DeltaNode Solutions

USER MANUAL

Release 15-01

DeltaNode™ Wireless Technology

Contents

1 Introduction

This document contains quick guidelines on how to operate the DeltaNode Fiber-DAS concept and how to install a Remote Unit on site, commission and maintain such a system for the life span of the entire installation.

When other manufacturers have converted off-air repeaters into fiber-fed repeaters, DeltaNode has developed the concept from scratch with fiber distribution in mind from the start. This allows for extremely good radio performance and we are proud of having the best in class noise figure of less than 3 dB for the whole system, antenna > remote unit > base station interface port.

1.1 RF on fiber

A fiber distributed antenna system (Fiber-DAS) is a very efficient way of transmitting radio signals over large distances. Up to about 25 km of fiber between the head-end and the remote unit is allowed, providing that the radio access technology (RAN) do not suffer timing issues and that the fiber loss is within the specification.

The main principle is to use an infra-red light source which is modulated with the combined radio signals that needs to be propagated. The fiber channel system is ultra wide-band, ranging from 88 MHz up to 2600 MHz and thus covering most types of radio communication systems such as FM broadcast, VHF communication radios (so called PMR systems), TETRA, GSM, CDMA, WCDMA and other radio access technologies that are available.

The dynamic of the fiber is good enough to tolerate multi-carrier, multi-band and multi-operator solutions this way, but of course they all share the available dynamics and if there are a very large number of carriers the fiber attenuation needs to be looked at of course.

Because most land mobile radio systems and cellular systems are using Frequency Division Duplex (FDD) this means that there needs to be either two separate fibers, one for the uplink (signals from the terminal towards the base station) and for the downlink (signals from the radio base station towards the terminal) or they may be multiplexed on the same fiber using different wavelengths.

The most popular way is to use wave-length division multiplexing (WDM) which is the normal configuration of the DeltaNode Fiber-DAS concept. However, separate UL/DL fibers can be used if it is necessary or desired.

- ✓ *Single mode fiber*
- ✓ *Angled connectors*
- ✓ *Optical loss < 15 dB*

Because the modulation is analogue the system requires the fibers to be of single mode type. All connectors used in DeltaNode equipment for Fiber-DAS are of SC-APC type with a 7° angle. It is very important that all connectors in patches et cetera between the Master Unit (MU) and the Remote Unit (RU) are angled; otherwise reflections are caused which will cause problems with the quality of the signals throughout the entire DAS system.

2 Installation guidelines

2.1 Health and Safety

DeltaNode DAS system is an advanced system and should be handled by skilled staff. DeltaNode is offering training of installation service providers in the case where this is necessary.

Read all available documentation and warnings before handling the equipment! Equipment failures due to improper handling are normally not covered by the product warranty!

Respect all warning signs on the equipment and in the documentation. Make sure to only operate the equipment on frequencies allowed to use. **Do not modify the equipment!** The equipment contains a Class 3B laser and the equipment is Class 1. **Never look into the Laser beam directly or indirectly, it is strong invisible light and may cause serious damage to human eyes!**

Always use protective hat on fiber and connector end when fiber is removed from socket! Always clean socket and connector after a fiber has been removed before you re-attach it again!

Make sure to keep passwords and other operational information away from unauthorized personnel!

- **DeltaNode DAS system is an advanced system and should be handled by FCC Licensee or FCC approved staff.**
- **Read all documentation and warnings before handling the equipment.**
- **Obey all warning signs on the equipment and in documentation**
- **The equipment may get hot during operation, do not operate outside permitted temperature range and keep away from heat sensitive material!**
- **Always disconnect the unit before opening; opening is not intended to do in the field!**
- **The equipment contains ESD sensitive components. Open the equipment ONLY in a safe location designed for handling ESD products and use grounding devices!**
- **The product transmits RF signals. Make sure to keep away from Antennas and other radiating devices!**
- **Avoid overheating by sunlight exposure!**
- **If the RU may be exposed to strong direct sun, use sun protector plate provided by DeltaNode! (see picture below)**

- **Consult a FCC licensee or other applicable regulation body for details on RF requirements and safety issues on RF!**

- ***Warning!***
  It is NOT recommendable to use markets unknown manufacturers for the passive components within the DAS. Before using the passive components, the datasheets of such components should be revised closely by the responsible network provider and all link budgeting calculations should be done accordingly.

2.2 Installing the Master Unit

All equipment must be properly grounded. This means that the ground peg in the mains connector for both head-end gear (Master Unit) and remote gear (Remote Units) must be connected to Phase, Neutral and Ground in a proper way before the plug is inserted in the unit.

The chassis of the remote and the rack of the master unit should be grounded to a potential bar or safety grounding bar when operated. **All electrical installations should be done by an FCC Licensee or/and a certified electrician only!**

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

Figure1: Master Unit Frame (example1)

Figure2: Master Unit Frame (example2)

- Mount the BMU frames into cabinets
- Mount ethernet switches and cables
- Mount power cables (use P101 on the frames for primary power, P102 for secondary power)
- Install BGW and connect cables
- Insert all units
- Start switches
- Start BGW, wait for a few minutes until it comes up and log into it to start optimizing the system

2.3 Installing the Remote Units

The remote units have two different types of mounts.

1. The standard wall mounts. This mount is fixed to the wall with suitable bolts and then the remote is just slided in and fixed with 4 screws (included) so it cannot escape the wall mount. Snap in the complete single or dual chassis into the Wall bracket. Tighten the four bolts (two on each side)

   See Pictures Below!

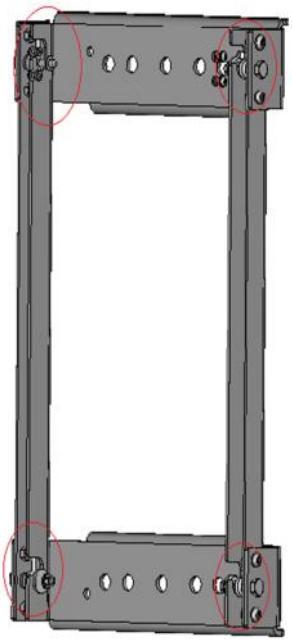

Figure 2:Wall mount frame

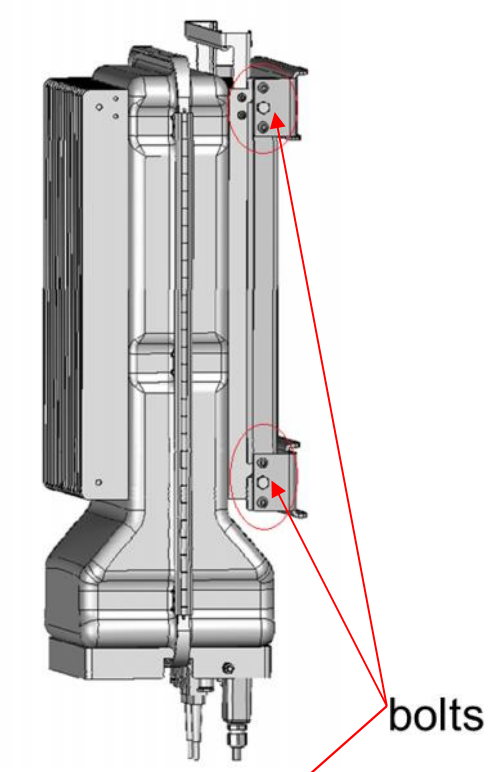

Figure 3: RU in the frame

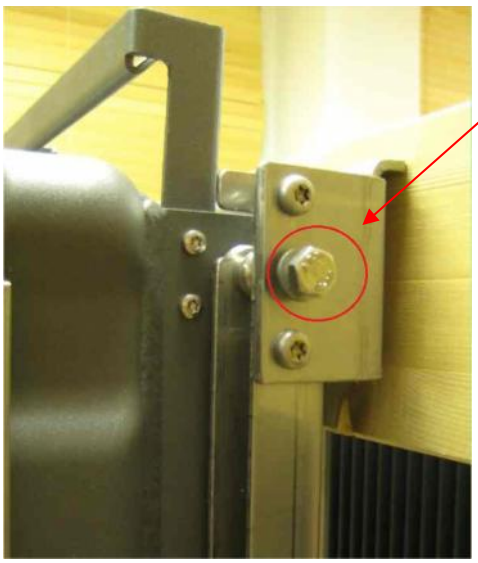

Figure 4: Tightening Bolt of the frame

2. The pole mounts. The pole mount kit is an addition to the wall mount kit. They are first assembled together, and then mounted on a pole after which the remote unit is slid in and fixed with 4 screws (included), as seen in pictures above.

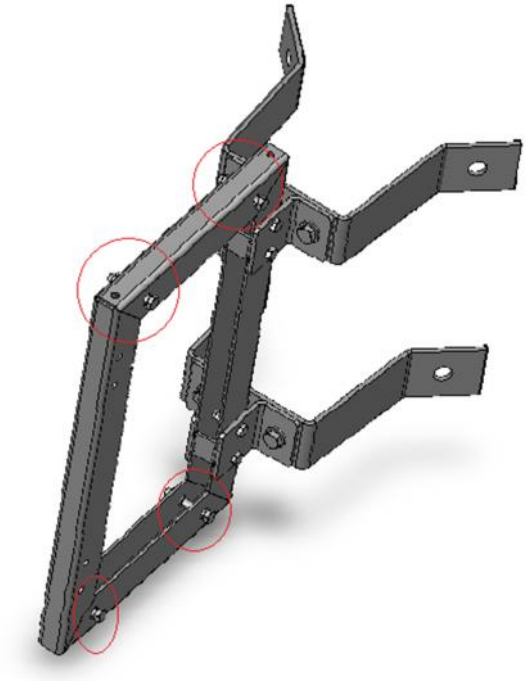

Figure 5: Pole mounting frame

3. Connectors and connections of the RU are listed in the picture below.

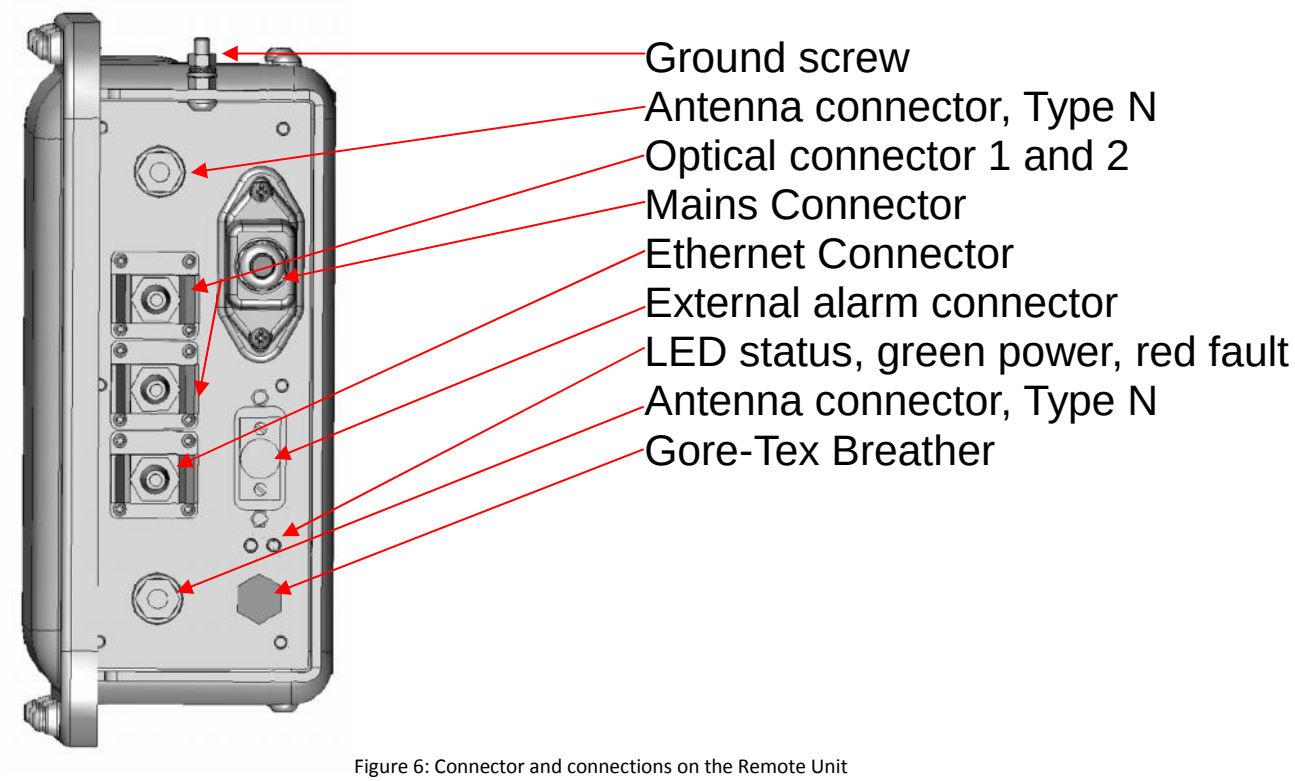

Figure 6: Connector and connections on the Remote Unit

After this the fibers should be connected in the fiber optical port. This can either be done with standard SC/APC fibers or a special heavy-duty SCRJ-cable for outdoor and rough environments (IP65 class). Antenna jumpers are connected to the N-type or DIN 7-16 connectors at the bottom, and finally the power cord is connected using an IP65 protective housing (included, see picture below).

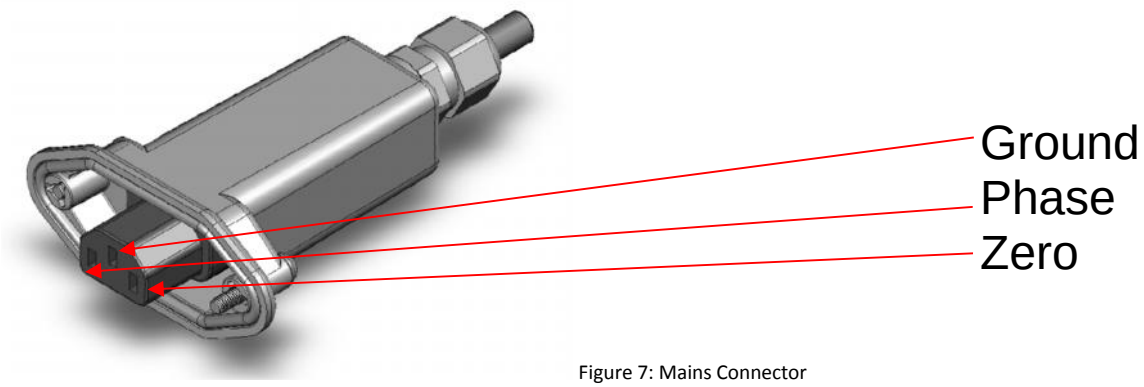

Figure 7: Mains Connector

When the power is connected the remote automatically turns on and will attempt to connect to the master unit over the fiber.

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After the successful mounting installation and powering the Remote units, user can now start optimizing the DAS system and accessing the Remote units through the Base Station Gateway.

Login and access information such as username and passwords are provided separately.

3 System Description

3.1 Purpose

The DAS system is intended to distribute wireless services for voice and data over dedicated fiber from Master units located at the BTS site hotels to small Remote units intended for discrete mounting in an urban or suburban environment on poles or other outdoor locations. The system is built on multiple wideband RF links both uplink and downlink running on a separate fibers between the BTS site and Remote unit using multi drop for best fiber usage and CWDM technology.

3.2 General

The system has either a common optical cable for its signal paths (uplink and downlink) or separate optical cables, all units are equipped with remote control and the communication is performed via a sub-carrier channel on each optical link. Every remote unit has a WEB interface that is accessible from a standard PC with a WEB browser. In the master unit there are low power TX and Rx RF cables connection from the various BTS's to the optical interface through some splitters. The system is managed by a CGW, Central Gateway that is the overall interface point of the system for management function.

The CGW can interface to top level O&M systems, it has routing and firewall functionality alarm log and access control for the complete DAS system. It has the function to interconnect all control communication, monitor the modules in of the DAS system and send alarms to a common point via Email and/or SMS.

3.2.1 Specifications:

Preliminary System Requirements

- Optical link budget <15dB
- Support CWDM/multicolor operation and multidrop.
- Support wireless systems in the frequency range of 88-2200 MHz

Preliminary Specifications and Requirements – NOC/O&M Software

- Web based
- SNMP export capability (option)
- Real Time Operation
- IP based communication links
- SMS export capability
- E-mail export capability

The Fiber-DAS system consists of two major parts; Master Unit and Remote Unit. The Master Unit (MU) and one or more Remote Units (RU) are connected to each other using optical fiber link.

3.3 Master Unit

The Master Unit consists of a 19 inch frame rack with modules that are selected depending on the system design. Generally all Master Units contains a power supply, at least one Base Station Interface Unit (BIU), an RF splitter/combiner unit called the Point of Interconnect (POI) and minimum one Fiber-Optic Interface card (FOI).

3.3.1 MFU – Master Frame Unit

The Master Frame Unit houses the other modules such as power supplies, fiber-optic interface cards and base station interface units.

Figure 8: Master Unit

The frame in the picture shows a frame equipped with 3 base station interface units, 6 fiber-optic interface cards and one power supply (as just an example).

Functional description

One frame supports several modules which can be placed anywhere in the frame as well as a combination of several different types of units in a frame. There are 16U positions in the frame that can be utilized. The modules have different widths which can be found in each module's specifications in the following sections of this manual.

This means that one shelf can house up to 4 power supplies or 8 base station interface cards or up to 16 fiber-optic interface cards. Each frame needs at least one power supply, but they do not necessarily have to be placed in the frame that they power. Quite often a system has more than one power supply and they are usually placed together in one frame for easy access.

Each frame has two Molex connectors that can be connected to a power supply. This allows for a primary and a redundant power supply to be connected to it to ensure operation even if one power supply should fail.

The frame also contains fans used to ventilate the units housed in the frame. These are high quality fans that have a high MTBF.

3.3.2 BIU – The Base Station Interface

The BIU is the interface used between the operator's base station and the Fiber-DAS system. This module has several RF connectors on the front panel and it contains duplex filters (optional) or separate uplink/downlink paths which can be chosen depending on the needs for the connection to the base station. In most cases the duplexed version with a combined DL/UL port is used.

Figure 1: Base station interface

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.

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.

Using it as a splitter means you connect the combined signal to the COMMON port and you can then receive 8 ports with equal signal strengths on ports 1-8 (minus insertion loss).

3.3.3 FOI – The Fiber Optic Interface unit

The FOI is the unit responsible for converting the RF signals in the downlink to fiber-optical laser that can be transmitted over the fiber link to the remote unit. It is also responsible for receiving the laser light transmitted by the Remote Unit and convert it back to RF signals that will then usually go into the POI and then later in to the BIU and further to the Base Station.

The fiber-optic interface can either be a single fiber interface (with WDM) or a dual head with separate Rx and Tx connectors. This is ordered as needed when the Master Unit is specified.

Each FOI can serve up to 4 Remote Units over a single fiber.

Figure 2: Fiber optic interface

Safety and Care for fibers

The laser is a Class 3b laser that produces invisible infra-red coherent light. EXTREMELY IMPORTANT is to avoid looking into fiber connectors and receptacles. Not safe to view with optical instruments. Always use the protection caps on not used 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.

Functional description

The output power of the laser is calibrated and tuned to 3 000 µW.

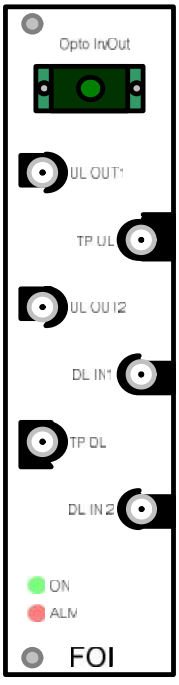
The FOI is powered from the rack backplane and communicates with Ethernet with the other modules in the Master Unit.

The unit contains adjustable attenuators.

This interface is designed to work with SC-APC connectors (7° angled physical connector) and single 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 DAS- system.

✓ *Single mode fiber*
✓ *Angled connectors*
✓ *Optical loss < 15 dBo*

Ports of the FOI



OPTO IN/OUT
This is the receptacle for the optical fiber. The illustration shows the module with built in WDM (combined Rx/Tx).

UL OUT 1/2
These are the RF ports that normally are patched to the POI for interconnecting and then further on to the BIU.

DL IN 1/2
These are the RF ports where the signal in the DL from the POI is patched into the FOI for conversion to laser light and further to the RU.

TP UL/DL
These are test ports that can be used to check the signal levels or noise in the DAS- system.

There are also two LED´s on the unit which can be used for visual check of the current status of the FOI. Green led for operation status and the red one for current alarm status.

3.4 Remote Unit

There are many different kinds of remote units with a wide range of gain and output power to cater to many different needs. A low and medium power unit can house up to 4 different frequency bands in one unit, the high power versions can handle up to 2 different bands in one single unit.

Chassis types

RUs comes in mainly two different chassis, a single compact chassis for 1-2 bands and a dual chassis for up to 4 bands. This is how they can be configured:

Chassis type	Low	Medium	High
Single chassis	1-2	1-2	1-2
Dual chassis	3-4	3-4	3-4

Table 1: Chassis types

Figure 3: Dual chassis remote

Figure 4: Single chassis remote

It is also possible to have combinations of the above. For example it is possible to build a dual chassis with 2 medium power bands and 1 high power band in the same remote. Each side of a dual chassis is virtually identical to a single chassis remote unit. This ensures unparalleled flexibility when building multiple operator / multiple band solutions.

A dual chassis may have 1-2 optical remote units (FOR). This way they can be fed from different directions for redundancy.

Remotes can also be daisy-chained by way of RF cables, meaning up to two chassis can share the same fiber-optical interface providing up to 8 bands in a single location. Variants are available upon request.

Commonly for all Remote Units is their excellent noise figure, contributing to an overall noise figure for the whole system from remote to head-end into the base station of < 3 dB for the RF link.

Both chassis complies with IP65 protection for use in any environment. The coating is a durable coating which eases the convection cooling. No fans are used for the DeltaNode Remote Units. Both chassis are available both with wall and pole mounting kits as requested.

External Antenna´s that are most commonly used in combination with DDS Remote Unit family for outdoor environment are 17 dBi gain antennas. Antenna used for MPE radiation calculation is a 17 dBi antenna.

Most commonly used manufacturers antennas in combination with DeltaNode DAS systems to our knowledge are Cellmax, Kathrein and Amphenol antennas, and we believe that these manufacturers holds best RF quality and performance.