Intelibs

**Intelibs, Inc**

# Medium power Remote Unit Product manual

**MRU Operational Manual for GPS-iDAS Application**
**Version: 1.0**
**03-16-2020**

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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*

*This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.*
*This equipment generates, uses and can generate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radiocommunications. However, there is no guarantee that the interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*
*· Reorient or relocate the receiving antenna.*
*· Increase the separation between the equipment and receiver.*
*· Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.*
*· Consult the dealer for technical assistance.*

# 1 Introduction

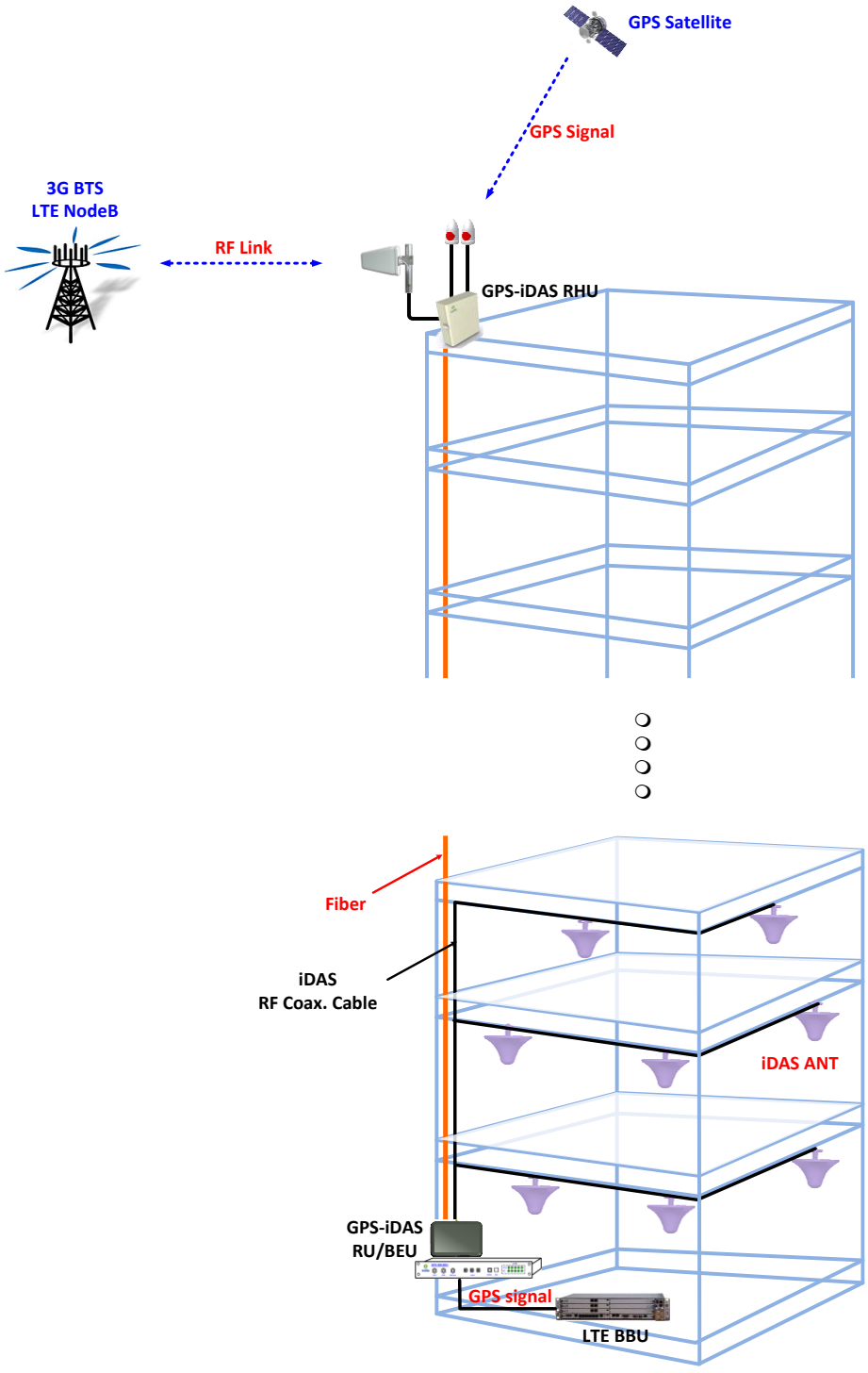
Medium power Remote Unit (MRU) is a part of the Hybrid Distributed Antenna Systems (HDAS) to provide remote RF coverage solution from the Head End Unit such as RHU or MLU fed by the RF source via OTA or Wireline connection. MRU is built on a small form factor with a single antenna port for dual band frequencies with the following features:

1. Quadruple-Band support by one box with small form factor
2. Multiple Technology support
3. Low Power consumption fed by local AC adaptor of DIN-F connector
4. +33 dBm/band Down Link Tx Power (4-band composite power of +39dBm at Antenna port)
5. SNMP based remote management support
6. Single mode Fiber fed with 10 Km distance of 5dBo
7. Auto Gain Control(AGC), Auto power Limit Control(ALC) and Auto Shut Down(ASD) function

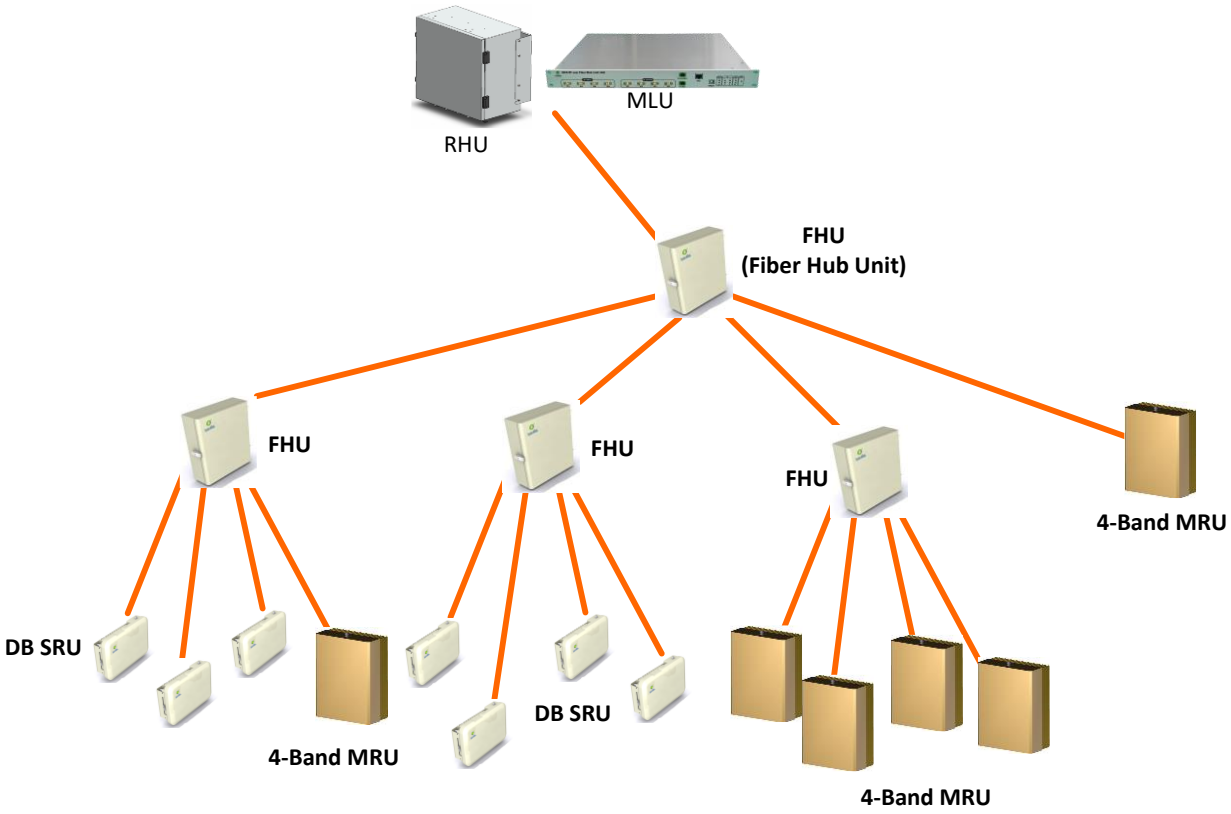
Including RHU and MLU, Hybrid DAS is comprised of the following subsystems:

- RHU (Radio Hub Unit): Over-the-Air Interface unit between RF source and Remote Units, Convert RF signal into optical waves.
- MLU (Main Link Unit): Wire-connected Interface unit between RF source and Remote Units, Convert RF signal into optical waves.
- FHU (Fiber Hub Unit): Fiber distribution and aggregation interface between RHU and multiple RUs. Each FHU supports up to 4 SRU/MRUs and total up to 16 SRU/MRUs by two level FHU configurations
- SRU (Small Remote Unit): Small power (23 dBm per band) remote unit
- MRU (Medium Remote Unit): Medium power (33dBm per band) remote unit
- RU (Remote Unit): High power (40 dBm per band) remote unit for outdoor/indoor
- MU (Master Unit): Element management server

As illustrated in Figure 1-1, Hybrid DAS network is comprised of RHU, FHU, MRU and SRU. Each RHU can support up to 16 SRU's that can cover up to 500Ksf$^2$ indoor space or 16MRU's that can be cover up to 800Ksf$^2$.




(a) RHU-MRU configuration with GPS over fiber




(b) RHU/MLU-FHU-MRU/SRU configuration

Figure 1-1 Various network diagram using RHU(MLU)/MLU/FHU/MRU/SRU

# 2 Product Description

As shown in Figure 2-1, MRU is a compact platform with the natural heat convection. As unified form factor, MRU services multiple technologies on a single platform with 4 band operating frequencies. It can be mounted on the wall. Variety of the service antenna can be used from small form factor antenna to indoor multi-band ceiling Omni antenna (or panel antenna).

Figure 2-1 MRU Picture

## 2.1 External interface ports and Status Indicators

MRU has main interface connections at topside of the enclosure, which includes optic, antennas and dc power input. The status LEDs and USB port for maintenance are located on left side. Figure 2-2 shows the top and bottom side of MRU.

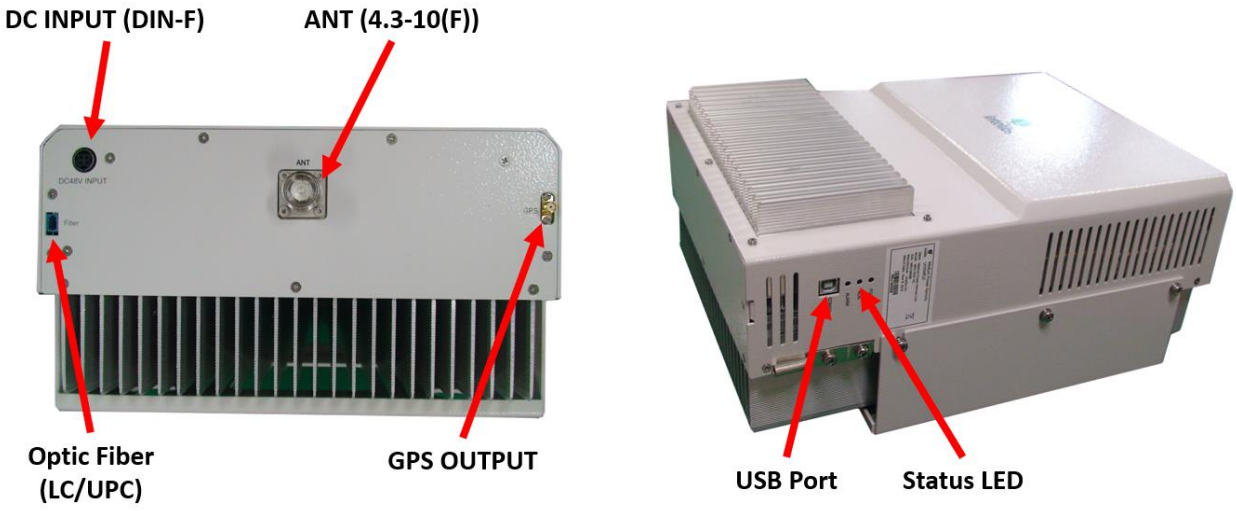



Figure 2-2 Top and bottom side of MRU

Table 2-1 Interface ports

| Port | Connector type | Position | Destion |
|---|---|---|---|
| Power | DIN-F | Top | +48V DC inlet, DIN-F adapter |
| Debug | USB-B | Left Side | Serial interface for local GUI and debugging |
| Optic | LC/UPC | Top | Optic fiber connection with FHU or RHU |
| GPS Out | SMA-Female | Top | GPS signal output port to BBU |
| ANT | 4.3-10-Female | Top | The port for ANT connection |

Table 2-2 Status indicator LEDs

| Name | Normal state | Abnormal state | Description |
|---|---|---|---|
| Power | Green | Off | Power injection status |
| RUN | Green/Blinking | Off | CPU working status |
| Alarm | Green | RED | Major Alarm indication |

## 2.2 Block Diagram

Figure 2-3 shows block diagram of the MRU which supports Quad-band Cellular carriers.

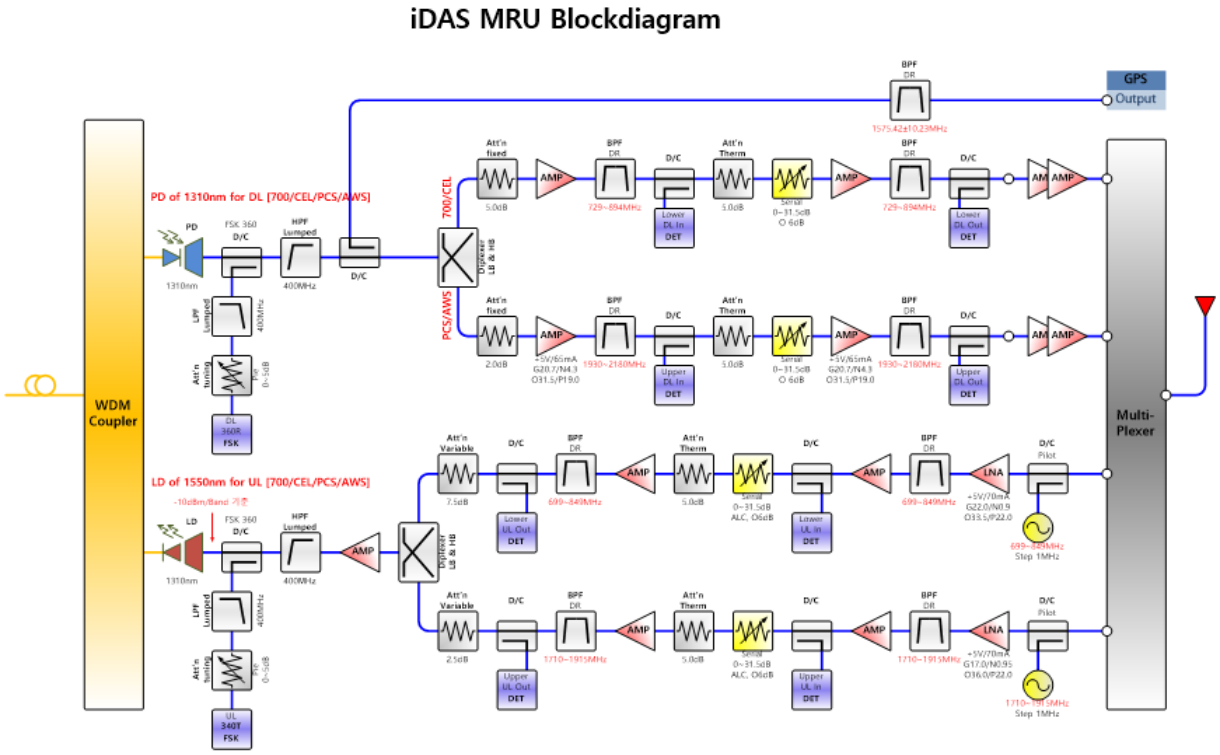



Figure 2-3 Block diagram of MRU

Figure 2-5 Exterior in 3-dimension

## 2.3 Technical Specifications

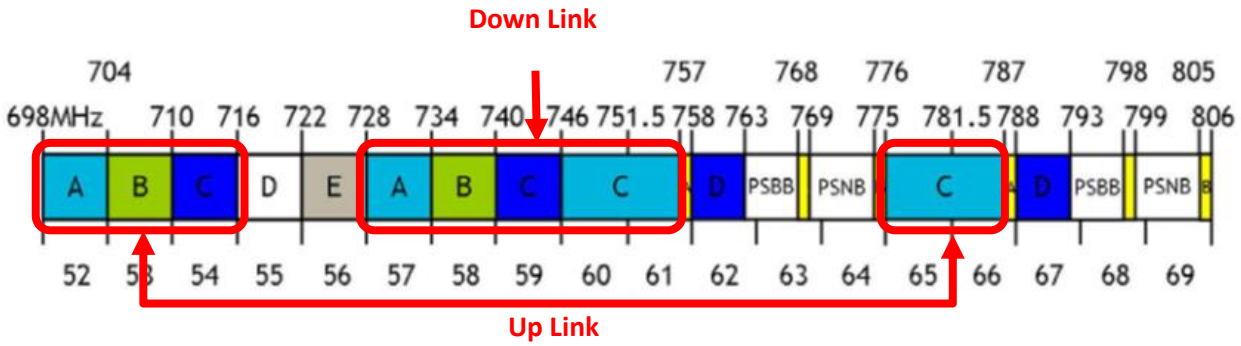
### 2.3.1 General specifications

Table 2-4 General Specifications

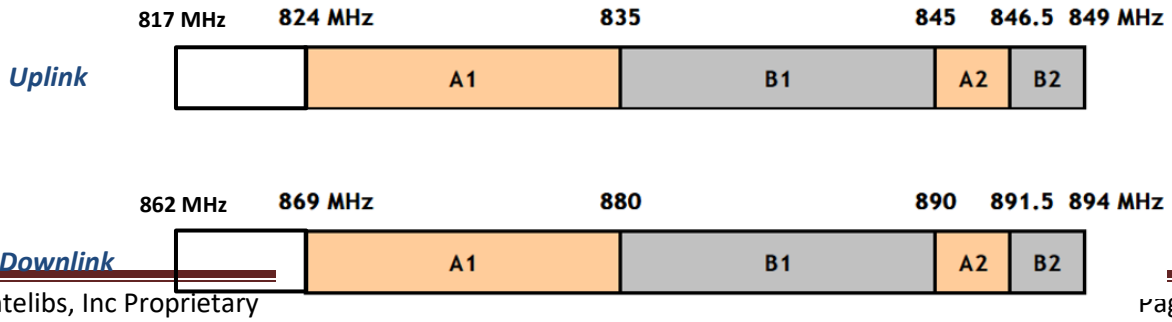
| Specification | Values | Remarks |
|---|---|---|
| Dimensions | 14.37(H) x 11.00(W) x 5.7(D) inch<br>365(H) x 280.4(W) x 145(D) mm | without holder bracket |
| Weight | 15 Kg (33 lb) | |
| ANT and RF connector | 4.3-10 Female | |
| Optic port | LC/UPC type | |
| GUI port | USB B-type | |
| Input Supply Voltage | +48VDC | DIN-F connector with AC/DC converter |
| Operating Temperature | -10 ~ +45 °C | |
| Humidity | 5 ~ 80% Relatively | |

### 2.3.2 Frequency allocation

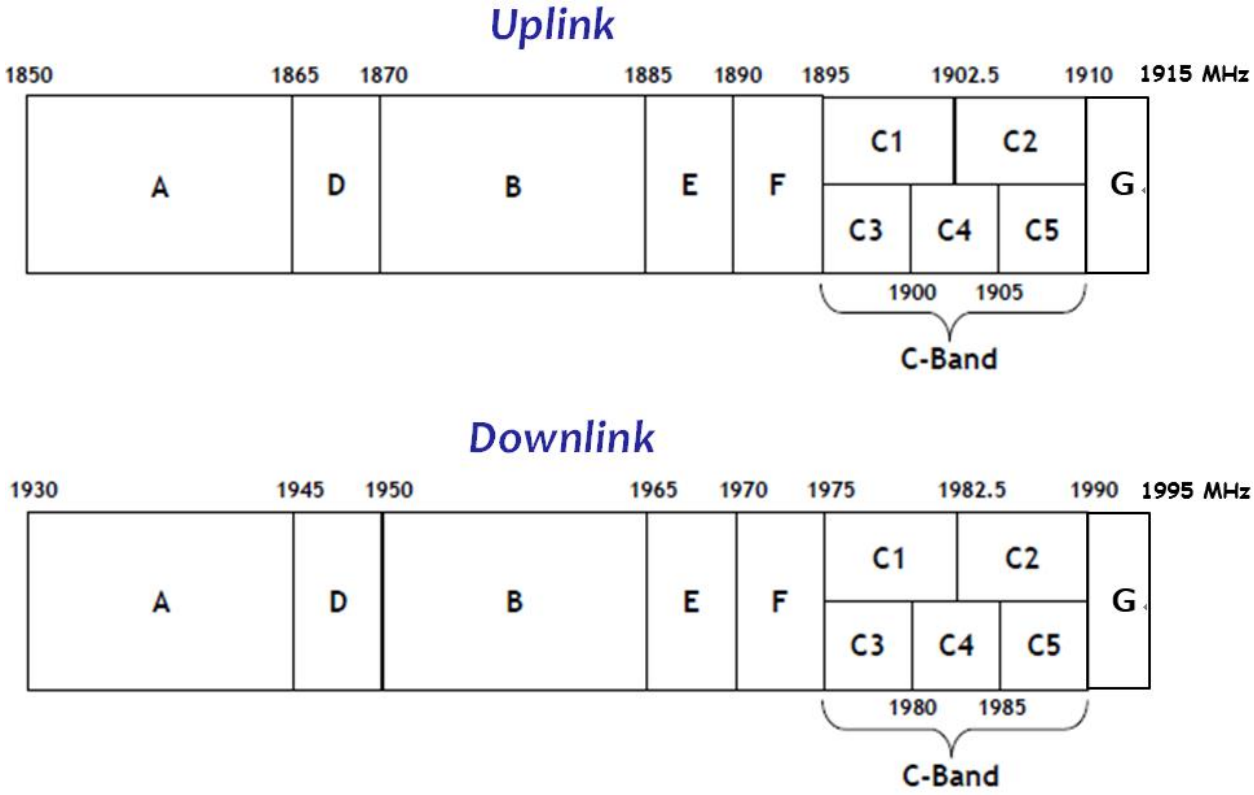
#### *2.3.2.1 700MHz band*



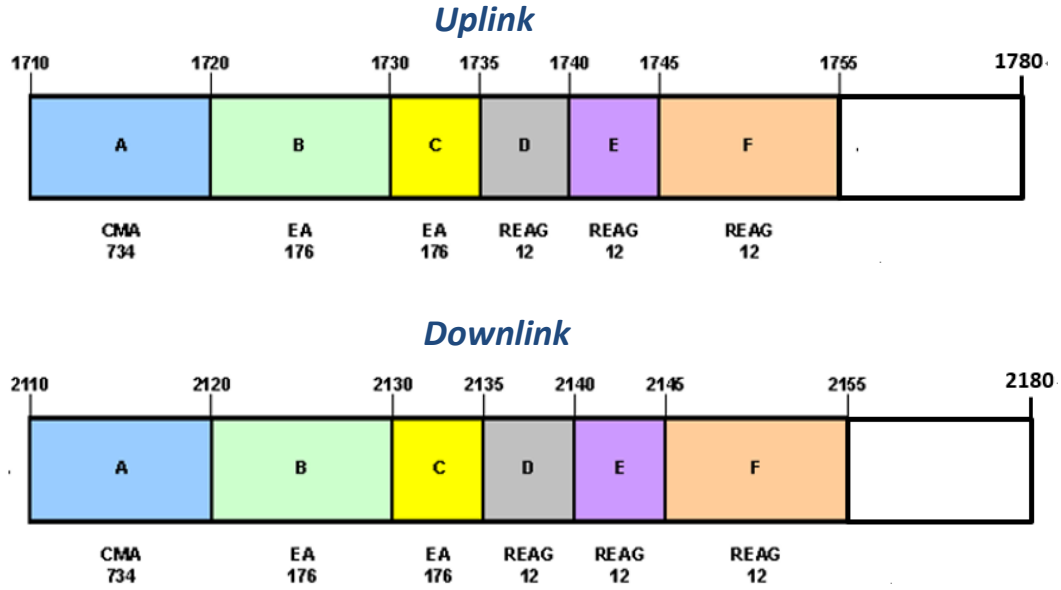

#### *2.3.2.2 850MHz band*



### 2.3.2.3 1900MHz band




### 2.3.2.4 AWS band



### 2.3.3 RF specifications

#### *2.3.3.1 iDAS MRU specifications*

Table 2-5 Power specifications

| Specification | Values | | Remarks |
|---|---|---|---|
| **Frequency Band** | DL | 700LTE: 728 ~ 757MHz<br>PCS: 1930 ~ 1995MHz | 850MHz: 862 ~ 894MHz<br>AWS: 2110 ~ 2180MHz |
| | UL | 700LTE: 698~716/776~787MHz<br>PCS: 1850 ~ 1915MHz | 850MHz: 817 ~ 849MHz<br>AWS: 1710 ~ 1780MHz |
| **System input level** | DL | -25 ~ -5dBm/band | @ MRU optic output port |
| | UL | -45dBm/band max. | @ ANT input port of MRU |
| **Composite Power** | DL | +33dBm/band max. | @ Composite PWR of MRU |
| | UL | -5dBm/Band max. | @ Optic input port of MRU |
| **System Gain** | DL | 45dB typ.(50dB max.) | @ Be able to compensate 5dBo fiber loss |
| | UL | 45dB typ.(50dB max.) | |
| **Gain Control Range** | DL | 0 ~ 30dB by 1dB step | @ ±0.7dB error at 0~25dB |
| | UL | 0 ~ 30dB by 1dB step | |
| **Noise Figure** | UL | 5dB typ. (8dB max.) | @ MRU→ RHU |
| **VSWR** | DL/UL | 1.5: 1 Max. | @ All of RF Port |
| **Output spurious** | DL/UL | Comply to 3GPP/3GPP2/FCC | @ Composite out power |
| **System Delay** | DL/UL | 500nsec max. | |
| **EVM** | DL/UL | Less than 5% | @ CDMA, WCDMA, LTE signal |
| **Optical wavelength** | DL | 1310nm | @ WDM included |
| | UL | 1550nm | |
| **Optical loss** | DL/UL | 5dBo max. | @ RHU ←→ 4band RU |
| | | | |
| **Connector type** | RF | 4.3-10 Female | @ ANT port |
| | | SMA Female | @ GPS port |
| | Optic | LC/UPC | |
| | Power | DIN-F | @ AC/DC Adaptor |
| | Debug | USB-B type | |
| **Temperature** | -10 ~ +45˚C | | @ Indoor type |
| **Humidity** | 5 ~ 80% Relatively | | |

### 2.3.4 Power Specifications

Table 2-6 Power specifications

| Item | Specification |
|---|---|
| Rated Input Voltage | +40 ~ +55 VDC typ. |
| Permissible range | Tolerance ±5% |
| Power consumption | 150W typ. 170W max. |

# 3 Installation

## 3.1 Installation Tools

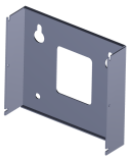
Table 3-1 Installation tools

| Torque Wrench | 4.3-10 Torque Wrench | ESD Gloves | Antenna cable w/ 4.3-10(M) |
|---|---|---|---|
|  |  |  |  |
| LC/UPC-LC/UPC Optic Fiber, 10m | Ground wire line | Optic connector cleaner | Wire Stripper & Cutter |
|  |  |  |  |
| Rubber Mallet | Digital Multi-meter | Screw Driver | |
|  |  |  | |

## 3.2 Item Check List

Check that all the following items have been included with the box delivered. If anything is missing, please contact Intelibs.

Table 3-2 Item check list

| MRU | AC/DC Power Adaptor(Included in box) | MRU Bracket(Included in box) |
|---|---|---|
|  |  |  |

## 3.3 Unit Mounting

MRU should be installed vertically such as wall mounting because of heat dissipation. If MRU want to be installed on the rack horizontally, proper cooling devices like fan are required. The following diagrams illustrate the methods for mounting MRU in a typical wall. The brackets for wall mount are provided with MRU system.

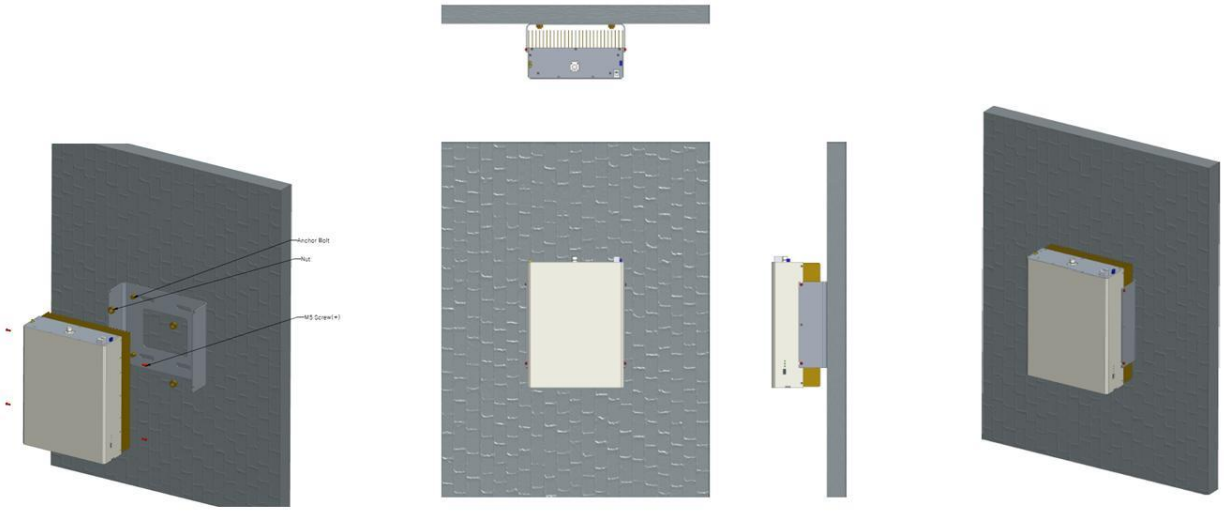


Figure 3-1 Wall mounting

## 3.4 Antenna

MRU uses various antennas depends on its application and environment. MRU provides one antenna port for 4-Band transmission at the top side of the system. Figure 3-2 shows antenna connection with 1/2inch coaxial cable in case of passive DAS.

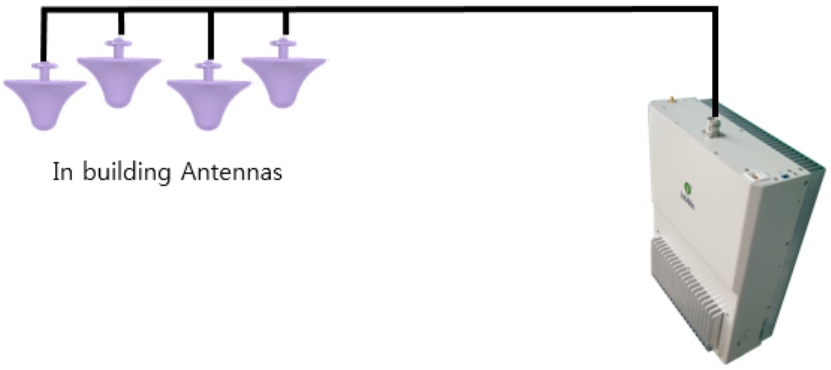



Figure 3-2 Antenna connection

## 3.5 Power cable

MRU uses +48V DC power by DIN-F passive injector. For DC power source, AC/DC converter with DIN-F connector can be used. Connect DIN connector power cable to the “DC” port.

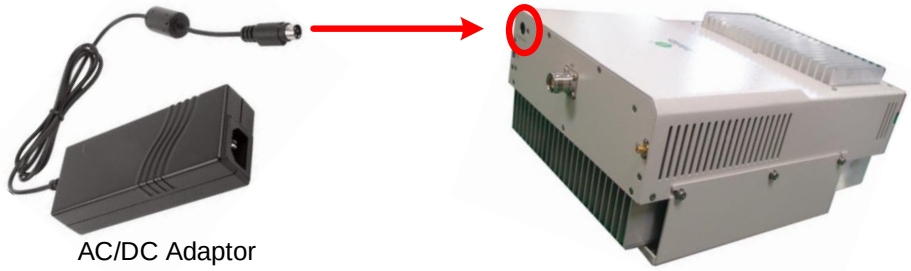



Figure 3-3 Power cable connection

## 3.6 Optic cable

MRU provides one optic port for upward direction, “Optic” port, and optic connector type is LC/UPC .

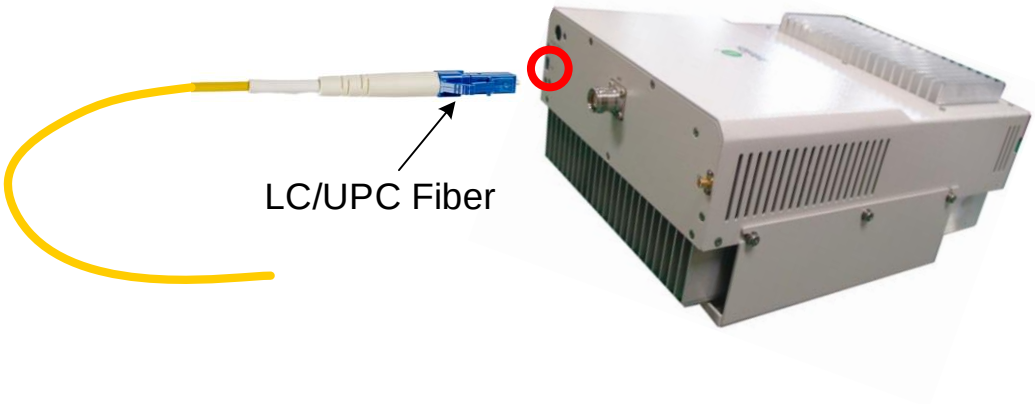



Figure 3-4 Optic cable connection

Figure 3-5 and 3-6 shows various optic connection of RHU-FHU-MRU equipment.

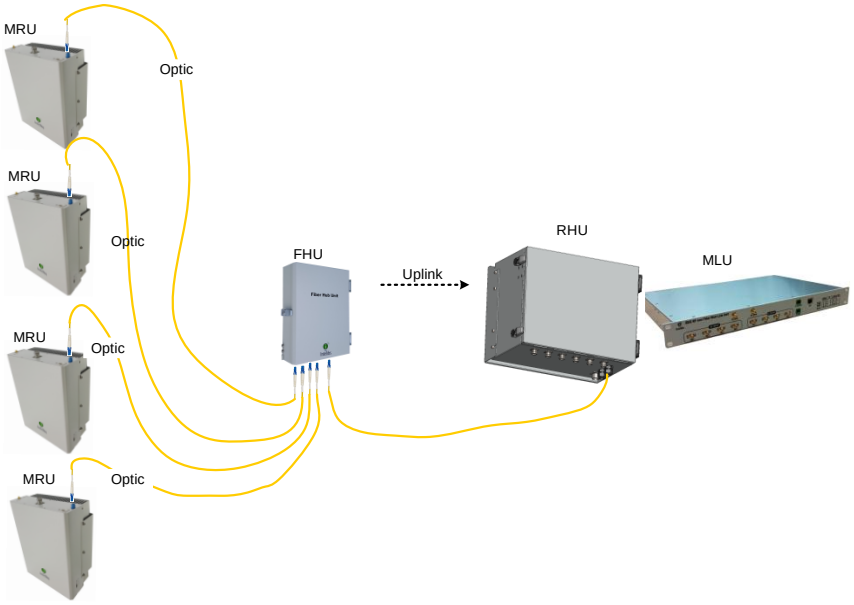



Figure 3-5 Optic cabling when cascading DAS systems with one FHU/MLU

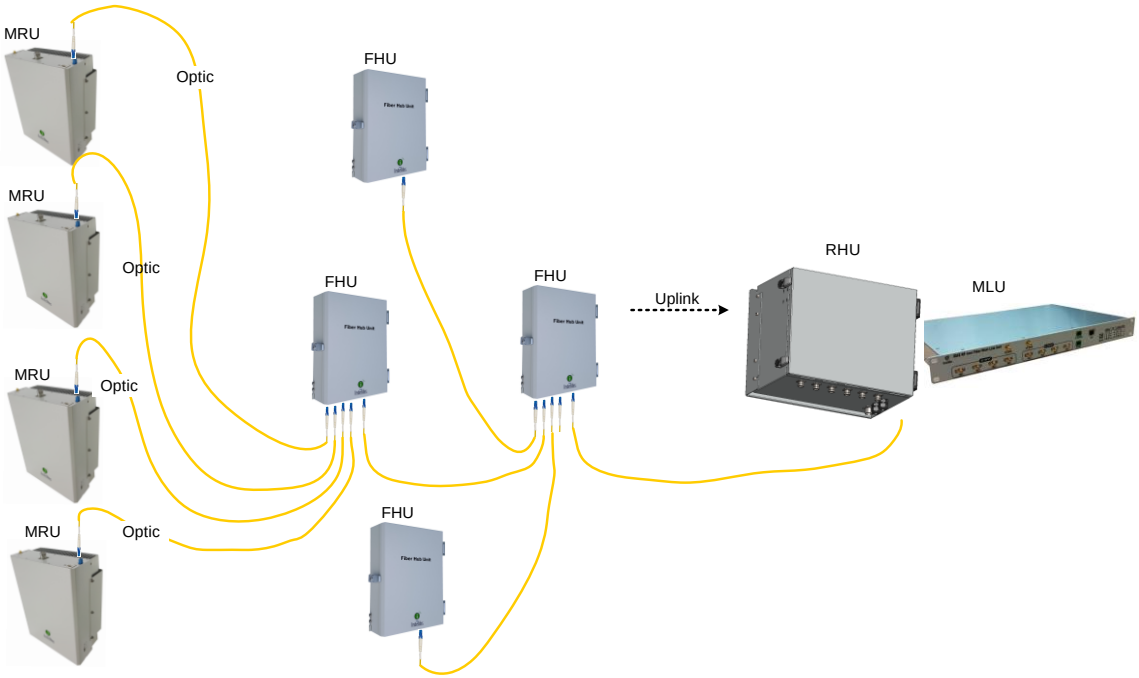



Figure 3-6 Optic cabling when cascading DAS systems with two-stage FHU

# 4 Configuration and Maintenance

SRU can be configured in three ways via remote internet connection or local serial port connection.

- Local management interface through the internet or serial connection
- Web interface through the internet
- SNMP interface through the internet

Master Unit is a remote management system that provides SNMP and Web interface, and maintains all functions of optical DAS system including configurations, monitoring, and real time alarm reporting.

The local management interface can be set up through IP network, serial interface, and Bluetooth.

The configuration and maintenance for SRU is performed by accessing RHU system through any interfaces provided by RHU.

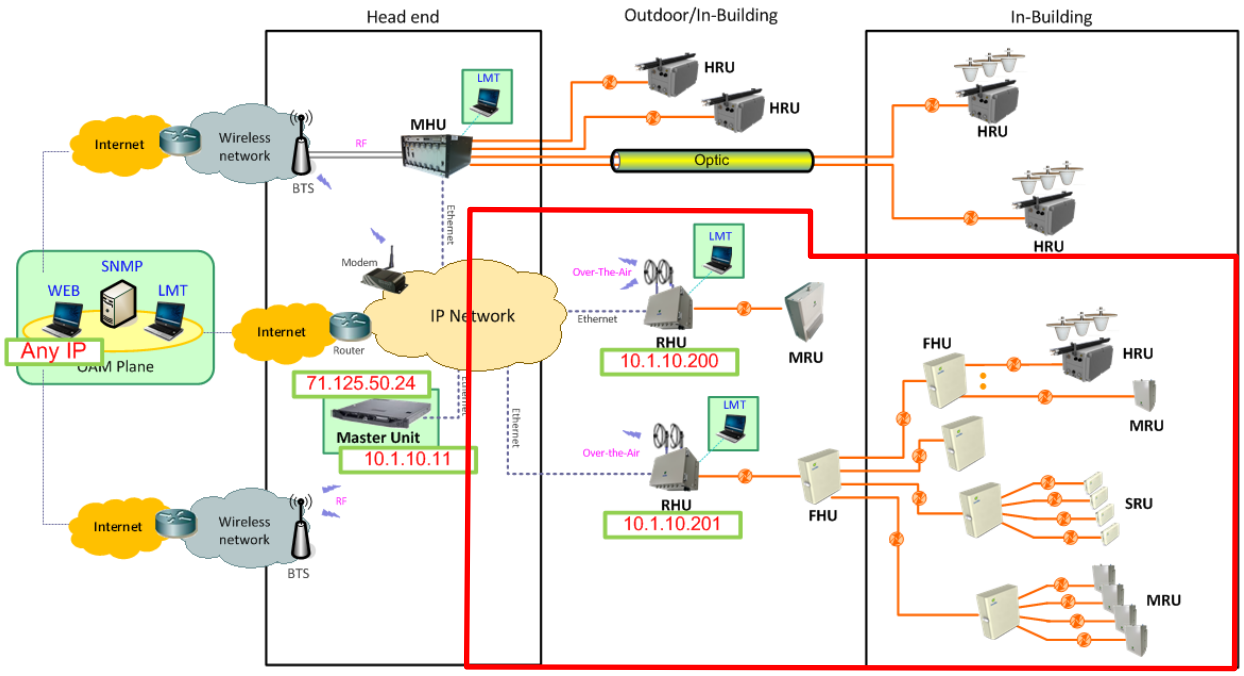



Figure 4-1 DAS management network and entities

Configuration guide below shows how to configure and manage MRU system. Figure 2-15 is an example DAS network for the configuration.

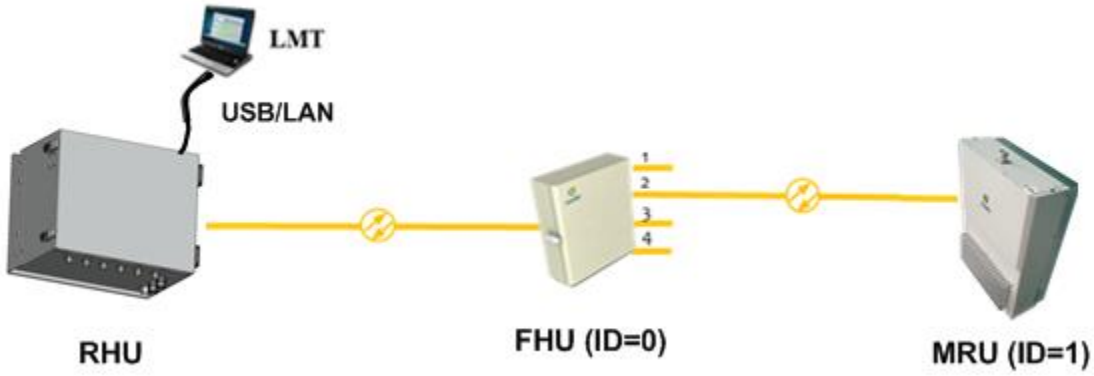
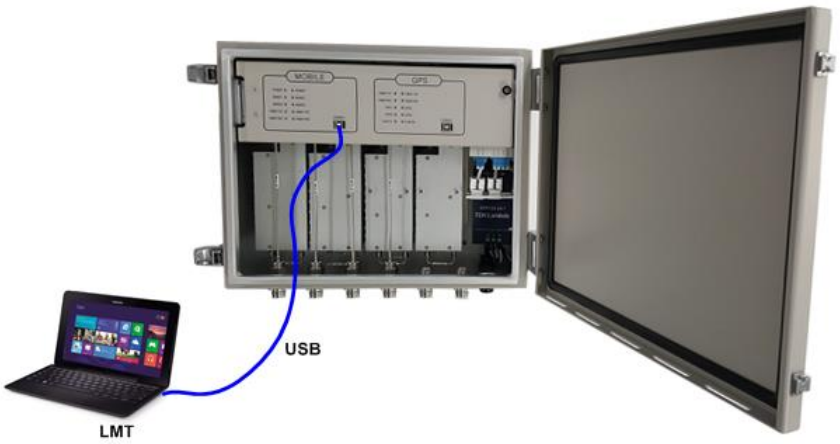


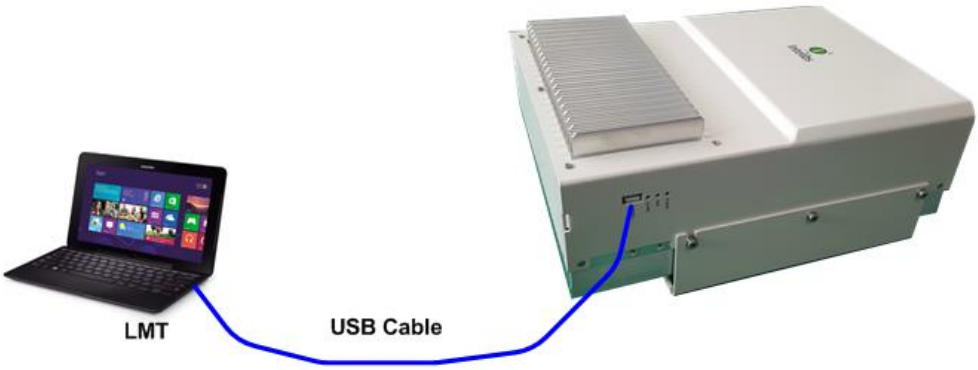

Figure 4-2 RHU/FHU/MRU network

## 4.1 GUI connection

The on-site local connection between LMT and RHU system can be established via USB interface.




[Laptop connection to MHU]




[Laptop connection to MRU]

Figure 4-3 USB connection

If the USB connection has been established, LMT is ready to start. Click the short cut icon on your laptop and follows the steps below.

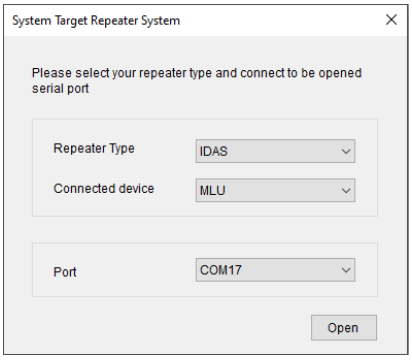
***Step 1***

- Run the IDAS GUI.


***Step 2***

- Select the connection parameters as follows:
    - Choose [File → connect] from GUI window
    - Repeater Types: IDAS
    - Connected Device:  choose one of MLU, FHU or MRU
    - Connections

- Serial Port: The port number established via USB

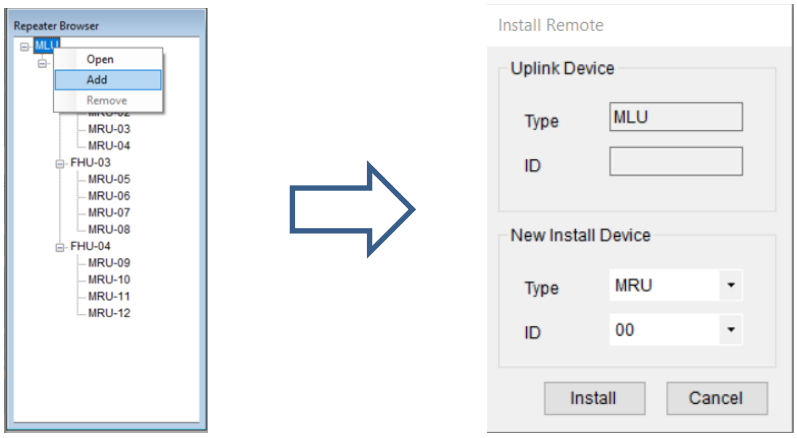



## *Step 3*

- Connection is established you can see MLU, FHU and MRU connection diagram
- Select the “MLU” on the above window.

## *Step 4*

- If you want to add the unit to manage, please right click of mouse and you can see the sub-screen below.
- You can open the installation screen as below when you select “Add” button.




- For setting ‘Install Remote’, Input proper type and ID in “New Install Device” part.

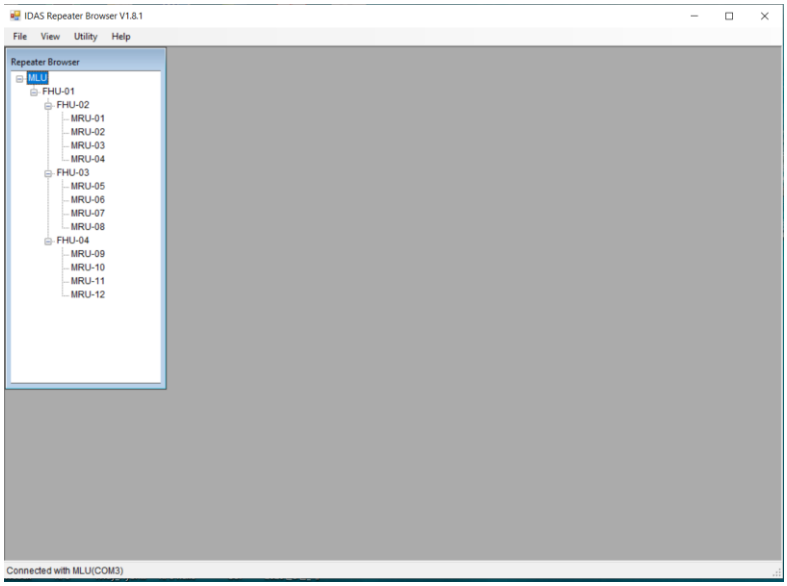
In this window

- Uplink Device type: the type of Upper level Device, like MLU or FHU
- Uplink Device ID: ID number of Upper level Device of MLU or FHU
- New Install Device type: Unit type that is installed, FHU or MRU
- New Install Device ID: Unit ID that is installed

- Install : Add the Unit under Uplink Device

## *Step 5*

- Check the installed device as below browser




## *Step 6*

- Double click “MRU” from above browser, then MRU status screen is opened as below.


If connection is established successfully, then all parameters of MRU can be set on the GUI, and all status information can be displayed on the GUI. MRU’s status and parameters that can be controlled by GUI are described in Table 4-1, 4-2, and 4-3.

Table 4-1 General/Environment/Optic

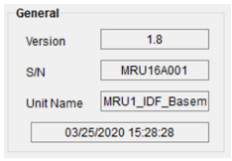
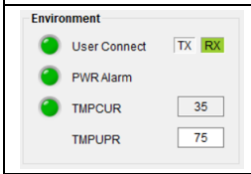
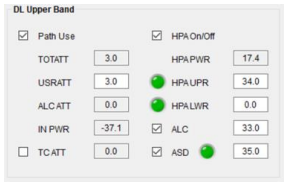
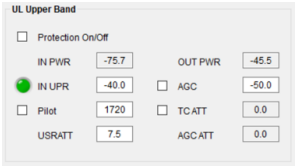
| Status group | Parameters | Status | Control | Description |
|---|---|---|---|---|
|  | Version | √ | | Firmware Version of the Unit |
| | Serial Number | √ | | Serial number of the unit |
| | Unit Name | √ | √ | Set the information of the unit<br>- Name, location and so on |
| | Time/UpTime | √ | | Current time or Up-time display |
|  | User Connect | √ | | Connection status with MLU/RHU |
| | PWR Alarm | √ | | Display DC Power Alarm |
| | TMPCUR | √ | | Current chassis temperature of the Unit |
| | TMPUPR | √ | √ | Set temperature upper limit, and display its value and alarm status. |
|  | LDPWR | √ | | Current optical output power of LD (Laser Diode) to transmit to upper unit. |
| | LDLWR | √ | √ | Set the lower limit of output power of LD, and display its value and alarm status. |
| | PDPWR | √ | | Current optical receiving power of PD (Photo Detector) of optic module connected to MRU. |
| | PDLWR | √ | √ | Set the lower limit of PD power, and display its value and alarm status. |

Table 4-2 DL Lower and Upper Band

| Status group | Parameters | Status | Control | Description |
|---|---|---|---|---|
|  | Lower Band | √ | | Selects Lower Band (700/850MHz) channel |
| | Upper Band | √ | | Selects Upper (1900MHz/AWS) channel |
|  | Path Use | √ | √ | Turn On/Off of the usage of this path and display its status |
| | TOTATT | √ | | Downlink total attenuation value |
| | USR ATT | √ | √ | Downlink attenuation value that is set by user |
| | ALC ATT | √ | | Attenuation value due to DL ALC function |
| | IN PWR | √ | | Display the downlink input level coming from upper unit |
| | TC ATT | √ | | Displays downlink temperature compensation attenuation value and enable/disable downlink temperature compensation function. |
| | HPA On/Off | √ | √ | Turn On/Off downlink HPA (High Power Amplifier). |
| | OUT PWR | √ | | Display downlink output power to ANT port |
| | OUT UPR | √ | √ | Set upper limit of downlink output power, and displays its value and alarm status |
| | OUT LWR | √ | √ | Set lower limit of downlink output power, and displays its value and alarm status |
| | ALC | √ | √ | Set ALC (Automatic Level Control) function's activation level, and enable/disable ALC. |

| | | | | |
|---|---|---|---|---|
| | ASD | √ | √ | Set ASD (Automatic Shut Down) function's activation level, and enable/disable ASD. |

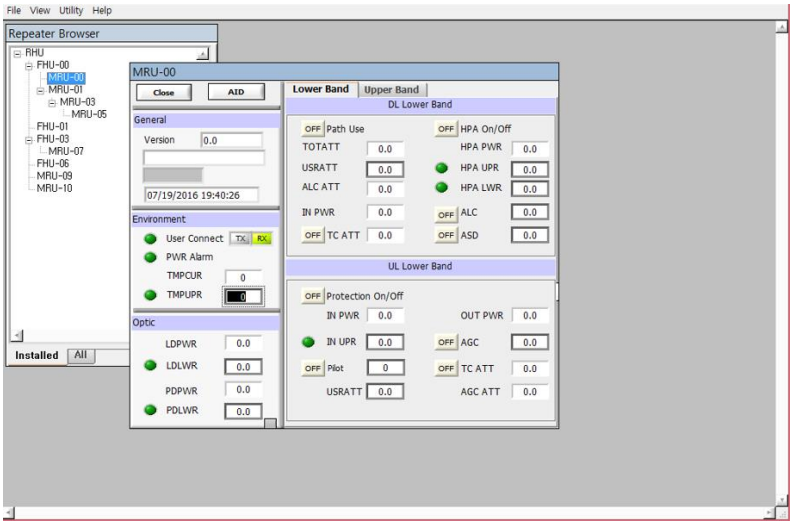
Table 4-3 UL Lower and Upper Band

| Status group | Parameters | Status | Control | Description |
|---|---|---|---|---|
|  | Protection On/Off | √ | √ | Enable/disable uplink protection function. |
| | IN PWR | √ | | Displays uplink power coming from ANT port |
| | IN UPR | √ | √ | Set upper limit of uplink input power, and displays its value and alarm status |
| | Pilot | √ | √ | Enable/disable uplink Pilot signal and selects uplink CW channel. |
| | USERATT | √ | √ | Set uplink attenuation by user, and displays its value. |
| | OUT PWR | √ | | Displays uplink output power that is transmitted from MRU |
| | AGC | √ | √ | Set AGC (Automatic Gain Control) function's activation level, and enable/disable AGC. |
| | TC ATT | √ | √ | Displays uplink temperature compensation attenuation value, and enable/disable uplink temperature compensation. |
| | AGC ATT | √ | | Displays attenuation value due to AGC (Automatic Gain Control) operation |

Following is one example of GUI operation which sets the upper limit of MRU chassis' temperature.

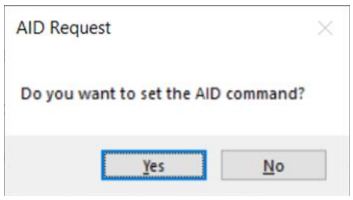
***Step 1***

- Click the box which is on the right side of "TMPUPR". A number in the box represents current upper limit of chassis' temperature and changes the value. And then enter the key.



***Step 2***

- Enter desired TMPUPR value by entering number and enter. Then press “Yes” button when this “AID Request” screen is displayed.




The small color box on the left side of “TMPUPR” represents current status of upper limit of MRU chassis’ temperature. If the box is GREEN, operating status is in normal condition. If the box is RED, “TMPUPR” alarm occurred and remains.

# 5 Appendix I. Ancillary Devices – Antenna, Cable and other Passive Device

Intelibs does not provide the ancillary device, however the following or equivalent devices are recommended:

- Recommended Antenna:
  - Omni-directional Antenna

| | |
|---|---|
| Specific Frequency | 698-960 MHz / 1710-2700 MHz |
| Gain dBi | 1.5 dBi / 2.5 dBi |
| PIM Minimum | -140 dBc |
| Polarization | Vertical |
| Horizontal Beamwidth | 360 deg |
| Maximum VSWR | 1.8:1 |
| Maximum Power | 50 W |
| RF Connectors | N Female |
| Jumper Included | Yes |
| Antenna Mounting Style | Ceiling |
| Item Height | 3.35 in |
| Item Length | 7.3 in |
| Item Width | 7.3 in |
| Item Weight | 0.73 lb |
| Mfg. Warranty | 1 Year |

  - Directional Panel antenna

| | |
|---|---|
| Specific Frequency | 698-800 MHz / 800-960 MHz / 1710-2170 MHz / 2200-2700 MHz |
| Gain dBi | 6 dBi / 6 dBi / 7 dBi / 7 dBi |
| Polarization | Vertical |
| Horizontal Beamwidth | 94 deg / 83 deg / 65 deg / 90 deg |
| Vertical Beamwidth | 72 deg / 53 deg / 50 deg / 50 deg |
| Maximum VSWR | 1.7:1 / 1.5:1 / 1.5:1 / 1.5:1 |
| Maximum Power | 50 W |
| RF Connectors | N Female |
| Item Height | 2.4 in |
| Item Length | 10.3 in |
| Item Width | 7.1 in |
| Mfg. Warranty | 1 Year |

- Coaxial Cable:
  - LDF4, AL4RPV-50 1/2” Plenum Air Aluminum coaxial cable or equivalent coaxial cables
- Fiber Cable:
  - LC/UPC type signal mode optical cable

# 6 Human RF Exposure – Maximum Permissible Exposure Evaluation

The recent FCC developed guideline for evaluation of the human exposure to the RF emissions. The maximum permission Exposure (MPE) for power density of the transmitter operating RF ranges between 300 KHz and 100 GHz. As the Intelibs RHU belongs to the fixed equipment, Analysis has been conducted to evaluate the MPE from the distance greater than 20 Cm as the fixed equipment required.

Antenna gain is restricted to 1.5W ERP (2.49 W EIRP) in order to satisfy RF exposure compliance requirements. If higher than 1.5W ERP, routing MPE evaluation is needed. The antenna should be installed to provide at least 20 cm from all persons to satisfy MPE requirements of FCC Part 2, 2, 1091.

RU transmits far below that FCC power density restricts. FCC defines power output limits at 20 cm distance for various frequency ranges:

- Over 300 mHz to 1.5 GHz the limit is determined by frequency /1500
- Above 1.5 GHz the limit is 1 mW/cm^2

The basic equation for determining power density is:

S = PG/4(pie)R^2

Were S is power density , which is mW/Cm^2

PG, the transmitted power from the antenna identified as EIRP (Equivalent Isotropically Radiated Power)

R is the distance of interest from the antenna.

Typical Installation Example:

As the typical height of a floor is assumed as 10foot high, an average person is assumed 6foot high, the distance from antenna to body is 4 feet (112 cm).

For PCS 1900 band, the maximum power output per carrier is assumed 33dBm. With the assumption of 7dBi antenna gain is used, PG in the equation is equal to 40dBm EIRP.

Using S = PG/4pieR^2

S = 10/(4*3.14)*112^2 = 63.5μW/cm^2

Also the distance to be satisfied for FCC regulation of 1mW/cm^2 is about 29cm from the antenna of 7dBi according to following caculation:

S = 10/(4*3.14)*29^2 = 0.947mW/cm^2

# Two Year Limited Warranty

Intelibs, Inc. (“Intelibs”) offers a standard two year warranty from defects in material and installation. INTELIBS may at any time exclude from this Agreement any Hardware or Software which (1) has been modified, repaired or serviced by anyone other than Intelibs’ service staff without the prior written approval of Intelibs, (2) has been subjected to unusual physical or electrical stress, whether such stress results from accident, neglect, misuse, lightning, failure of electrical power, air conditioning, humidity control, transportation, the making of specification or configuration changes requested by Customer, or any other cause other than ordinary use, and whether or not such stress is the fault of the Customer, (3) has been purchased from another Vendor and is networked, linked, attached or otherwise intended to work with the System or (4) has been moved from the place of installation. When the system has been improperly modified, repaired, stressed, used or moved as described above, Intelibs may, at its option and subject to the approval of the Customer, perform such corrective work, including any repairs, replacements and adjustments, as are in Vendor’s opinion necessary to restore the System to the condition it would have been in if subjected only to normal wear and tear at the Customer’s expense.

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