable inputs – 3 ports (TR, IR, EX)	
BATTERY	Pb BATT, Li-BATT inputs – 2 ports	
External Fan	External Fan Power Input – Single port	
Power Ground	Single port	
Telecom Ground	2 ports	1 for each Left/Right side

2. System Network Configuration

- The Sierra basic network configuration:



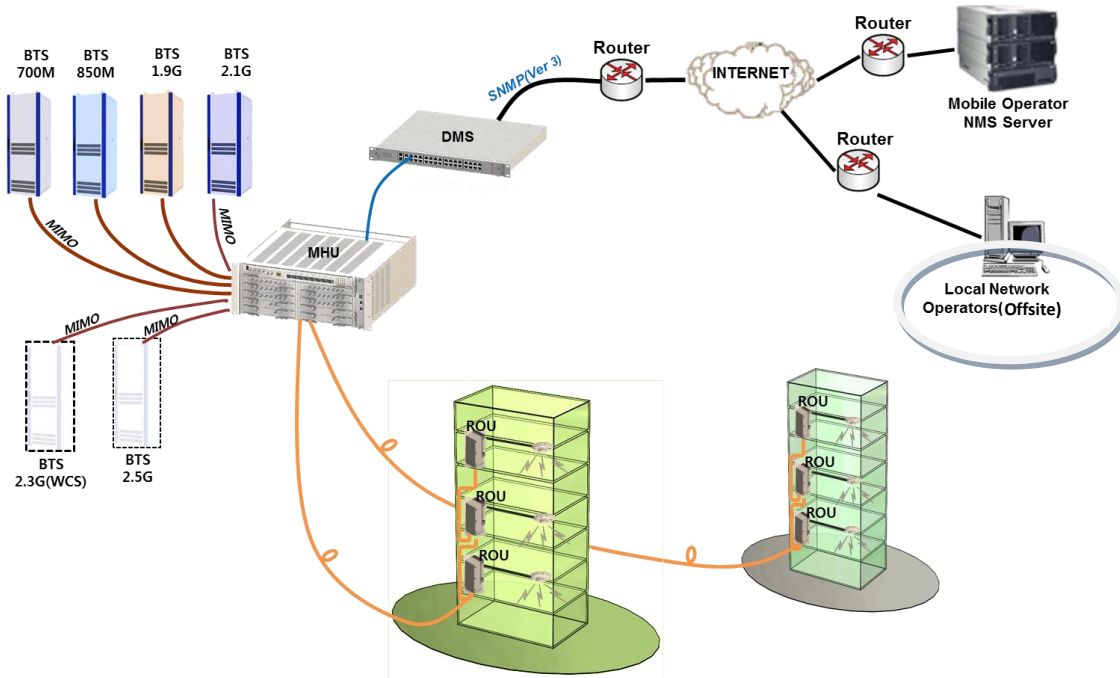
- Network configuration with SROU 10W expansion:



- MHU is interfacing with BTS(Base Transceiver Station) via RF cable and it has 8 optical interfaces with ROUs via optical cable.
- ROU is interfacing with MHU using optic cable and can be cascaded with up to 8 ROUs.
- As for the scalability of Sierra, the total number of ROUs per each BR port is limited up to max. 8.
- SROU 10W is interfacing with ROU 10W through an optic cable and is installed in the same site of ROU.

- MHU capacity can be scalable up to max. 64 ROUs plus 64 SROU 10Ws.

The network topology of Sierra is configured as follows;



Main features of Sierra

Function	ROU 10W
Input power	120V
Interface (Input)	Optic
Interface (Output)	RF
Service Band Accommodation	LTE, Cellular, PCS, AWS, SMR, WCDMA
Type	10W : Indoor type
Cascading	Maximum 8
Back-up Battery	Supported

Advanced features of SIERRA

- Various network configurations (RF Interface with BTS. Various types of ROU configurations)
- Support for 700MHz(LTE,28MHz),850MHz(SMR, Cellular,25MHz),1.9GHz(PCS,65MHz), 2.1GHz(LTE, 45MHz) service/ In-building, etc.
- 4+2 bandwidth services on one ROU system
- Improving system efficiency by using the DPD, APD technology
- Node Isolation (ROU) to prevent service interruption from lower nodes

3. System Architecture

3.1 Architecture

A. Types of Model

Sierra equipment is configured as shown below; the model name is as follows.

No.	Equipment	Part Numberl
1	ROU 10W	FR-RMDL10U

B. Design Considerations

- MHU and ROU use both an internal FAN and an external FAN to increase the cooling effect
- Definition of service

	Service	SISO	MIMO
ROU 10W	700MHz	Applicable	Applicable
	850MHz	Applicable	Not Applicable
	1.9GHz	Applicable	Not Applicable
	2.1GHz	Applicable	Applicable

- Sierra provides a port connected to external battery in both ROU and MHU.
- RF Connector of MHU is a SMA female type and RF connector of ROU is a DIN-Type female type.
- The unit of this system is modular type in order for an easy module replacement and a maintenance User is easy to plug-in or plug-out.
- Each units of this system are anti-insect , anti-dust and anti-pollution design structured.
- Each units of this system is designed to bear the vibration test regulation.
- Providing LTE Timing Advance function (0~110us).

B. Structure and Shape per each equipment

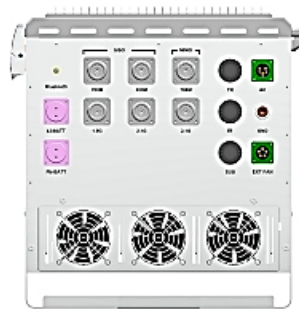
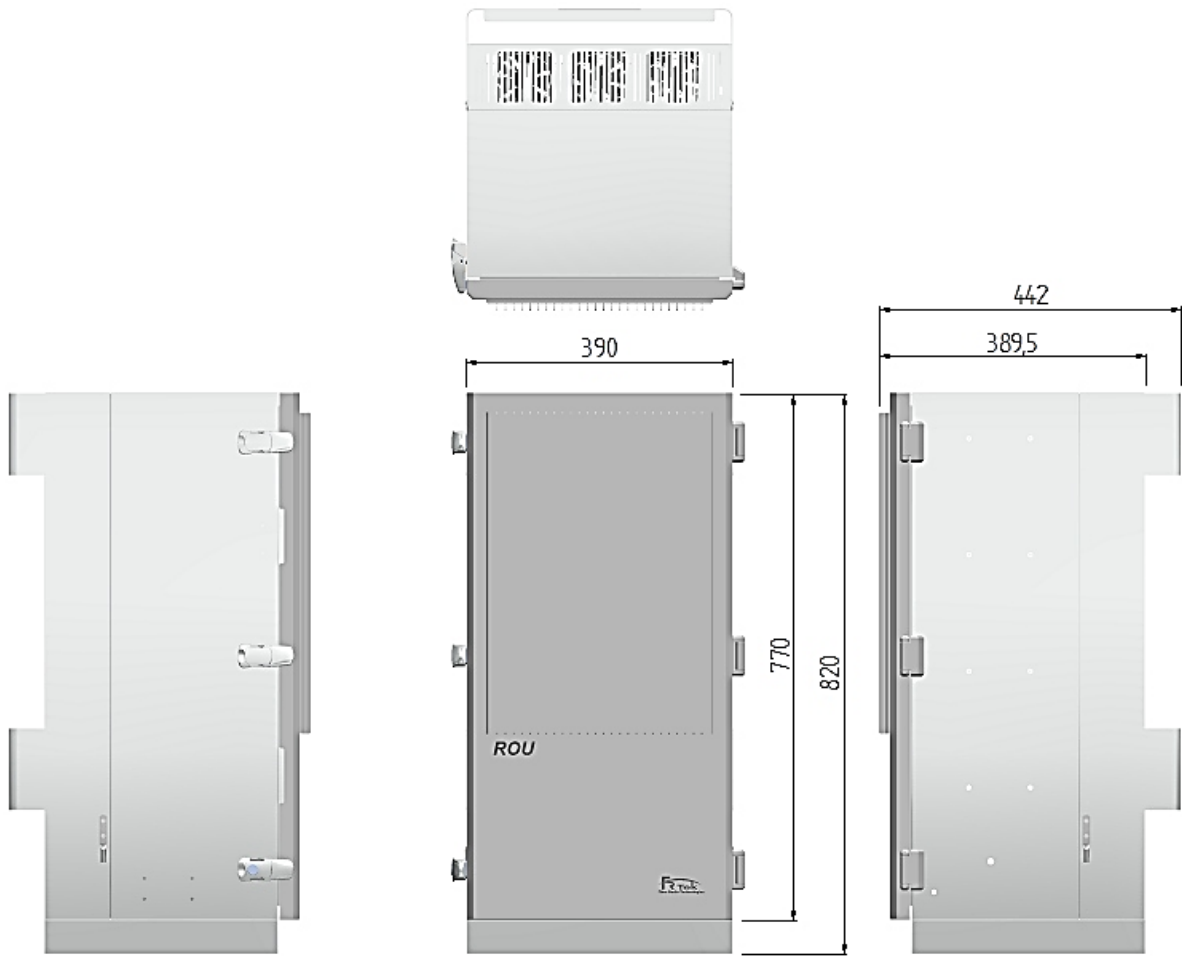
(1) ROU 10W Structure and Shape

ROU 10W is designed as an indoor type repeater to install it at in-door. Physical dimension is designed to meet the requirements of user convenience and small installation space. Power supply uses an AC 120V, in case power failure occurs; it has an battery backup ports with an AWG(American Wire Gauge) 6 ground terminal rug. External Interface Specifications and size are as follows;

Features	Item	Quantity	Interface spec	Remarks
Interface SPEC	AC 120V	1	MS Connector	
	Pb-BATTERY	1	MS Connector	
	Li-Battery	1	MS Connector	
	Antenna Port	6	DIN-Type Female	
	Optic Port	3	SMA Female	
	External FAN Port	1	MS Connector	
Size	L*W*H (inch)	17.4"L x 15.35"W x 32.28"H		W/O rack mounting brackets
				With bracket
Weight	pound	170lb		10W
PWR Consumption	Watt	700		In lab test condition



[ROU 10W Front View]



[ROU 10W external appearance]

4. System Specification

4.1 System Specification

This DAS system is designed for US market and it can support 700MHz SISO/MIMO, 850MHz SISO, 1900MHz SISO, 2100MHz SISO/MIMO and is going to support the 2300MHz SISO/MIMO, 2500MHz SISO/MIMO service(under development)

Main ROU can support 700MHz, 850MHz, 1900MHz and 2100MHz, Sub ROU can support 2300MHz and 2500MHz signal.

4.1.1 Functional Specification

SIERRA meets the following features and performance features, the details are not specifically mentioned shall follow functional and performance requirements of “3GPP TS25.1 / TS25.104”, “3GPP TS25.1 / TS25.106”, “3GPP TS25.1 / TS36.104”.

SIERRA incorporates the following basic functional requirements.

- 1) MHU is connected with ROUs by optical cable for RF (wired) and ROU shall be installed and operated at the shade area. LTE, Cellular, PCS, AWS signal transmission between 2 devices will operate through Single-mode optical fiber. (Optic: supportable for 5.7Gbps)
- 2) The radio quality of LTE, Cellular, PCS, AWS serviced by SIERRA is the same level as the radio quality of the base station.
- 3) When the mobile terminal enters the adjacent base station, SIERRA supports a continuous call (hand over) of the terminal.

4.1.2 System Specification per Band(ROU10W)

A. 700MHz (28MHz), SISO/MIMO

- Frequency Features

SPEC		Performance Requirements	Remarks
Frequency Band	TX	728 ~ 757MHz	28MHz, LTE Service
	RX	699 ~ 716MHz 777 ~ 787MHz	

- Output Features

SPEC		Performance Requirements	Remarks
Output Level	TX	+40dBm/Total	4W@Operator

	RX	+5dBm/Total	
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- Noise Figure and Features

SPEC		Performance Requirements	Remarks
Noise Figure (NF)	RX	7dB or under	Max Gain
Unwanted emission features (within band)	10W	±5.05MHz	-14dBm or under
		±10.05MHz	-14dBm or under
		±15.5MHz	-16dBm or under
ACLR	BW _{channel}	45dBc	
	2 * BW _{channel}	45dBc	

- Other Performance Requirements

SPEC	Performance Requirements	Remark
VSWR	1.5 : 1 or under	
TX, RX Separation	100dBc or more	

B. 850MHz (32MHz), SISO

- Frequency Features

SPEC		Performance Requirements	Remarks
Frequency Band	TX	869~890MHz(862 ~ 868, 891~894MHz N/A)	22MHz(out of 32MHz)
	RX	817 ~ 849MHz	

- Output Feature

SPEC		Performance Requirements	Remarks
Output Level	TX	+40dBm/Total	
	RX	+5dBm/Total	

- Noise Figure and Features

SPEC		Performance Requirements	Remarks
Noise Figure(NF)	RX	7dB or under	Max. Gain
Unwanted Emission Features (Within band-LTE Signal)	10W	±5.05MHz	-14dBm or under
		±10.05MHz	-14dBm or under
		±15.5MHz	-16dBm or under
ACLR	BW _{channel}	45dBc	

	2 * BW _{channel}	45dBc	
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- Other Performance Requirements

SPEC	Performance Requirements	Remarks
VSWR	1.5 : 1 or under	
TX, RX Separation	100dBc or more	

C. 1.9GHz (65MHz), SISO

- Frequency Features

SPEC		Performance Requirements	Remarks
Frequency Band	TX	1930 ~ 1995MHz	65MHz
	RX	1850 ~ 1915MHz	

- Input/output Features

SEPC		Performance Requirements	Remarks
Output Level	TX	+40dBm/Total	
	RX	+5dBm/Total	

- Noise Figure and Unwanted Emission Features

SPEC		Performance Requirements	Remarks
Noise Figure(NF)	RX	7dB or under	Max. Gain
Unwanted Emission Features (Within band-LTE Signal)	10W	±5.05MHz	-14dBm or under
		±10.05MHz	-14dBm or under
		±15.5MHz	-16dBm or under
ACLR	BW _{channel}	45dBc	
	2 * BW _{channel}	45dBc	

- Other Performance Requirements

SPEC	Performance Requirements	Remarks
VSWR	1.5 : 1 or under	
RX, TX Separation	100dBc or more	

D. 2.1GHz (45MHz), SISO/MIMO

- Frequency Features

SPEC		Performance Requirements	Remarks
Frequency Band	TX	2110 ~ 2155MHz	45MHz
	RX	1710 ~ 1755MHz	

- Output Features

SPEC		Performance Requirement	Remarks
Output Level	TX	+40dBm/Total	
	RX	+5dBm/Total	

- Noise Figure and Unwanted Emission Features

SEPC		Performance Requirements	Remarks	
Noise Figure (NF)	RX	7dB or under	Max. Gain	
Unwanted Emission Features (Within Band)	10W	±5.05MHz	-14dBm or under	Max. Output RBW 100KHz
		±10.05MHz	-14dBm or under	
		±15.5MHz	-16dBm or under	Max. Output RBW 1MHz
ACLR	BW _{channel}		45dBc	
	2 * BW _{channel}		45dBc	

- Other Performance Requirements

SPEC		Performance Requirements	Remarks
VSWR		1.5 : 1 or under	
RX, TX Separation		100dBc or more	

* Standard conditions of the above is 1SET standard each MHU/ROU

E. EMS Interface Specification

- (1) Protocol : MHU ↔ ROU(Optic)
- (2) MHU ↔ ROU (Optic)
- (3) ROU ↔ ROU (Optic)
- (4) Top surveillance : PC base EMS
- (5) Debugger interface: USB2.0(MHU, ROU)

F. Optical characteristic requirements

(1) Transmitter

SPEC		Performance Requirements	Remarks
Center wavelength	TX	1270 ± 1nm	
	RX	1330 ± 1nm	
Optical Output Power		- 5 dBm or more	

(2) Receiver

- Receiving element Type: InGaAs PIN Photodiode
- Max receive input range: 0dBm
- Max Rx Sensitivity: -15dBm

(3) Fiber optic cable

- Type: Single-mode fiber
- Loss: 0.25dB/km (1240 ~ 1620nm) or under

4.1.4 Mechanical condition

4.1.4.1 Structure and Shape

- MHU and ROU are to be designed considering the convenience of workers and space of installation site. The appearance of SIERRA design should be streamlined.

Equipment	Type	Option
ROU 10W	Enclosure Type	Indoor

- SIERRA is enabling to use an internal fan, only ROU uses an external fan.
- SIERRA provides a port connected to external battery to ROU.
- RF Connector of MHU is SMA Female and RF Connector of ROU is DIN-Type Female
- Components of the system should be modular. Each component to be fitted to the structure that can be

easily mounted and separated. Replacement and maintenance should be facilitated.

- Each device must be designed as a structure that cannot be dust, contaminants and insects that attack.
- Each device of the system is to be designed to withstand a specified vibration test.
- All parts of the cabinet should be smoothly processed in order to prevent physical damage during maintenance
- Providing Timing Advance function (0~100us).

4.1.4.2 Manufacturing and Processing

- Sealing material has a strong characteristic to heat, does not tear or damage to the chemical.
- Internal and external wiring are designed as wire wrapping method or a connector connection. A structure that can withstand the vibrations.
- The printed circuit board is to use the product at least equal to the epoxy resin or glass. Solder is sophisticated; it is elegant in appearance after soldering. The electrical insulating film treatment is to prevent a reduction in corrosion and pollution prevention and moisture and insulation resistance due to the wiring between the accumulations of dust. The manufacturer was consulting us before choosing the colors.
- Internal and external surfaces of the coating cabinet have a uniform color.
- Exterior of the cabinet is designed to withstand foam (Blistering), exfoliation (Peeling) and cracks for 5 years or more.
- It is designed and manufactured with taking into account the carbon emissions reduced (reduced power consumption, reduced material use, and so on)

4.1.4.3 Materials and components

- Passive device has a stable characteristic for the frequency and temperature changes. Active element is industrial or equal to or more semiconductor. The integrated circuit is a solidified device.
- The type of wire is flame retardant coating wire, and SIERRA uses a wire having a sufficient current capacity and withstand voltage.
- Coaxial cable connected between each of the components is shielded cable coated with aluminum or brass.
- All metal used in the present device are designed to withstand a localized corrosion, including general corrosion, stress corrosion (Stress Corrosion) and crack (Cracking).
- Plastics being used should not be melt by Solvent and there should be no crack, molting and color when it exposed to ammonia.
- Plastics should not be cracked when chemical materials which is being used for cable assembly such as filling compound, insulator, etc.)

- Housing, component, PCB, solder, cable, etc. that are applied to the device shall be in accordance with current RoHS (Restriction of Hazardous Substances Directive).

4.1.5 Electrical conditions

- MHU, ROU operate normally in the commercial power supply (AC120 / 60Hz). (Considering of the photoelectric composite cable power input)
- ROU can be operated with the external back-up battery only
- The power wiring should be attached to the inside of the door, designed to prevent damage.
- There is a function of overvoltage and overcurrent protection in the DC inputs.
- Withstand voltage is applied to the input and output 3KV for 1 minute, the leakage current is less than 10mA.
- Leakage current is less than 3.5mA in the phase transition (120V).
- There should be no damage in case of 5 times surge voltage shock - 4kV at AC input port and 4kV at DC input port.
- Grounding of equipment is separated; communication ground and power ground.
- Fuse must be able to determine whether or not a problem with the naked eye, it can be replaced without dismantling the equipment.
- All parts used in this repeater meet the conditions of FCC Regulations Title 47, Part 15, Subject J, and EMI Class B.
- Ground cables equivalent to #6AWG should be installed with a ground table into an enclosure.

4.1.6 Management and monitoring

- SIERRA can be configured up to the GUI for 1pc of MHU,64 pcs ROUs. Status Monitoring and Control is enabled.
- SIERRA is designed to maintain the previous states such as setting up the device parameters and operating conditions during recovery after a power outage.
- SIERRA is upper interworking by MHU and EMS Server
- A system control is possible by an operator using a Local GUI or Web GUI.

4.2.6 Environmental conditions

- When a specified temperature and humidity test, should not cause any traces of condensation inside the unit.
- Even if not in working order, SIERRA is designed not to be occurring internal condensation and functional depression.
- When subjected to prescribed vibration test, should not have any performance and mechanical damage of the system.
- When conducting prescribed waterproof test, the sign of water penetration inside the device should not be.
- MHU environment testing depends on the ambient operating standards
- Environmental test items and items iterations depends on the testing procedure of the business environment.
- Major environmental test conditions are as follows

Contents		Performance Requirements	Remark
Operational environment test	Indoor	- Temp' : -10 ~ +60°C - Humidity : 0 ~ 95% RH	- Output Change : Within ±3dB - Internal/external of enclosure has no changes or problems
	Outdoor	- Temp' : -40 ~ +60°C - Humidity : 0 ~ 95% RH	- Output Change : Within ±3dB - Internal/external of enclosure has no changes or problems
Vibration Test		- 10 ~ 150Hz, Gravity Speed 2G (IEC 60068-2-6)	- System performance is no change - Internal/external of enclosure has no changes or problems
Noise Testing		- GR-65-Core(4.6), Level 2	- 65dBA or under (When use external Fan)

5. Operational Program

5. Overview

5.1 Program overview

This operational program is designed to monitor and control the SIERRA.

The operational program communicates via the USB-B Type Port of equipment.

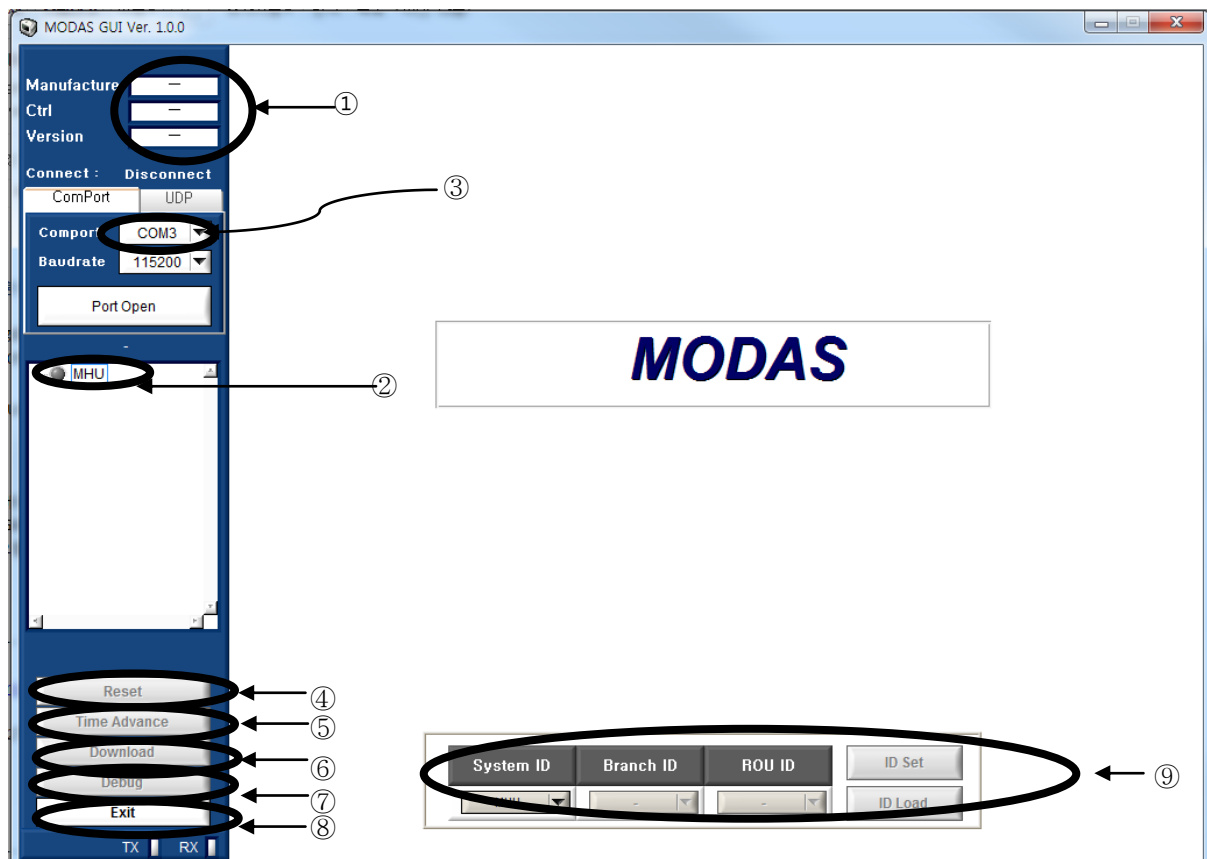
5.2 Screen configuration

5.2.1 GUI

This equipment is available to monitor and control via the GUI at the Local.

GUI Configuration, Monitoring, and Control items are shown in the following figure.

(Possible future changes)



[Main Screen]

- ① Environment Information – Showing equipment manufacturer, control manufacturer and information of version.
- ② Tree Information
 - Showing the connection status of current equipment.

- Green LED signifies regular equipment, Yellow LED equipment signifies Link Fail, Red LED signifies Alarm, Grey LED signifies equipment.
- When you do double-click of mouse left button, you can check status of equipment.

- ③ Com Port
 - Showing the PC connection port which was connected currently.
 - Automatically re-search connected RS-232C port when you click the Refresh.
 - When you click Port Open and Port Close, RS-232 Port will do <Connection> and <Close>.
- ④ Reset – Showing the controller DTU and reset screen of system.
- ⑤ Time advance setting – Showing Time advance setting.
- ⑥ Download – Showing CPU F/W Download window per equipment.
- ⑦ Debug – Showing Debug Screen.
- ⑧ Exit – Terminate the program.
- ⑨ ID setting – Read the ID of the connected equipment, and sets the ID.

5.4 ROU Status Verification and Control

- [Status Mode] to request information on the Status ROU equipment is 1Sec intervals.
- Clicking the [Setup Mode] button at the top, [Set] button is activated. Enter to [Settings mode], and now stop the Status Request and to Control the ROU items.
- If the setting is successfully completed, [Setting success] message will be shown at the window.
- When clicking the [Close] button at the top of the window, the screen is shut down and return to the [GUI Main] screen.

5.4.1 700MHz

- 700MHz Details (SISO – MIMO Items are the same)

Items		Unit	Remark
700MHz	Link Path	700MHz / 2.3GHz	Status
	Insert	Insert / None	Status
	TX Detect AMP	dBm	Status
	TX Detect RRFU	dBm	Status
	TX ATT	dB	Status/Control
	TX FB ATT	dB	Status/Control
	TX SD (High)	dBm	Status/Control
	TX SD Alarm (High)	Alarm : Red, Normal: Green	Status
	TX ALC (High)	dBm	Status/Control
	TX ALC (Offset)	dBm	Status/Control
	TX SD On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (Offset)	ON/OFF	Status/Control
	RX Detect RRFU	dBm	Status

	RX Detect RRFU 2	dBm	Status
	RX ATT	dB	Status/Control
	RX ATT 2	dB	Status/Control

[700MHz Details]

5.4.3 850MHz

– 850MHz Details

Items		Unit	Remark
850MHz	Insert	Insert / None	Status
	TX Detect AMP	dBm	Status
	TX Detect RRFU	dBm	Status
	TX ATT	dB	Status/Control
	TX FB ATT	dB	Status/Control
	TX SD (High)	dBm	Status/Control
	TX SD Alarm (High)	Alarm : Red, Normal: Green	Status
	TX ALC (High)	dBm	Status/Control
	TX ALC (Offset)	dBm	Status/Control
	TX SD On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (Offset)	ON/OFF	Status/Control
	RX Detect RRFU	dBm	Status
	RX ATT	dB	Status/Control
	RX Overpower	Alarm : Red, Normal: Green	Status
	10MHz PLL	Alarm : Red, Normal: Green	Status
	TX Delay	us	Status/Control
	RX Delay	us	Status/Control
	Over Power	Alarm : Red, Normal: Green	Status
	VSWR	Alarm : Red, Normal: Green	Status
	Over Temp	Alarm : Red, Normal: Green	Status
HPA Temp	°C	Status	
Amp On/Off	ON/OFF	Status/Control	
DTU TX Power (Block SMR ~ Block D)		Status	

[850MHz Details]

5.4.4 1.9GHz

– 1.9GHz Details

Items		Unit	Remark
1.9GHz	Insert	Insert / None	Status
	TX Detect AMP	dBm	Status
	TX Detect RRFU	dBm	Status
	TX ATT	dB	Status/Control
	TX FB ATT	dB	Status/Control

	TX SD (High)	dBm	Status/Control
	TX SD Alarm (High)	Alarm : Red, Normal: Green	Status
	TX ALC (High)	dBm	Status/Control
	TX ALC (Offset)	dBm	Status/Control
	TX SD On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (Offset)	ON/OFF	Status/Control
	RX Detect RRFU	dBm	Status
	RX ATT	dB	Status/Control
	RX Overpower	Alarm : Red, Normal: Green	Status
	10MHz PLL	Alarm : Red, Normal: Green	Status
	TX Delay	us	Status/Control
	RX Delay	us	Status/Control
	Over Power	Alarm : Red, Normal: Green	Status
	Amp On/Off	ON/OFF	Status/Control
	DTU TX Power (Block SMR ~ Block D)		Status

[1.9GHz Details]

5.4.5 2.1GHz

2.1GHz Details (SISO – MIMO Items are the same)

[2.1GHz Details]

Items		Unit	Remark
2.1GHz	Link Path	2.1GHz / 2.5GHz	Status
	Insert	Insert / None	Status
	HPA USE	Enable / Disable	Status/Control
	TX Detect AMP	dBm	Status
	TX Detect RRFU	dBm	Status
	TX ATT	dB	Status/Control
	TX FB ATT	dB	Status/Control
	TX SD (High)	dBm	Status/Control
	TX SD Alarm (High)	Alarm : Red, Normal: Green	Status
	TX ALC (High)	dBm	Status/Control
	TX ALC (Offset)	dBm	Status/Control
	TX SD On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (High)	ON/OFF	Status/Control
	TX ALC On/Off (Offset)	ON/OFF	Status/Control
	RX Detect RRFU	dBm	Status
	RX ATT	dB	Status/Control
	RX Overpower	Alarm : Red, Normal: Green	Status
	10MHz PLL	Alarm : Red, Normal: Green	Status
	TX Delay	us	Status/Control
	RX Delay	us	Status/Control
	Over Power	Alarm : Red, Normal: Green	Status
	VSWR	Alarm : Red, Normal: Green	Status
	Over Temp	Alarm : Red, Normal: Green	Status
	HPA Temp	°C	Status
Amp On/Off	ON/OFF	Status/Control	
DTU TX Power(Block A ~Block F)		Status	

6. System Installation

6.1 ROU 10W Installation

6.2.1 ROU 10W Configuration

ROU 10W is configured of 6 pcs RF modules, Digital Board, CPU, PSU, Optic Switch and Optic module.

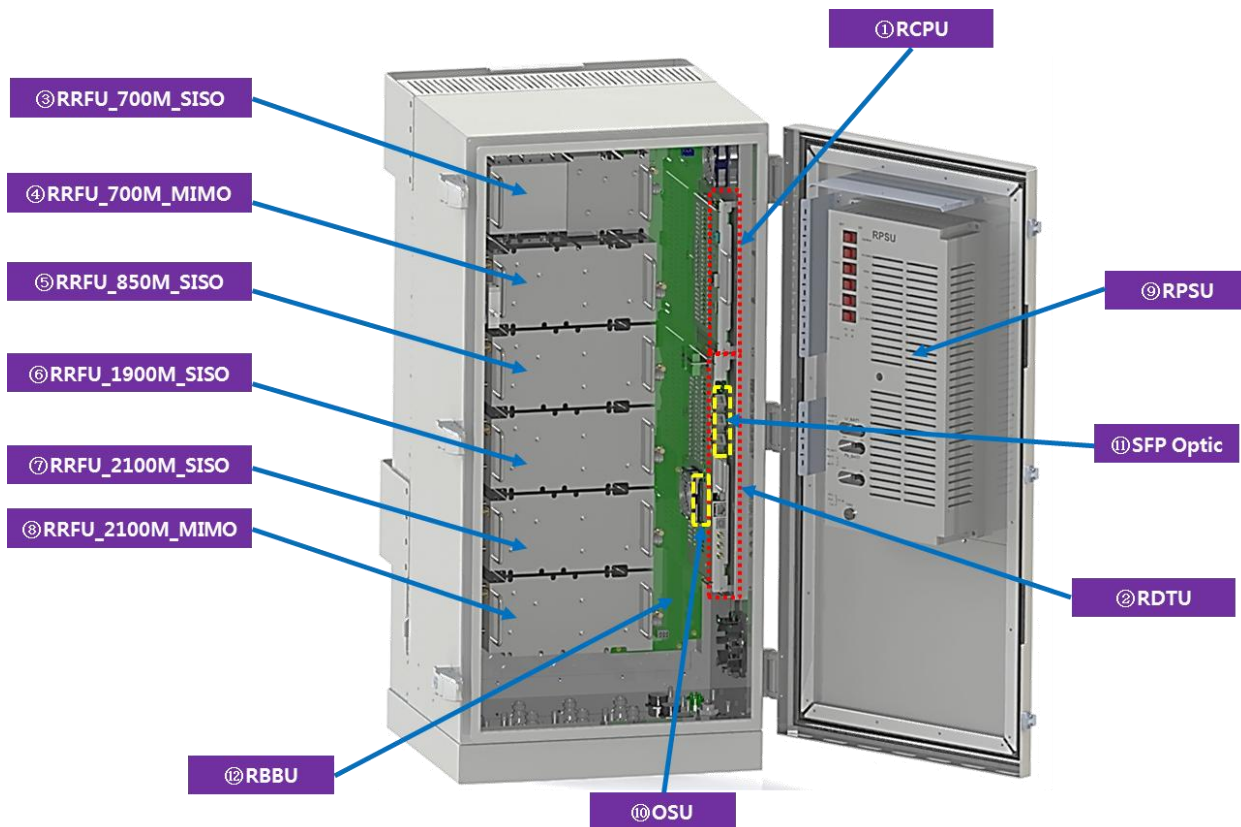
ROU 10W supports 4 bands and expandable to 2 more bands - 700MHz and 2.1GHz with MIMO service

ROU 10W can service up to 4 service providers per each band and the maximum output per band is up to 10W.

The definition of ROU 10W module is as following.

ROU 10 is powered by AC 120V(55 ~ 65Hz) and it also connects to battery backup port depending on the installation environment. AC 120V power connector is located under the outdoor enclosure and the connector recommended is MS3106A-16-10S(F) connecting to power distribution panel.

Maximum output per each service provider shall be limited up to 4W.

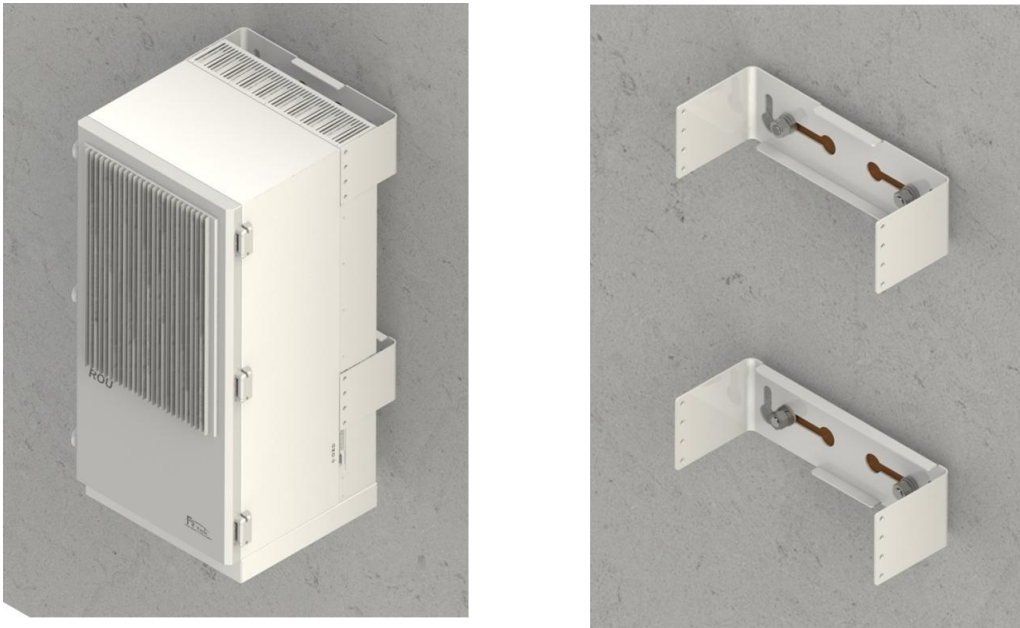


[ROU 10W Units Configuration]

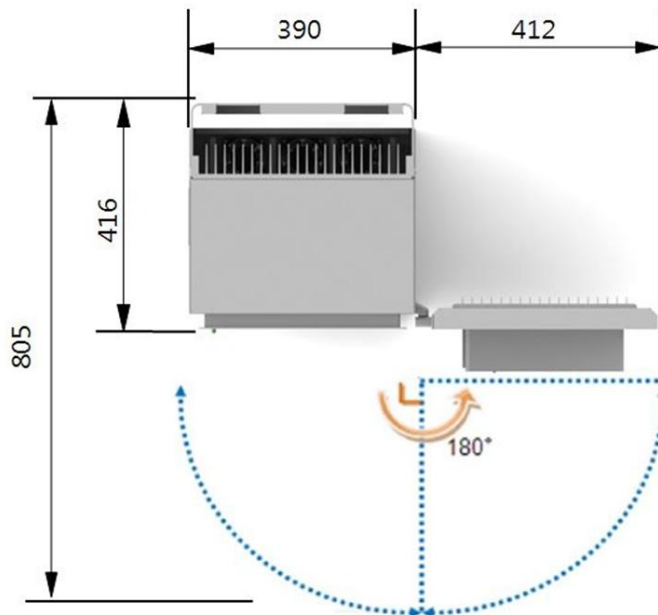
NO	Module	Description	Unit	Q'ty
①	RCPU	Monitor and control each modules status, Local GUI & Web GUI support	EA	1
②	RDTU	Digital Signal Processing(O/E, E/O Conversion), DPD and Filter Function support	EA	1
③	RRFU_700M_SISO	700M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
④	RRFU_700M_MIMO	700M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑤	RRFU_850M_SISO	850M(LTE) TX/RX Signal Amplification and Transmission, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑥	RRFU_1900M_SISO	1900M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑦	RRFU_2100M_SISO	2100M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑧	RRFU_2100M_MIMO	2100M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑨	RPSU	Input: AC 120V, Pb, Li-BATT Supported	EA	1
⑩	OSU	Optical Path Switching Function	EA	1
⑪	SFP Optic	1270/1330nm@10Gbps Optic Signal Transmission	EA	1
⑫	MBBU	ROU 10W Unit PWR Supply and Signal Interface		

6.2.2 ROU 10W Installation

ROU 10W is designed as wall mount type and there shall be 412mm space at the right side of system in order for easy maintenance in case of door open.



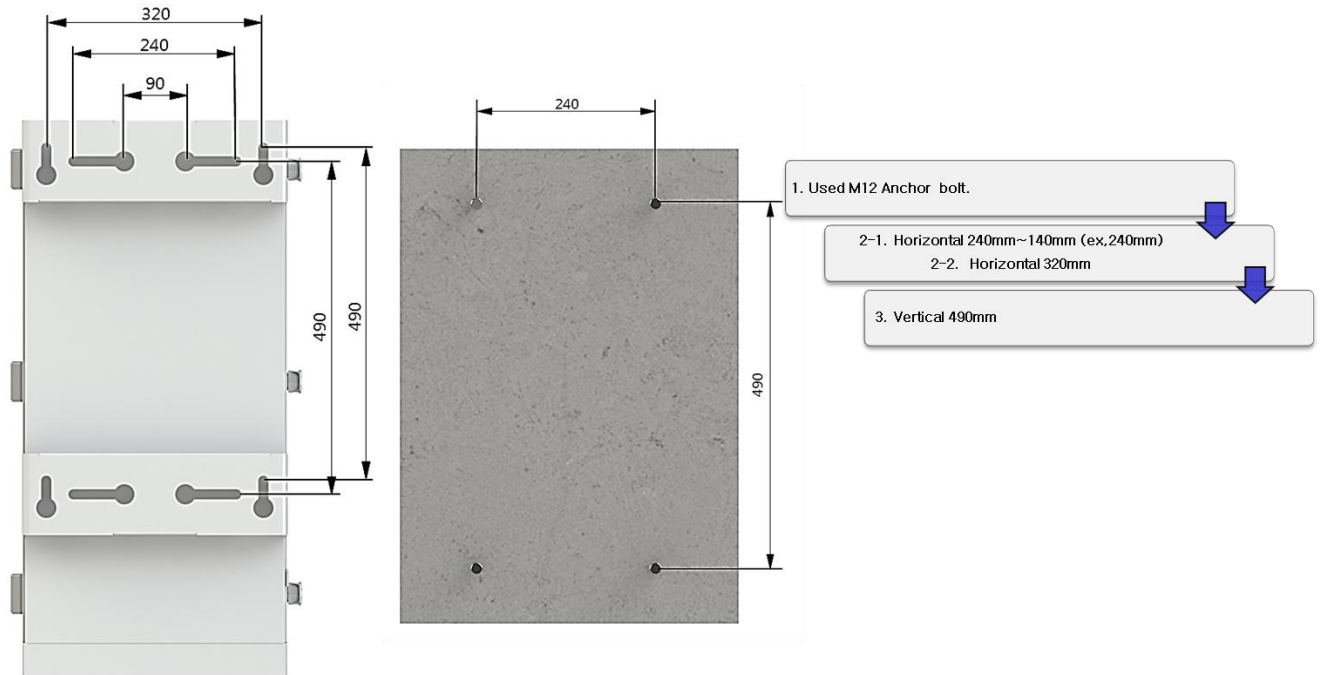
[ROU Wall Mount Installation Picture]



[ROU Open view]

ROU 10W is using an anchor bolt for wall mount installation and is fixed.

The brief picture for wall mounting is as following.

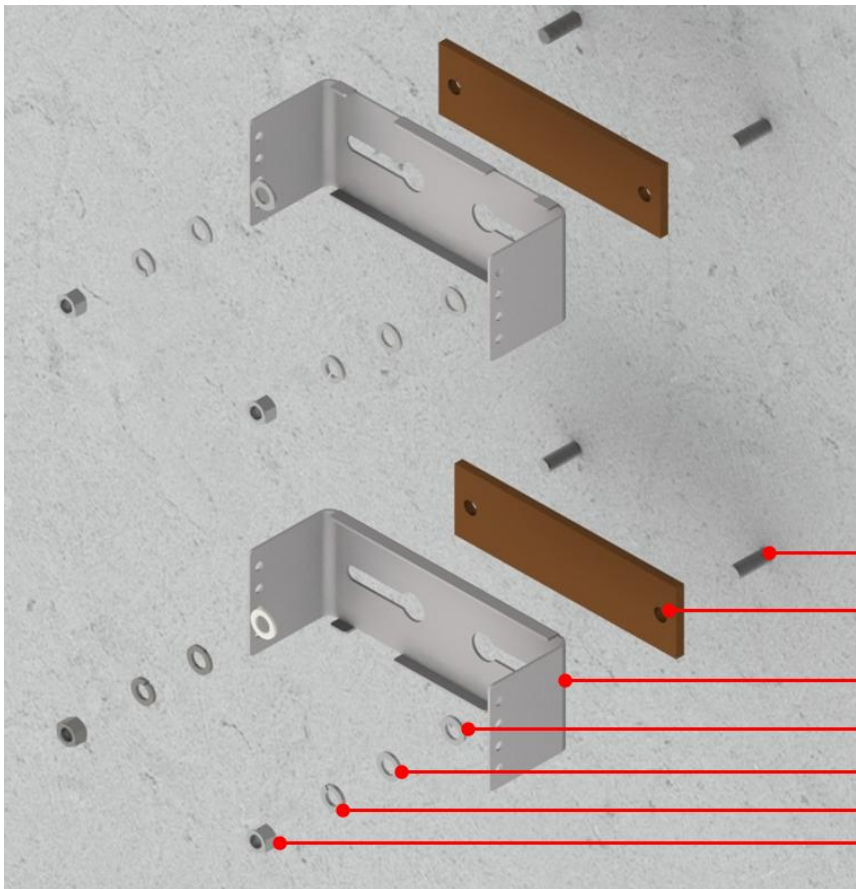


[ROU 10W Anchor bolt Assembly]

The picture below is mounting bracket assembly drawing for ROU 10W wall mount installation.

Assembly order is as following.

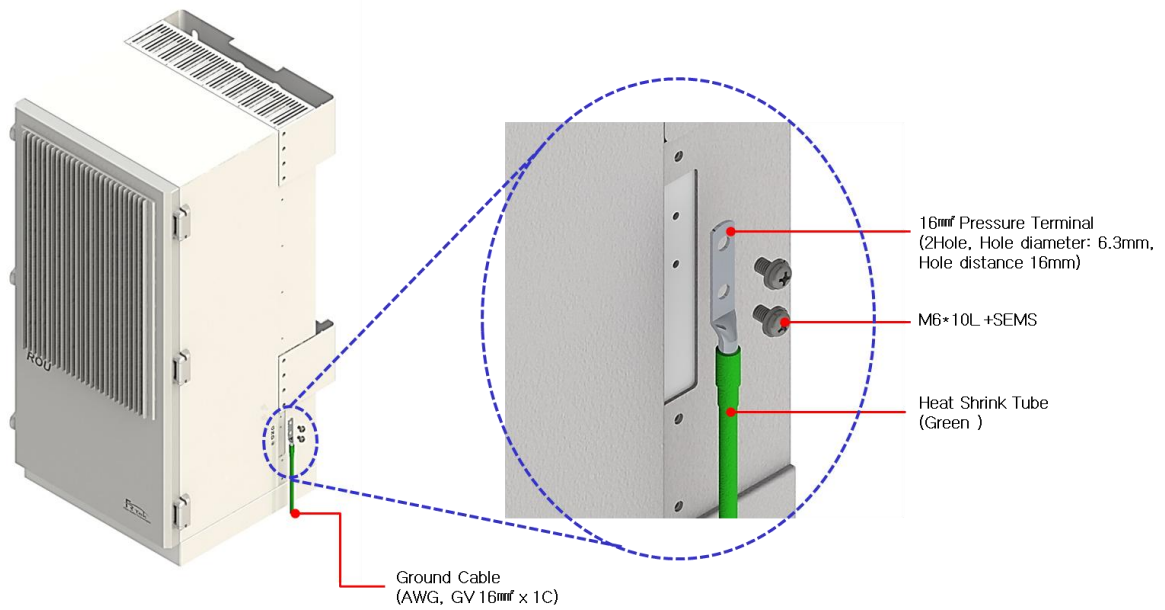
- Insert Bakelite to M12 Anchor bolt.
- Locate ROU 10W in accordance with M12 Anchor bolt.
- Insert M12 Insulation Bushing, M12 Plane washer, M12 Spring washer.
- Tightening them using M12 nut spanner.



- M12 Anchor Bolt
- Bakelite
- Mount Bracket
- M12 Insulation Bushing
- M12 Plane Washer
- M12 Spring Washer
- M12 Hex. Nut

[ROU 10W Wall mount Installation Assembly Drawing (Excluding enclosure image)]

ROU 10W connects the ground of outdoor enclosure and the ground of building for the safety of system from electricity risk and protects system and system operation.



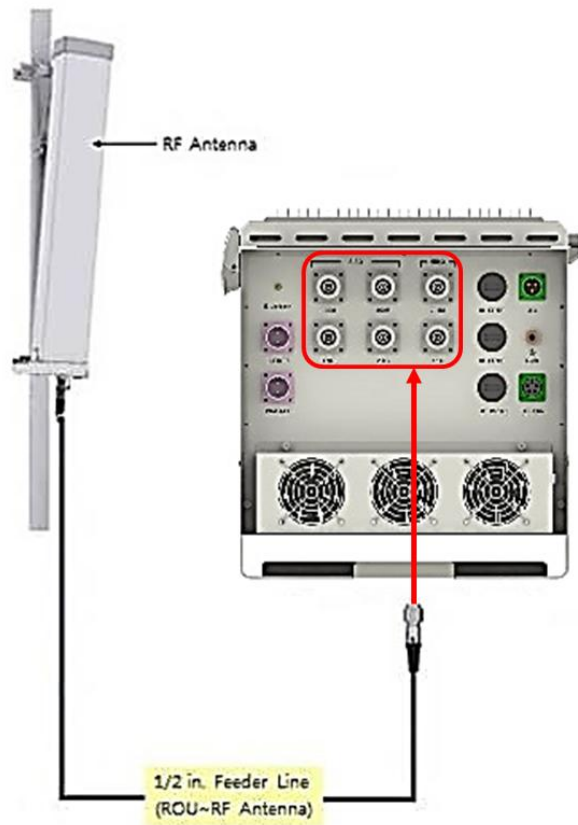
[ROU 10W Ground Cable Connection]

ROU 10W is configured of 6 modules and It has 6 antenna ports assigned for each band at the bottom of the enclosure.

Antenna port connector type is Din connector and the maximum antenna output port is 10W.

The brief drawing which connects to the antenna of ROU 10W is as following.

Antenna shall be used for ROU 10W by approval of service provider or officially approved and antenna type can be selective by the installation environment.



[ROU 10W Antenna Cable Connection]

6.3 ROU 40W Installation

6.3.1 ROU 40W Configuration

ROU 40W is configured of 6 pcs RF modules, Digital Board, CPU, PSU, Optic Switch and Optic module.

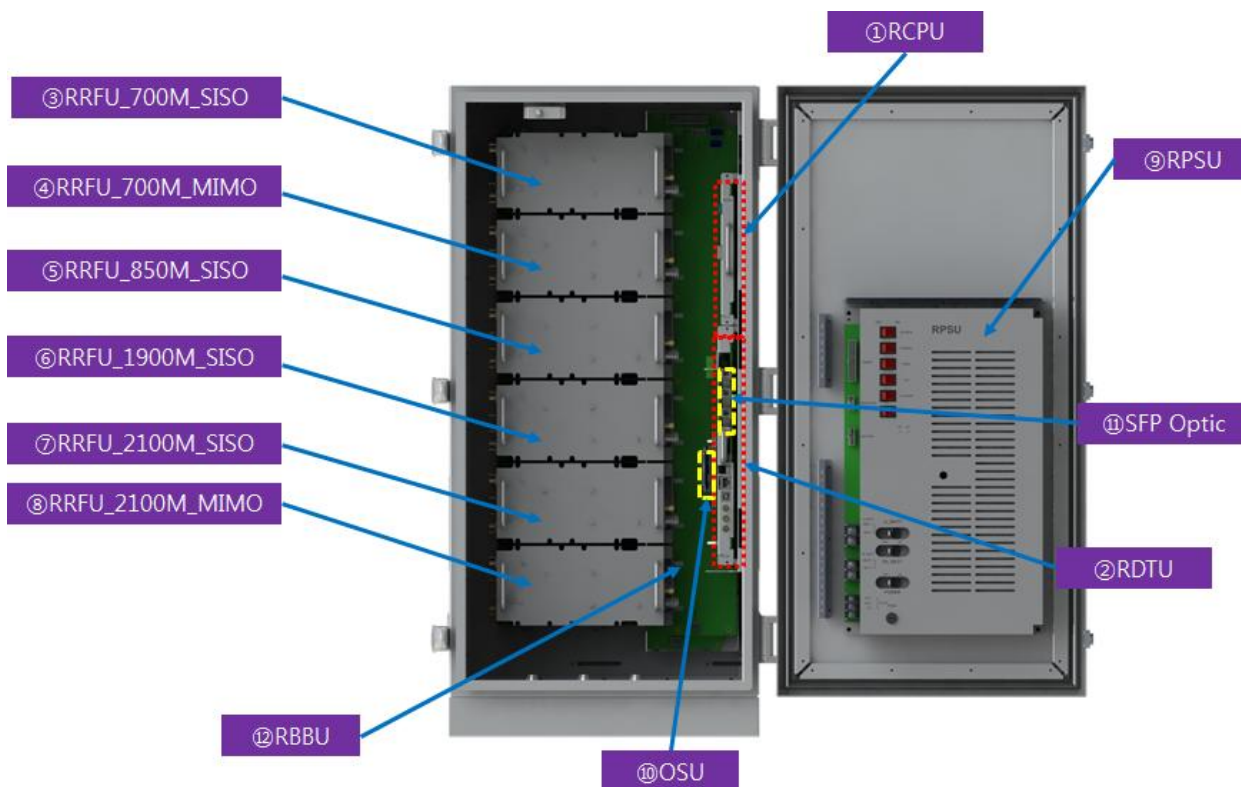
ROU 40W supports 4 bands and is expandable to 2 more bands - 700MHz and 2.1GHz with MIMO service

ROU 40W can service up to 4 service providers per each band and the maximum output per band is up to 40W.

The definition of ROU 40W module is as following.

ROU 40W is powered by AC 120V(55 ~ 65Hz) and it also connects to battery backup port depending on the installation environment. AC 120V power connector is located under the outdoor enclosure and the connector recommended is MS3106A-16-10S(F) connecting to power distribution panel.

Maximum output per each service provider shall be limited up to 10W.



[ROU 40W Units Configuration]

NO	Module	Description	Unit	Q'ty
----	--------	-------------	------	------

①	RCPU	Monitor and control each modules status, Local GUI & Web GUI support	EA	1
②	RDTU	Digital Signal Processing(O/E, E/O Conversion), DPD and Filter Function support	EA	1
③	RRFU_700M_SISO	700M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
④	RRFU_700M_MIMO	700M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑤	RRFU_850M_SISO	850M(LTE) TX/RX Signal Amplification and Transmission, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑥	RRFU_1900M_SISO	1900M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑦	RRFU_2100M_SISO	2100M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑧	RRFU_2100M_MIMO	2100M(LTE) TX/RX Signal Amplification and Transmission Filter, Sub DTU, RF Converter, HPA Unified Structure	EA	1
⑨	RPSU	Input: AC 120V, Pb, Li-BATT Supported	EA	1
⑩	OSU	Optical Path Switching Function	EA	1
⑪	SFP Optic	1270/1330nm@10Gbps Optic Signal Transmission	EA	1
⑫	MBBU	ROU 10W Unit PWR Supply and Signal Interface		

SIERRA is a digital transmission repeater system with Optical Cable.

The key technologies applied to SIERRA are follows.

- Node Isolation
- APD (Analog Pre-Distortion) Amp
- Digital FA Filter
- DPD(Digital Pre-Distortion) Amp

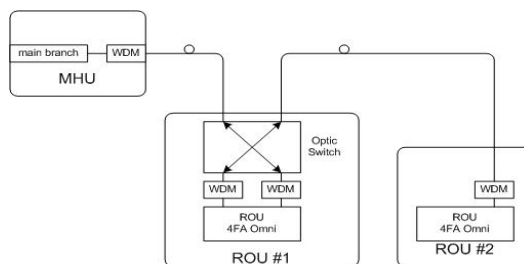
A. Node Isolation

When occurring Node Fail or turning power off, so as not to affect the lower node service, there are switching function is implemented as follows;

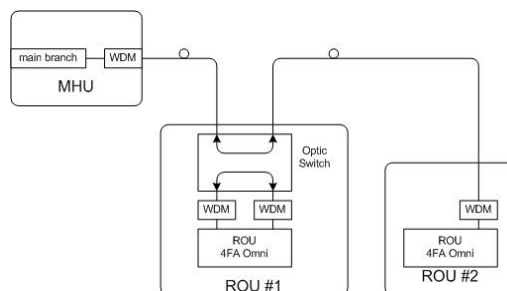
ROU: Optical Switching

- Optical Switching

The following figure is for an illustration of the operating principle of implementing the Node isolation function using optical repeaters Optical switch in general. When occurring Node isolation conditions on the node (fail or power off), Switching the optical switch of the node at the CPU for normal services of sub-nodes. The optical connection is cut-off status, and upper node and lower node are directly connected. If it is in Node isolation Status, remote monitoring of the node and control are not performed, so Special conditions for recovery (automatic recovery after a period of time, etc.) should be given.



< Optic switch connection diagram at Normal operational Status >



< Optic switch connection diagram at Node isolation Status>

B. APD (Analog Pre-Distortion) Amp

Recently, Green IT policy is one of international issues. Therefore, many techniques have been reviewed for Green IT. In particular, much research and products have been developed for high-efficiency, low-power technology Amp. Development of the DPD Amp is currently available by the research and development of high efficiency AMP results in the last few years. Recently APD Amp technology is also being actively developed. APD is a circuit implementation is simple and cost-effective compared to the DPD. Therefore, Remote Amp of the SIERRA is to implement a low-power high-efficiency system to apply the APD Amp. APD Amp technology is similar to efficiency and DPD Amp, the implementation is simpler than the DPD Amp, the cost is cheaper, it can be applied to Midrange equipment and it has competitive price.

The following is a comparison of the major features of the technology in a number of ways Amp.

Contents	HPA	LPA	DPD	APD
System	Analog PD/Doherty	Feed Forward	Digital PD	Analog PD
Efficiency	8~13%	7~8%	20~30%	20~25%
Cost	Standard	High	medium	Low
Implementation	Standard	Complicated	Complicated (AD/DA conversion required)	Same as standard
Size	Standard	Increase about 20%or more	Decrease about 20% or more	Decrease about 20% or more

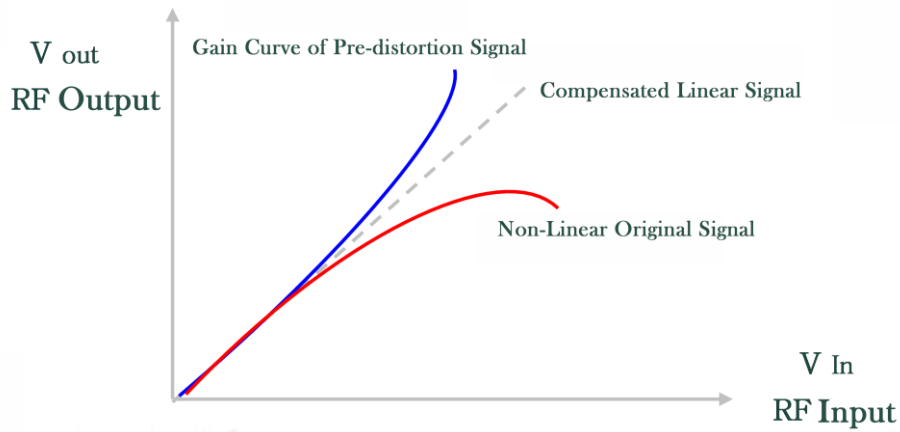
- DPD and NPD have more competitiveness compared to general HPA in efficiency, cost, and size aspects.

(1) The operation principle of APD Amp

- To compensate for possible problems with existing Amplifier are taken,
 - 1) Improve the efficiency of the AMP
 - 2) Designed to operate at low power
- As shown in the picture below, APD ensures a linear gain characteristic (Composite Linear Gain Curve) by

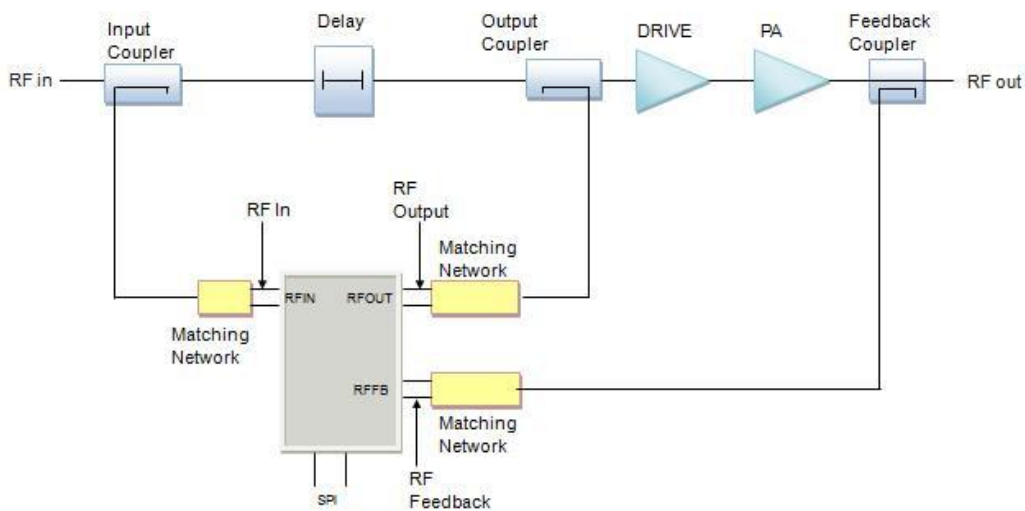
eliminating non-linear gain characteristic (Inherent "Non-linear" Gain Curve) that occurs in the power amplifier and transceiver.

- Creating complementary correction signal: It is the same signal, but a signal having a non-linear gain characteristic of the opposite (Gain Curve of Pre-Distortion Signal)
- It effects to eliminate non-linear gain characteristic.



[Operation concept of APD AMP]

(2) Block diagram and Explanation of APD Amp



[Block diagram of APD Amp]

- **Input coupler :**
The RF signal is input to the APD via a coupler. The input RF signal is used to find the Correction constant as compared to the RF signal Feedback from APD.
- **APD**
Creating the signal which can correct IMD with the signal from RF Input and outputting to RF OUT.
- **Delay**
APD serves to compensate for the internal signal delay
- **Output coupler**
Correction signal output from the APD adds the main path.
- **Matching Network**
Transform the impedance value of the RF signal to the value available in the APD.
- **Drive**
Increase the overall gain of the amplifier and auxiliary amplifier for driving the final AMP.
- **Final AMP**
The primary output amplifier, Amplifier for amplifying the RF power to the standard value using a high-power transistor.
- **Feedback**
Fundamental sampling signals for implementing APD function

C. Digital FA Filter Technology

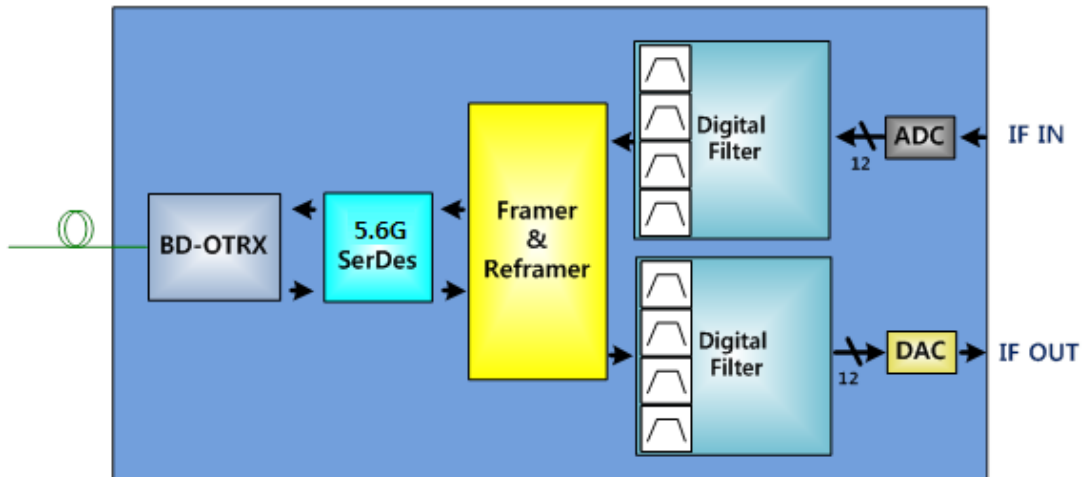
SIERRA is able to be off for a channel (FA) is not used within the band to suppresses unnecessary radiation as possible. FA Filter feature is implemented in Digital signal processing.

Digital FA Filter structure applied to SIERRA

As shown in the figure below, both TX and RX was implemented on an FPGA by adding the FA Filter Block of Digital Board.

The main features are as follows:

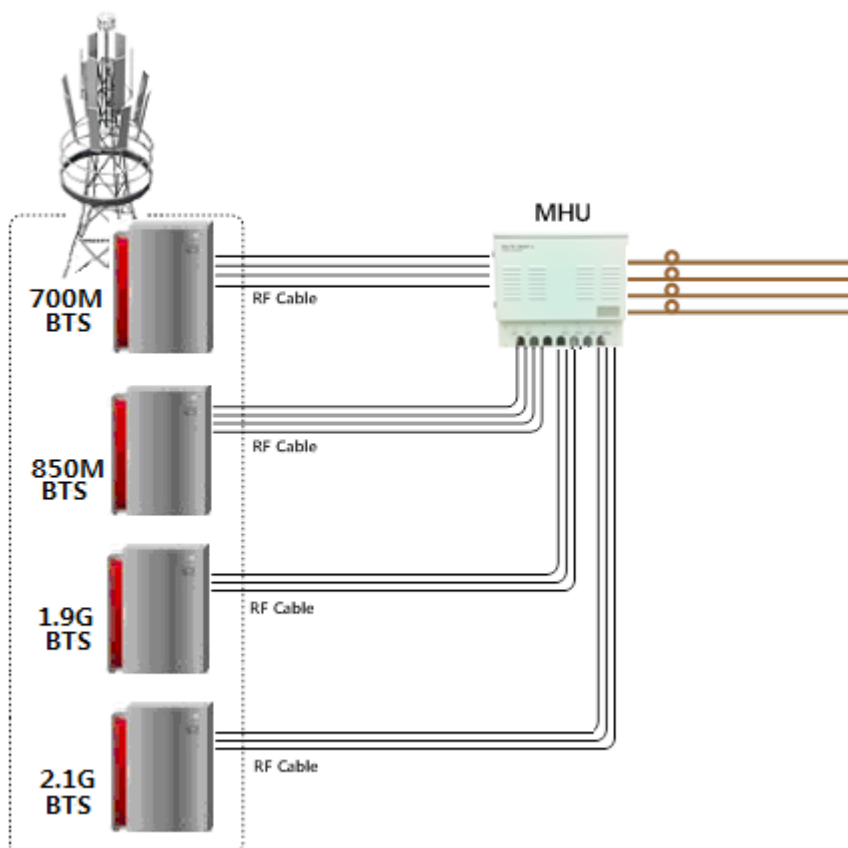
- DSP Block
- Digital FA SAW Filter Tx/Rx implements 700M-4FA, 850M-4FA, 1.9G-7FA, 2.1G-6FA per band
- Ensure Digital Filter uniformity performance (Ripple, Output change)



[Digital Board Block Diagram]

6.2 Technical details of SIERRA’s interworking

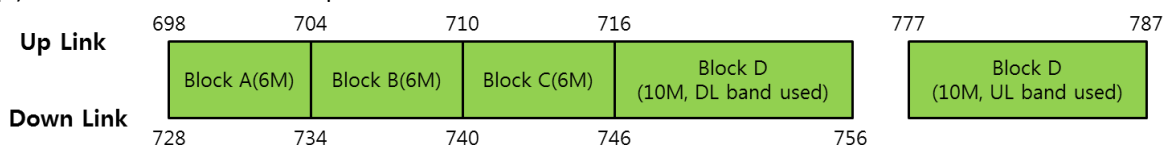
SIERRA is able to connect with BTS per each band via wired (RF)



[Wired connection between MHU and BTS]

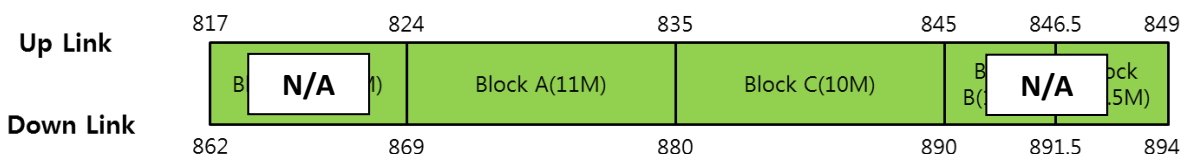
6.2.1 Service Block per each band

(1) 700MHz – Max. 4 Service Operators



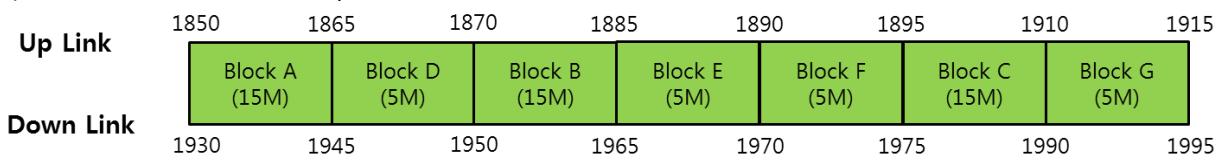
- It can supply a Block: LTE 5M, d Block: LTE 5M, C Block: LTE5M, D Block: LTE 10MHz and one per block)
- Digital Filter is implemented on each Block and can be ON/OFF controlled.
- As per 700MHz, MIMO service is possibly designed.

(2) 850MHz -- Max. 4 Service Operators



- It can supply Block which supports SMR.
- A Block can support CDMA 8 carriers, WCDMA 2 carrier, LTE 1 carrier and they are selectable by service requirement.
- B Block can support CDMA 1 carrier.
- C Block can support CDMA 7 carriers, WCDMA 2 carrier, LTE 1 carrier and they are selectable by service requirement.
- D Block can support CDMA 2 carriers.
- Digital Filters are implemented to each Blocks and can be ON/OFF controlled.
- 850MHz can support SISO service.

(3) 1900MHz -- Max. 4 Service Operators



- 1900MHz is consisted of 7 blocks and any 4 blocks can be selected for service.
- A, B, C Block can support CDMA 11 carriers, WCDMA 3 carriers and LTE 10M, 15MHz and they are selectable by service requirement.
- D, E, F, G Block can support CDMA 3 carriers, WCDMA 1 carrier and LTE 5MHz and they are selectable by service requirement.

7. Alarm and Troubleshooting

(1) AC (MHU, ROU)

■ Phenomenon

- PSU LED : PSU AC LED Off
- Alarm window : GREEN → RED

■ Causes

- Input power 120V/AC is not normally enters

■ Appropriate Measures

- Solution : Check the Input power 120V/AC
- Measures : Check the input power 120V/AC, if there is no problems, check the operation by replacing PSU.

(2) DC (MHU, ROU)

■ Phenomenon

- PSU LED : PSU DC LED RED
- Alarm window : GREEN → RED

■ Causes

- PSU output voltage decreases 85% or under

■ Appropriate Measures

- Solution : Replacing PSU
- Measures : Check the operation by repacing PSU

(3) LD Alarm (MHU, ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- LD of optical module is not normal

■ Appropriate Measures

- Solution : Replacing optical module
- Measures : Check the operation by repacing optical module

(4) PD Alarm (MHU, ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- PD of optical module is not normal

■ Appropriate Measures

- Solution : Clean optical connector and check optical cable or replacing optical moduel
- Measures : Clean optical connector, check the optic cable and fix the problem.
If there is no falut, replace the optical module.

(5) TX/RX PLL (MHU, ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- MHU: Has the problem at TX PLL in MUDC(750M/800M/1.9G/2.1G)
- ROU 10W: Has the problem at TX PLL in RRFU intergrated moduel Converter

■ Appropriate Measures

- Solution : MHU- Replacing MRFU(750M/800M/1.8G/2.1G)
ROU - Replacing RRFU intergrated module Converter(750M/800M/1.8G/2.1G)
- Measures : MHU- Check the operation by repacing MUDC(750M/800M/1.8G/2.1G) of Path(alarm occuring)
ROU 10W- Check the operation by repacing RRFU intergrated module converter(750M/800M/1.8G/2.1G)

(6) Internal FAN (MHU, ROU 10W)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- Occuring some problems at internal fan

■ Appropriate Measures

- Solution : Check and replace the FAN
- Measures : Check the operation by chekcing and repacing the fan

(7) External FAN (MHU, ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- Occuring some problems at external fan

■ Appropriate Measures

- Solution : FAN Check and replace
- Measures : Check the operation by chekcing and repacing the fan

(8) TX S/D(High) (ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- TX output is higher than alarm setting value

■ Appropriate Measures

- Solution : Set appropriate TX ATT
- Measures : Setting the TX ATT in accordance with environment and truning ALC on to prevent to be S/D.

(9) DTU Status (MHU, ROU)

■ Phenomenon

- Alarm window : GREEN → RED

■ Causes

- Occur the problems at harbness connected DTU board or DTU board

■ Appropriate Measures

- Solution : Replacing the harbness connected DTU, if it still has the problem, replace the DTU board
- Measures : Check the operation by replacing the harbness connected DTU or DTU board.

(10) DTU Link Fail (MHU, ROU)**■ Phenomenon**

- Alarm window : GREEN → RED

■ Causes

- Occur the problems of link fail between DTU board and CPU

■ Appropriate Measures

- Solution : Check Reference clock or Check the connectivity between DTU board and Back Board
- Measures : Check the connectivity status of DTU board and replace DTU board.

(11) VSWR (ROU)**■ Phenomenon**

- Alarm window : GREEN → RED

■ Causes

- Occur the problems at antenna input port or AMP

■ Appropriate Measures

- Solution : Check antenna inputport connection status, if there is no fault, replace the AMP
- Measures : Check the antenna input port and if there is no fault, replace the AMP and confirm it works.

(12) Over Power (ROU)**■ Phenomenon**

- Alarm window : GREEN → RED

■ Causes

- Has the problem at RRFU intergrated module output

■ Appropriate Measures

- Solution : Although it set the static output by controlling ATT, if it still has the problem, RRFU intergrated moduled should be replaced
- Measures : Check the operation by chekcing and repacing the RRFU intergrated module

(13) Over Temp (ROU)**■ Phenomenon**

- Alarm window : GREEN → RED

■ Causes

- RRFU's intergrated module temperature is more than 85 °C

■ Appropriate Measures

- Solution : Checm the temparatrue table. Even though it is set appropriate temarature, still has a problem. APD AMP should be replaced.
- Measures : Check the operation by replacing the RRFU intergrated module

(14) Battery (ROU)**■ Phenomenon**

- Alarm window : GREEN → RED
-

■ Causes

- Battery has some problems.

■ Appropriate Measures

- Solution : Replacing the Battery
- Measures: Check the operation by replacing the Battery