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Installation and Operation Manual for the DDL Series Remote Radio Head Model Numbers DDL100/DDL200/DDL300/DDL400

Manual Part Number
7-9570-1-1 (Rough Draft)

WARNING: This is **NOT** a consumer device. It is designed for installation by **FCC Licensees** and **Qualified Installers**. You must have an **FCC license** or express consent of an FCC Licensee to operate this device. You must register Class B signal boosters (as defined in 47 CFR 90.219) online at www.fcc.gov/signal-boosters/registration. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of $100,000 for each continuing violation.

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DISCLAIMER

Product part numbering in photographs and drawings is accurate at time of printing. Part number labels on TX RX products supersede part numbers given within this manual. Information is subject to change without notice.

Manual Part Number 7-9570

First Printing: August 2016

Version Number	Version Date
1.0	08/10/16
1.1	08/19/16

Symbols Commonly Used

WARNING !!!

High Voltage

CAUTION or ATTENTION

Hot Surface

Important Information

ESD Electrostatic Discharge

Training Video Available

Electrial Shock Hazard

Heavy Lifting

Safety Glasses Required

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Figures and Tables

For Class A or Class B Unintentional Radiators

This equipment has been tested and found to comply with the limits for a Class A or Class B 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 the user will be required to correct the interference at his own expense.

Pour Classe-A ou Classe-B Radiateurs Involontaires

Cet équipement a été testé et jugé conforme avec les limites de la Classe-A ou Classe-B des appareils numériques, suivants à la Partie 15 des règlements de la FCC. Ces limites sont conçues pour fournir une protection raisonnable contre les interférences dangereuses lorsque l'équipement est utilisé dans un environnement commercial. Cet équipement génère, utilise et peut émettre des fréquences radio et, s'il n'est pas installé et utilisé conformément aux instructions du manuel, ceci peut causer des interférences dangereuses aux communications radio. Le fonctionnement de cet équipement dans une zone résidentielle est susceptible de causer des interférences mauvaises dans lequel l'utilisateur sera tenu pour responsable de corriger l'interférence à sa propre discrétion.

WARNING: Changes or modifications which are not expressly approved by Bird Technologies could void the user's authority to operate the equipment.

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ATTENTION: 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.

ATTENTION: Cet appareil est conforme à la Partie 15 des règlements de la FCC. L'opération doit se conformer aux deux conditions suivantes: (1) cet appareil ne peut causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent provoquer un fonctionnement indésirable.

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OVERVIEW

This manual details the Installation and Operation of the Bird Technologies Remote Radio Head System models DDL100/DDL200/DDL300/DDL400. The system is designed to distribute wireless service for voice and data to/from a Master Unit located at the BTS site and to/from the Remote Radio Heads (Remote Units) which are indoor mounted throughout the coverage area.

Figure 1 shows an overall layout of a typical installation. The DDL Remote Unit transmits into a distributed antenna system (DAS) for downlink output signals and a fiber optic cable for uplink output signals. The DDL Remote Unit is designed as the peripheral part of the overall DAS network/system and performs as a downlink transmitter and an uplink receiver. A Fiber DAS uses fiber optic cables to distribute RF signals from a base station to remotely located antenna when coaxial cable losses would be to high or it is impractical to install coaxial cables. Fiber DAS can be used indoors to cover large buildings where outside penetration of RF signals is insufficient. It can also be used to provide coverage in areas such as road tunnels, rail tunnels, airports, metro lines, etc.

The system uses a common optical cable for its signal paths (uplink and downlink) between the remote units and master unit. Either WDM or CDWM is used as the optical transmission technique. In addition, the fiber optic cable carries an optical sub carrier which allows control signals to pass between the maser unit and the remote units.

The system is managed by a central gateway computer (CGW) that is the overall interface point for system management functions. The CGW computer is connected to the master unit and has routing, firewall functionality, alarm logging, and access control for the complete DAS system. The remote unit has a WEB based GUI interface that is accessed via the CGW computer.

The Bird Technologies Fiber-DAS system consists of two major parts including a Master Unit (MU) which functions as the head-end and at least one or more Remote Units which function as remote-ends. Connection between the customers BTS and the Master Unit (or head-end) is through coaxial cable while the connection between the Master Unit and Remote Units is through fiber optic cable.

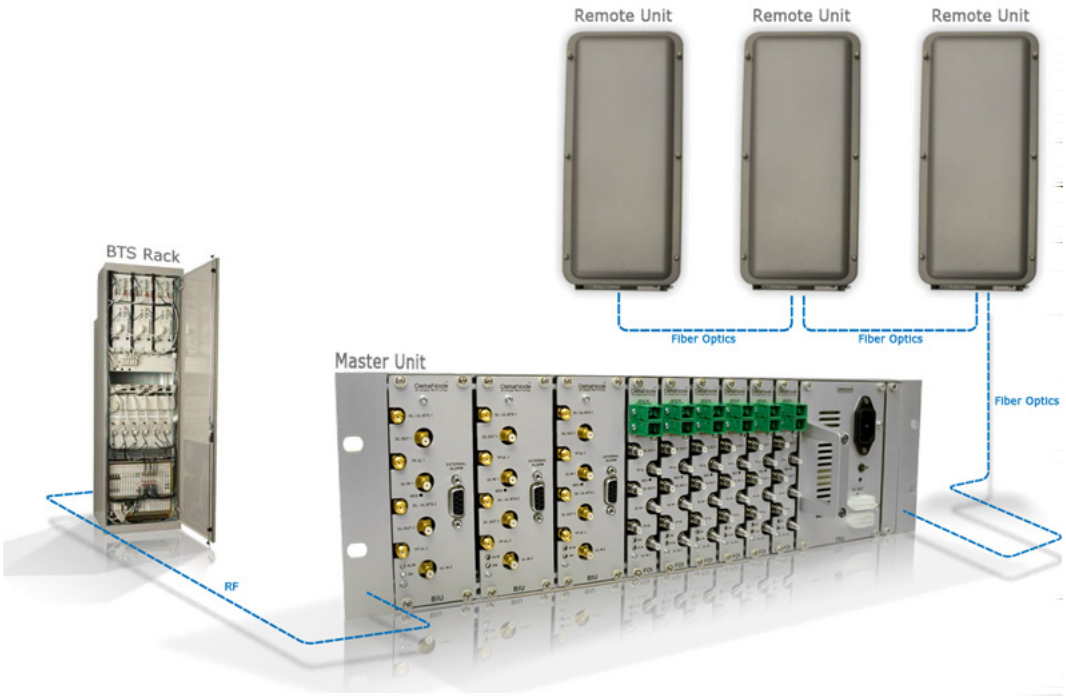

Figure 1: Typical Fiber DAS system.

UNPACKING

Each major component of the Fiber DAS system is individually packaged and shipped via motor freight or UPS. It is important to report any visible damage to the carrier immediately. It is the customer's responsibility to file damage claims with the carrier within a short period of time after delivery (1 to 5 days).

REMOTE UNIT

The DDL Remote Unit is a high performing wideband remote radio head equipped with linear variable gain amplifiers supporting 4 operating bands as listed in **Table 1**. The lightweight, convection cooled IP42 chassis ensures high performance in any indoor environment. The DDL Remote Unit is designed for indoor mounting only. One chassis can house from one to four different operating bands. Product model numbers reflect the number of installed bands. DDL100 has 1 band, DDL200 has 2 bands, DDL300 has 3 bands, and DDL400 has 4 bands installed. Labels are placed on the front panel next to the DAS RF connectors to designate the operating bands used and where to make the proper antenna line connections. The Remote Unit is shown in **Figure 2** and specifications are listed in **Table 2**.

INSTALLATION

The following sub-sections of the manual discuss general considerations for installing the Remote Unit. All work should be performed by qualified personnel and in accordance with local codes.

Location

The layout of the antenna distribution system will be the prime factor in determining the mounting location of this unit. However, safety and serviceability are also key considerations. The unit should be located where it can not be tampered with by the general public, yet is easily accessible to service personnel. Also, consider the weight of the unit and the possibility for injury if it should become detached from its mounting for any reason.

The unit needs to be installed such that there can be unobstructed air flow around the back of the chassis. Insure that the heat sink fins are unobstructed. The various subassemblies within the equipment cabinet will stay warm during normal operation so in the interest of equipment longevity, avoid installation locations that carry hot exhaust air or are continually hot.

Mounting

Figure 3 shows the mounting hole layout for the chassis. Mount the cabinet using 3/16" (5 MM) diameter steel bolts (not supplied). We recommend flat washers on both ends and a lock washer under the nut. Nut and bolt mounting is preferred to the use of lag bolts. Use backer blocks where necessary to spread the force over a larger area. In areas of known seismic activity, additional devices such as tether lines may be necessary.

Because Bird Technologies cannot anticipate all of the possible mounting locations and the structure types where these devices will be located, we recommend consulting local building inspectors, engineering consultants or architects for advice on how to properly mount objects of this type, size and weight in your particular situation. It is the customers responsibility to make sure that these devices are mounted safely and in compliance with building codes.

Connections

All RF cabling connections to the booster should be made and checked for correctness prior to powering up the system. N(f) bulkhead connectors are

Band	Uplink (MHz)	Downlink (MHz)	Pout (DL) dBm/Composite
700 (LTE)	698 - 716 776 - 787	728 - 756	23
850 (CELL)	824 - 849	869 - 894	23
1900 (PCS)	1850 - 1915	1930 - 1995	23
2100 (AWS)	1710 - 1780	2110 - 2180	23

Table 1: Operating Bands.

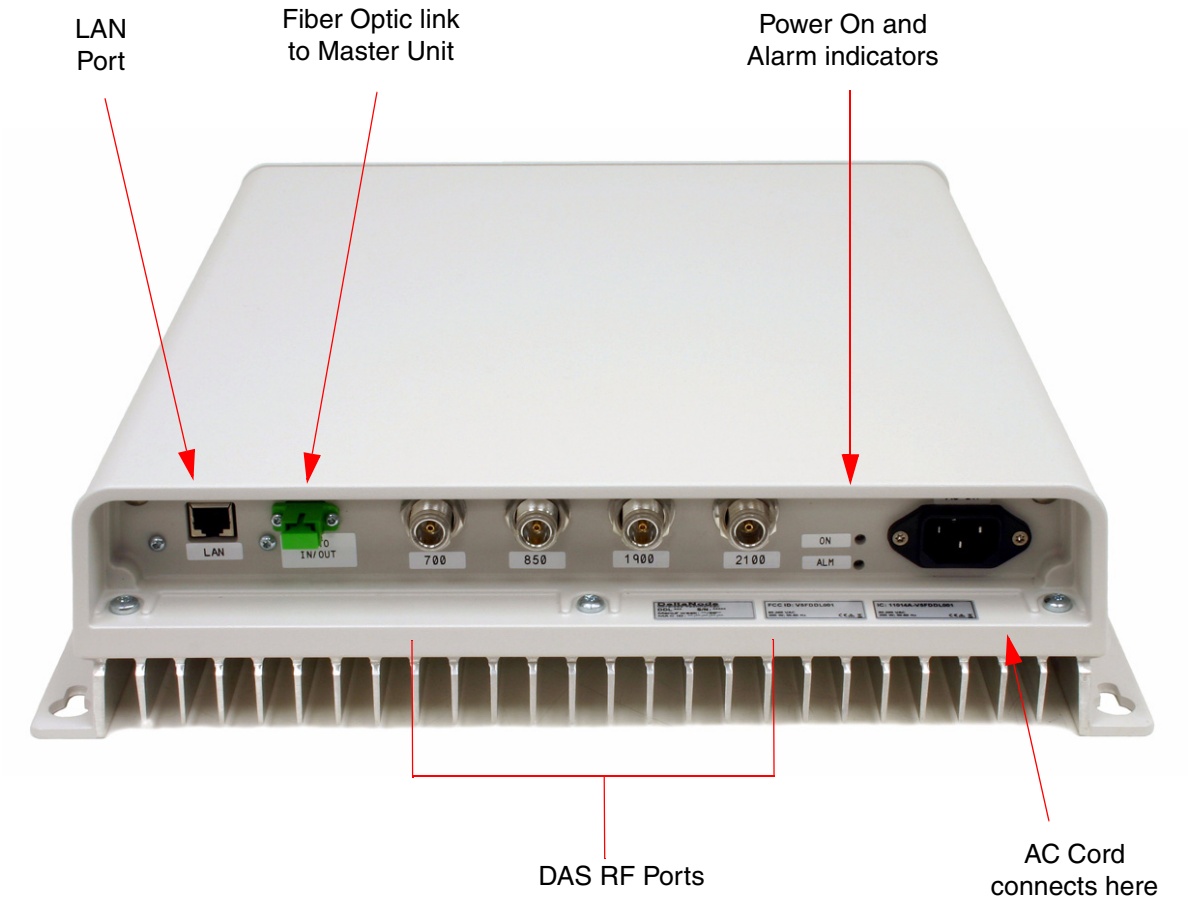

Figure 2: Front view of the DDL Remote Radio Head.

Specification	Value
Noise Figure	4.5 dB
Delay Excluding Optical Fiber	< 0.5
Power Requirement	90 - 264 VAC
Operating Temperature Range	-20 to +50
DFB Laser Output Wavelength	1270 - 1610 nm
Optical Output Power	3 mW
Maximum Optical Input Power	10 mW
Optical Return Loss	<-40 dB
Casing	IP42
Dimensions (WxDxH)	15” x 3.6” x 15”
Weight	26.4 lbs.

Table 2: DDL Specifications.

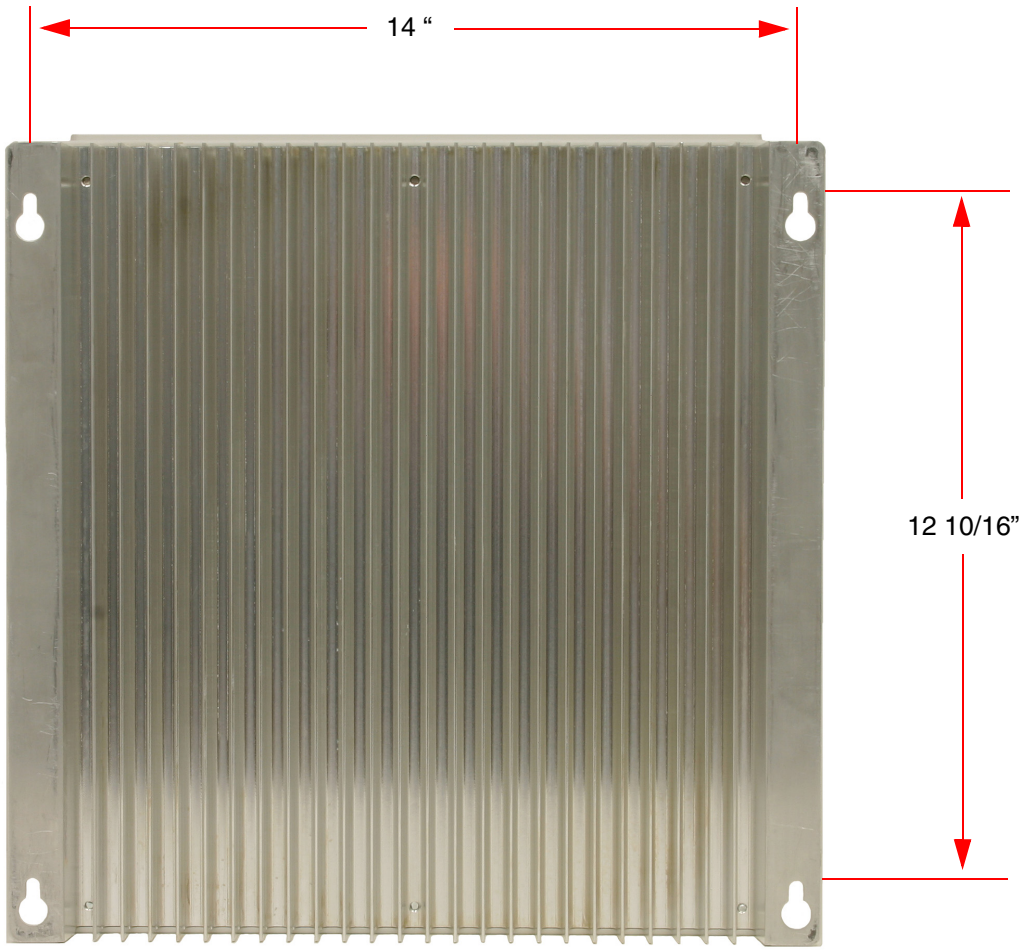

Figure 3: Chassis mounting dimensions.

available at the front of the unit for connection to the system antennas. Make sure the correct branches of the antenna system are connected to the correct front panel connectors or the system will not work properly. Using high quality connectors with gold center pins is advised.

RF EXPOSURE

To comply with FCC RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the DAS antenna of this device and all persons. This device must not be co-located or operating in conjunction with any other antenna or transmitter.

EXPOSITION RF

Pour conformer aux exigences d'exposition de FCC RF, une distance de séparation d'au moins 20 cm doit être maintenue entre les DAS antenne de cet appareil et toutes les personnes. Cet appareil ne doit pas être co-localisé ou exploités en conjonction avec toute autre antenne ou transmetteur.

FUNCTIONAL BLOCK DIAGRAM

Signal flow through the DDL Remote Unit is illustrated with the functional block diagram shown in **Figure 4**. This diagram shows the DDL400 model which has four operating bands. The DDL100 through DDL300 models are similar but have less operating bands and therefore fewer boards and assemblies mounted in the chassis.

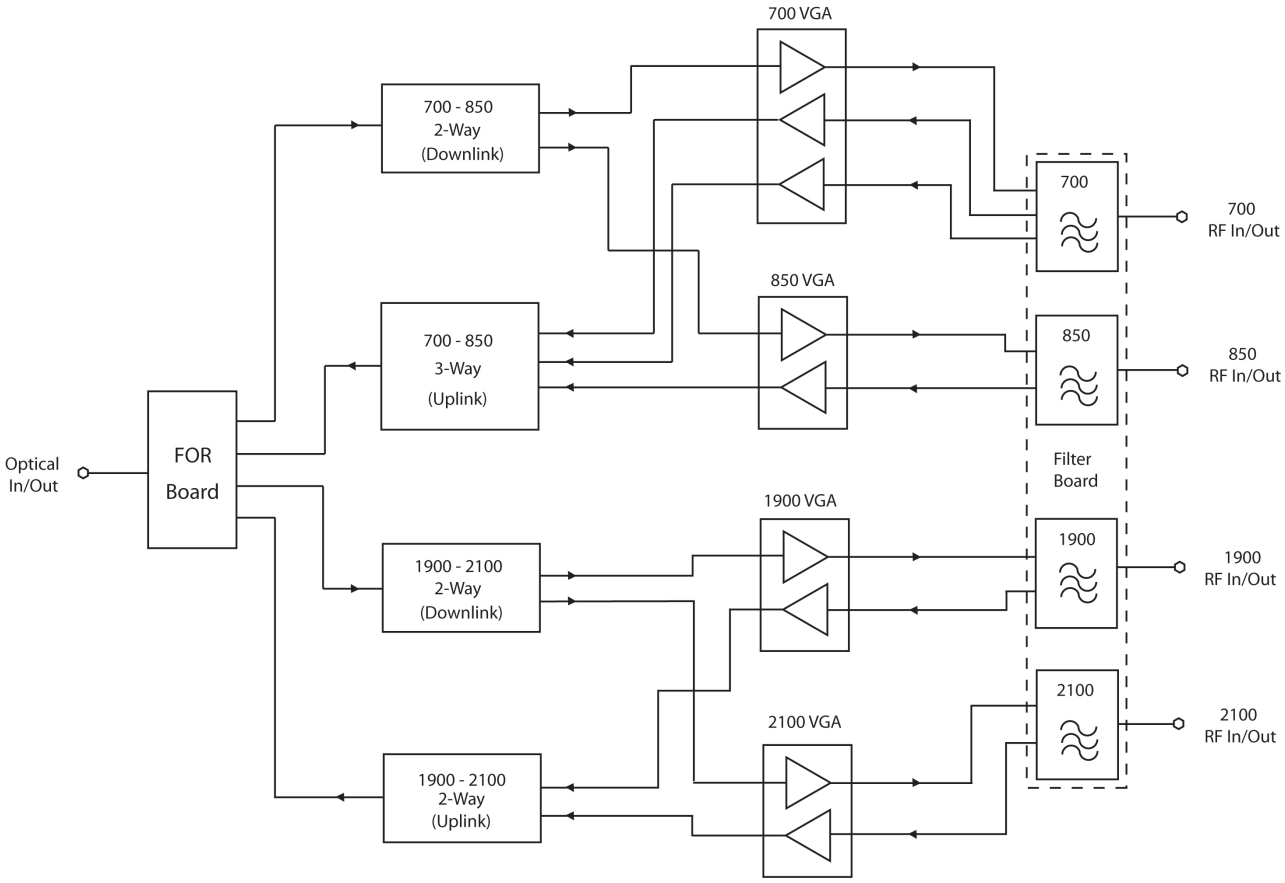

Figure 4: DDL Functional block diagram.

RF downlink and uplink signals are found at the four individual RF ports (N-type connector) shown on the right side of the drawing. These are RF signals traveling to and from the users handheld units via the DAS antennas. Uplink signals from the handhelds are passed through the filter assembly and are fed into the uplink side of the respective VGA board. The signals are amplified by the VGA board and combined as needed, with uplink signals from other operating bands, using the 2-ways or 3-way. After the signals are combined they are fed to the input of the FOR board for conversion to optical signals and sent to the master unit.

Downlink signals going to the handhelds enter the DLL Remote Unit as optical signals from the master unit at the FOR board. The FOR board converts the optical signals into RF signals and outputs them to the downlink 2-ways. The 2-ways split the signals and apply them to the downlink amplifiers on the VGA boards. The signals are amplified by the VGA board, passed to the filter board, and output through the RF connectors to the DAS antenna elements.

OPERATION

Power is applied to the unit by plugging in the AC power cord. There is no power on/off switch so the unit will begin to boot-up immediately. The status of the unit is indicated by the ON and ALM front panel LED's. Refer to **Table 3** for a detailed explanation of the LED behavior.

The remote unit is software directed so control of the unit is accomplished via a web based GUI interface. The GUI interface is handled by the central gateway computer connected to the master unit. For convenience, access to the GUI interface can be gained using the front panel LAN port on the remote unit. However using this method for interfacing is slower due to the speed of the optical

State	On LED	Alarm LED	Note
Booting	2 Hz	Off	Normal Boot
Booting standalone mode	2 Hz	2 Hz	Not attached to rack
Booting read of MAC address failed	2 Hz	On	Error
Starting	0.1 Hz 90%	0.1 Hz 90%	Kernal startup
Operation	0.5 Hz 10%	Off	Normal operation
Operation	0.5 Hz 10%	1 Hz 10%	Minor alarm state
Operation	0.5 Hz 10%	2 Hz 25%	Major alarm state
Operation	0.5 Hz 10%	On	Critical alarm state

Table 3: DDL front panel LED behavior.

sub carrier that links the remote unit to the master unit.

Users have the ability to set the following parameters in the remote unit via the web based GUI application:

- Gain Values (UL & DL)
- ALC threshold (UL & DL)
- UL Test tone

Users cannot adjust/align any frequency response, linearity response or detector calibration levels.

The remote unit has a built in ALC (Automatic Level Control) with preset levels, to make sure that the linearity or spectral spreading does not exceed the regulatory limits. The ALC threshold is a setable value that defines what output power is allowed from the remote unit. If an inserted signal plus the set gain in the remote unit exceeds the set ALC threshold the remote unit will automatically reduce the gain so that the output signal level always matches the set ALC threshold. The device cannot end up in saturation due to the ALC feature. Saturation or over-modulation is even prevented for pulsed signal inputs. There are also configurable signal threshold parameters in the remaining components of the DAS system located in the master unit.

UL Test Tone is a help feature tool used only when commissioning the DAS network.

DL ALC threshold for the remote unit is 23 dBm and cannot be exceeded.

WEB BASED GUI INTERFACE

When first connecting to the remote unit via the web based GUI interface a system layout screen will be presented as shown in **Figure 5**. The screen will show all of the addressable boards connected into the system. Master unit boards are shown under the column titled Fiber optic Interface and remote unit boards are shown under the column titled Remote. In this example there are four FOI (Fiber Optic Interface) boards installed in the master unit and one FOR (Fiber Optic Remote) board installed in a remote unit. Sub carrier links between the boards are shown as lines on the screen display. To ease location and identification each box shown presents the user defined system name for the individual boards. Clicking on any of the boxes will call up the GUI Interface screen for that particular board.

Using the mouse to click on the FOR board shown in the example will call up an overview screen for that particular board as shown in **Figure 6**. This screen provides a convenient summary of the boards active alarms and RF status. A description of any alarm events are listed as well as when the alarm occurred. The RF status for all RF bands built into the remote unit, in this example there are 4 bands.

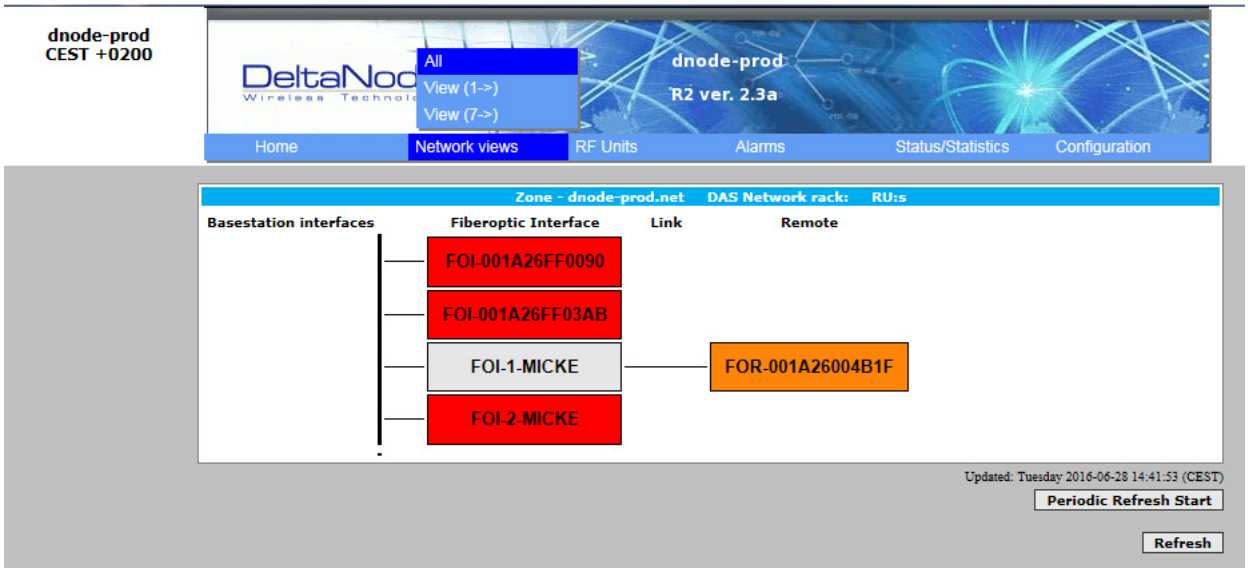

Figure 5: DDL system layout screen.

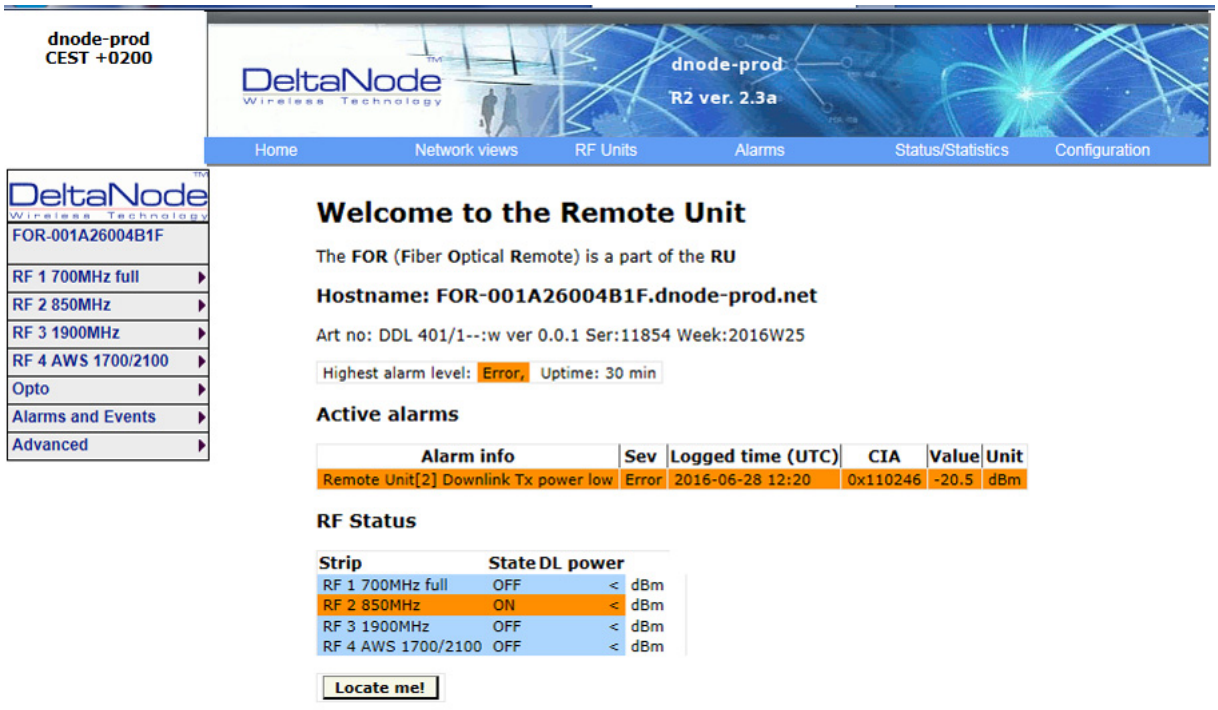

Figure 6: Typical overview screen. FOR board shown as an example.

At the bottom of the page is a button labeled “Locate Me”. When this button is clicked the remote units ON LED, located on the font panel, will blink rapidly for about 1 minute. This is a convenience feature that helps to physically identify units in a large installation.

On the right side of the overview screen area is group of drop-down style menu items which allow for detailed interaction with the board. Each band (referred to as an RF Strip) that is found on the board will have a menu item. In addition there are menu items for Opto, Alarms, and Advanced. The Opto selection allows the user to set the gain and check the status of the optical link between the remote unit and the master unit. Alarms provides a listing of all current alarms and provides access to an alarm log file which can hold up to 95 current and past alarm events. The Advanced selection allows the user to adjust network settings as well as verify things like IP addresses and MAC addresses.

When an RF Strip is selected for interaction a drop-down list will be presented as shown in **Figure 7**. In this example the RF Status menu item has been selected and RF status information is presented on the screen. This screen presents the current status of all uplink and downlink signal paths in the band. In this example there is a downlink and 1 uplink path. The values presented are a static snap shot taken at the time the screen was presented. To update the information press the reload button at the bottom of the screen. In addition, for convenience the periodic button can be pressed which will update the screen automatically at a periodic rate.

When the RF Config menu item is selected a page showing user configurable parameters is presented as shown in **Figure 8**. User configurable parameters include uplink and downlink gain value, uplink and downlink ALC threshold setting, and turning on/off an uplink test tone. Changes are made by clicking on the radio buttons and entering new values into the highlighted boxes. To initiate changes press the Submit button at the bottom of the screen.

MASTER UNIT

The Master Unit consists of a 19 inch frame rack (called a Master Frame Unit) with signal processing

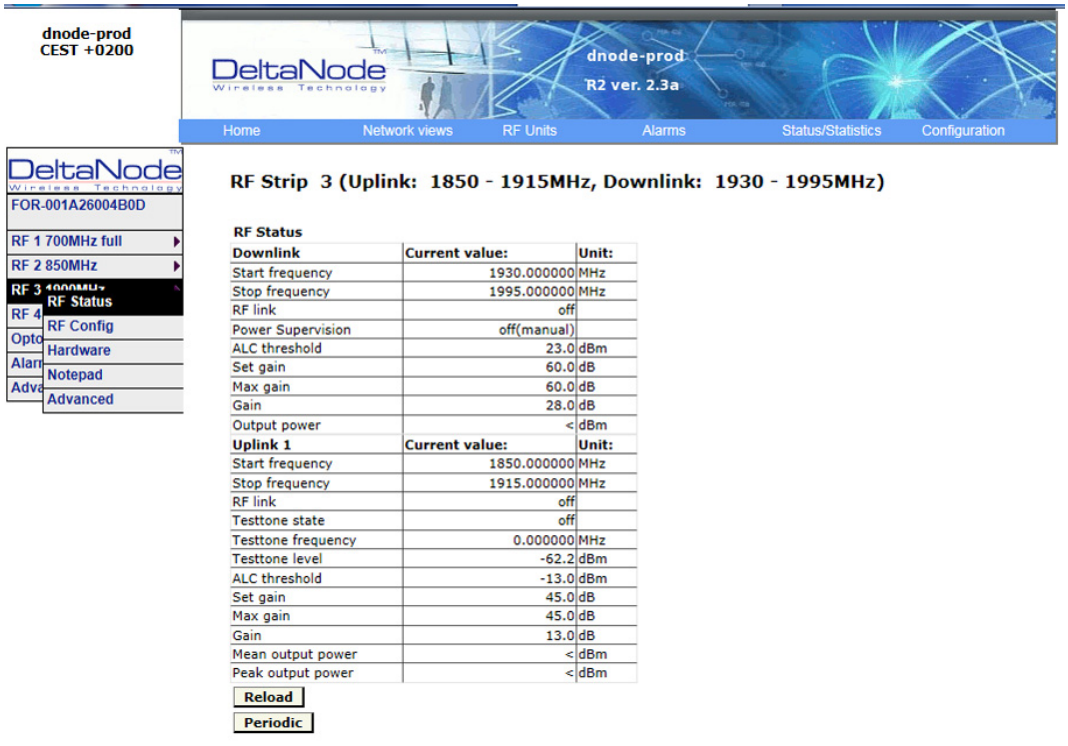

Figure 7: RF Status drop-down menu selection.

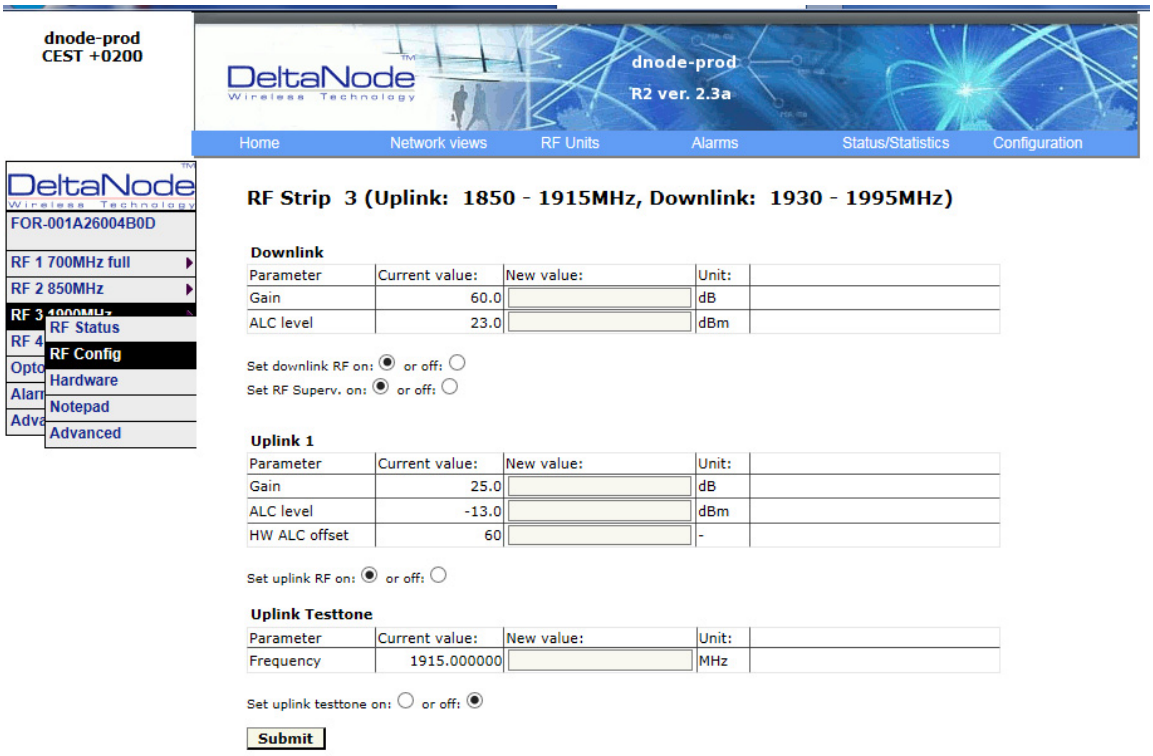

Figure 8: RF Config drop-down menu selection.

modules that are inserted into the rack frame depending on the specific system design. Generally all Master Units will contain a master frame unit, a power supply, at least one Base Station Interface Unit (BIU), an RF splitter/combiner unit called the Point of Interconnect (POI) and a minimum of one Fiber Optic Interface card (FOI). A block diagram of the typical Master Unit is shown in **Figure 9**.

The Master Frame Unit

The master frame unit houses some of the modules in a master unit including the power supply modules, fiber optic interface modules, and base station interface modules. Modules can be placed anywhere in the master frame unit and any combination of modules can be mixed. There are 16 slot positions for modules in the master frame. Each type of module placed into the master frame uses a different amount of slot positions. Power supply modules use 4 slot positions, BIU's use 2 slot positions, and FOI's use one slot position. In very large systems multiple master frame units can be used to house a multitude of modules as required. In the example shown in figure 1 the Master Frame Unit contains 3 BIU's, 6 FOI's, and a power supply module.

Each master frame in a system needs to be powered by a power supply module. The backplane in the master frame will distribute the supply voltage to all of the modules in the frame. The frame has two molex plugs for accepting power from a power supply module. Two dual plugs allow a primary and redundant power supply to be connected to the master frame. This connection scheme will ensure operation even if one supply should fail. The frame also contains a pair of fans used to ventilate the modules housed in the frame. These are quality fans with a high MTBF.

A power supply module that is connected to a master frame does not necessarily have to be housed in the frame. Quite often a system will have more than one power supply module which will be placed together in one frame for easy access.

BUI Module (Base Station Interface Module)

The BIU is the interface between the operator's base station and the Fiber-DAS system. This mod-

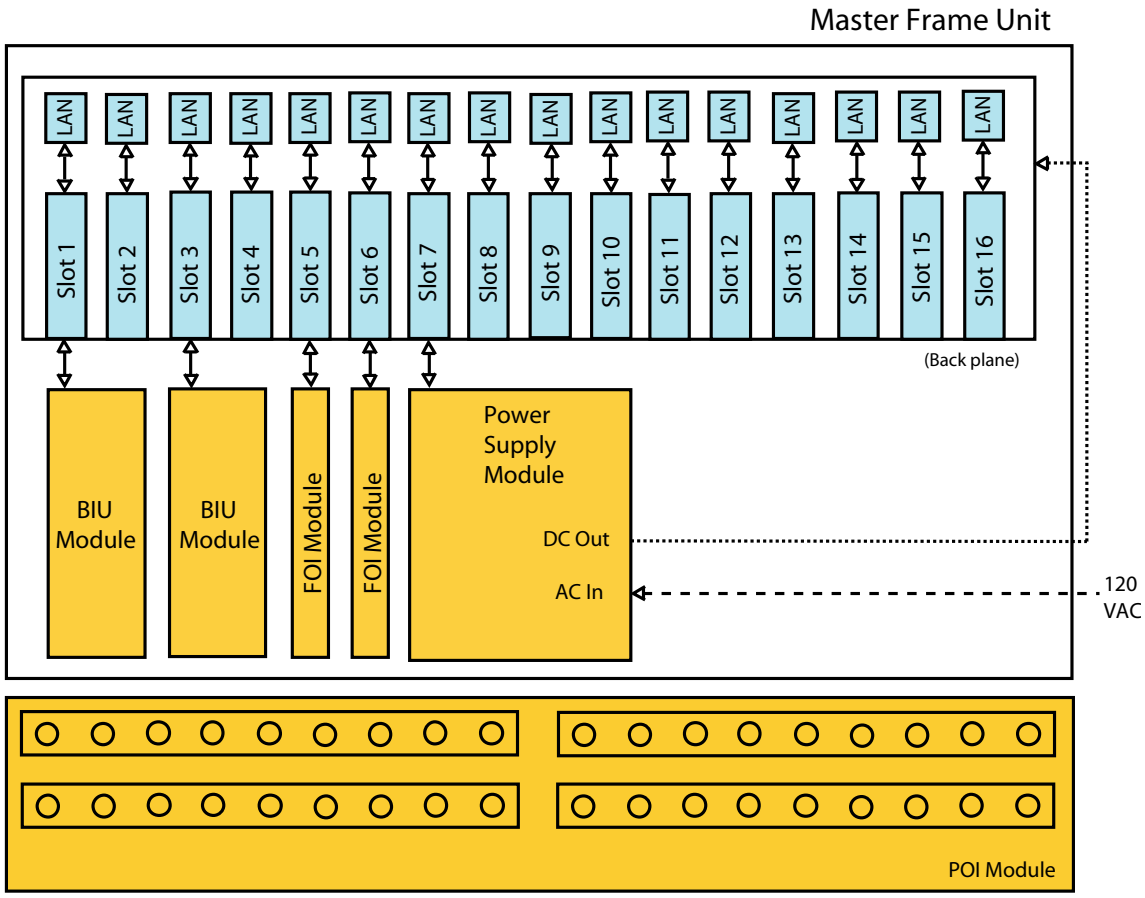

Figure 9: Typical Master Unit. In this example 2 BIU's, 2 FOI's and a Power Supply are each plugged into the backplane of a master frame unit. A single POI is not plugged into the backplane but is installed into the rack as part of the Master Unit.

ule has several RF connectors on the front panel and contains either duplex filters and combined DL/UL ports or separate uplink/downlink paths which can be chosen for connection to the base station depending on system requirements. In most cases the duplexed version with a combined DL/UL port is used. Refer to **Figure 10**.

FUNCTIONAL DESCRIPTION

In the duplexed version there are UL test connectors present (SMA) that can be used to monitor the signal out from the BIU. The version without duplex filters has the test connectors replaced by UL connectors and the normally combined DL/UL connectors are replaced by DL only connectors.

There are two separate RF channels and associated RF ports in a BIU (channel 1 and channel 2). Each channel contains a downlink and an uplink path. The two RF paths in the BIU cannot have different frequency bands. As an example a GSM 900 BIU will have two GSM 900 paths. If you wanted an 1800 path in the system it would require adding a second BIU module to the master frame unit. Note: BIU Modules need to be ordered for the specific frequency bands that they will serve.

The BIU has four QMA type (female) ports that are normally used to connect it to the Point of Interconnect (POI) Module. There are two uplink (input) ports and two downlink (output) ports. The isolation between DL1 and DL2 as well as between UL1 and

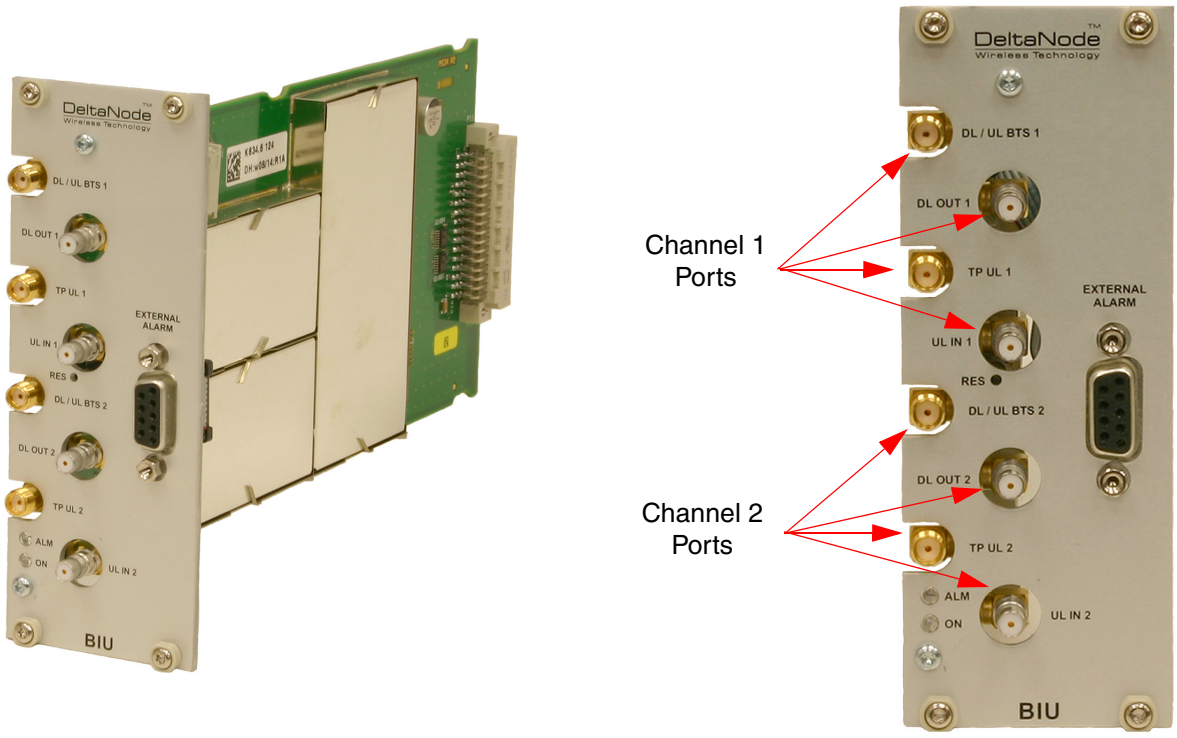

Figure 10: BIU Module. Front plate close-up also shown.

UL2 is > 50 dB. The ports that interface to the Base Station are SMA type (female). RF patch cables are used to patch the BIU ports to the customers Base Station and the POI Module.

Each downlink signal path in the module contains attenuation and filtering. One of the attenuation stages is adjustable and is used to adjust the signal strength to proper levels before feeding the signals into the POI module. In the uplink direction there is also filtering and attenuation as well as an amplifier stage. The adjustable attenuation stage is used to adjust the signal and the noise level into the base station uplink.

All connections necessary are made from the front of the BIU module itself. The maximum recommended input power to the BIU is 30 dBm. The module has high power alarms which activate at input signal levels > 30 dBm and low power alarms which activate at signal levels < 10 dBm. Signals with an input power higher than the recommended maximum can cause permanent damage to the module. It is therefore recommended that whenever connecting to high power base stations the customer place an inline attenuator between the base station and BIU module to ensure that the input power to the BIU can never exceed the specified maximum.

There is also an alarm port (DB9 connector) on the BIU module which in the future can be used to connect external alarms. This connector is currently not in use.

LED BEHAVIOR

The unit has two LEDs located on the front panel. One is the power on LED (green) and the other is the alarm LED (red). Both LEDs can indicate a number of states by different flashing behaviors. Refer to table 3**.** In an alarm state the web interface should be used to check the actual condition of the BIU module. The front panel alarm LED is designed to give a quick indication that an alarm condition exists and is also useful for locating an alarming BIU module when you are dealing with a rack that contains several BIU modules in it.

POI Module (Point of Interconnect Module)

The POI module contains four independent 1-to-8 splitter/combiners. The module is used in the Fiber DAS system to tie together signals between BIU modules and FOI modules in a multi-band or multi-operator system. Each of the 4 independent splitter/combiners has a COMMON port and 8 in/out ports (labeled 1-8). If you are using it as a combiner then you should connect the signals you want to combine to the ports 1-8 and you will receive the sum of the signals (minus insertion loss) on the COMMON port. Using it as a splitter then you should connect the signal you want to split/distribute to the common port. Each of the 8 output ports will then output the signal with equal signal strength at each port (minus insertion loss).

The POI module is a stand alone module designed to use 1 RU of rack space as shown in **Figure 11**. The module is not designed to plug into the master frame unit so it can be installed anywhere in the rack that is convenient for the customer. It is typically installed just below the master frame unit in most installations. This keeps the interconnect cables (QMA style connectors) reasonably short. The four independent splitter/combiner assemblies that make up the POI module are labeled as A through D.

FOI Module (Fiber Optic Interface Module)

The FOI module is responsible for converting RF signals in the downlink direction (from the base station) into optical signals that can be transmitted on a fiber cable to the remote unit. It is also responsible for receiving optical signals in the uplink direction from the Remote Unit and converting them back into RF signals which can be passed along to the base station. The FOI module is shown in **Figure 12**.

The fiber-optic interface can either be a single fiber interface (with WDM) or a dual fiber interface with separate RX and TX connectors. The type of FOI is ordered as needed when the Master Unit is specified. Each FOI can serve up to 4 Remote Units on a single fiber cable. The Remote Units must have different optical wavelengths in the uplinks to avoid interference. They can however, share the same optical wavelength in the downlink.

FUNCTIONAL DESCRIPTION

The FOI is powered from the master frame backplane and communicates via Ethernet with the other modules in the Master Unit. The FOI contains several adjustable attenuators which can be used to compensate for losses that occur before the FOI (e.g. in the POI) and for losses that occur on the fiber in the uplink. There are two sets of RF ports on the FOI that can be used to connect signals from two different strips in the POI. The FOI has a dual fiber interface style with separate uplink and downlink fiber optic connections.

There are two attenuators that can be set in the DL path, this allows for balancing the input signals from two different signal sources so that they can share the dynamics of the laser properly. The RF drive levels are measured and accessible in the web interface so that they can be checked. In the future alarm levels may be added to these test points.

This interface is designed to work with SC-APC connectors (7° angled physical connector) and sin-

Figure 11: POI Module.

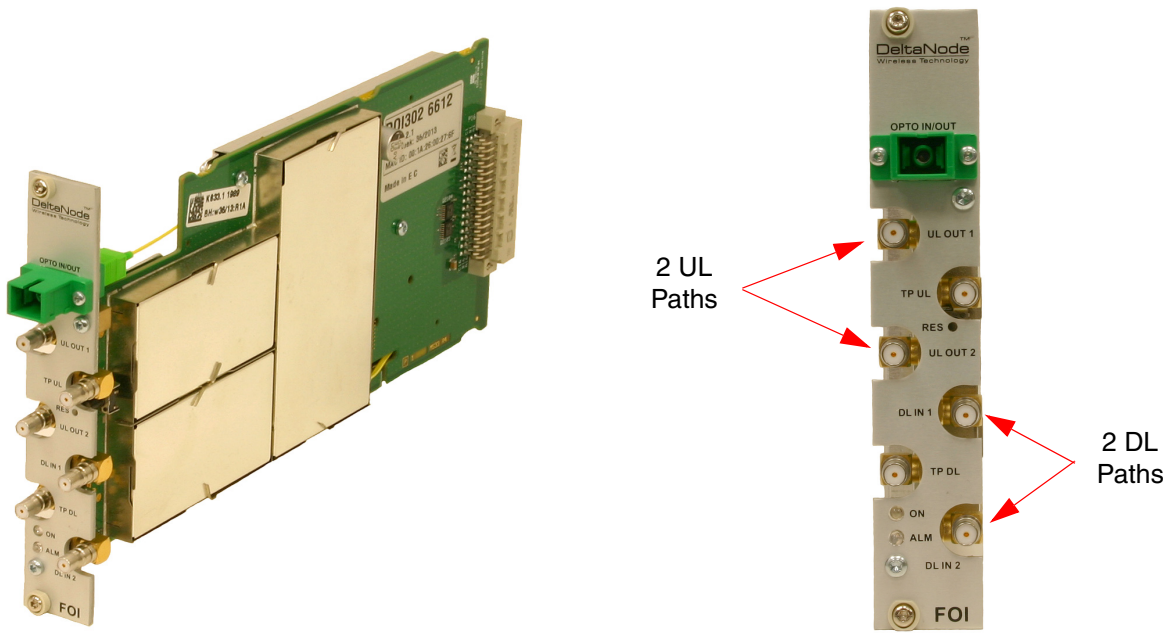

Figure 12: FOI Module. Front plate close-up also shown.

gle mode fibers only. All connectors between the master unit and the remote unit should be of angled type, otherwise problems with reflections will arise which may cause severe problems in the system.

The FOI has a nominal gain of 35 dB. The laser transmitter should see a maximum composite power in of approximately 0 dBm. This means that for 0 dB attenuation in the DL direction a maximum input of -35 dBm composite power is recommended (when attenuators are set to 0 dBm). If the DL attenuator is set to a higher value the maximum recommended input is adjusted accordingly. The output power of the laser is calibrated to 3000 µW. This can be used to check the loss over fiber in the remote because the remote reports the received optical levels. The loss may be different in the UL compared to the DL because of different wavelengths on the laser.

Safety and care for fibers

The laser is a Class 3b laser that produces invisible infra-red coherent light. Avoid looking into connected fibers and receptacles. Not safe to view with optical instruments. Always put the protection caps on unused fibers and receptacles.

Every time a fiber is disconnected and re-connected care should be taken to avoid dust to settle on the connector or in the receptacle. Clean with a dry fiber cleaning tool before reconnecting the fiber at all times. A single speck of dust can impact the transmission severely. Do not touch the fiber ends with your fingers. That will leave grease on the connectors and may cause severe problems.

CENTRAL GATEWAY COMPUTER

The central gateway computer (CGW) is the overall interface point for system management functions. The CGW computer is connected to the master unit and has routing, firewall functionality, alarm logging, and access control for the complete DAS system. Two types of CGW's are used, either the Remote Gateway Unit (RGW) or the Base Station Gateway Unit (BGW). The RGW is a smaller compact embedded solution while the BGW is a full featured Linux server that can be set up in many different ways. The gateway computer will assign IP addresses to all the subunits in the master unit and also for remote units when they are connected to the system. This will create a protected sub-net for the DAS system itself that should not be connected directly to a LAN. Connections to a LAN should only be made via the gateway computer.

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