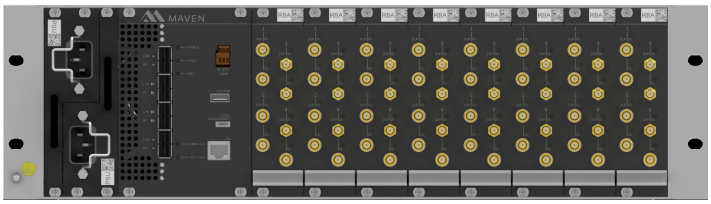
Maven Wireless Nebula DAS

Commissioning User Manual

Firmware version:

Document version: 1.5



Revision history

Date	Rev	Description	Signed
2022-02-01	1.1	Initial version	BRPA
2022-02-28	1.2	Minor updates to versions	MW
2023-06-12	1.3	Updates to versions	BRPA
2023-11-16	1.4	Updates to versions and addition of LFM systems	BRPA
2024-03-04	1.5	Add compliance statements, US format	GG

Notice on liability

Maven Wireless has made every effort to ensure that the content in this document is adequate and free from errors. Maven Wireless liability for any errors in the document is limited to the correction of such errors.

Confidential Notice

This document is confidential to Maven Wireless Sweden AB and is solely for the use of Maven Wireless employees or Maven Wireless customers where a valid NDA is in place. All material herein is the property of Maven Wireless. Any unauthorized reproduction, use or disclosure of any part thereof is strictly prohibited.

About this Document

This document has been written to be used by professional and trained personnel and the customer assumes full responsibility when using them. Maven Wireless is keen to provide the best and most accurate documentation and we welcome any comments and feedback about this document. Please submit any such comments via the support email listed below.

Contact Information

Manufacturer- Company HQ	Maven Wireless Sweden AB Torshamnsgatan 39A, 164 40 Kista SWEDEN Tel: +46 8 760 43 00
Web site	www.mavenwireless.com
Commercial contact	sales@mavenwireless.com
Support & Technical Assistance	support@mavenwireless.com Tel: +46 8 760 43 00
Twitter	@MavenWireless
YouTube	https://www.youtube.com/channel/UCo01dLixDPINBZoiYwqoUcw
Facebook	https://www.facebook.com/mavenwireless/

Disclaimer of Liability

The contents of this manual are current as of the date of publication. Maven Wireless reserves the right to change any part of the content without prior notice. The information in this manual is believed to be fully accurate and reliable. However, Maven Wireless assumes no responsibility for its use. In no event shall Maven Wireless be liable for any damage resulting from loss of data, loss of use, or loss of profits and Maven Wireless further disclaims any and all liability for indirect, incidental, special consequential or other similar damages. This disclaimer of liability applies to all products, publications and services during and after the warranty period.

Warranty

Standard product warranty is 12 months or as otherwise agreed.

All outdoor antennas must be installed with lightning protection. Damage to modules, as a result of lightning is not covered by the warranty.

Antennas must be connected before switching on AC or DC power. Energising the equipment prior to the connection of the antenna cable(s) is regarded as faulty installation procedure and therefore not covered by the Maven Wireless warranty.

Unauthorized changes to equipment

Any changes or modifications not expressly approved by Maven Wireless (who are responsible for compliance) could void the user's authority to operate the equipment.
The equipment must be installed and operated in accordance with any license required from the radio authorities in the country concerned. In most cases a failure to obtain or the contravention of a license is a criminal offense. It is the user's responsibility to ensure any required licenses are obtained, that system installations are commissioned in accordance with their terms and that no changes can later be made which contravene them.

Standards and approvals

- The Maven DAS complies with the following standards
- EMC Directive 2004/108/EC
- Low Voltage Directive 73/23/EEC
- RED directive 2014/53/EU
- EN 50121-4 (to special order)
- UL 62368-1, CSA C22.2, NEMA 4X
- FCC 15B, ICES-003; FCC 22, 24, 27, 90; ISED RSS 130, 132, 133, 192

General Safety Warnings and Compliance

Always observe standard safety precautions during installation, operation and maintenance of this product.

Safety to personnel

Before installing, replacing or modifying any of the equipment, the entire manual should be read and understood. The user needs to supply the appropriate AC or DC power to the equipment. Incorrect power setting can damage the equipment and may cause injury to the user.
Be aware that the equipment can in certain conditions become very warm and can cause minor injuries if handled without protection such as gloves.

Electrical Shock

To prevent electrical shock when installing, modifying or replacing the system power wiring, disconnect the wiring at the power source before working with uninsulated wires or terminals.

Non Ionising Radiation

The Remote Unit outputs Radio Frequencies at high power. The connected antenna system must be engineered to comply with the requirements of 1999/519/EC: Council Recommendation of the limitation of exposure of the general public to electromagnetic fields 0Hz to 300GHz. Otherwise, in cases where the general public is not admitted to the coverage area, such other occupational limits may be applicable.

Maven Wireless customers must adhere to the standards when designing and commissioning DAS systems by ensuring that the combination of output power, splitting losses, antenna gains and separation distances to accessible areas yield field strengths below safe levels.

Note that in some instances it will be necessary to shut down Remote Units in order for work to be performed on or near system antennas. Adequate warning notices should be posted to ensure every installation is safe.

ISED non-interference disclaimer

This device contains licensed transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licensed RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.
This device complies with the Canadian ICES-003 Class A specifications. CAN ICES-003(A) / NMB-003 (A).

L'émetteur/récepteur autorisée contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio autorisée. L'exploitation est autorisée aux deux conditions suivantes :
(1) L'appareil ne doit pas produire de brouillage;
(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
Cet appareil numérique de la Canadian ICES-003. Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

RF Exposure Statement
This equipment complies with ISED RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance 20 cm (7.9 inches) between the radiator and any part of your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux radiations ISED CNR-102 établies pour un environnement non contrôlé. Une distance de séparation d'au moins 20 cm doivent être maintenue entre l'antenne de cet appareil et toutes les personnes. Lanceurs ou ne peuvent pas coexister cette antenne ou capteurs avec d'autres.

FCC Compliance Statement
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation. Please note that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Strato, Cirrus and Cumulus Unit Weight
The unit weighs 25kg. It can be lifted by one man but due care with handling is required. Personnel should have received suitable training and be provided with adequate PPE, at a minimum safety shoes, preferably a lifting belt.

Optical Hazards
Master and Remote units are linked together by commercially available optical transceivers to the SFP+ or QSFP+standards. Usually these are optical hazard Class 1 and require no optical hazard markings or special precautions. For this reason no warning labels are applied to the Maven Master or Remote Units.

The instructions accompanying the optical transceivers themselves will describe the optical hazard class and any necessary hazard mitigation measures. These must be followed for the type in question. Laser warning labels must be applied immediately adjacent to the optical transceivers if the type in use is of a higher hazard class.

For use only by Trained Personnel
The devices should be installed and energized only by trained personnel who are familiar with the type of equipment and the associated hazards.

The high power remote unit has an access cover protected by keys. The keys should only be issued to suitably trained persons. There are no user serviceable parts inside and maintenance must be carried out by trained staff in workshop conditions. Apart from the access cover, the devices must not be opened on site.

Login details of user accounts must be controlled so that only competent persons possess the privilege to adjust frequency bands and operating levels.

Use in accordance with this manual
The protection provided by the equipment may be impaired if installed and used in a manner not specified by the manufacturer. Follow all guidance contained in this manual.

Electrical & Environmental Ratings

Orion Master Unit

Voltage Rating	115-230V AC +/-10% **or** 48V DC, 42.3-60V -15% / +20%
AC Frequency	50/60 Hz
Current	1.3-0.65 A rms AC **or** 3.0-2.1 A DC
Temperature	+5 to +45 ℃
Relative Humidity	5 to 85 % Non Condensing
Indoor/Outdoor Use	Indoor
Environment	Weather Protected, Temperature Controlled, EN300-019-1-3, Class 3.1
Operational Spacing	None Specified, air flow must not be impeded front or back
Dimensions	130 x 436 x 309 mm in standard 19” rack format
Weight	< 8kg in max configuration

Stratus/Cumulus Remote Unit and Cirrus Off-Air Master Unit

Voltage Rating	115-230V AC
AC Frequency	50/60 Hz
Current	5.2-2.6 A rms AC
Temperature	-25 to +55 ℃
Relative Humidity	10 to 100 % Non Condensing
Indoor/Outdoor Use	Indoor/Outdoor
Environment	Weather Protected, Not Temperature Controlled - EN 300-019-1-3, Class3.3
Operational Spacing	Horizontal side by side - 300 mm Horizontal front to back - 300 mm Vertical top to bottom - 500 mm
Dimensions	670 x 383 x 270 mm
Weight	25 kg

Table of Contents

General description of Maven Digital DAS

Maven DAS components and operating principle

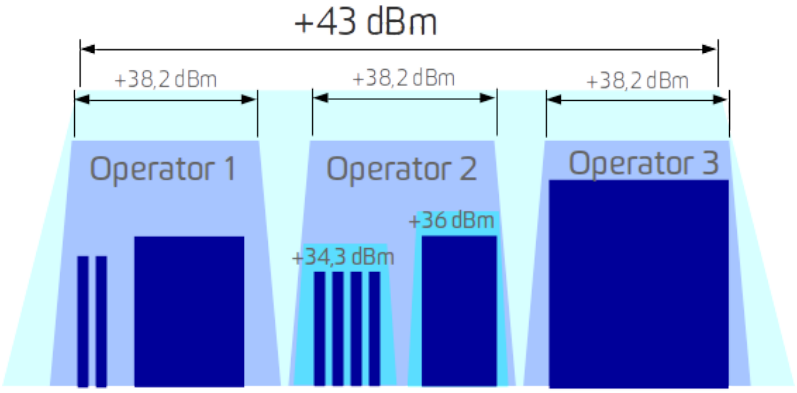
The Maven digital DAS consists of:

- One or more Orion master units and / or Cirrus off air master units, which connect to operators' base stations and convert downlink RF signals to digital signals, and digital signals to RF in the uplink. Orion master units connect physically to the base stations using RF cables (with couplers / attenuators if needed), while Cirrus off-air masters connect over the air via a donor antenna directed toward a base station site.
- One or more Stratus or Cumulus remote units, which recreate the downlink signals for broadcast over the antennas in the coverage area, and which convert uplink signals from mobile terminals into digital signals to send back to the base stations.
- Digital fiber-optic interconnections between the units, using industry-standard digital fiber interfaces (QSFP+ / SFP+) which can be selected for a range of distances from 100m to 40+ km over multimode or single mode fiber.

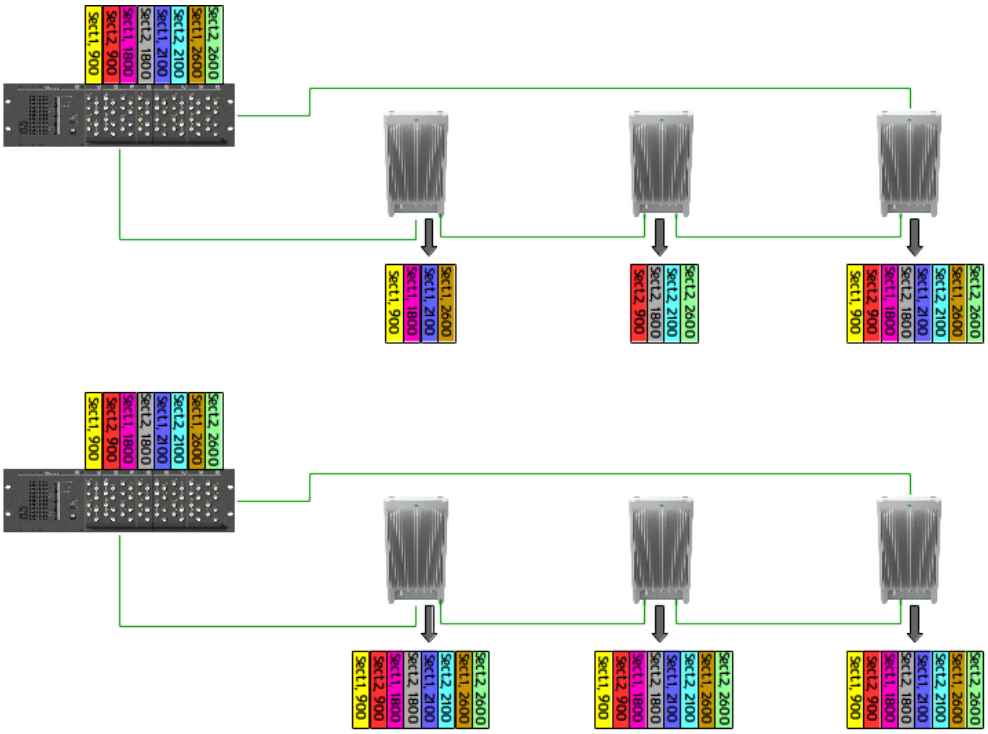
Coverage in Maven DAS is software-defined: each operator specifies in the management GUI which frequency ranges they are using for their carriers, which are then known to the system as a named "sector input". These sector inputs are filtered into separate bidirectional (DL / UL) digital data streams that are distributed over the digital fiber network. Each operator can then decide:

- What sector inputs should be enabled at which remote units: this allows each operator to for example define their own sectorization.
- What downlink and uplink gain should be provided for each sector input to and from each remote.
- What share of the maximum output power at each remote is allocated to each operator, and for each operator how they allocate that power to sector inputs of different technologies.

The separation of sector inputs by digital filtering allows the downlink signals from several operators to be combined into a single Orion band module with different power levels, while still allowing each operator to define their own coverage parameters without being affected by changes in the other operator signals. In the uplink, only the signals specified by the operator are passed by the filtering which means that signals from uncoordinated mobile terminals do not appear as an interfering signal at the base stations.



Separate sector inputs routed to Stratus with different power levels per technology and operator



Software-defined control of sectorization

Coverage parameters can be changed at any time via the management GUI, allowing signals to be added or removed, power levels to be changed or sectorization adjusted remotely. The figure shows a number of sector inputs for one operator: in the first example, capacity is concentrated on one remote, while in the second example capacity is distributed evenly. These changes can be made independently for each operator, with the separate frequency ranges for several operators sharing each band module.

Migration from analog DAS

Maven digital DAS offers a flexibility in system design which does not exist with analog DAS. In an analog DAS, all signals in all frequency bands are combined into a single analog signal which is used to modulate the laser in the optical transceiver. This combined signal is carried by the fiber and converted back to an analog signal at the detector at the destination. There is no choice in which signals are carried: the entire frequency range connected at one end is hard-wired to appear at the other end, and there is no selectivity to prevent unwanted signals from interfering. Also, relative signal levels are fixed for each operator input in proportion to the combiner attenuations, with no scope to set different levels for different carriers.

In an analog DAS, the fiber transmission forms part of the analog signal path: this means that distortion from non-linearity and noise in the fiber transmission appears directly in the RF signal. Also, the loss through the fiber appears directly as loss in the RF signal level, and while analog DAS units typically compensate for this to some extent it is still usually required to perform manual trimming of signal levels. Also, with longer fibers the noise increases, which may require compromises in for example reaching the desired uplink gain and noise level simultaneously.

In the Maven digital DAS, each operator input signal is digitized into sector inputs covering specific frequency ranges. This means that sectorization and distribution of signals is independent of the physical fiber connections. With digital fiber interconnections, there is effectively no contribution from the fiber distribution to the signal quality: the digital signal entering the fiber is transmitted perfectly to the far end. Unit gains are factory calibrated, and end-to-end gain is independent of the fiber length. Also, the digital distribution automatically provides redundancy to maintain coverage in the event of a fiber interruption, as long as an alternative path exists through the fiber network.

analog DAS is sensitive to reflections and discontinuities in the optical signal path at connectors, which appear as distortion in the signal. As a result, analog DAS requires APC-style angled connectors. In contrast, digital links in Maven DAS can use datacom standard LC connectors.

analog DAS

- Combined input signals transmitted over fiber between fixed source and destination.
- No selectivity against unwanted uplink signals.
- Noise, distortion and gain affected by fiber transmission.
- Sensitive to reflections at connectors, need special APC optical connectors.
- Delay balancing via physical spools of fiber

Maven digital DAS

- Input signals split into individual sector inputs which can be separately controlled.
- Flexible signal distribution and topology.
- Unwanted uplink signals filtered out.
- Perfect transmission of signals over fiber.
- Factory-calibrated end-to-end gain.
- Datacom standard LC connectors.
- Automatic delay management and balancing via signal processing.

Fiber Topologies

QSFP+ and SFP+ digital fiber connections

Maven digital DAS uses two types of digital fiber connector modules: QSFP+ and SFP+.

The main digital backbone connections use QSFP+ modules which integrate 4 lanes of 10 Gbit/s to give a total link capacity of 40 Gbit/s. These are available in 3 main connector variants:

- Quad lane WDM with duplex LC connector. The data for the 4 lanes are sent using different wavelengths over a common fiber, with separate fiber strands for transmit and receive directions. This gives a total aggregate capacity of 40 Gbit/s in each direction, which corresponds to a maximum RF signal bandwidth of approximately 1200 MHz. These are available for maximum fiber reaches from 100 m to 40 km, with the shorter reaches using multi-mode fiber and longer reaches requiring single-mode fiber.
- Four separate lanes with MTP/MPO connector. Each of the 4 lanes is available as a separate transmit / receive pair which can be broken out into 4 separate links, for example terminating at 4 separate LC connectors. Each lane carries 10 Gbit/s, corresponding to a maximum RF bandwidth of approximately 300 MHz. These are available in reaches from 100m to 10km, again using multimode or single mode fiber depending on reach.
- Optical patch connectors with integrated fiber. These provide 40 Gbit/s capacity and are a convenient and good value option for short connections between units, with the pre-formed fiber interfaces avoiding any risk of contamination of fiber terminations.

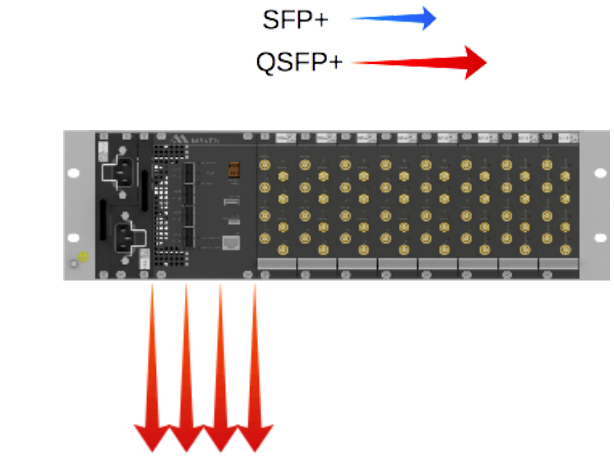
SFP+ connections carry a single lane of 10 Gbit/s (300 MHz maximum RF BW) and are primarily intended for local interconnect. They may however also be used as an alternative to QSFP+ where bandwidth requirements are lower and if a larger fan-out is required: 4 x SFP+ duplex LC connectors can be connected to a single QSFP+ MTP/MPO module using 4 fiber pairs. Also, SFP+ modules are available in a wider range of variants (including DWDM and BiDi) and may be useful in special situations where fiber availability is extremely limited.

SFP+ modules are also available in 3 main connection variants:

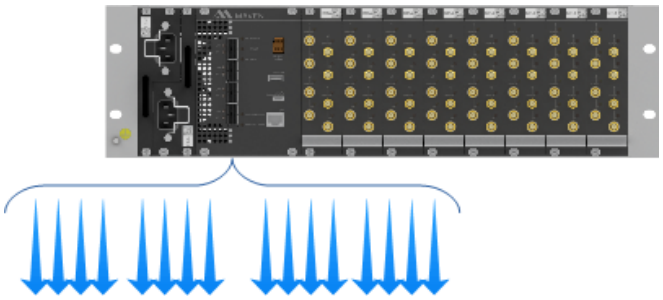
- Duplex LC connector. The data for the lane is carried over separate fiber strands for transmit and receive directions. The supported reaches and fiber types are the same as for the corresponding QSFP+ module. In addition, DWDM modules allow the use of external optical multiplexers to combine a large number of wavelengths over a single fiber pair, useful for example where capacity is limited between a remote site and the coverage area.
- BiDi module with simplex LC connector. These modules use WDM to multiplex transmit and receive signals over a single fiber strand. The modules are typically available in reaches up to 10 km. Care must be taken to install the modules in matching pairs, with TX and RX at opposite ends of the fiber using the same wavelength.
- Optical patch connectors with integrated fiber. These are the 10 Gbit/s equivalent of the QSFP+ patch connectors.

Orion digital fiber connection options

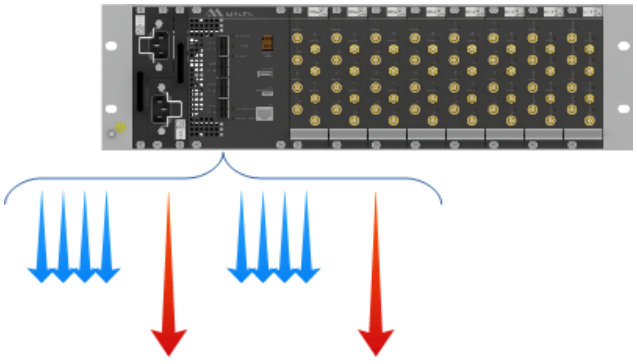
The Orion head end unit has 4 connector slots for QSFP+ digital fiber connector modules. These are typically connected using quad lane 40 Gbit/s configurations, giving 4 links with the full 1200 MHz RF bandwidth per link. However, if more fan-out is required, each module can be replaced with an MTP/MPO breakout module to give a maximum of 16 links at 10 Gbit/s / 300 MHz each.



Option 1: Using 1 up to 4 QSFP+ fiber modules



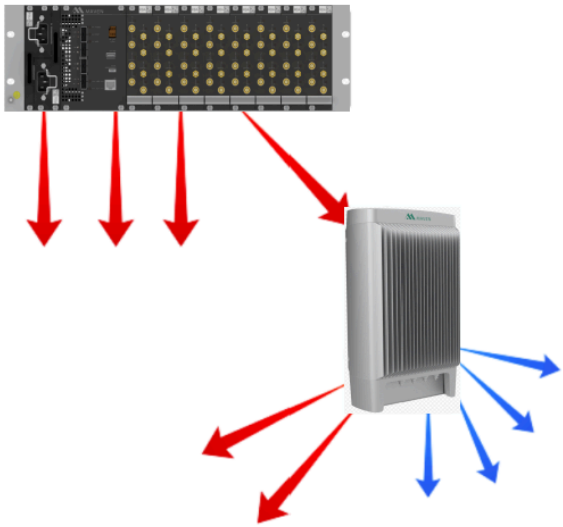
Option 2: Using QSFP+ breakout modules



Option 3: Mixing option 1 & 2 above

Stratus, Cumulus and Cirrus digital fiber connections

The remote units and the Cirrus off-air master have 3 connector slots for QSFP+ digital fiber connector modules and 4 connector slots for SFP+ digital fiber connector modules. The QSFP+ connection ports are typically used for the core front-haul fiber network, and the SFP+ connectors are typically used for local connections at the remote location. A common use of these local connections is to provide additional bands and MIMO paths by connecting extra units.



QSFP+ and SFP+ fan-out in the Stratus remote unit

Topologies and redundancy

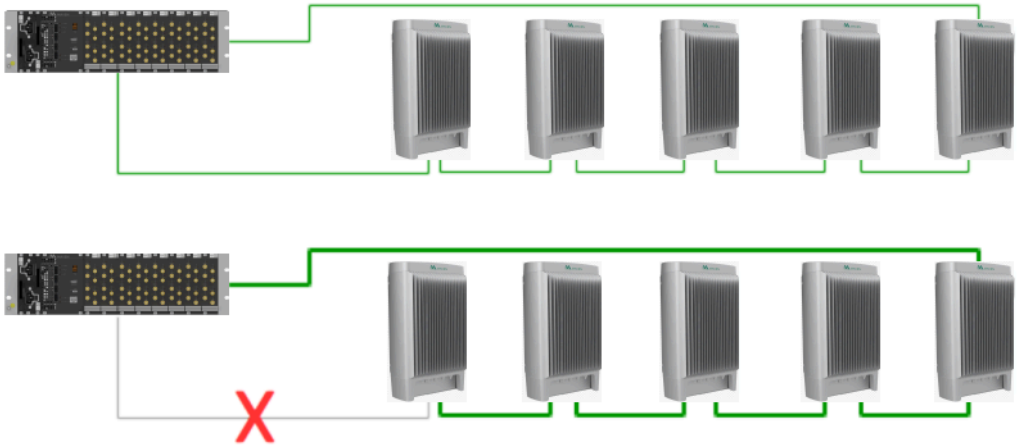
The QSFP+ and SFP+ connectors can be used to interconnect the units in the Maven digital DAS in any desired topology. The system automatically registers unit interconnections and topology and, as long as a physical path exists with enough transmission capacity, arranges the distribution of the digitized sector inputs so that they are routed where they are required. Orion / Cirrus master units and remote units can be located wherever is most convenient in the system.

Some commonly used topologies are:

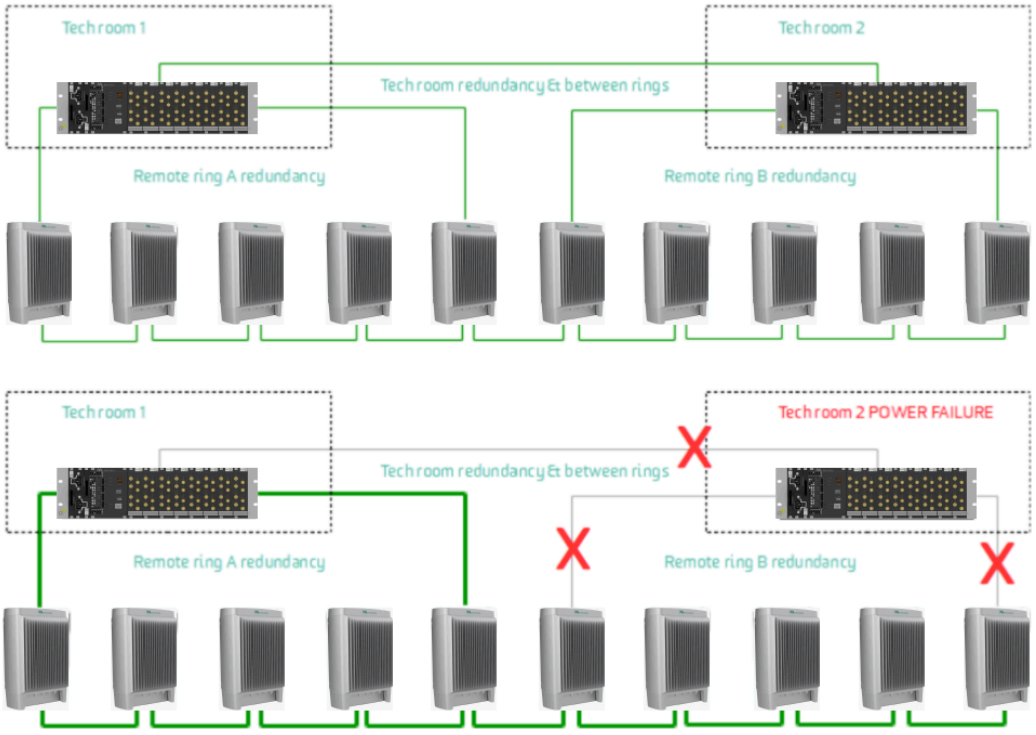
- **Star topology -** many remotes are connected to a central master unit. This is the typical arrangement used with analog DAS.
- **Chain topology** - where units are connected in series. This arrangement is particularly useful along tunnels or railway tracks.
- **Ring topology** - an extension of chain topology where the last unit in the chain is connected back to the start, as shown in the first example. Interruption of a single connection does not affect coverage; the alternative path around the ring is automatically used.
- **Tree topology** - each unit has several connectors, 4 QSFP+ connectors on an Orion and 3 QSFP+ connectors on a remote or Cirrus. This means that units can be connected in a fan-out tree, with the number of connections increasing at each step through the tree.
- **Mesh topology** - a mesh is a general pattern where additional connections are made beyond the minimum needed to provide routing. This provides a number of alternative redundant paths. The additional paths can be selected to maintain RF distribution in the event of more serious events. The second example shows such a configuration, with two

Orion master nodes in separate equipment rooms (for example, a system fed from two sites for redundancy purposes). The remotes are connected in two rings, with mesh cross-connections between the rings and between the equipment rooms. Even if power is lost at one of the equipment rooms, coverage can still be provided from the other equipment rooms.

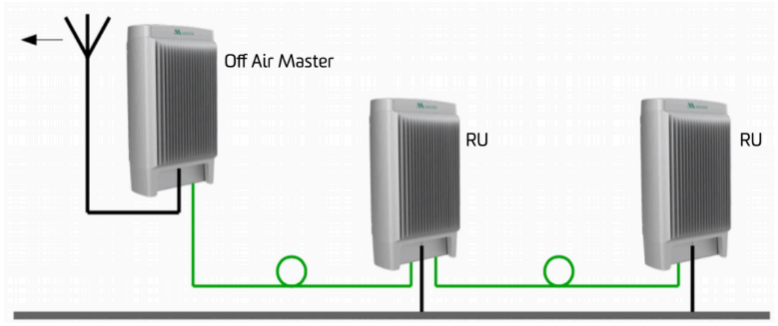
It is recommended to keep the number of interconnection hops between a master unit and the most distant remote to fewer than 10. The fan-out capabilities mean that the number of remotes which can be reached within this limit is larger than would be needed in any practical system.



Ring connection topology providing redundancy on broken link or unit power failure



Redundant mesh connections provide continued service even with more serious disruption



Cirrus Off Air master and remote units.

Optical Transceiver Selection

The choice of Optical Transceivers is dictated by the capacity and reach required by each optical link.

Only Optical Transceivers recommended by Maven should be used. Please discuss the system requirements before purchasing them.

The calculation of link capacity for particular system topologies and frequency capacities is beyond the scope of this manual but assistance is available with system design via the Support and Technical Assistance details listed in the Contact Information section.

Commissioning

The Maven DAS is commissioned using any standard web browser, from a PC connected using the USB port.

All nodes in a DAS installation of Master and Remote units contain the same information, so commissioning of the whole installation can be done from any node as long as the digital links are up between nodes.

Commissioning a system mainly consists of:

1. Configure the connected Sector inputs / Base stations connected to the system.
2. Configure any needed band module attenuation.
3. Route the RF signals to the desired remote units.
4. Fine tune uplink and downlink gain and power output

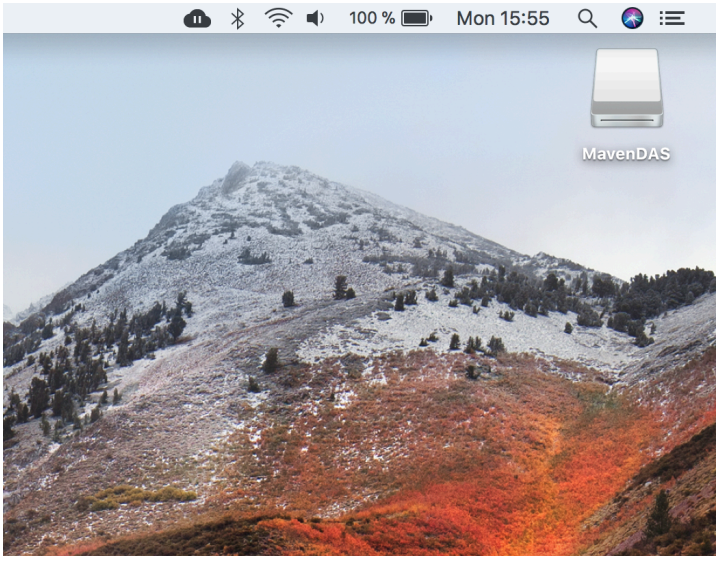
> *Commissioning must respect the terms of any license from the Radio Authorities in the country concerned.*
> *Maximum output powers at certain nodes might also be constrained by Non Ionising Radiation Safe Levels. All commissioning must respect the parameters decided at the system design stage.*

Browser Compatibility

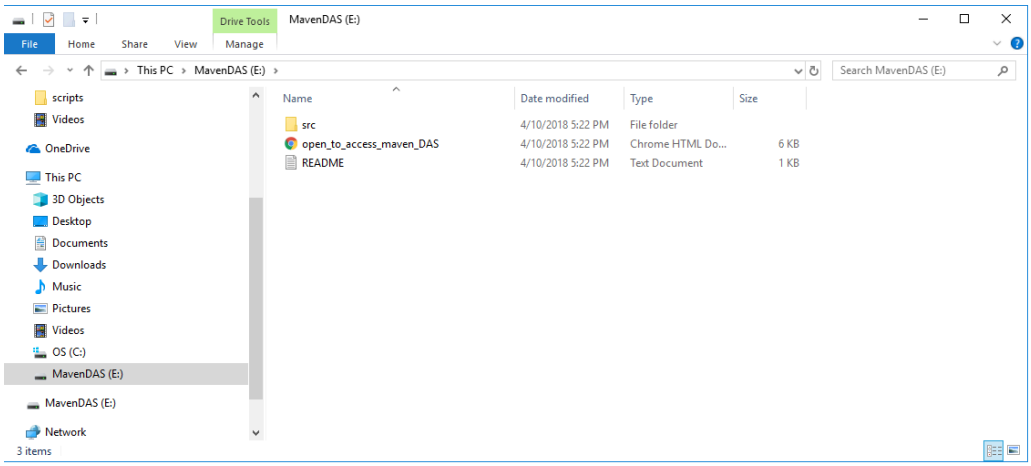
Maven DAS can be accessed via any modern web browser such as Chrome, Firefox, Safari or Edge as long as they are updated to the latest version.
Using one of these is strongly recommended.

Accessing the web interface

Connect the provided USB cable from the laptop to the micro USB connection of the unit (labeled LOCAL MANAGEMENT).
A removable disk will now be presented in your operating system, on Mac it will typically be a drive on the desktop.



On Windows it normally ends up as a drive in the Explorer, or as a new window:



Open the drive and open the link open_to_access_maven.html, which will provide a link to reach the login dialog of Maven DAS.

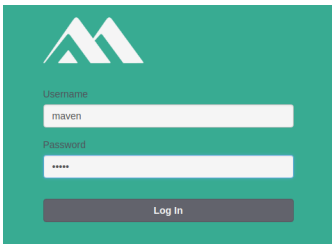
On most occasions the access works out of the box, but should there be any problems, the opened link provides detailed instructions on how to set up your particular OS to access the equipment.

> *When opening the connection to a unit the first time, browser will warn about insecure certificates and these must be added as exceptions in the browser.*

Default Login Parameters

Login credentials are case sensitive, and the same login parameters are used in the whole DAS installation regardless of which unit login is performed via.

Username	Password
maven	maven



It is strongly recommended to change the password in accordance with network policy after first login to the system

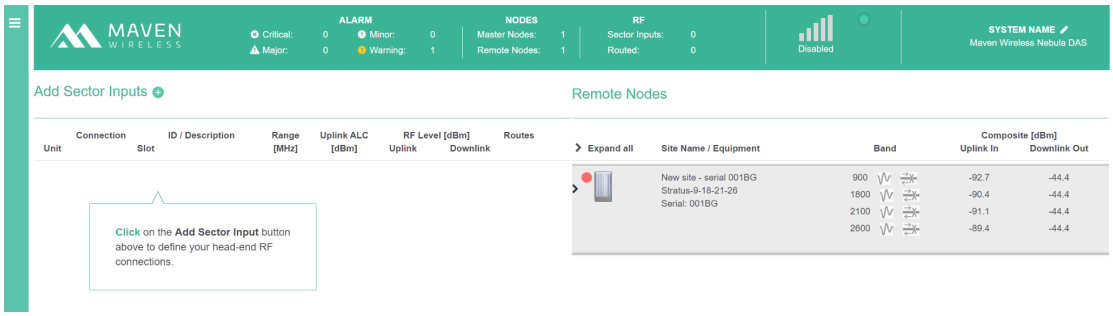
Navigation

When successfully logged in to the system, the RF Status page is presented to the user. The web interface looks the same regardless of where you are logged in from. I.e, it is possible to administer the entire system from a remote unit in the tunnel, the user interface will be identical from all nodes as long as they are properly connected.

A number of different screens are available from the main menu, available by clicking on the in the upper left corner of the web interface. The following chapters describe each page and the tasks to carry out on each page.

RF Status

The RF status page displays all relevant RF parameters and signal levels of the system. This is where new RF inputs are configured and where they are routed to the different remote nodes.



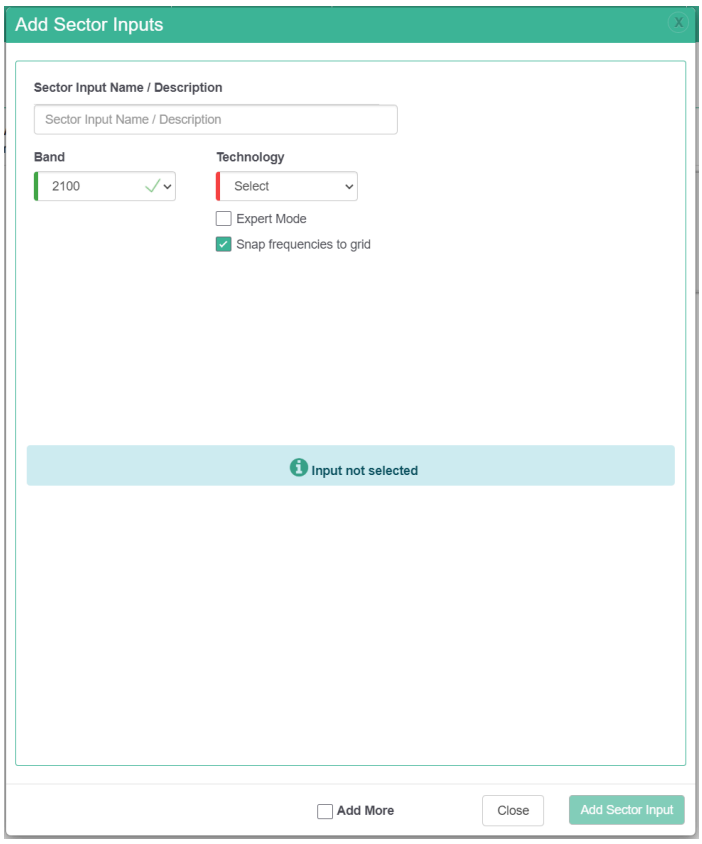
The left hand side shows all Sector Inputs, which are the BTS signals connected to Orion or Cirrus master units of the system.

The right hand side displays all Stratus or Cumulus remote units connected to the DAS to which these signals can be transported.

The Site Name is a configurable name that can be given to this DAS installation to easily identify the site remotely. Refer to section Change Site Name on how to give each unit a user friendly name.

Adding a Sector Input

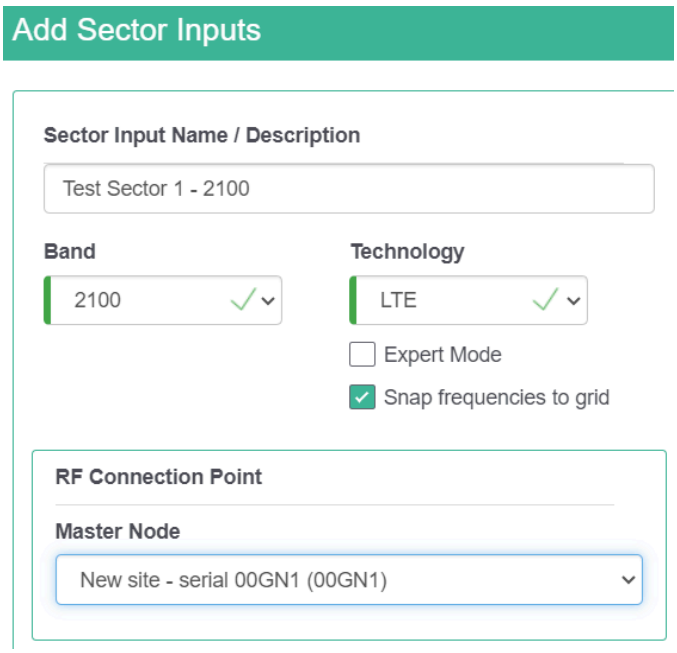
The procedure of registering a new BTS connection is by adding Sector inputs. Click on the icon next to the Sector Inputs caption, which brings up the Sector Inputs dialog. A BTS connection containing more than one signal (for example more than one carrier) in the same frequency band can be defined as multiple sector inputs, so that each of the carriers can be handled independently in the system.



Each field requiring attention or which contains a user error is highlighted with a red line. The Add Sector Input button is disabled until all fields are properly filled in.

Configure Description, Band and Technology

Sector Input Name / Description - For each Sector Input it is possible to set a user friendly name making it easy to identify this Sector Input, by operator, by technology, by location, etc.
Band - Configures the frequency band in which this sector input operates.
Technology - Configures which cellular standard this sector input contains. The setting is important to optimize performance.



The sector inputs are implemented by digital filtering to separate different signals. The digital filters are configured using filter libraries defined for different technologies according to the 3GPP requirements for repeater out-of-band gain as defined for each technology (and, for low gain paths such as in a DAS between Orion and Stratus or Cumulus, additional rejection to give adequate separation of the wanted carrier from neighboring carriers).

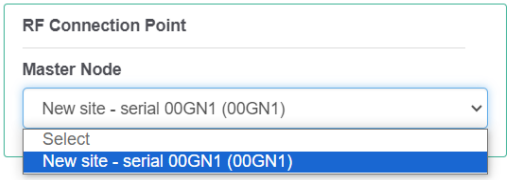
Filter bandwidths are defined according to the standard channelisation for the technology. So for example, GSM filter bandwidths are listed in multiples of 200 kHz, WCDMA filters have multiples of 5 MHz, and LTE has the standard bandwidths 1.4, 3, 5, 10, 15, and 20 MHz.

For GSM the passband width is the same as the bandwidth, while for WCDMA and LTE the passband width is according to the actual occupied bandwidth of the corresponding technology within the standard bandwidth.

In addition, WCDMA filters for more than one carrier are defined for carrier spacings less than the standard 5 MHz. These narrower filters are defined in steps of 200 kHz, so for example for 2 carriers there are filters defined at 9.8, 9.6, 9.4 and 9.2 MHz. These filters are defined on the assumption that WCDMA carriers are centered 2.5 MHz from the passband edge, so that 3GPP requirements for out-of-band gain are met towards adjacent bands.

Where a combination of GSM with for example WCDMA is wanted in one sector input, and particularly if the GSM carrier is located at one of the sub-band edges, the "MIX" mode should be selected. This applies the (stricter) GSM out-of-band gain at the band edges and ensures that repeated signals meet 3GPP requirements. If the GSM signal is located for example between two WCDMA carriers, then the GSM out-of-band gain requirements will be met and a WCDMA filter covering the whole sub-band can be used instead.

Select Connection Point



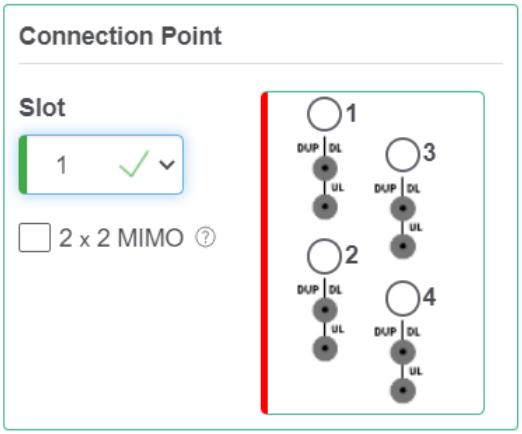
Master Node
When band and technology are configured, the drop down list is populated with the master nodes in the system having band modules which support that frequency band.

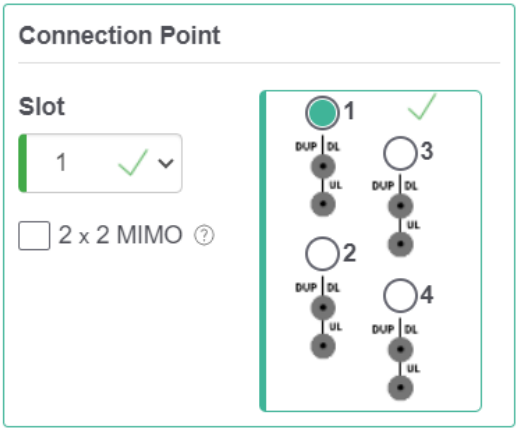
Select the relevant site/serial number for the connection.

Connection / Slot (Orion master unit)
If an Orion master node is selected, the Connection Windows are populated with the band module slots in the Master Node relevant to the frequency band.

Select the slot for the connection.

Cirrus off-air masters have fixed band allocations so the slot selection is not applicable.





Connector on Main Connection Band Module (Orion Master Unit)
When a Main Connection is chosen for the Orion master unit, the user interface is updated to indicate whether it is a one, two or four port band module.

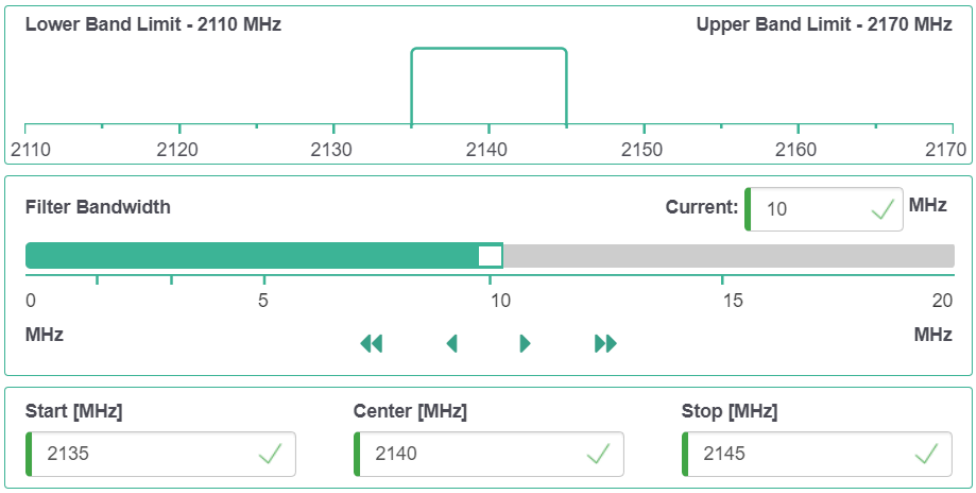
Connection point is chosen by clicking the radio button on the picture of the band module.

For 2x2 MIMO connection. Enable the checkbox 

which assigns a pair of identical MIMO A/B sector inputs on adjacent identical band modules.

Configure Filter Bandwidth and Center Frequency

The drop down contains all available filter types for this band and technology.
Select the Bandwidth and center frequency matching the connected BTS signal, or equivalently the start and stop frequencies



center frequency can be entered in the center edit box or by dragging the frequency box at the frequency bar.

> *In order to configure Duplex / Simplex mode for band modules, refer to section Setting Duplex / Simplex Mode and Band Module Attenuation*

Finally, add the Sector Input

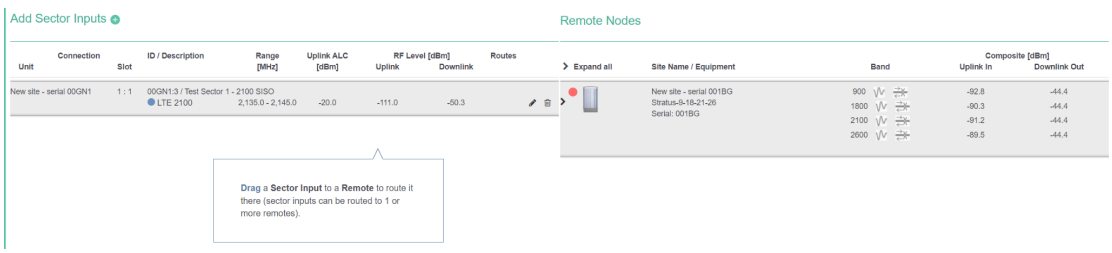
Once the filter and center frequency are configured to be within the band limits the Add Sector Input button is enabled. Click to add the sector and return to the start screen.
Ticking the 'Add more' checkbox allows more Sector Inputs to be added before going back to the start screen.

> *When the sector input is added it means that they system sets up a digital filter at the configured band module (Orion) or antenna input band (Cirrus), meaning that the RF is ready to route to whatever destinations are configured (next section).*

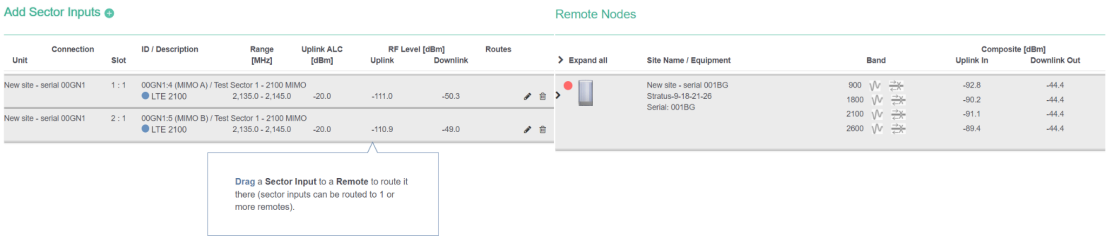
Routing RF to Remote Units

When Sector Inputs are configured in the system they should be routed to the desired remote units where coverage from the sector input is required.

For SISO connection,

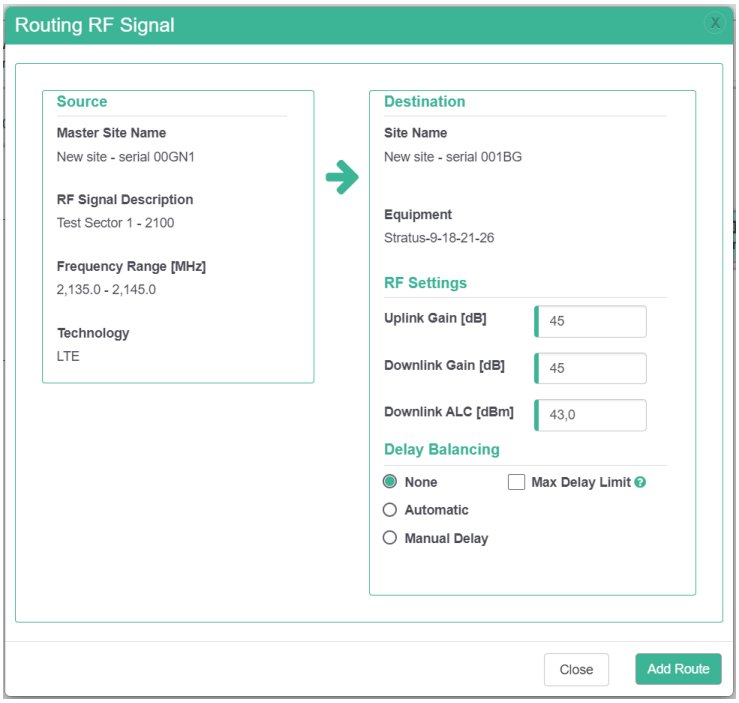


For MIMO connection,



Routing is achieved by dragging the sector input to desired Remote Units and dropping them there. It is only possible to drag a sector input to a remote which supports the frequency band of the sector input.

When successfully dragged, a dialog is displayed to configure the RF settings on this remote.



The configurable parameters are:
Uplink Gain - This is the end to end gain from input in remote to output in the master unit, adjustable in 0.1 dB steps.
Downlink Gain - This is the end to end gain from input of master unit to output of remote unit, adjustable in 0.1 dB steps.
Downlink ALC - This is the maximum output power in the downlink path for this sector input.
Delay Balancing - Delay balancing uses digital technology to measure and compensate for different delays between master units and remote units. Where the same signal is routed to several remotes, this allows the timing in overlap areas to be controlled in order to minimize inter-symbol interference. For example, LTE signals require a maximum delay difference of 4.7 µs. Delay balancing options are:

- **None** - No additional delay is added to the RF path.

- **Automatic** - If a sector input is routed to multiple remotes, all routes configured with Automatic delay will be balanced so that the RF comes out the RF port on all remotes at the same time, using the worst path delay as the value. Routes of the same sector input that are configured with Manual or None are not affected.
- **Manual** - Configuring a routed Sector input with manual delay will set the delay for this RF path to this constant value. If configured lower than actual path delay, the path delay will be used.
- **Max Delay Limit** - When the maximum delay limit is enabled, this field specifies the maximum allowed physical RF rout delay in microseconds)connector to connector including RF filtering). If the delay is exceeded, the route will not be created and an alarm will be generated. For manual delay balancing, this field also specifies the wanted RF route delay after balancing.

  Click on 

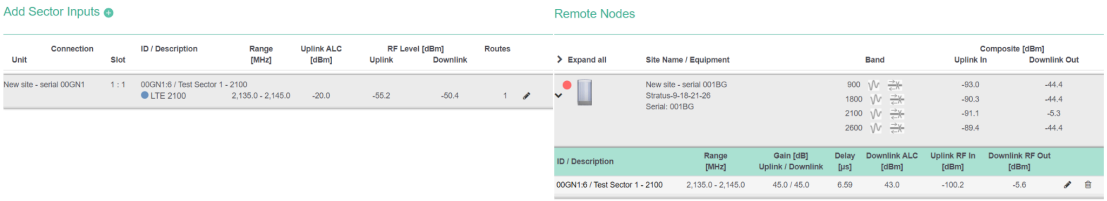
option, set delay in microseconds upon requirements

.

When desired gain and ALCand Delay balancing option is configured, clicking 

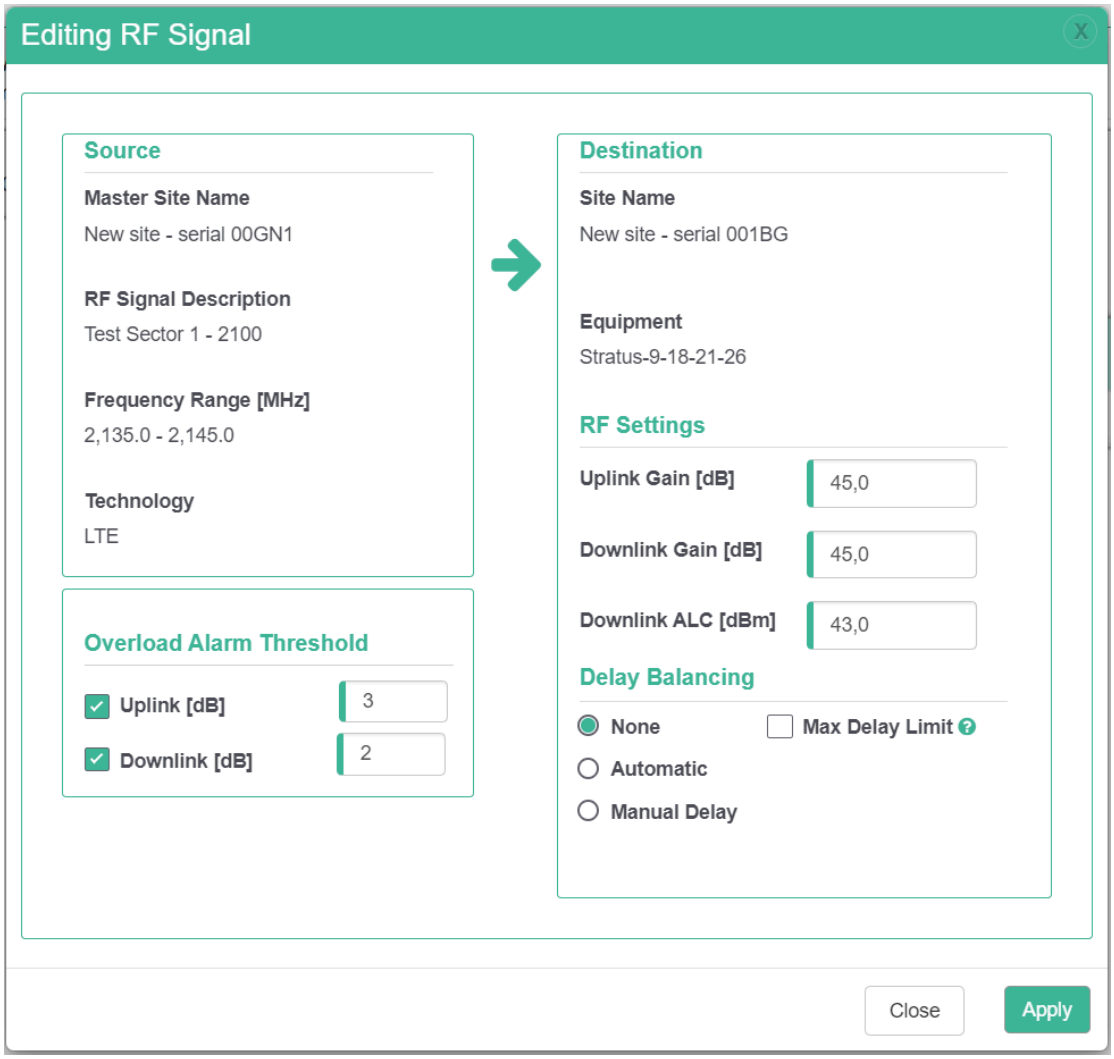
initiates routing of the signals to the desired destination.
Click on the right arrow > under Site/Serial Number to get a view of routed sector input for this remote, and corresponding sector input parameters.



Once the sector input is displayed in the remote unit (normally takes a couple of seconds) the RF coverage is provided on the remote unit, providing RF coverage to the customers.

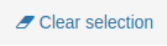
Changing RF settings in Remote

In order to fine tune the gain and ALC parameters at a remote unit, simply click the icon and change the desired parameters.



Viewing Routes

By clicking on a Sector Input in the left side of the page, all Remote Nodes which sector is routed to are highlighted (all other Remote Nodes are hidden).

Clicking again on Sector Input to clears selection, as does clicking 

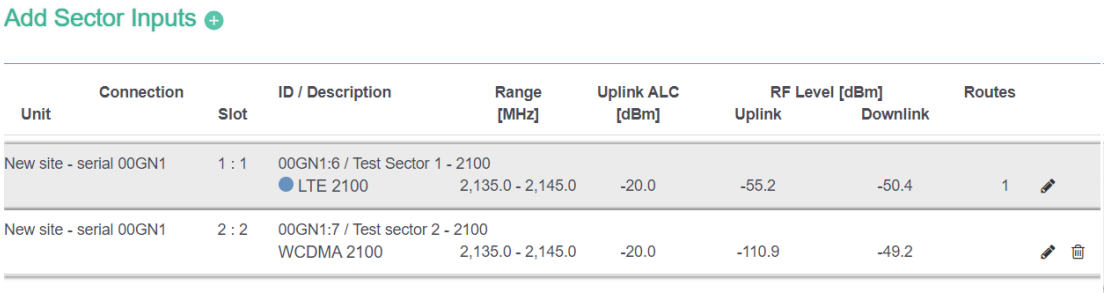
Deleting a Route

Clicking the  on a routed Sector Input removes the routing of this Sector Input to the remote node.

Deleting a route means the remote node will no longer transmit RF signals for this Sector Input from the antenna, the RF coverage in this remote for this Sector Input is removed.

Deleting a Sector Input

Sector Input can only be deleted once all routes for this Sector are Removed.

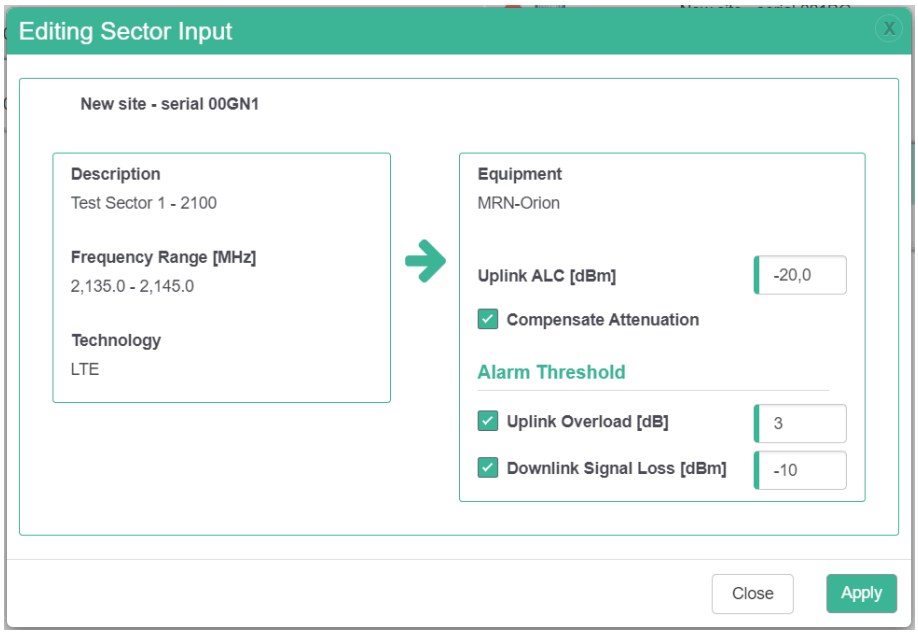


Clicking the next to non-routed sector inputs deletes the Sector Input.

This cannot be undone, double check that the routing to delete is the intended routing.

Editing a Sector Input

Once the sector input is created click on to change the ALC thresholds.



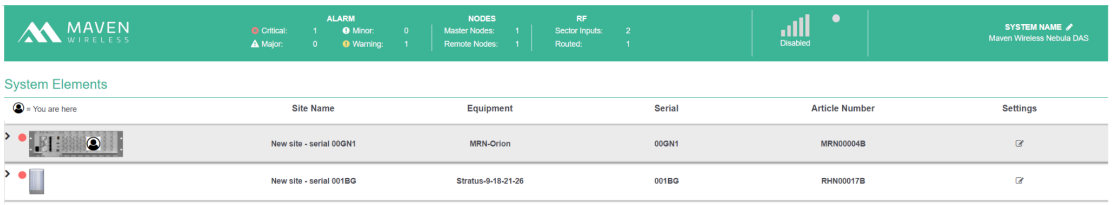
Uplink ALC - this is the maximum output power level in the uplink path for this Sector input out towards the base station.

System Elements

The System Elements page summarizes information that is specific to each hardware unit, rather than related to sector inputs. The page has an entry for each unit in the DAS, and the accessible information includes:

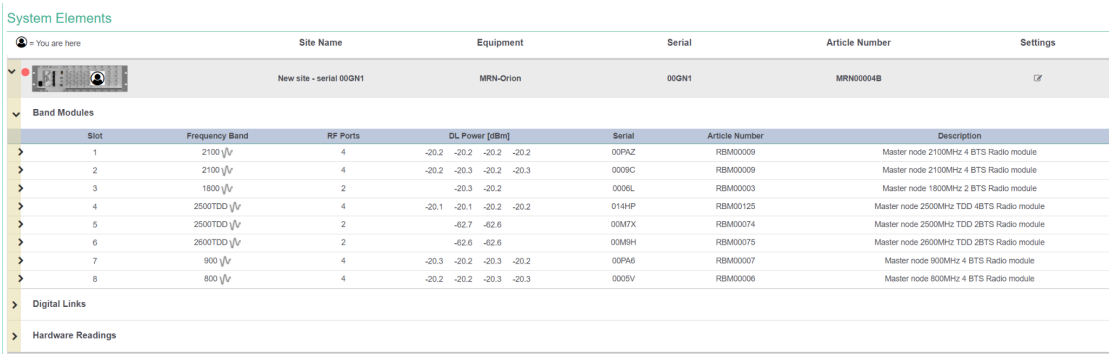
- Hardware readings such as temperatures, fan speeds, supply voltages.
- Composite RF power and return loss for remotes.
- Orion band module per-port power level and settings. This is also where Simplex / Duplex settings for band modules are configured, as well as the Band Module attenuations.
- Digital link status.
- General per-unit settings:
    - SSH configuration
    - Ethernet / IP settings
    - Unit site name
    - Unit alarm log clear
    - External Alarm configurations (for Stratus, Cirrus and Cumulus nodes)

Each unit is shown in a row with site name, unit type, serial number and article number.
Each row shown with the sign > can be expanded to show additional information.



Setting Duplex / Simplex Mode and Band Module Attenuation

The Orion band modules support downlink input power levels from <0 dBm to +30 dBm, however for power levels greater than 0 dBm it is necessary to configure the RF attenuators for the corresponding port in the band module to reduce the power level. Base station connections can be selected to be either Duplex or Simplex mode for each port.
Configuration is done under the Band Modules section of the Orion containing the sector input.



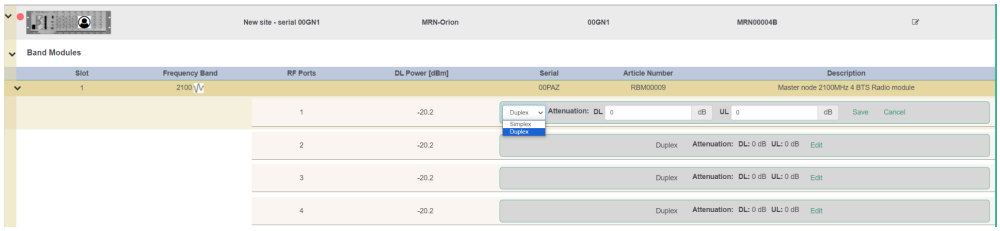
Select the band which needs to have its settings modified. Here it is possible to change each port between Duplex and Simplex, and also to adjust the DL and UL attenuation in the band module.

Select DL attenuation as per BTS output power and the external RF attenuation between the BTS and the Orion:

```
DL attenuation value = (BTS output power) - (External attenuation)
```

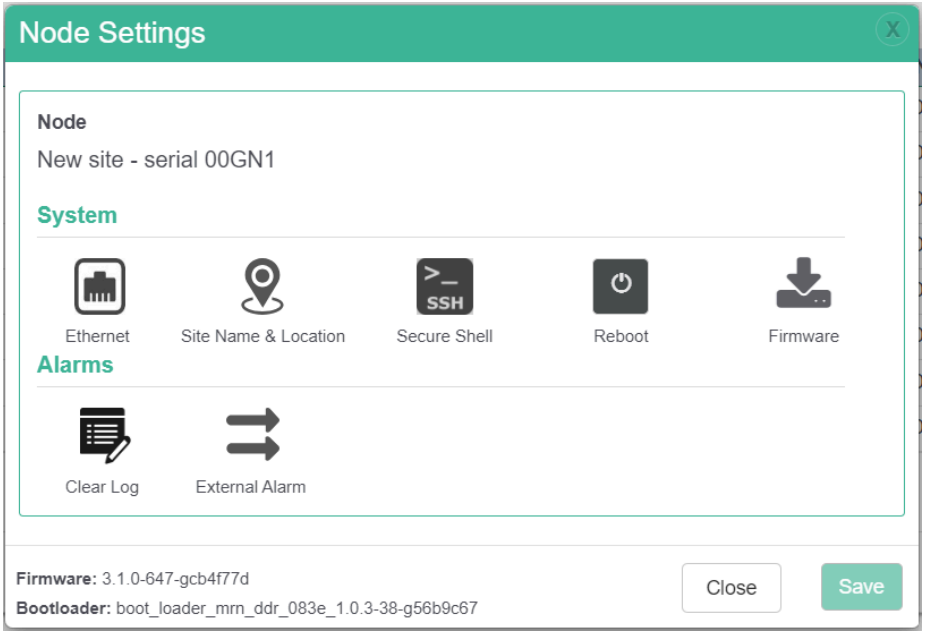
Example 1:
If BTS output power is 43 dB and the attenuator used is of 30 dB then the DL attenuation value should be 13 dB.
Example 2:
If BTS output power is 43 dB and the attenuator used is of 13 dB then DL attenuation value should be 30 dB.
Typically, the UL attenuation value is set to the same value as the DL attenuation.

> *The DL and UL attenuation values are not compensated for in the routing gain. The actual DL and UL gains between Orion band module port and remote antenna port will equal the programmed DL or UL routing gain minus the corresponding DL or UL band module attenuation. Displayed RF signal levels do take into account the attenuation, and should indicate the actual signal level at the RF connector port on the band module.*



Per Node Settings

To edit the Per Node Settings settings, click  in the right hand side of the row for the unit to change, which brings up the following dialog:

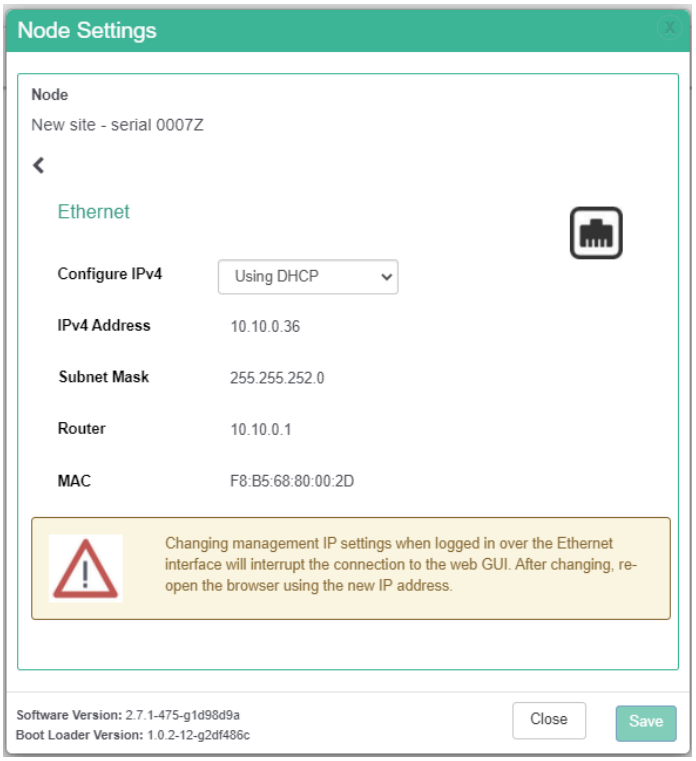


External Alarms are not available in Orions, but only in Cirrus, Cumulus and Stratus

Change Ethernet / IP Settings

To edit Ethernet / IP Settings click on 

:



Each unit can either automatically receive its IP settings via DHCP, in which case the received parameters are displayed as read-only, or can have its IP settings configured manually. After making a change, click Save to set the parameters.

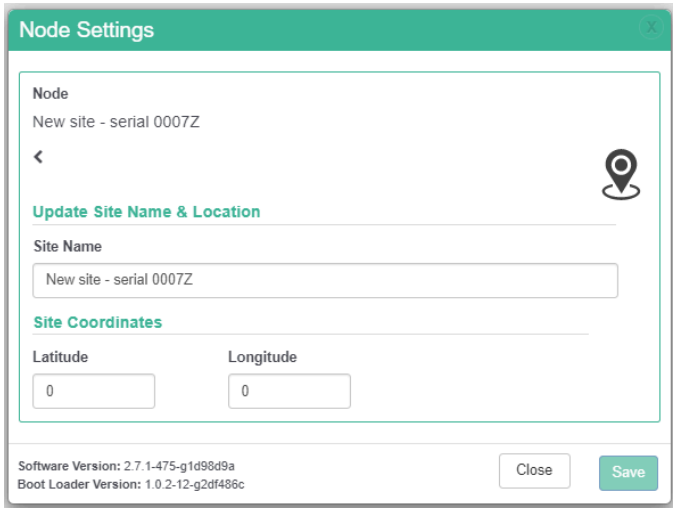
Changing the management IP settings when logged in over the Ethernet interface to the unit being changed will interrupt the connection to the web GUI. After changing, re-open the browser using the new IP address.

Change Site Name

Site name is a specific name for this specific node within the system. A recommendation is to give the node a name so that it is easy to figure out where the unit is installed.

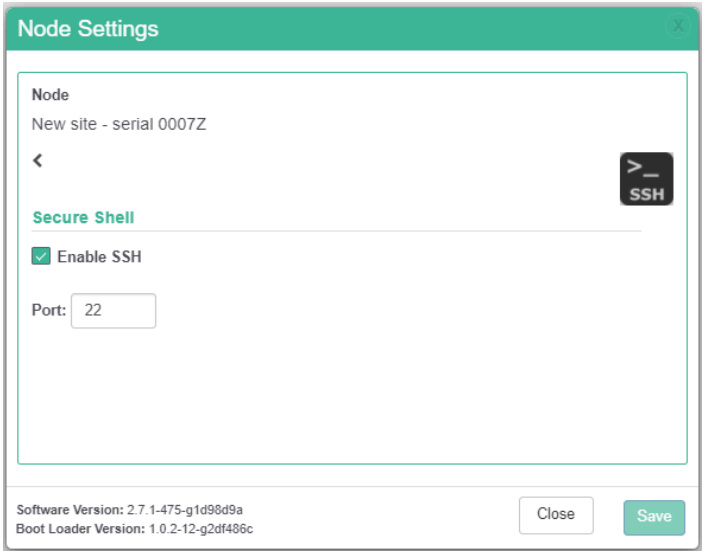
To change the Site name click on 

which brings up the Site Name dialog.



Change SSH settings

To change SSH setting click 

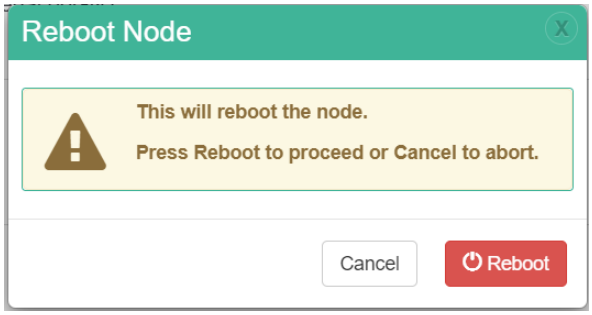


By default SSH is enabled on the standard port 22, allowing remote access over the Ethernet interface (if connected). SSH can be disabled, or the port number can be changed to a different non-standard value if required by the customer network configuration. After making any changes, click Save.

SSH to one of the system master units is required in order to perform remote firmware upgrade from the NMS. Remember to re-enable SSH in this case.

Reboot the Node

To reboot the Node click on Reboot . It will show the message below.



Reboot feature will only reboot that particular Node where the user is logged in and not the whole DAS.

Firmware

To Upgrade or Downgrade a node, click on Firmware to continue.
Upgrade or Downgrade node will cause the node to reboot, with brief loss of radio coverage.

Firmware feature will only upgrade or downgrade that particular Node where the user is logged in and not the whole DAS.

External Alarm Inputs

Each Cirrus, Stratus and Cumulus contains general purpose External Alarm Inputs, which are configured via  External Alarm .

Each of the four alarm inputs (only two in the picture) have the following configurations:

- **Alarm When** - configuring this to *Energised* means an alarm will be triggered when there is voltage applied to the alarm input, while *Not energized* means alarm will be triggered at absence of a voltage applied.
- **Alarm Message** - this message is added to the alarm entry when this external alarm input is triggered, to give a clear indication of the cause for the alarm.
- **Alarm Clear Message** - this message is attached to the alarm entry when the alarm clears.

Clear Log

 Clear Log Clicking this icon gives the possibility to clear out inactive alarms from the alarm log for this particular node.

Digital Links

To check link status per opto module, expand Digital Links.

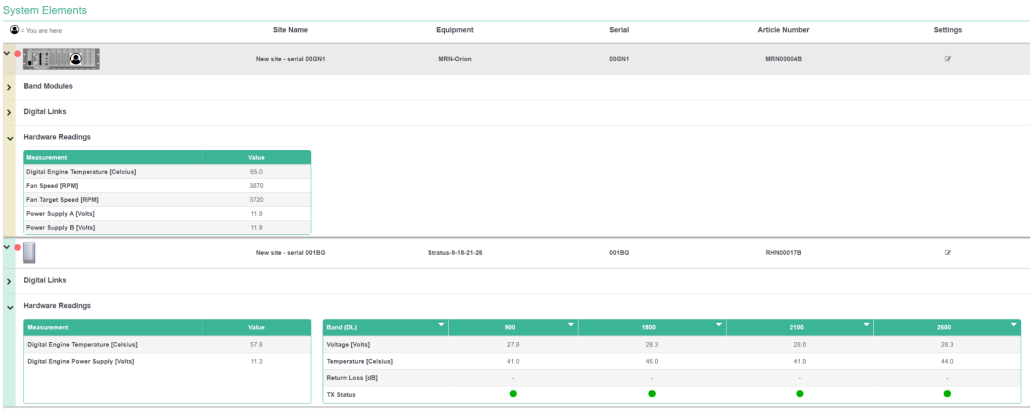
For each module, the following information is shown:

- Module type including optical wavelength
- Optical slot of installation
- Port number (1-16)
- Link status (up / down)
- Measured delay to far side (if link is up)
- Received optical power level
- Details of connected unit such as port, name and what kind of node it is

If a QSFP+ is connected using an MTP/MPO break-out connector to multiple different units, each of the connected lanes is shown separately.

Hardware Readings

To view hardware readings, expand the Hardware Readings row.

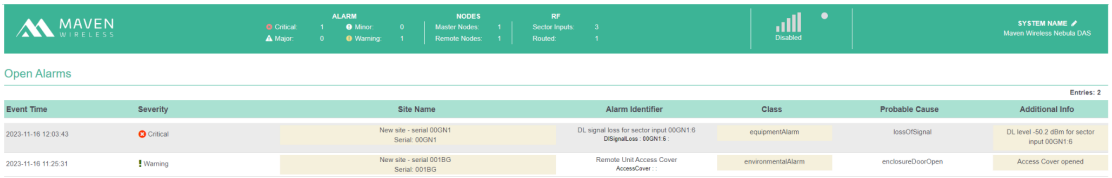


This gives per node readouts of temperatures, voltages and so on. This can be used to figure out if the node is running within allowed ranges or if it is close to reaching an alarm condition.

Open Alarms

The Maven DAS continuously monitors all critical parameters of the installation, and triggers an alarm if any abnormal condition or fault is detected.
The Open Alarms menu option gives an overview of all currently active alarms in all the nodes in the system. As soon as the alarm condition is no longer met, it will be removed from the open

alarms list. If any alarms are shown as active (bold) in the system status panel of the top of the screen, clicking on the active alarm entry will automatically select the open alarms page.



Field	Description
Event Time	This indicates at what time alarm happened
Severity	X.733 Alarm Severity level, one of: Critical Major Minor Warning
Site Name	Name of the site where alarm was detected
Alarm Identifier	Description of the alarm source, plus the unique alarm identifier in the particular node
Class	X.733 Alarm Class, one of communicationsAlarm qualityOfServiceAlarm processingErrorAlarm equipmentAlarm environmentalAlarm integrityViolation operationalViolation physicalViolation securityServiceOrMechanismViolation timeDomainViolation other
Probable Cause	A hint of what the reason for the alarm might be, as defined by X.733. Such as lossOfSignal degradedSignal enclosureDoorOpen powerProblem Refer ITU Recommendation X.733 for full list.
Additional Info	Additional information about this particular alarM, such as current levels or status when the alarm was triggered.

Please refer to the Maven Wireless Nebula DAS Alarms for a complete list of alarms and how to respond to an alarm indication.

Alarm Log

The alarm log shows a chronological log of all alarms and alarm clear events that have occurred in the system.