Marine Mesh Radio
User Manual v1.01

Wireless IP Communications System
Marine Standard

Table of Contents

Change History

Version	Date	Change Summary	Author
v1.0	18/04/2016	Initial Draft	MB
v1.1	08/08/2016	Product Updates	RE

About the User Manual

This user manual describes the operation of the MMR Marine Mesh Radio.

Initially, the user manual introduces the reader to the operation of the MMR system. This includes a description of the various components, a guide to their use and how to connect them together, in order to produce a working system.

As part of this description, hardware interfacing, system initialisation and the use of the system interrogation web interface are described in detail.

The guide follows a step by step approach, describing the simple sequence in which the system needs to be configured to get the user up and running in the shortest possible time.

This is followed up with further system detail, including fault finding technical specifications and connector pinouts.

User Manual Part Number

The VE part number for this manual is **110-3157**

Warranty and Support

All Visual Engineering products are supplied as standard with a 12 month 'Return to Base' warranty.

In the event of a suspected product failure, users should contact the Visual Engineering support team on the telephone number +44 (0) 1206 211842 or please email us at:

support@visualengineering.co.uk

Should the fault persist or if the support team are unable to resolve the fault, it may be necessary to return the equipment.

Equipment should only be returned using the RMA (Returns Management Authorisation) process. Users should contact the support team on the above number and request an RMA form and RMA number.

Introduction to the MMR System

The MMR system is a wireless mesh IP communications network designed specifically for operation at sea.

MMR allows up to sixteen vessels to share IP traffic in a wireless mesh network. It is capable of a capacity of up to 8.9Mb/s, offering broadband communications to any enabled vessel. The data rate varies depending on mode of operation, the number of nodes within a system and the range between nodes.

MMR consists of a rugged outdoor unit (ODU) and an indoor interface unit (IDU). The two units are connected via a single 20m cable supplied with the system.

The ODU is easily mounted using jubilee clips included in the kit and is connected to the system's antennas.

The IDU supplies power and a network connection to the ODU and also connects to the local network. This connection provides user feedback on network and wireless performance. The system can be supplied in a range of power levels and frequency bands to match different regional requirements.

The MMR network is self forming, fluid and self healing, there is no central point of control. Each link within the MMR network can be up to 25km in distance. The system can exchange any type of typical network traffic, including voice, video and general IP.

The MMR radios within the mesh exchange data on a single frequency, thereby simplifying spectrum management. The entire mesh occupies just 6MHz of bandwidth, options to select narrower bandwidths of 2.5, 3.0, 3.5 and 5.0MHz is also possible. The MMR radios employ the COFDM modulation scheme and therefore offer excellent RF penetration and performance in the presence of reflections and multipath inherent in marine operations.

The highly flexible mesh topology means that data can be exchanged between nodes in a point to point or multi point fashion, the range of the system can be extended by using nodes as repeaters.

The mesh architecture makes the MMR product ideal for coordinating operations such as complex maintenance, drilling, recovery and survey operations, taking place across multiple vessels. The long range of each link in the mesh allows connected vessels to be spread across a wide area of ocean.

General control of the MMR system can be achieved via a simple web browser interface, control of the whole network can be achieved from any node.

The system is currently offered in the L Band with a Frequency Range of 1.35GHz to 1.362GHz.

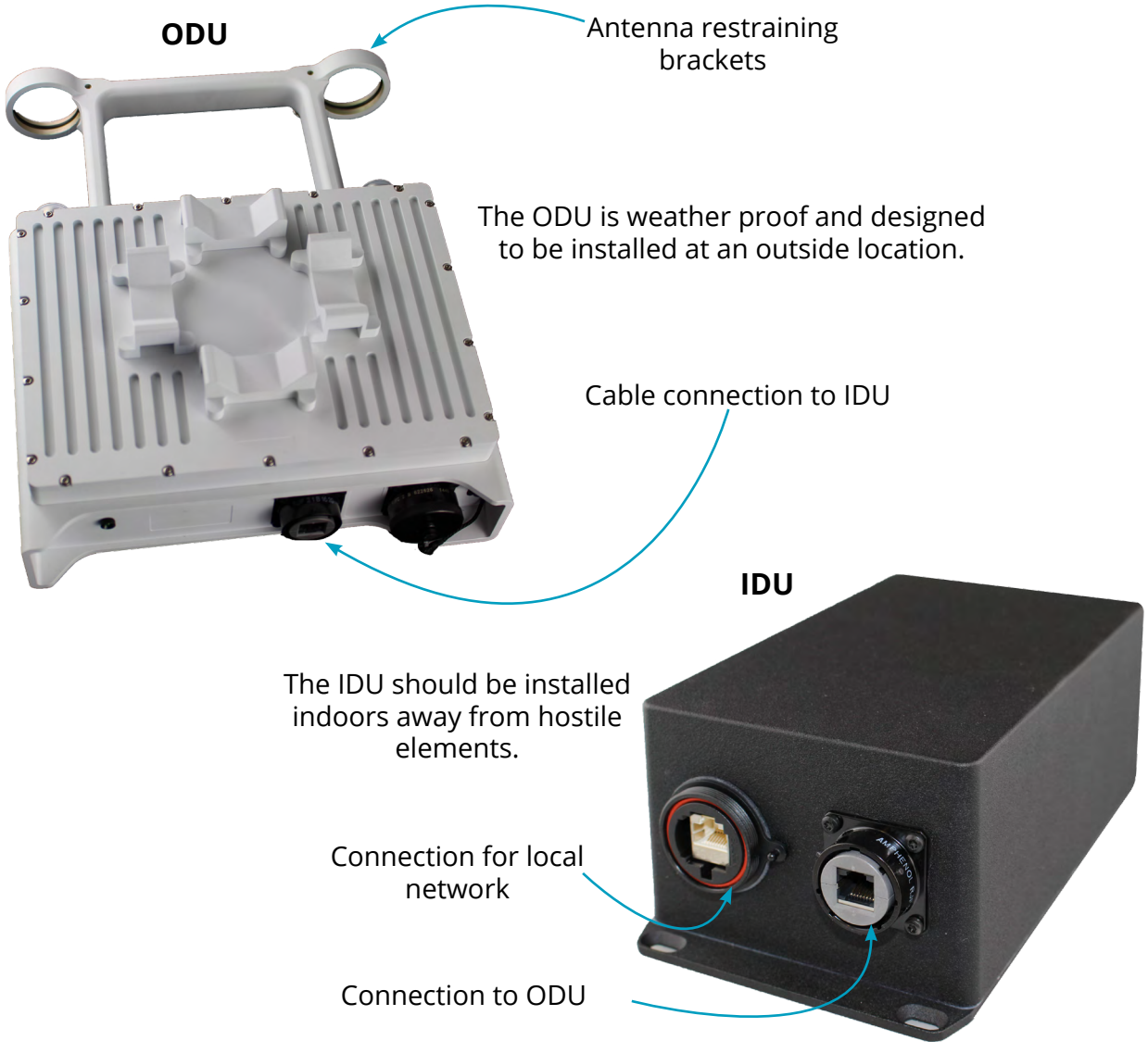
The MMR Kit

The L Band MMR kit includes the following components, listed together with its part number:

• L Band Outdoor Unit (ODU)	110-8670
• Indoor Unit (IDU)	110-8706
• L Band Omni Antennas x 2	110-3106
• 20m Interface Cable with Amphenol connectors	110-8919
• IDU Power Cable	110-8704
• 2m IDU Ethernet Cable	110-8705
• Jubilee Mounting Clips x 2	

Key Components

The MMR kit has two principle components, an outdoor unit (ODU) and an indoor unit (IDU). These are both shown below.



Antennas

The MMR kit comes complete with two omni RF antennas. These have N-Type connectors that screw directly onto the ODU, within the antenna restraining bracket. The N-Type connectors only need to be finger tight, take care not to over tighten.

Each antenna has an anodised colour coded end cap which identifies its working frequency range. The relationship between end cap colour and the frequency band is detailed in the following table.

Antenna Frequency ID	
Frequency Band	Colour
L Band	Gold
S Band	Red
C Band	Blue

Antenna frequency band identifier end cap
L Band

Cables

The MMR system has three interconnect cables, these are detailed below.

20m Interface Cable with Amphenol connectors, part number: 110-8919

This connects the IDU to the ODU

2m IDU ethernet cable,
part number:110-8705

This connects the IDU to the local ethernet network

2m IDU power cable,
part number:110-8704

This connects the IDU to the DC power

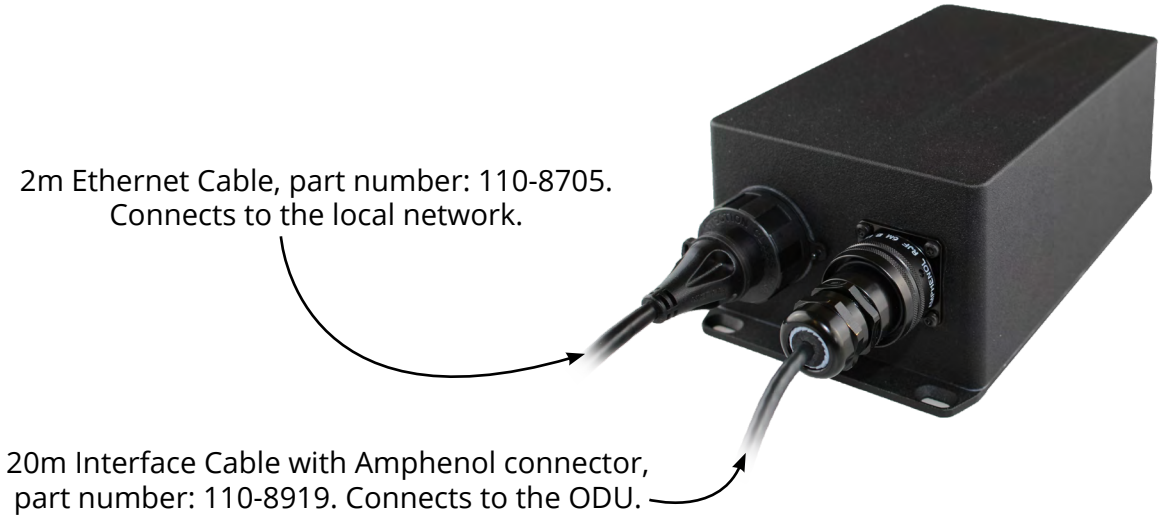
Part Numbers and Labels

All components of the MMR system have part numbers and QR code identification. These numbers should be quoted to Visual Engineering for fault reporting and re-ordering purposes.

Installation of the MMR System

IDU Installation

There are two connectors on the front of the IDU, one is for the 20m interface cable to the ODU, the other is for the connection to any preferred local ethernet network. Connect each connector as shown below. Twist each connector until it locates into position with a positive click.



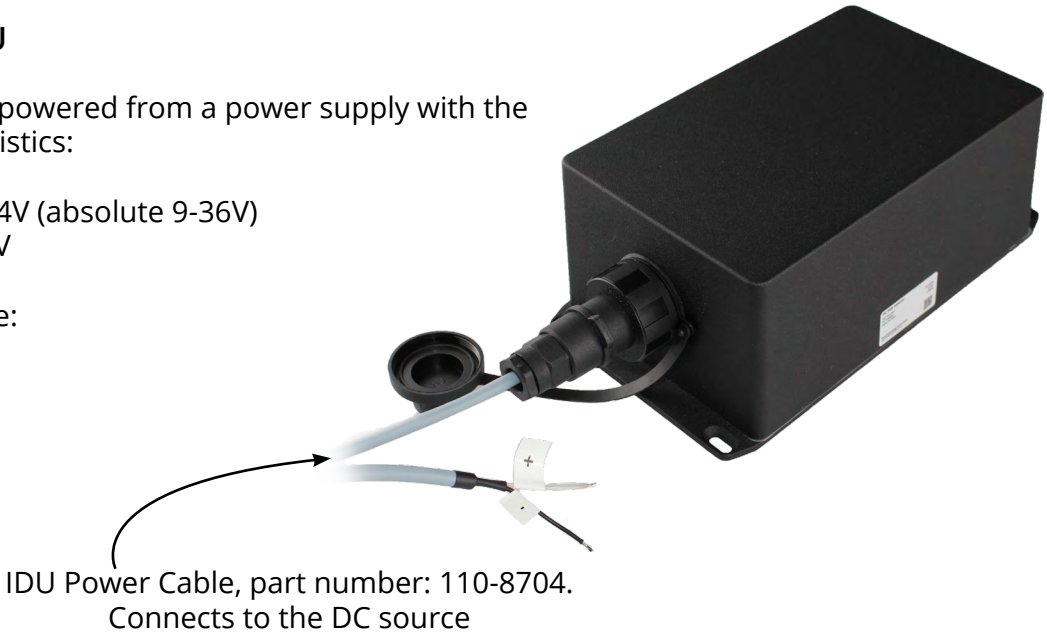
There is a single connector on the rear of the IDU this is for the DC power. The other end of the cable is terminated as tinned wire for connection into the DC source

Powering the IDU

The IDU should be powered from a power supply with the following characteristics:

Voltage: Nominal 24V (absolute 9-36V)
Current: 0.9A at 24V

The DC power cable:
Black - wire = GND
White + wire = 24V



Outdoor unit Installation

Connect both antennas through the restraining bracket on the ODU, as shown below. The antennas should be screwed in firmly, taking great care NOT to over tighten the N Type RF connectors. Finger tighten the antenna restraining bracket screws, the bracket is designed to prevent antenna connector damage during voyages at sea.

Now connect the weatherproof end of the 20m interface cable to the “Primary’ amphenol connector on the ODU, as shown below.

The green power LED should now be lit as shown. Since the ODU draws power from the IDU, if the LED is not lit check that the IDU is powered.

The hanging strain relief cable should be connected by clipping the carabiner to the slot in the ODU, as shown here.

Mounting the ODU

The ODU should be installed on a vertical or horizontal pole using the jubilee clips provided, as shown below.

Note: When handling the ODU the user should be careful to avoid manoeuvring the unit by handling the antennas. Doing this can cause damage to the antenna connectors.

The ODU is designed to be exposed to the elements. It should be mounted as high as possible on the vessel and on shore. Attach it to a pole using the jubilee clips provided.

The antennas should be in free space and not obscured by any other structures. They should be away from metal structures by at least 20cm horizontally.

MMR Range, Bitrate & Bandwidth

The MMR system can operate in a number of bandwidth settings, this setting has an effect on the available bitrate. This together with the frequency band alters the maximum range of the system. The following table cross references bandwidth, bitrate, frequency and range.

Bandwidth Setting	Bitrate	Frequency	Maximum Range
2.5MHz	2.6Mb/s	L Band 1-1.5GHz S Band 2-2.5GHz C Band 5.5-6GHz	38km* 24km* 11km
3.5MHz	3.7Mb/s	L Band 1-1.5GHz S Band 2-2.5GHz C Band 5.5-6GHz	35km* 22km* 10km
5MHz	5.4Mb/s	L Band 1-1.5GHz S Band 2-2.5GHz C Band 5.5-6GHz	32km* 18km* 9km
6MHz	6.5Mb/s	L Band 1-1.5GHz S Band 2-2.5GHz C Band 5.5-6GHz	30km* 16km* 8km
6MHz	8.9Mb/s	L Band 1-1.5GHz S Band 2-2.5GHz C Band 5.5-6GHz	25km* 13km* 7km

*Note: To achieve the maximum ranges, significant transmit and receive antenna heights will be required to overcome earth curvature issues. Typically, 20m transmit and receive antenna heights.

MMR Web Interface & Configuration

The following web browser control interface is not required for normal operation.

Web browser control of the MMR system should only be undertaken by users wishing to achieve the following:

- Change the system frequency
- Change the system IP addresses
- Understand the RF performance of the system better

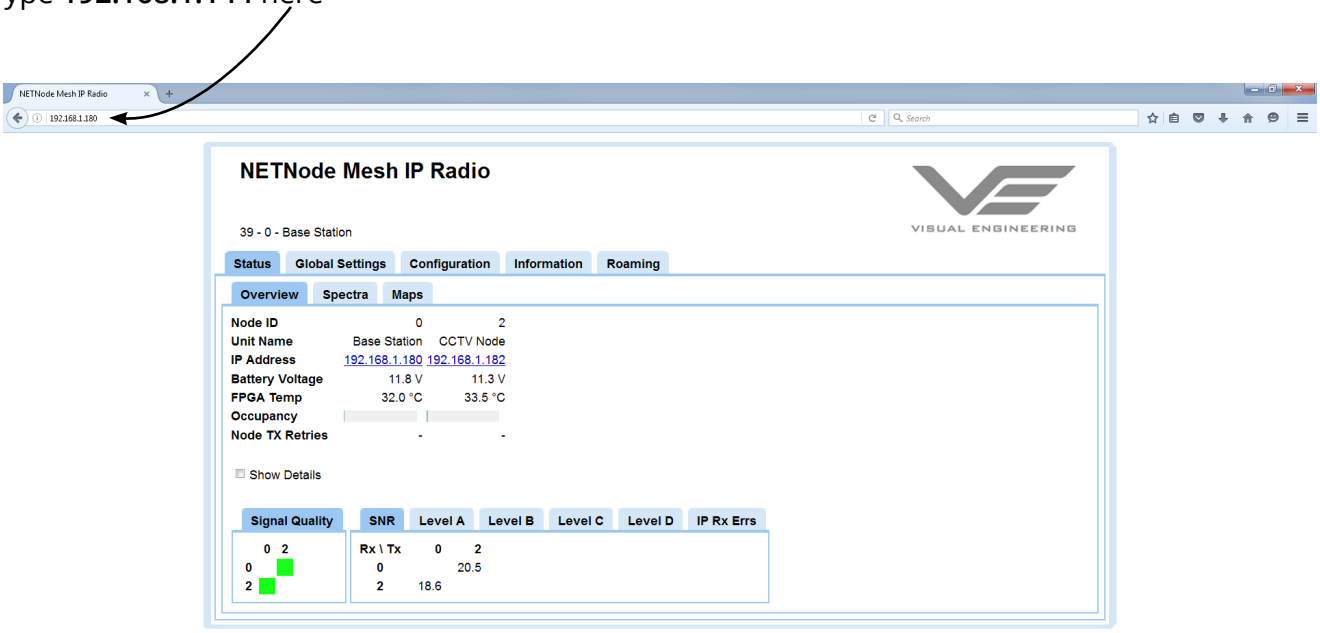
Users should be very careful when using this interface because it is entirely possible to make changes that will leave the system inoperable, requiring the system to be returned to base for repair.

Activating the Web Interface

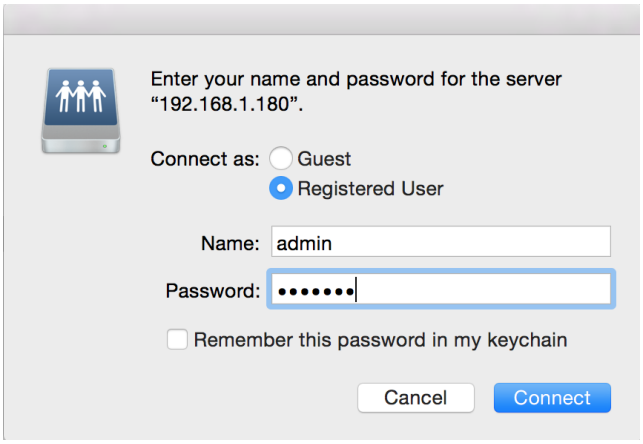
Power up the IDU and connect a PC to the 'Network' connector on the IDU's front panel.

- Open a web browser on the PC
- Type the IP address of the MMR node you wish to configure, e.g. **192.168.1.144**
- The web browser opens the **Status** → **Overview** page following a **Login Prompt**

Type **192.168.1.144** here



Login Prompt

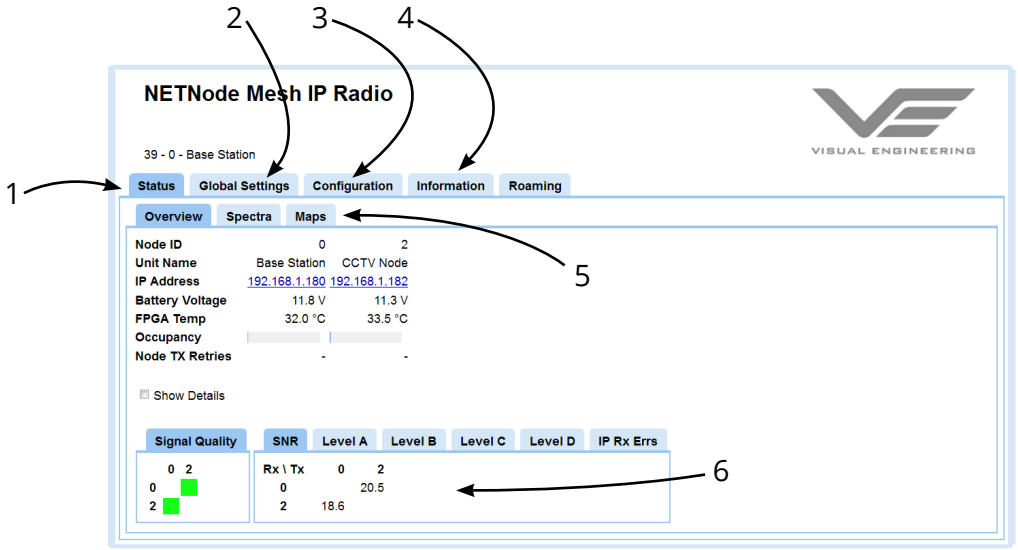


- Authentication is required to connect
- By default, the Name is **admin**
- By default the Password is **meshweb**
- Click the Connect button

Once logged in to the MMR system the user can begin configuring it to suit.

The Main Window

This is the main entry point for the RF configuration of the MMR system. The following six parameters are explained in the table that follows.

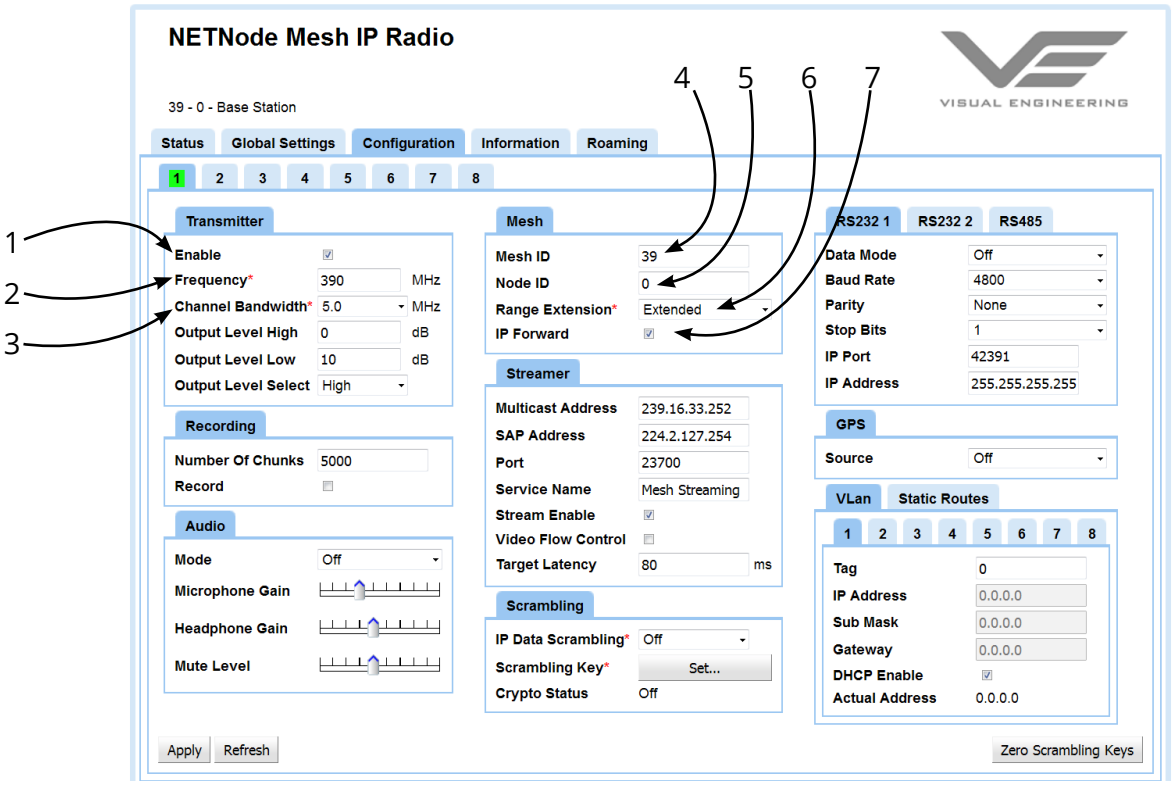


Item	Description
1	**Status tab**. Divided into Overview, Spectra and Maps sub-tabs. This displays detailed status information of received signal quality, battery and mapping information.
2	**Global Settings tab**. Divided into Main, Ethernet Ports and Interlink Mode panes. The Set Clock, Format File system, Restore Defaults and Password buttons are found here.
3	**Configuration tab**. Divided into Transmitter, Recording, Audio, Mesh, Streamer, RS232, GPS, Scrambling and VLAN panes. The Configuration tab contains the list of 8 presets. In each preset the user can specify demodulation parameters, decoding modes, and descrambling configuration.
4	**Information tab**. Contains information including software versions and unit specific data. This information is of use during a support call.
5	**Sub-Tabs**. Simply enables the user to break down information from a tab.
6	**SNR Pane**. The tabs and sub-tabs are broken down into panes of information. This particular one is all about Signal to Noise ratios, for example.

Basic Settings

This explains how to configure a mesh so that the user can start to explore what can be done with a mesh network. These basic settings are set to appropriate default values in a MMR system.

There are only seven things to configure to form a mesh network. Choose the configuration tab and set up these seven options.

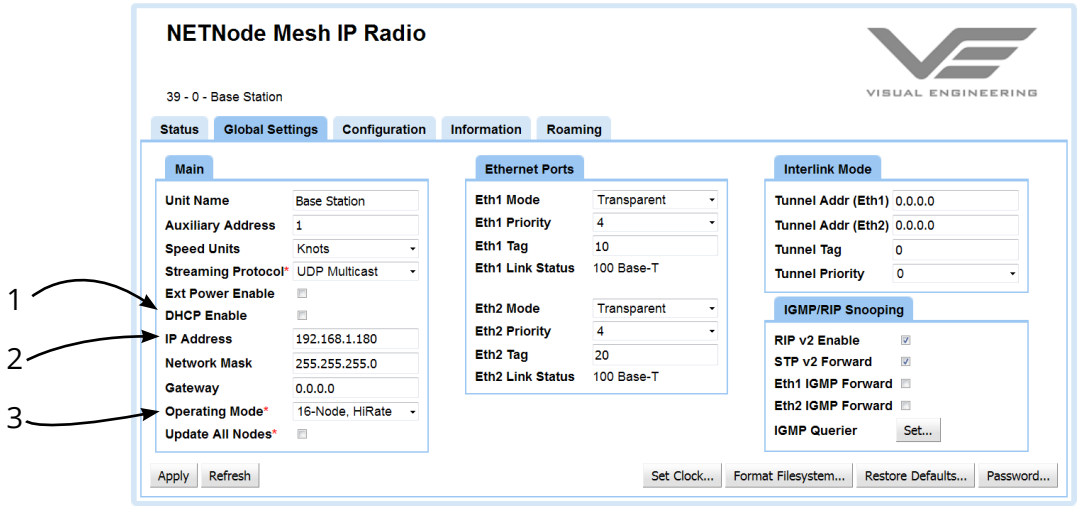


Item	Description
1 Enable	Place a check in this box to switch the transmitter on.
2 Frequency	Type in the frequency required for use in the mesh. This must be the same on all units (see configuration defaults earlier).
3 Channel Bandwidth	Select the required bandwidth to use for the mesh from the drop-down list. This must be the same on all units. This is normally set to 5MHz. Lower bandwidths will give extra range but will reduce capacity.
4 Mesh ID	Type in the required mesh ID. This must be the same on all units in the mesh network. The mesh ID tells the unit which mesh it belongs to. All nodes are defaulted to Mesh ID 101.
5 Node ID	Type in a Node ID for each node in the mesh. The node ID must be unique and can only be 0 to 11 for a twelve node mesh system. Note: A node may automatically reassign its node ID at power up if it finds a conflict with an existing node.
6 Range Extension	Select 'Extended' on all nodes for increased range of performance. This will reduce the bandwidth slightly.
7 IP Forward	Place a check in this box to switch the IP forwarding on.

Note: Remember to click the **Apply** button. This is vital to saving all your work

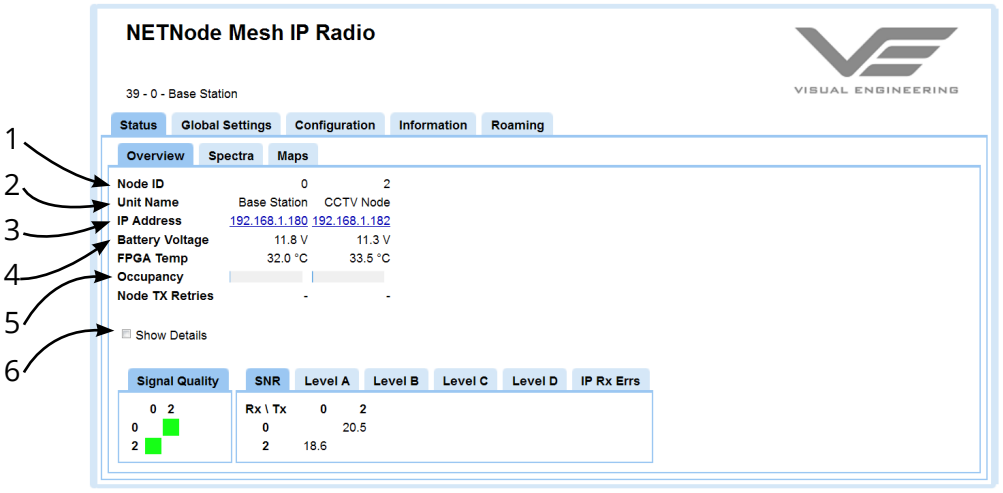
The Global Settings Tab

Global settings are applied to the unit generally and occur in all eight configurations.



Item	Description
1 DHCP Enable	Check this box if you need the MMR to obtain its IP address remotely from a DHCP server.
2 IP Address	Complete this box to give the MMR a fixed IP address when DHCP is not used, it is not used by default.
3 Operating Mode	This should be set the same for every node in the mesh and is defaulted to '16 node HiRate'.

The Status Tab

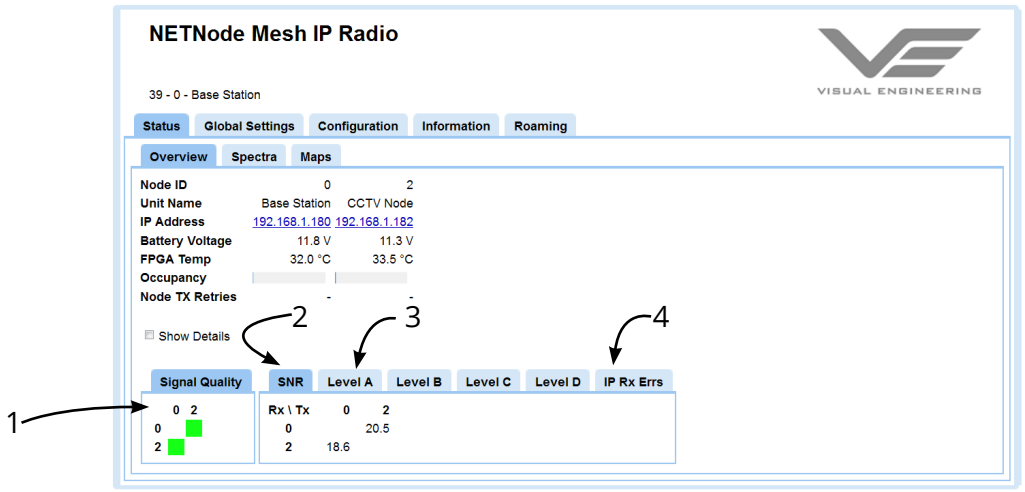


This displays detailed status information of received signal quality and enables navigation between nodes. The Status tab is divided into three sub-tabs:

- **Overview**
- **Spectra**
- **Maps**

Item	Options	Notes
1 Node ID	0 to 11 or 0 to 15	We are showing two Node IDs, 1 and 2. There could be up to sixteen nodes in a mesh, numbered 0 to 15.
2 Unit Name	You can use up to 12 alphanumeric characters for the Unit Name	The Unit Name is a friendly name to make it easier to identify each camera node. This name is assigned in the Global Settings Tab.
3 IP Address	192.168.1.180 for example	This shows the IP address of the unit that we set up in our initial configuration. Notice that it is shown as a hyper-link. If you click on one of these hyper-links the browser will switch to that node.
4 Battery Voltage	0 to 16v	This returns the current input voltage of the node. The voltage should show approximately 12v.
5 Occupancy	Blue and Orange Bars	The blue bar gives a visual indication of the volume of data generated by this node. An orange bar gives a visual indication of the volume of data passing through this node.
6 Show Details	Check box	Displays network information about IP packets etc.

The Status - Overview Tab



1. Signal Quality

This gives a simple picture of the signal quality around the mesh system. Ideally, it would have steady green boxes for all links. Naturally, mobile units will go out of range or interference will cause a unit to degrade for a while.
The clever thing is the mesh will find a new routing and heal itself when it can, so keeping your network on air.

Here's what the colours mean:

Colour	Meaning
Green	16 QAM mode – maximum data rate
Amber	QPSK mode – reduced data rate
Red	BPSK – lowest data rate passing between nodes
White	Link broken or not configured

2. SNR Pane

This pane shows the Signal to Noise Ratios for each of the nodes. Typically SNRs > 15 is very good, 8 to 14 is good, 7 or less is starting to get low.

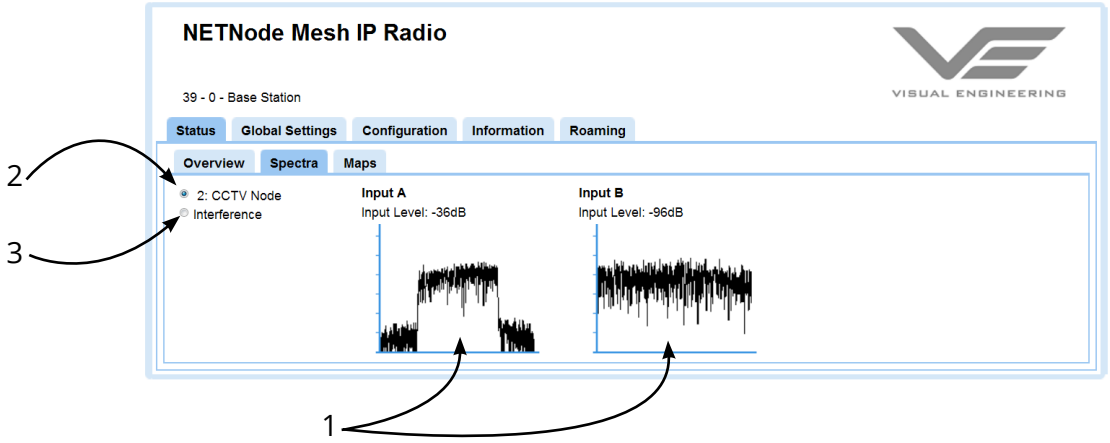
3. Level A Pane

Shows the dBm value for antenna A on a node. There are similar panes for antennas B, C and D.

4. IP RX errors Pane

This pane shows the number of IP receive errors for each node on the system.

The Status - Spectra Tab



1. The Spectra Displays

There are two displays labelled A and B which show the spectra being received on the two diversity antennas of the node that is being interrogated.
In the above example there is a valid COFDM signal being received on Input A of -36dB. The second antenna, Input B, is showing no signal. It can be assumed, therefore, that the second antenna is not connected.

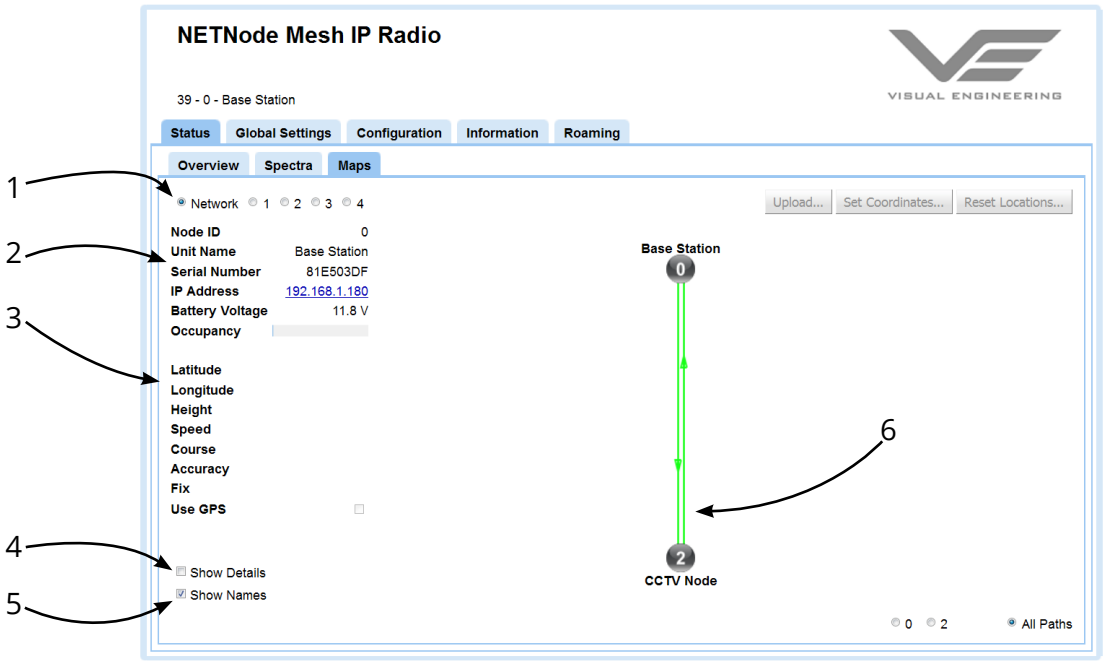
2. Node Selection

There could be several nodes transmitting on the mesh so we need to define which node we are looking at. This is done with the radio buttons on the left side of the spectra display.
In our example there is only one node on the network, the CCTV Node. This is the one that has been selected.

3. Interference

If the Interference button is selected the display shows the spectra when none of the nodes in the mesh are transmitting. This enables the user to look for interference on the system frequency that is to be used.
In an ideal clean RF environment, with no interference, the user will see a spectra for both inputs as shown above for Input B of -96dB.

The Status - Maps Tab



1. Radio Buttons

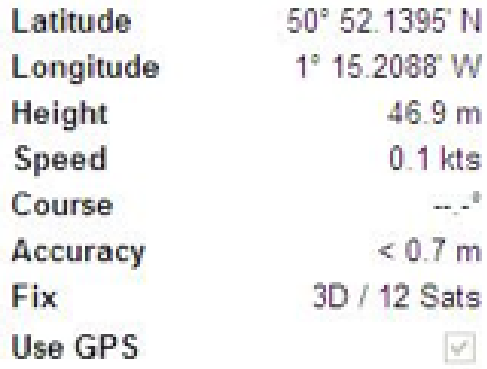
The radio buttons enable you to choose between Network and one of four map displays for the mesh. Leave it on Network for now.

Note: When you are in **Network** mode the **Upload, Set Coordinates** and **Reset Locations** buttons are greyed out.

2. Node Information

Under the radio buttons you'll see some node information about the node you are currently attached to. This was covered earlier in the Status Tab section.

3. GPS Information



If the node that we select has a GPS receiver connected and the **Use GPS** box is checked, the node can broadcast precise information about its location to other nodes or fixed assets on the mesh.

4. Show Details Checkbox

When the **Show Details** box is checked the node information is expanded to show things like TX IP Packets which are useful when diagnosing network problems.

5. Show Names

When the **Show Names** box is checked the friendly names for the nodes are shown on the network map display.

6. Display Pane

In the previous example the network display is selected. This gives a simple graphical view of the nodes in the mesh and the links between them.

Note: The buttons above the display are greyed out as they have no function when the **Network** radio button is selected.

Each node is shown as a circle with a white number. If the number turns red, then the node is temporarily congested.

If the **Show Names** box is checked, the node name is displayed.

The links between the nodes are shown as coloured lines. As each node supports bi-directional operation there are normally two lines for each link. Here is what the colours mean:

Colour	Meaning
Green	16 QAM mode – maximum data rate
Amber	QPSK mode – reduced data rate
Red	BPSK – lowest data rate passing between nodes
White	Link broken or not configured

In the previous example there are static lines but when connected to a live system these lines change as the state as the RF environment changes or nodes move about.

Using Serial Data

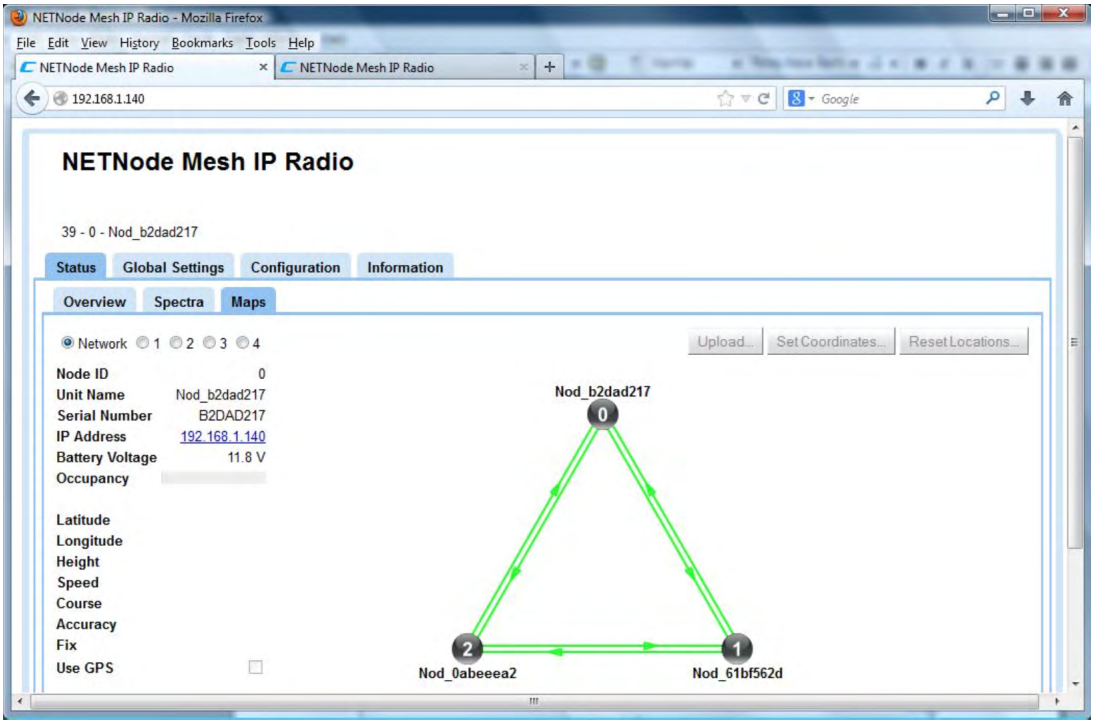
Before configuring MMR for the transfer of serial data, users should ensure that both the primary and secondary cables are connected between the IDU and the ODU.

Point to point bi-directional data may be transmitted over the MMR system via telnet or via the RS232 serial port on the front panel of the IDU.

MMR supports UDP and TCPIP. If UDP is selected, the system does not check that the data arrived at the destination. TCPIP uses an acknowledgment mechanism to check the arrival of data and re-transmit if necessary.

Before attempting to transfer data between nodes, ensure the two MMR nodes have a communications path between them by checking the Status page on the web interface. There does not have to be a direct path between the two nodes, there could be a forwarding node between them.

In the example below, it is required to transfer data between nodes 0 and 1. Since there is a direct connection between the two nodes the user can proceed and configure the serial data connection. If for instance the connection between node 0 and node 1 was lost the configuration could still occur via the forwarding node 2 that sits between them.

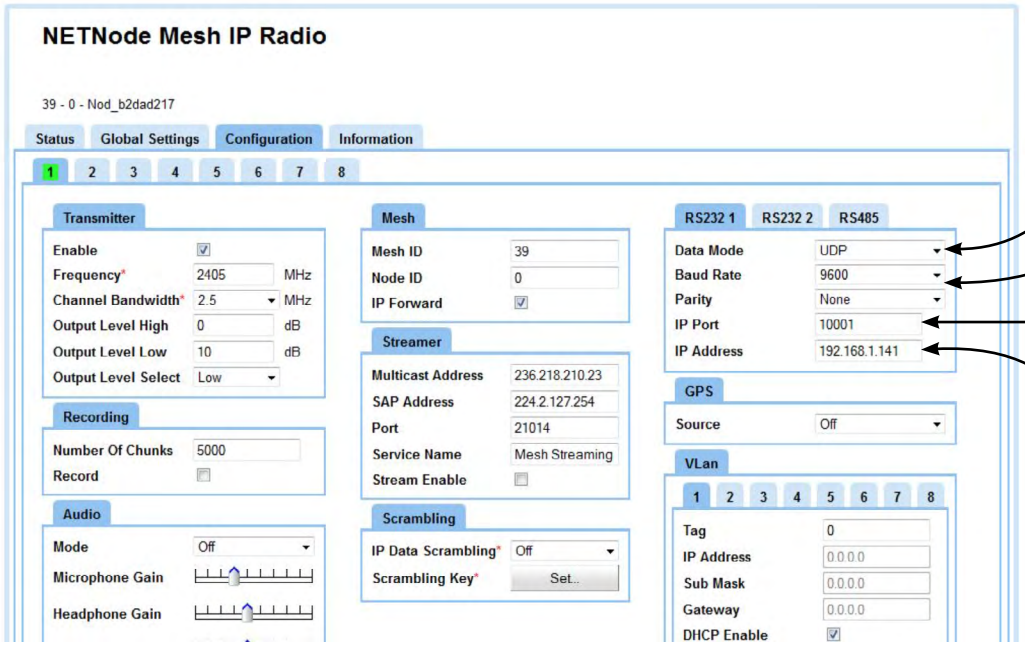


Configure Serial Data

Ensure that both the Primary and Secondary cables are connected between the ODU and IDU for node 0 and node 1. Connect RS232 devices to the two IDUs.

For this example, node 1 has IP address 192.168.1.140 and node 1 is 192.168.1.141.

The configuration page for node 0 is shown below:



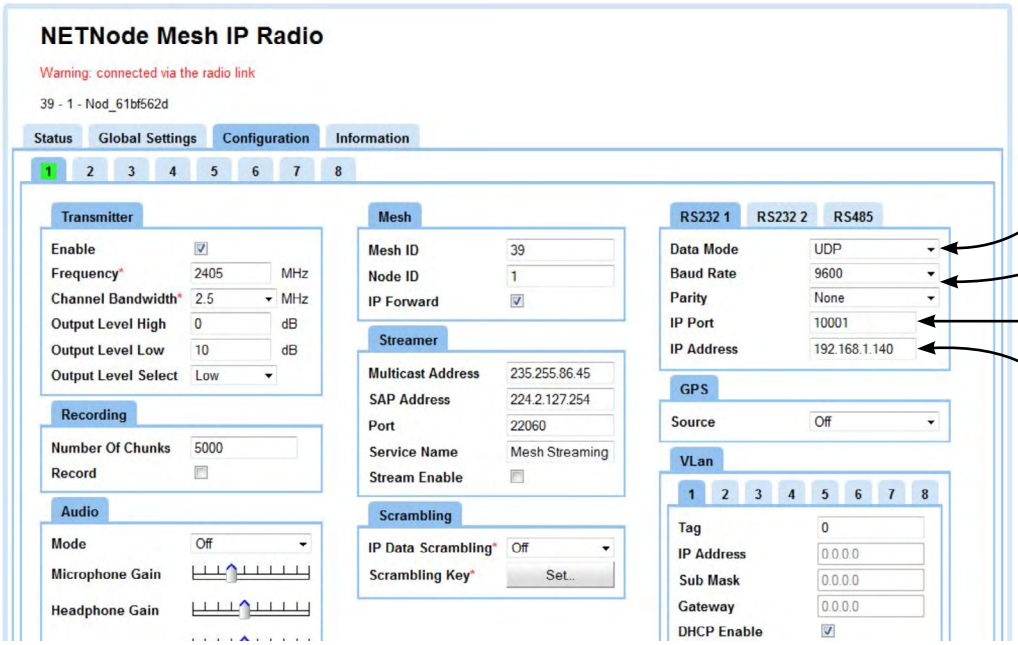
Set the Data Mode to either UDP or TCPIP

Set the Baud Rate & Parity

Set a common port number, shared between the two nodes

Set the IP address of the other node (192.168.1.141 in this example)

The configuration page for node 1 is shown below:



Set the Data Mode to either UDP or TCPIP

Set the Baud Rate & Parity

Set a common port number, shared between the two nodes

Set the IP address of the other node (192.168.1.140 in this example)

It should now be possible to transfer data between the two nodes.

Fault Finding

Fault	Corrective Action
The front panel LED is off	1. Check connection between the ODU and the IDU 2. Check the IDU is powered on
Node will not Mesh	1. Check unit is on same config as others 2. Check unit has unique node number 3. Check default settings are common across the mesh
Range is Low	1. Check Antennas are correctly positioned and connected 2. Check for interference and change channel if necessary

Technical Specifications

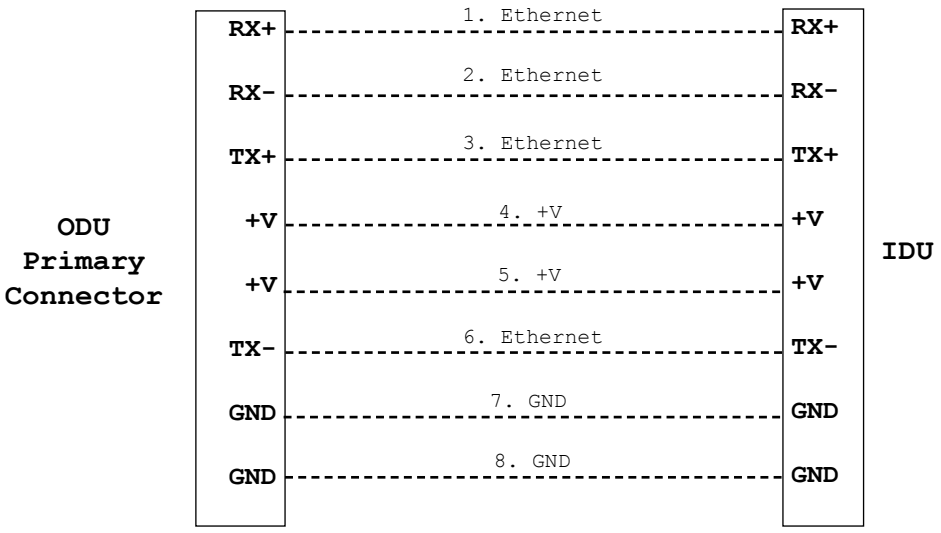
Specifications			
Radio Power	2W	**Interface Cable Length**	20m
Radio Frequency	1.3 to 1.362GHz	**Power**	24v Nominal
Radio Capacity	8.9Mb/s	**Consumption**	20W
Radio Modulation	COFDM	**Control**	Web browser
Maximum Nodes	16	**Control Features**	Frequency, Status, Power
Encryption	ABS	**ODU Dimensions**	295 x 225 x 62mm
Interfaces	RJ45 100 base T	**IDU Dimensions**	188 x 119.5 x 82mm
Filter	50dB roll off in 50MHz	**Environmental**	IP67

Default Settings	
Frequency	1365MHz
Operating Mode	16 Node High Rate
Enable	Checked
Bandwidth	6MHz
Mesh ID	39
IP Forward	On

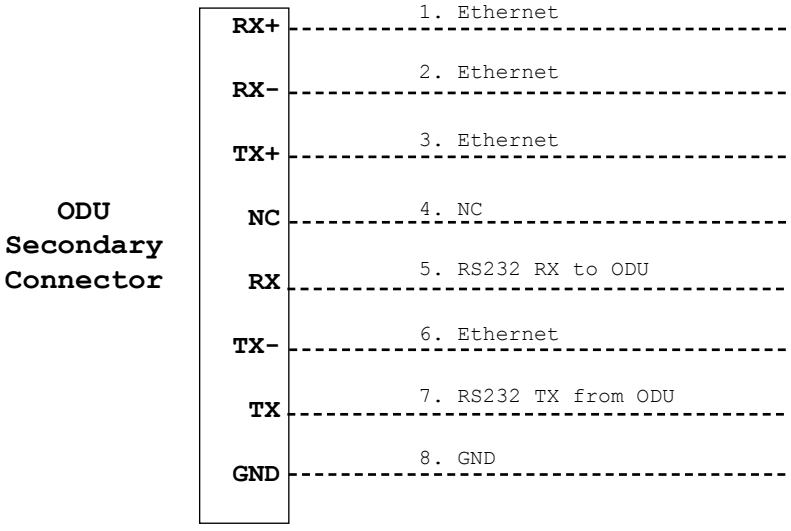
Antenna Specifications	
Frequency	1.35 to 1.45GHz
Type	Omni Directional
Gain	6dBi
Vertical Beam	25°
Connector	N Type Male
Dimensions	ø60 x 460mm

Connector Interfaces

The primary connector on the ODU connects to the IDU using the 20m interface cable, part number 110-8919. The pinout for this cable is detailed below.



The secondary connector on the ODU does not have a cable. The pinout for this connector is detailed below.



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