Zinwave's Unified Connectivity Platform Installation Manual

Edition

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About this guide

This guide contains hardware installation and software configuration & operating instructions for the Zinwave UNItivity System.

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

Safety notices

Cautions and warnings

This unit is fitted with a 5A 20x5mm anti-surge ceramic fuse (RC). For continued protection against risk of fire, replace only with same type and rating of fuse. Keep all product information for future reference.

High voltages exist inside the product; do not remove the lid or base: No user serviceable parts inside.

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection is intact) only. No operator serviceable parts are inside this system. Refer servicing to an authorized Zinwave Ltd service centre. To prevent electrical shock, do not remove the covers.

Notes

- Read this User Manual and follow all operating and safety instructions.
- Position the power cord to avoid possible damage; do not overload wall outlets.
- Do not place this product on or near a direct heat source, and avoid placing objects on the terminal.
- Do not operate this device near water or in a wet location.
- Use only a damp cloth for cleaning. Do not use liquid or aerosol cleaners. Disconnect the power before cleaning.
- Installation of the UNItivity system must be contracted to a suitably trained and competent professional installer.

Declaration of Conformity

- Hereby, Zinwave Ltd, declares that this Distributed Antenna System is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
- Zinwave Ltd, vakuuttaa tŠten että Distributed Antenna System tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
- Hierbij verklaart Zinwave Ltd, dat het toestel Distributed Antenna System in overeenstemming is met de essenti‘le eisen en de andere relevante bepalingen van richtlijn 1999/5/EG
- Bij deze verklaart Zinwave Ltd, dat deze Distributed Antenna System voldoet aan de essenti‘le eisen en aan de overige relevante bepalingen van Richtlijn 1999/5/EC.
- Par la prŽsente, Zinwave Ltd, dŽclare que ce Distributed Antenna System est conforme aux exigences essentielles et aux autres dispositions de la directive 1999/5/CE qui lui sont applicables
- HŠrmed intygar Zinwave Ltd, att denna Distributed Antenna System stŒr I šverensstŠmmelse med de vŠsentliga egenskapskrav och švriga relevanta bestŠmmelser som framgŒr av direktiv 1999/5/EG.
- Undertegnede Zinwave Ltd, erklærer herved, at følgende udstyr Distributed Antenna System overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF
- Hiermit erklŠrt Zinwave Ltd., dass sich dieser Distributed Antenna System in †bereinstimmung mit den grundlegenden Anforderungen und den anderen relevanten Vorschriften der Richtlinie 1999/5/EG befindet
- ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Zinwave Ltd, ΔΗΛΩΝΕΙ ΟΤΙ Distributed Antenna System ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ
- Con la presente Zinwave Ltd, dichiara che questo Distributed Antenna System è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.
- Por medio de la presente Zinwave Ltd, declara que el Distributed Antenna System cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE
- Zinwave Ltd, declara que este Distributed Antenna System está conforme com os requisitos essenciais e outras disposi□›es da Directiva 1999/5/CE.

Optical UNIremote interference

This is a “Class A” product (as defined in EN 55022). In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

FCC compliance and interference statements

UNIhub. This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1) This device must accept any interference and

2) This device must accept any interference received including interference that may cause undesired operation

Changes or modifications not expressly approved by Zinwave Ltd. could void the user’s authority to operate the equipment.

UNIremote.

This device complies with Part 22, Part 24, Part 27, Part 74 and Part 90 of the FCC rules. Changes or modifications not expressly approved by Zinwave Ltd. could void the user’s authority to operate the equipment. For a list of services, please contact Zinwave.
UNIremote with FCC ID: UPO302-0007 only supports services in the following bands of operation:

- 150.0 – 174.0 MHz
- 406.1 – 454.0 MHz
- 456.0 – 512.0 MHz
- 470.0 – 608.0 MHz
- 614.0 – 698.0 MHz
- 698.0 – 824.0 MHz
- 851.0 – 869.0 MHz
- 869.0 – 894.0 MHz
- 928.0 – 929.0 MHz
- 931.0 – 935.0 MHz
- 935.0 – 940.0 MHz
- 1930.0 – 1990.0 MHz
- 2110.0 – 2155.0 MHz

IC compliance statement

The nominal passband gain is 25 dB and the nominal bandwidth is 150 MHz to 2.94 GHz.

The rated mean output power is 20 dBm and the input and output impedances are 50 ohms

The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device."

Rack mount instructions

Double Pole / Neutral Fusing.

- Elevated Operating Ambient – If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient. Therefore, consideration should be given to installing the equipment in an environment compatible with the maximum ambient temperature (Tma) specified by the manufacturers. UNIhub has a Tma of 45˚C.
- Reduced Air Flow – Installation of the equipment in a rack should be such that the amount of air flow required for safe operation of the equipment is not compromised.
- Mechanical Loading – Mounting of the equipment in the rack should be such that a hazardous condition is not achieved due to uneven mechanical loading.
- Circuit Overloading – Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
- Reliable Earthing – Reliable earthing of rack-mounted equipment should be maintained. Particular attention should be given to supply connections other than direct connections to the branch circuit (e.g. use of power strips).
- Disconnect Device – The socket outlet shall be installed near the equipment, be easily accessible and will act as the main point of disconnect for the UNIhub.
- Keep these Instructions in a safe place.

Manual Handling – The UNIhub is heavy and care should be taken to avoid inquiry when lifting and handling this equipment. To avoid damage to the equipment do not support the whole weight of the UNIhub using only 1 handle.

General safety considerations

The installation of electrical supplies in support of UNItivity products shall be in accordance with national and local regulations.

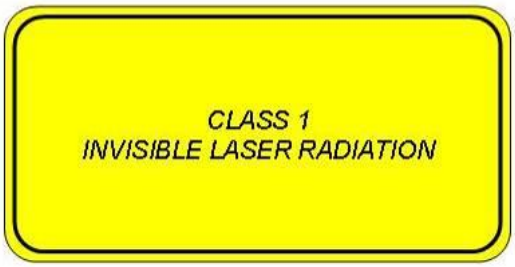
Other aspects of the installation for UNItivity products and interconnecting cabling shall be in accordance with the following standards:

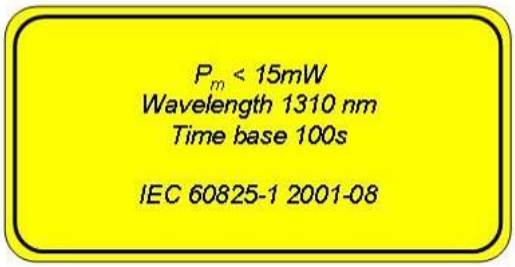
- EN 50174 series: Information technology – Cabling installation
- IEC 60825-2: Safety of laser products – Part 2: Safety of optical fiber communication systems (OFCS)
- This equipment complies with 21CFR1040 - Performance Standards For Light-Emitting Products (FDA).

RF exposure

This equipment complies with FCC radiation exposure limits set forth for an occupational/ controlled environment. This equipment should be operated with a minimum distance of 20cm between radiator and your body.

Optical Safety Precautions





- Do not remove the fiber Port dust covers unless the port is in use. Do not stare directly into a fiber Port.
- Cover any unconnected fiber ends with an approved cap.
- Do not stare with unprotected eyes at any broken ends of the fiber.
- Use only approved methods for cleaning optical fiber connectors.
- Do not make any unauthorized modifications to this fiber optical system.
- No warning signs are required as it is a Class 1 hazard.
- Use Class 1 test equipment.

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Installation, use and storage

UNItivity is designed to operate in conditions conformant with Pollution Degree 2 as defined in IEC 60950 (the normal environmental class for offices).

The installation of sub-assemblies into the main units of UNItivity shall only be undertaken if precautions required by IEC/TS 61340-5-1 have been taken.

This covers the installation of Zinwave Optical Modules into the UNIhub Unit.

WARNING: 

CLASS I PLUGGABLE EQUIPMENT TYPE A as defined in IEC 60950. This equipment is intended for connection to other equipment or a network, relies on connection to protective earth and must be connected to an earthed mains socket-outlet.

Country specific warnings:

Finland "Laite on liitettŠvä suojamaadoituskoskettimilla varustettuun pistorasiaan"
Norway “Apparatet må tilkoples jordet stikkontakt”
Sweden "Apparaten skall anslutas till jordat uttag

CAUTION: 

Operating voltage is autosensing 120V or 230V.

Signal and input power

CAUTION: 

The input power to the UNIhub Unit when configured as a Primary should not exceed +15dBm. Power levels greater than +25dBm will damage the unit

CAUTION: 

The input power to the Zinwave UNIremote should not exceed -10dBm. Power levels greater than 0dBm will damage the unit

CAUTION: 

The total broadband composite output power of the UNIremote is limited to +18 dBm in Europe and +20 dBm in the USA and Canada. The maximum allowed EIRP in the USA & Canada is +28 dBm which corresponds to an antenna gain of 8 dBi. Contact Zinwave for the maximum output power in other regions

CAUTION: 

The maximum allowed antenna gain when operating in Europe in the 2.4GHz ISM band shall be +2 dBi. Contact Zinwave for further information regarding use of the ISM band in other regions

Table of Contents

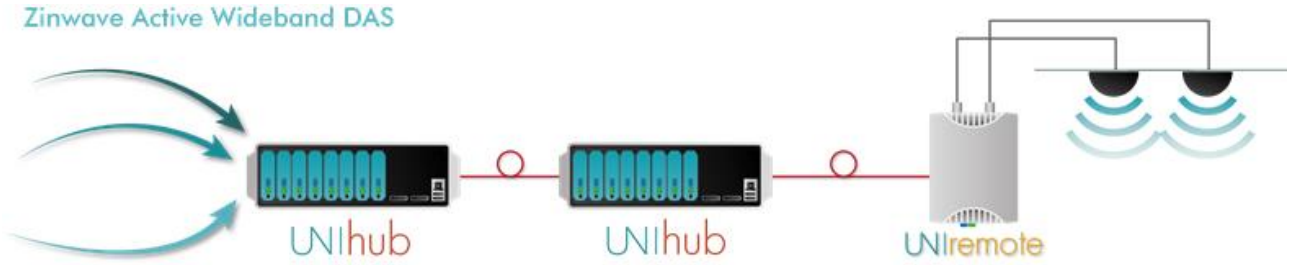
1 Overview of UNItivity, Zinwave's unified connectivity platform

1.1 *Overview*

UNItivity is a unified connectivity platform for in-building wireless and IP data coverage.
Based on advanced photonics and wideband amplifier technology, UNItivity has been designed to provide Ubiquitous RF coverage over large areas and to support a multitude of wireless and IP data services, irrespective of carrier frequency or signal protocol.

The wideband design is unique in its offering of inherent support for all radio standards, i.e. systems carrying a multitude of different services can be implemented without requiring multiple infrastructure overlays, or specific band units. In addition, new services can be easily added to the distribution system without needing to add more components to the infrastructure.

Enhanced scalability is achieved through a double-star architecture (UNIhub configured as Primary or Secondary and up to 64 UNIremote), while also supporting small site solutions in a single star configuration (with up to 8 UNIremote). The UNItivity platform can thus be used to provide cost-effective coverage in small, medium and large area installations.



A modular system design adds another dimension of flexibility to UNItivity, allowing use of the same set of equipment for a wide variety of different installations. All UNIhub use the same chassis with their function defined by the modules inserted in them. Only those modules required need be inserted, allowing each installation to "grow on demand", and therefore be tailored to suit almost every environment and building topology in the most cost-effective way.

Throughout the document the UNItivity products will be referenced as follows to simplify explanation of functionality and operation:-

- UNIhub – Configured as a Primary Unit – **PH**
- UNIhub – Configured as a Secondary – **SH**
- UNIremote – **RU**
- Optical Module – **OM**
- Service Module - **SM**

1.1 Key features

- Simple 3-stage fiber-optic DAS: one **PH** distributes to eight **SH**, each of which distributes to eight **RU**. This gives a maximum of 64 **RU** fed from one **PH** (when more **RU** are required, more than one **PH** can be used within a system).
- The same components support a 2-stage, single star configuration: one **PH** distributing to 8 **RU**.
- Wide frequency range: 150 – 2700 MHz, with both FDD and TDD systems supported.
- Each UNIhub has four inputs. All four are used as service inputs in the **PH**. In the **SH**, one input is used for an **OM** which will form the connection to the **PH**.
- Only system to deliver truly broadband solution over multimode fiber (MMF), but can also be used over single mode fiber (SMF).

- Maximum total supported cable distances: The maximum fiber loss per link is 5dBo. This corresponds to the following typical lengths:
  - 550m for MMF with modal bandwidth of at least 500MHz.km @ 1300 nm
  - 2000m for SMF. Greater distances may be possible following an accurate measurement of the optical loss
  - Self-calibrating system with gain levels adjusted automatically to accommodate different cable lengths
  - Hot-pluggable modules used in both **PH** and **SH**
  - Web based network management with SNMP monitoring
  - Unique service distribution matrix on the UNIhub.

Zinwave's patented technology allows the multimode or single mode optical fibers specified for structured (or generic) cabling by the following standards to be used as the transmission system:

- North America: ANSI/TIA/EIA-568 series;
- European: EN 50173 series;
- International: ISO/IEC 11801.

NOTE: Optimal performance of UNItivity may require the re-termination of the optical fibers within legacy multimode optical fiber infrastructures installed using components meeting the above-mentioned standards.

The Zinwave transceivers within the UNIhub and antenna units are "fiber agnostic" i.e. they can be used with either 50/125 mm or 62.5/125 mm MMF, or with SMF. UNItivity channels can be up to 550 metres long provided that the MMF cable has a modal bandwidth of at least 500MHz/km @ 1300 nm.

NOTE: Channel lengths of up to 2000 metres can be delivered, using the same UNItivity System components, over SMF cabling.

This length of interconnection is more than adequate to facilitate a high quality, broadband, in-building coverage extension system for multiple, simultaneous wireless feeds. Without Zinwave's technology, such distances can only be achieved in most scenarios by expensive re-cabling of buildings using coaxial cables or single mode optical fiber, or by reverting to narrowband techniques which restrict the systems' capability.

Zinwave's unified connectivity platform is ideally suited to applications where multiple cellular and/or WLAN services are required and can be easily configured for various deployment scenarios such as: at campuses, large high-rise buildings and multi-tenanted facilities.

2 System architecture

The UNItivity platform is built up of UNIhub, **PH** or **SH** units and **RU's**. Smaller systems comprise a single **PH** and up to 8 **RU's**. Larger systems can comprise one or more **PH** each of which can serve up to eight **SH** and hence up to sixty-four **RU's**).

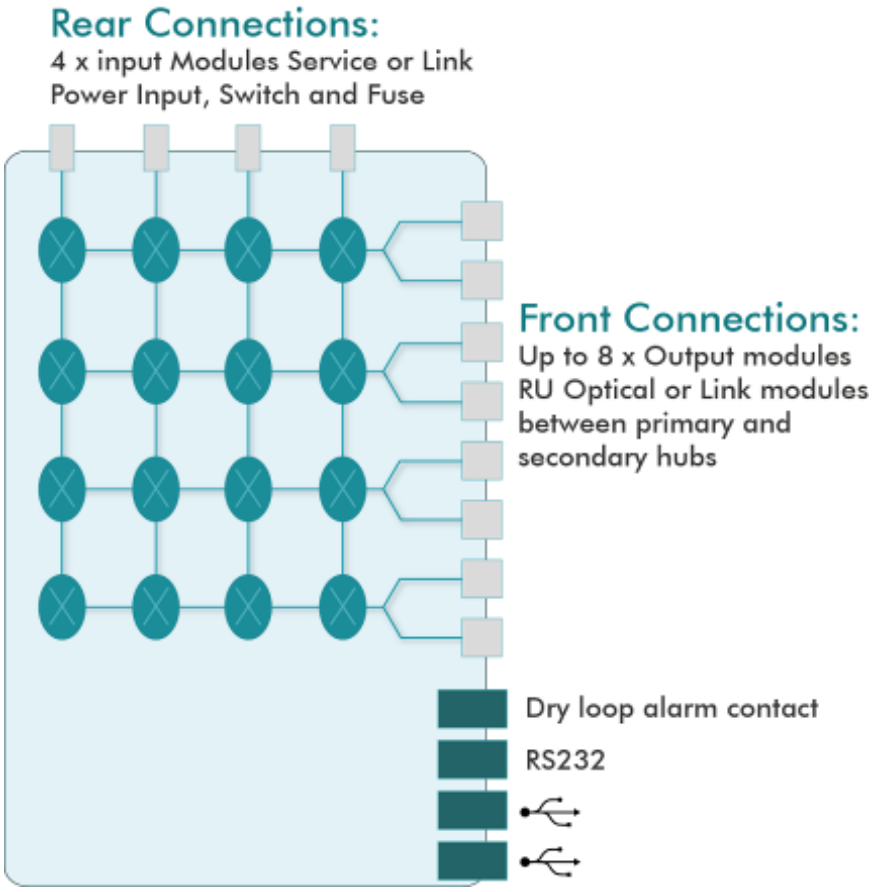
2.1 The components

2.1.1 UNIhub configured as a Primary:

The **PH** interfaces to service sources such as base stations or repeaters via Service modules (**SM**). It can be equipped with up to 4 **SM** in the rear which accept signals from any service in the range of 150-2700 MHz. It can connect to a **SH** in a double star configuration, direct to **RU** in a single star configuration, or a mixture of both.

Each UNIhub can be equipped with up to 8 Optical modules (**OM**) in the front to connect via optical fiber to a **SH** or **RU**. Note Only two UNIhub can be daisy chained together.

The PH schematic is shown below:



2.1.2 UNIhub configured as a Secondary:

SH interfaces to a **PH** through an **OM** fitted in the rear and distributes and receives RF signals from the **RU**. Up to **OM's** can be fitted in the front to connect via optical fiber to 8 **RU's**.

The switch matrix within the UNIhub, independent of configuration allows for further control over distribution of RF signals through the platform.

2.2 UNIhub Plug in Modules

2.2.1 Service Module (SM)

SM's, fitted to the rear of the **PH**, provide connection of the RF signal sources (e.g. BDA, BTS, and WLAN access point) via a pair of simplex N-type female connectors per RF port. The ports are labelled A to D for connecting up to four RF transceivers. The ports labelled "IN" are connected to the transmit port of the RF transceiver (= downlink). The ports labelled "OUT" are connected to the receive ports of the RF transceivers (= uplink).

2.2.2 Optical Module (OM)

Up to 8 **OM's** can be fitted to the **PH** for connection to **SH** in a double star configuration or direct to up to **RU** for a single star configuration. Up to 8 **OM** can be fitted to the **SH** for connection 8x **RU's**, plus 1 (rear) for connection to the **PH**

The **OM** have an angled SC connector (APC-SC) in the transmit direction and a straight SC connector (PC-SC) in the receive direction.

All modules require an appropriate Zinwave patch cord irrespective of the existing or installed fiber and connector type

2.2.3 UNIremote (RU)

The **RU** defines the final cell coverage, communicates via optical link to UNIhub and receives and amplifies signal from user, hand held devices, laptops, mobiles phones

An **RU** is a small wall or ceiling mountable units which amplify the received signals for transmission over a wireless link (in the case of the downlink signals) and amplify the received wireless signals for transmission over the optical link (in the case of the uplink signals).

2.3 Antenna

The Zinwave UNItivity Platform can use a variety of antennas connected to the **RU** via coaxial cable. The choice of Antenna will depend on the service requirement within the operational bandwidth of the system.

It is important to ensure that any installed antennas meet the Tx/Rx isolation requirements detailed in this document, and that they are installed in accordance with all relevant safety and exposure regulations

2.4 Configuration and Control

The UNItivity platform provides a built-in Element Management System (EMS), for centralised monitoring, and configuration. With a user friendly web interface, the management features can be

accessed using a standard Internet browser, and standard alarms management tools, thus not requiring any proprietary equipment or software.

Configuration and set up of the system is detailed in the “Configuration and Control Guide”.

3 Key Installation specifications summary

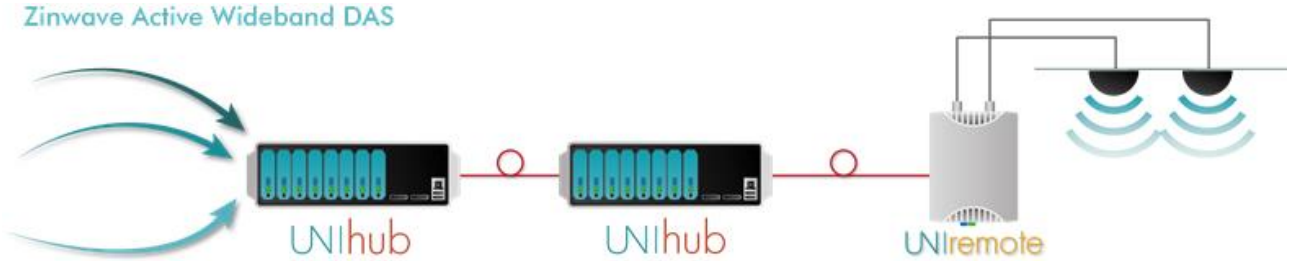
Fiber specification	
Optical Loss per link	<5dBo
Optical Return Loss (reflection)	Better than 30dB
Recommended Fiber type	Single mode
Recommended connector type	APC
Antenna isolation	Better than 40 dB between Tx and Rx antennas
Maximum Distance between Centralized power supply and **RU**	At least 200m (using all cores/4 pairs of CAT5 cable)

4 Hardware Installation

This chapter explains how to install a UNIhub, UNIremote and Antennas.

4.1 Overview

Given the wide range of possible configuration with the UNItivity platform this installation manual details the installation steps required to set up a dual star configuration. Alternative configuration installation will utilise a subset of these instructions.



Simple dual-star configuration to illustrate installation procedures

While all locations are different it is recommended that UNItivity hardware is installed in the following order:

- Install the **PH** into a 19" rack.
    - Provide mains power to **PH** and switch on.
    - Populate the **PH** with required number of **SM**,
    - Populate the **PH** with required number of **OM**.

- Install the **SH** into a 19" rack.
    - Provide mains power to **PH** and switch on.
    - Populate the **PH** with required number of **OM**.

- Install **RU's** and Antennas
- Make optical and RF connections:
    - Connect **PH** and **SH** via fiber infrastructure.
    - Connect UNIremote to **PH** and **SH**.
    - Connect Antennas to **RU's**
    - Apply power to **RU's**
- Connect service inputs to **PH**.

Once you have done this, you're ready to configure your system using the pre-installed software, via a web browser. This is explained in the "Configuration and Control Guide".

4.1.1 Module types

Before installing modules, it may help to understand what each module does, and where it can be installed (i.e. front or rear panel of a UNIhub):

Zinwave UNItivity Module types

		Installed in?		
Module	**Description**	**Primary**	**Secondary**	**Connectors**
SM	Input of RF signal sources (e.g. BDA, BTS,)	Rear slots only	N/A	N-type female
OM	Fiber (SM APC, MM PC) link between UNIhub or **RU's**	Front slots only	Rear slots (connection. to **PH**) Front slots (connection to **RU**)	SC duplex (APC Tx PC Rx)

4.1.2 Slot numbering

The slots on the front and rear panels adhere to a numbering system that is reflected in the web-based configuration application:

- Front (from left to right, looking from the front of the unit) slots 1 to 8
- Rear (from right to left, looking from the rear of the unit) slots A to D

4.2 Installing the UNIhub

CAUTION: 

UNIhub is designed to have front to back air flow and the installation of the equipment in a rack should be such that the amount of air flow required for safe operation of the equipment is not compromised.

4.3 Install the UNIhub into a rack

CAUTION: 

UNIhub are heavy 3U units (14.5kg) which must be supported at the front when installed into a 19" rack.

CAUTION: 

Manual Handling – UNIhub is heavy and care should be taken to avoid inquiry when lifting and handling this equipment. To avoid damage to the equipment do not support the whole weight of a UNIhub using only 1 handle.

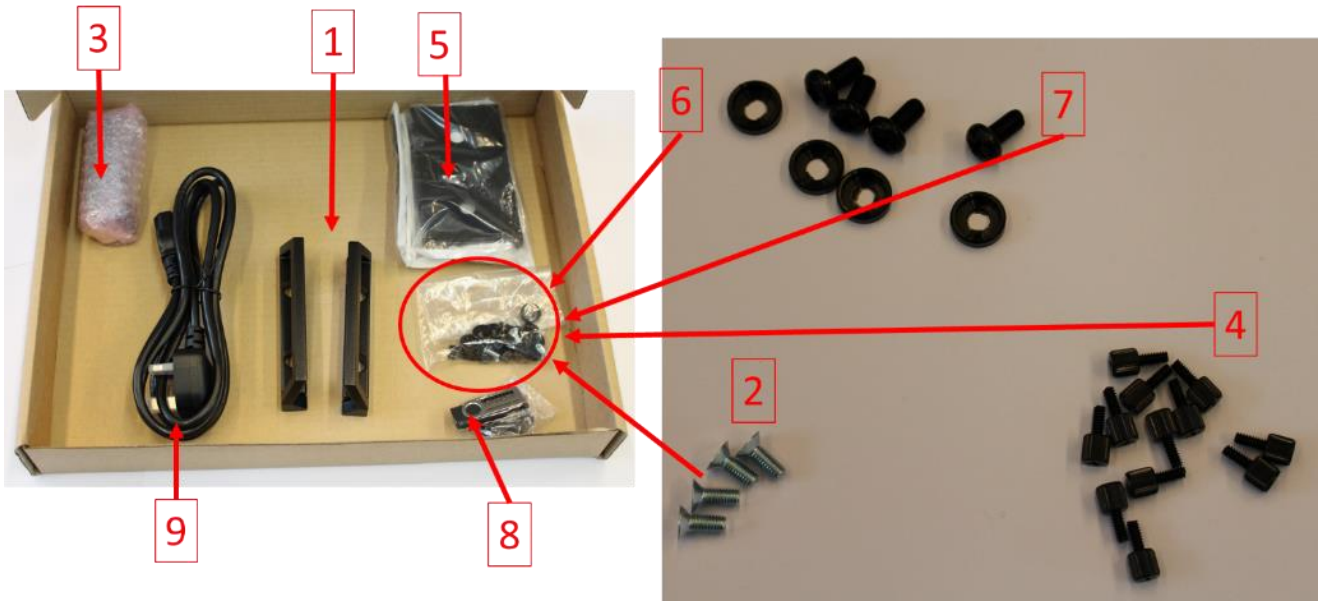
There are many 19" rack systems on the market of various depths. It is essential that the weight of the UNIhub is supported at the front. If it is not possible, alternative support mechanisms must be used such as front-to-rear chassis runners or fully supported shelves.

It is beyond the scope of this manual to cover all rack depths and mounting systems. Here we give an example installation using the supplied rack-mounting brackets.

4.3.1 Mounting Kit

Each UNIhub is delivered with an accessory box. This includes the following parts:

	Zinwave part Number	Qty	Part detail	Function
1	142-0231-01	1	PENTAIR INPAC HANDLES (PAIR)	Handles for UNIhub
2	128-0016	4	SCREW M5X12 CSK POZI STL ZINC	Handle screws
3	142-0048-05	12	3000 HUB MODULE BLANK PLATE	Blanking plates for unused slots
4	128-0043	12	SCREW THUMB 6-32X8MM PC CASE	Fixing screws for blanking plates
5	142-0232-01	2	PENTAIR RECESSED ANGLE BRACKET	Mounting brackets for Open frame racks
6	128-0113	4	M6 CUP WASHER BLACK	Mounting Bracket washers
7	128-0112	4	SCREW M6x12 PAN POZI STL BLACK	Mounting Bracket screws
8	507-0003-02	1	EMS USB	Latest software for UNIhub
9		1	Mains cord for hub (country specific)	



The UNIhub is designed to mount directly into a 19 inch rack framework with no additional mounting bracketry.

To install the UNIhub into an "open" frame or relay rack the additionally supplied mounting brackets will be required.

4.4 19 Inch rack mounting

For mounting directly into a 19 inch rack the brackets (5) and associated washers (6) and screws (7) will not be required

To mount into a 19 inch rack in addition to the kit of parts detailed you will need the following tools and equipment before you start:

- 4 x M6 cage nuts appropriate for 19 inch rack frame
- M6 pozi-drive screwdriver
- Flat-bladed screwdriver
- Cage nut insertion/extraction tool

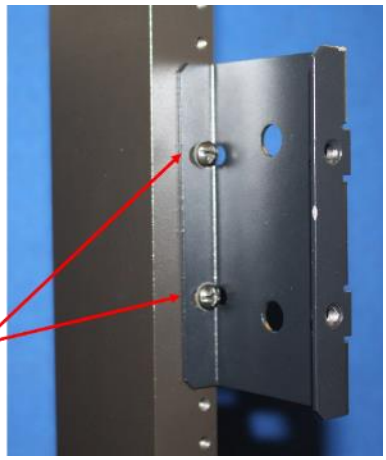
- Fix the Handles(1) to the UNIhub using screws (2)

- Install the cage nuts into the rack using a cage nut insertion/extraction tool.
- Fit the UNIhub into the rack using the pan head screws (7) and nylon washers (6).

4.5 Open Frame rack mounting

- Fit the brackets(5) and associated washers(6) and screws(7) to the frame in the required position using appropriate fixing for the rack (not supplied)

Ensure that the brackets are mounted as shown so that screws for mounting to the rack are accessible after the UNIhub has been installed



- Mount the UNIhub onto the offset bracket using the using the pan head screws (7) and nylon washers (6).

4.6 Provide mains power to UNIhub

- Make sure that the ON/OFF switch is in the OFF (O) position.
- Connect the AC power cord using the supplied IEC mains cord. Note the UNIhub has universal supply and voltage selection is not required.
- Plug the AC power cord into an outlet providing AC power
- Switch on the UNIhub.
- Check the LED status indicators shows correct operation.

Note if powered up with no modules installed the UNIhub should show 4 green LEDs. If modules are installed then the alarm warning and fault LEDs may show alarm conditions at initial start-up. This is due to the fact that no UNIremote elements are connected. These alarms can be cleared via the UNIhub Set Up page of the Configuration process once the system is correctly configured. Refer to the configuration Guide for more information.

Note: The UNItivity platform is designed to allow modules to be hot swapped. However during initial installation where modules may plugged in and out more frequently than under normal operating conditions it is recommended that the power to UNIhub is switched off until the initial module installation is completed

4.7 UNIhub Front Indicators:

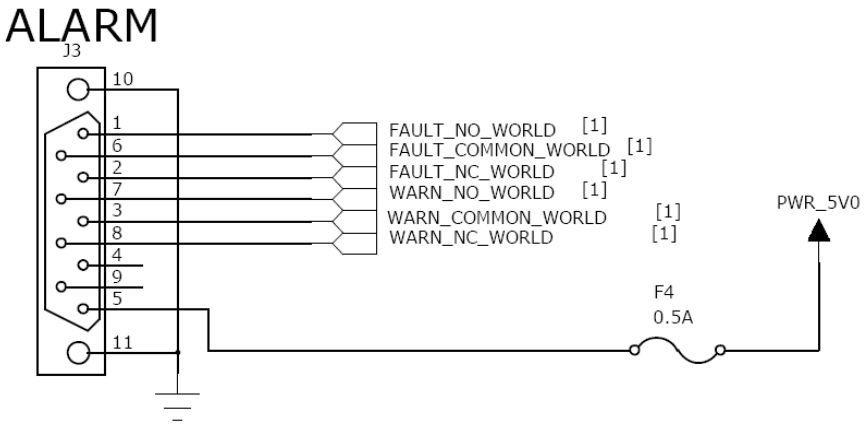
The front of each UNIhub is equipped with a number of LEDs and interface options

4.7.1 UNIhub front panel LED status

LED		Status	Description	Notes
⏻	Power Indication	Green	Power connected to CPU board	Shows processor is correctly powered
		Off	No power connected	
⊗	Service Indications	Green	No error. System is fully functional	This alarm cannot be masked and will ALWAYS be Red when loss of service conditions active.
		Red	Loss Of service currently active	
		Red/Green Flashing	Firmware programming in progress	
⚠	Warning Indication	Green	All Units operating correctly	
		Orange	Service or Hardware warning currently active	
	CPU Indicator	Green	CPU running	Shows Processor is correctly operational (same as current functionality)
		Red	CPU restarting	

4.7.2 Serial Interface wiring diagram

UNItivity can connect to external alarm sources or monitors via the 9-way D-type connector. The connector provides 4 relay outputs: normally open alarm; normally closed alarm; normally open warning; normally closed warning



The relays are activated by an alarm or warning event. The relays are deactivated by clearing the alarm or warning condition and resetting the alarm/warning filter.

Full details of alarms and functionality are provided in the “Configuration and Control Guide”.

4.7.3 Populating the UNIhub

- Follow the instructions below to install any **SM** into the rear of the **PH**.
- Follow the instructions below to install any **OM** into the front of the **PH** or front/rear of the **SH**.

CAUTION: 

OM must **ONLY** be installed on the front panel of a **PH** or the unit will not function as expected.

4.7.3.1 Installing a Module (general instructions)

In order to make a good signal connection, all modules are a very snug fit when you install them into a UNIhub.

- If necessary, remove any blanking panels from slots that you want to populate. To do this, remove the retaining screw using a cross-headed screwdriver.
- Carefully align and slide the module into the UNIhub.
- Once the module is in place, press it home firmly with your thumbs at the top and bottom to ensure the internal contacts mate correctly.
- Replace the retaining screw and tighten using a screwdriver. This is important as modules are equipped with floating SMA connectors at the rear which are slightly sprung to enhance connectivity. Without the retaining screw performance may be degraded
- It's good practice to fit blanking plates (supplied) to any unused slots in the UNIhub.

When you install a module into a slot, the three LEDs on the front of the module will indicate operational status. The UNIhub communicates with each module in turn, and cycles through the installed modules.

If no **RU's** are connected, only the right and middle LEDs will be operational. The right LED will be a dull red, indicating that power is connected but the module is disabled. This will change to green as the UNIhub detects the presence of the module. As the UNIhub polls each of the installed modules, the right LED will show green, and the middle LED will briefly show red.

During this period, UNIhub is checking for the presence of any **RU**. If none are found, the UNIhub will cycle to the next module. If a **RU** is connected, during normal start up the LEDs behave as follows:

4.7.3.2 Typical Module LED status

Left		Middle		Right		Status
OFF		OFF		DULL RED.		Initial start-up. Basic Power present on UNIhub to allow Module detection
OFF		OFF		GREEN		Module detected and full power connected to module
OFF		RED		GREEN		Power connected but no communication established with UNIremote
OFF		GREEN		GREEN		Power connected and communications established with UNIremote
ORANGE		GREEN		GREEN		Optical link in calibration
GREEN FLASH		GREEN		GREEN		Calibration complete, but final output stage not enabled
GREEN		GREEN		GREEN		Fully operational.

A fully functioning module will display three green LEDs.

There may be some variation in the exact sequence depending on the location of the unit in the system. For full information on LED status refer to the "Configuration and Control guide".

4.8 Installing the SH

Essentially, this is very similar to installing a **PH**. The only differences are in the modules you install:

- Install the **SH** into the 19" rack.
- Provide mains power and switch on.
- Ethernet connection to **SH** (optional).
- Rear panel: Install **OM**.
- Front panel: Install any **OM** to be connected to **RU**.

4.9 Installing the RU's

- RF Signal from UNIhub supplied via fiber.
- Power supplied in one of two ways:
  - Local mains, using an adaptor
  - **RU** 48V, via a Rack-mounted Central PSU

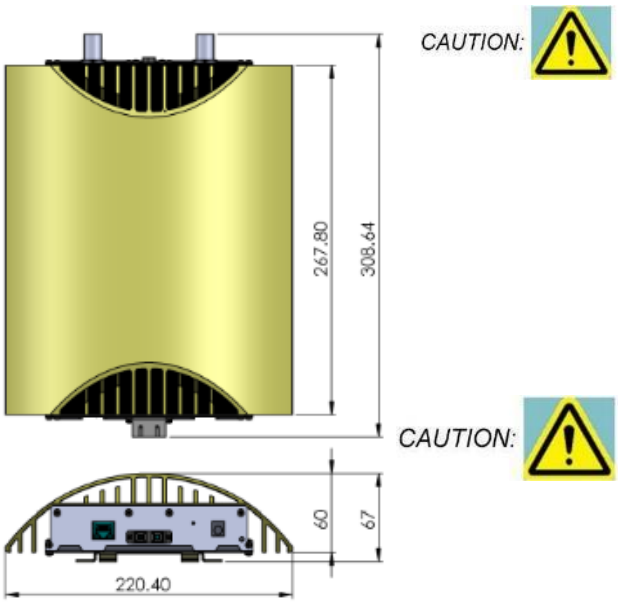
You should mount the **RU** and Antennas in the locations assigned in your system installation plan. Any extra coaxial extension cables (N-type male to N-type female)

- Fiber patch cords and power connections for the **RU**.

3 Zinwave-specific patch cords should always be used to connect an **RU** to the infrastructure cable.

4.9.1 Mounting a UNIremote

An **RU** has the following dimensions

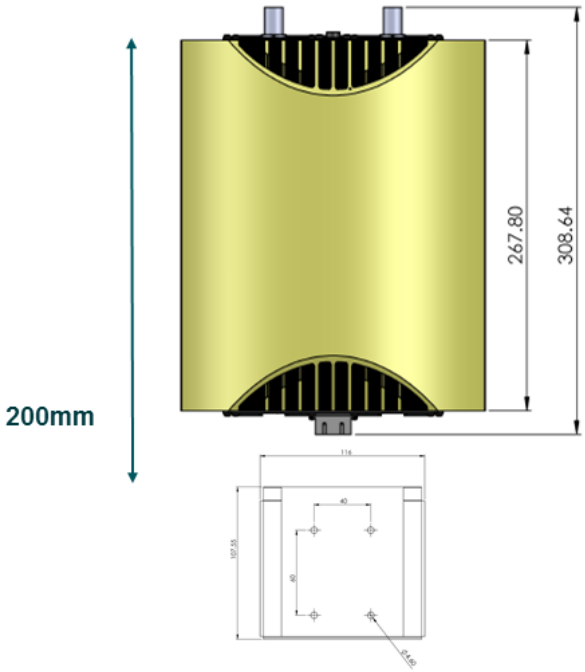


RU's should be vertically-mounted to ensure optimum cooling effect and to achieve the maximum ambient operating specification.
If the RU is mounted in the horizontal plane the maximum ambient operating temperature must be relaxed by 8C.

Avoid dust ingress to fiber connectors by mounting the UNIremote with the fiber connector facing downwards, or by leaving the dust-caps in place until the fiber is connected.

When choosing a mounting location for RU, note the following:

- The bracket can be mounted with the open slot at the top or side depending upon access requirements
- Allow for a minimum clearance of 180mm beyond the wall bracket's open edge to allow for the **RU** to be slotted in once the bracket is in place



- Ensure that adequate space is provided to allow for any power and signal cables to be connected and that minimum bend radii of cables are met.
- Often, the **RU** must be sited in equipment rooms, out of sight. This also allows for easier cable routing to the Antenna (which must exit from a hole in the ceiling).

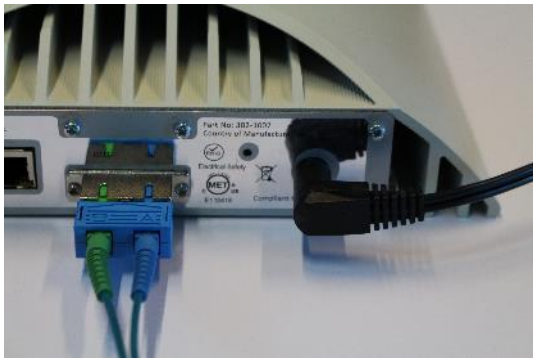
- Note which way up the bracket goes (for top or side mounting).
- Offer the **RU** mounting bracket up to the wall.
- Mark the four holes using a pencil.
- Drill four M3 holes.
- Fix the bracket to the wall using four M3 screws and appropriate fixings such as rawl plugs (not supplied).
- Position the **RU** appropriately, and then slide it into the bracket.

4.9.2 Powering an RU

An **RU** requires a separate power supply. This can either be from a local mains supply or from a central 48V dc supply.

There are two variants of mains power supply. The local mains power block has been recently introduced as a like for like replacement for the original adaptor.

Local mains Power supplies



Both variants detailed here are provided with a pre-terminated EIAJ5 connector which plugs into the **RU** as shown.

Local mains, via power block

The power block is designed for connection to a local mains supply. It is also supplied with a 2m long mains cable with appropriate plug which terminates in a figure of 8 connector.

This allows for greater flexibility when locating the **RU** in relation to the mains supply.

Extending Cable runs

Power blocks have a figure of 8 connector (non-polarized IEC 60320 C7) so for longer power runs a standard "figure of eight" extension cable can be used.

4.9.2.1 RU 48V, via Rack-mounted Central PSU

Using this connection method, you can power up to eight **RU's** from a centralised location.

You will need:

- One Rack-mount Central PSU
- For each **RU**, you will require:
- 1 x CAT-5 cable to connect from Central PSU to RU (RJ-45 interface) (not supplied)

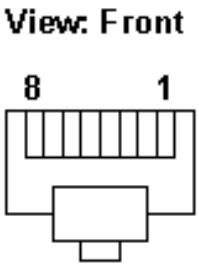
Proceed as follows:

- Install the Rack-mount Central PSU into the rack.
- Make up a CAT-5 power cable long enough to reach the **RU**. This should be a **straight-through** configuration (you **must** ensure that the pin out is the same at each end).

Note: If you want to use your own 48V power supply, rather than the Rack-mount Central PSU, wire the RJ45 connectors at each end as follows (in effect, you are making a 2-core cable):

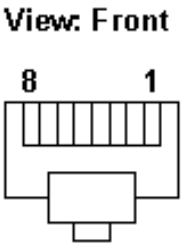
The pin outs for the UNIremote power supply is:

PIN 1	1(A) +ve
PIN 2	1(A) +ve
PIN 3	1(B) -ve
PIN 4	2(B)-ve
PIN 5	2(B)-ve
PIN 6	1(B) -ve
PIN 7	2(A) +ve
PIN 8	2(A) +ve



The pin out for the Rack Mount power supply is:

PIN 1	1(A) +ve
PIN 2	1(A) +ve
PIN 3	1(B) -ve
PIN 4	2(B)-ve
PIN 5	2(B)-ve
PIN 6	1(B) -ve
PIN 7	2(A) +ve
PIN 8	2(A) +ve



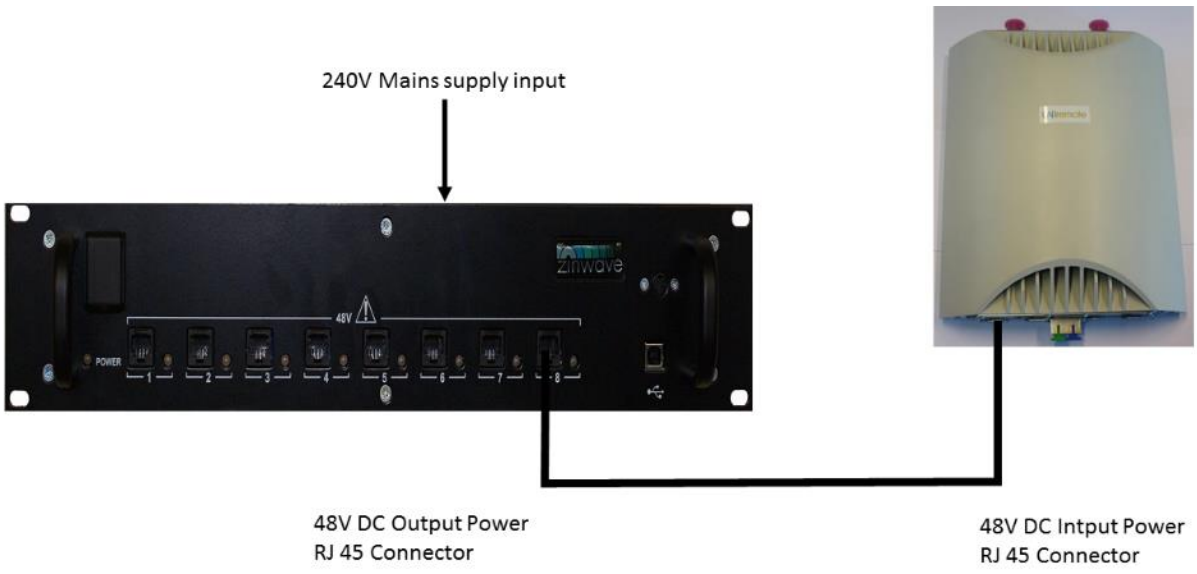
The wiring to the RU power supply uses two independent 48V supplies (48V1 and 48V2). Each supply has a positive and negative line connection, and each connection is made through one pair of pins of the Ethernet connector.

- 48V 1(A) (positive) pins 1,2
- 48V 1(B) (negative) pins 3,6
- 48V 2(A) (positive) pins 7,8
- 48V 2(B) (negative) pins 4,5

Note that the positive and negative polarity of 48V1 and 48V2 is not important and can be independently reversed. The polarity suggested above matches the wiring of our distribution box and this would avoid any future compatibility issues. We do need both 48V supplies to deliver the required current and spread it across all the wires

This pin out is compatible with standard Ethernet wiring (568A and 568B) with standard straight through cable, and both 100BaseT cross over and 1000BaseT crossover cables.

- Connect pins 1, 2, 3 & 6 together
- Connect pins 4, 5, 7 & 8 together
- Route the cable from the PSU to the **RU**



Note: The centralized power supply system was developed between the ratification of IEEE 802.3af in 2003 and 802.3at in 2009.

802.3af provides up to 15.4 watts of power and 802.3at (Type 1) provides up to 25.5 watts of power. The **RU** requires a maximum 30 watts of power and therefore does not conform to either standard. **RU's** requires a maximum of 2.5 amps at 12 volts and by using the four cable pairs in parallel, we do not exceed the capability of Ethernet cable.

5 Fiber Optic Requirements

Each fiber connection between UNIhub and RU must meet the following minimum standards and performance criteria

- Optical Loss: Less than 5dBo
- Return loss for ALL connections: better than 30dB
- Recommended Fiber: Single Mode
- Recommended Connector Type: APC

IMPORTANT:
To achieve best performance, the system needs 30dB back reflection to be working properly, and this has to be guaranteed throughout the entire link, so if there's even only one interface with a lower value, the link must be diagnosed until a value of at least 30dB is restored.

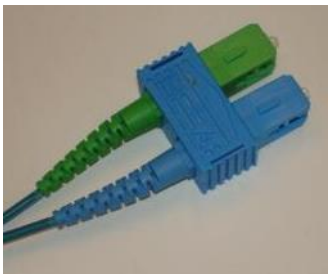
FUNDAMENTAL PRINCIPLES OF FIBER OPTIC SYSTEMS MUST BE FOLLOWED FOR EVERY INSTALLATION

Connector types must match (i.e. SC/APC to SC/APC or SC/UPC to SC/UPC). Otherwise, there will be an air gap between the connector faces that will create high back reflection and high optical loss.

If there is a change in fiber core diameter, light must always travel from a smaller to a larger core diameter. Otherwise, there will be excessive optical loss.
E.g. Single mode can transmit into multimode fiber but multimode CANNOT transmit into single mode

Fiber handling procedures should be carefully observed so as not to damage or introduce dirt to fiber interfaces during installation

5.1 Fiber Optic Interface



UNItivity platform uses SC connectors on both the optical module in the UNIhub and **RU**.
The system uses a laser in the transmit direction and photodiode in the receive direction hence the connectors are SC APC in the transmit direction (laser) and SC PC in receive.
With this combination the UNItivity platform can be deployed with both Single and Multimode infrastructures, although optimum performance is obtained with single mode architecture.
The interface to infrastructure equipment is usually achieved through the use of patch cords (jumper cables). All Zinwave supplied patch cords are provided with the correct SC/APC and SC/PC connectors for the Zinwave equipment and connectors as specified to match the installed infrastructure.

5.1.1 Zinwave Patch cords

Zinwave patch cords are designed to have the appropriate connectors and fiber type for the **OM's** and **RU's**.
All UNItivity platform use the same fiber connector:
OM's use single mode with an SC connector with an APC Ferrule for transmit and multimode with an SC connector with a PC ferrule on the receive direction.
Zinwave supplies the following standard Patch Cords:

5.1.1.1 Multimode

Part Number		Zinwave Equipment Side	Fiber Type	Patch panel side
500-0025	Transmit	SC APC	single mode	SC PC (beige)
	Receive	SC PC	multimodeOM1	SC PC (beige)

5.1.1.2 Single Mode

Part Number		Zinwave Equipment Side	Fiber Type	Patch panel side
500-0028	Transmit	SCAPC	single mode	SCPC (blue)
	Receive	SCPC	single mode	SCPC (blue)

Part Number		Zinwave Equipment Side	Fiber Type	Patch panel side
500-0029	Transmit	SCAPC	single mode	SCAPC (green)
	Receive	SCPC	single mode	SCAPC (green)

It should be noted that standard patch cords terminate in SC connectors for connection to the infrastructure cabling
Other patch cords can be supplied on request

5.1.2 Non Zinwave patch cords

Where Zinwave patch cords are not used care must be taken to ensure that the correct connector and fiber type is provided.
Any non Zinwave patch cords must follow the same connector and fiber types as detailed below.
Note infrastructure connector is not specified but must be suitable for the fiber deployed

5.1.2.1 Fiber and Connector Specifications for Zinwave equipment

Fiber Jumper Specification for OS1 Single-mode Plant Fiber

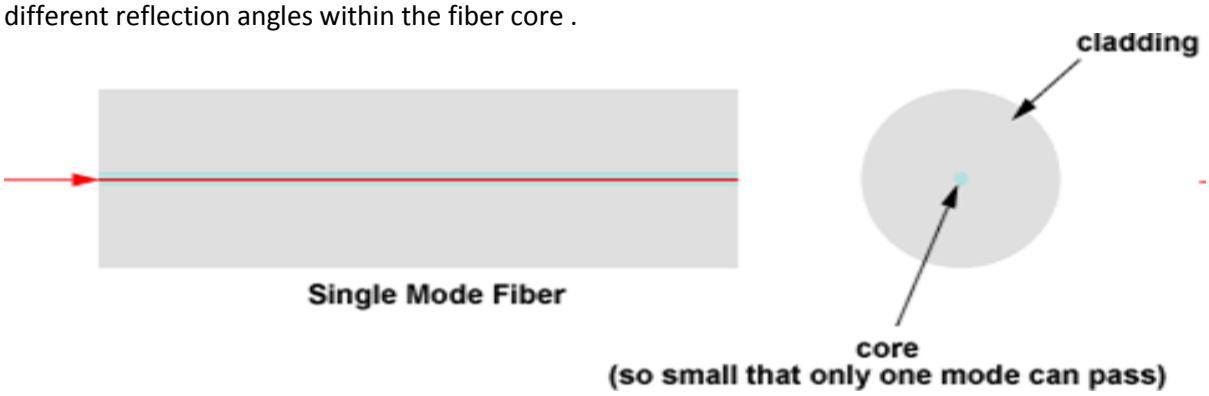
- Launch fiber from Zinwave equipment is OS1 Single-mode – Zinwave connector is SC/APC
- Receive fiber into Zinwave equipment is OS1 Single-mode – Zinwave connector is SC/UPC

- **Fiber Jumper Specification for OM1** Multi**-mode Plant Fiber**
- Launch fiber from Zinwave equipment is OS1 Single-mode – Zinwave connector is SC/APC
- Receive fiber into Zinwave equipment is OM1 multi-mode – Zinwave connector is SC/UPC
- **Fiber Jumper Specification for OM2** Multi**-mode Plant Fiber**
- Launch fiber from Zinwave equipment is OS1 Single-mode – Zinwave connector is SC/APC
- Receive fiber into Zinwave equipment is OM1 or OM2 multi-mode – Zinwave connector is SC/UPC
- **Fiber Jumper Specification for OM3** Multi**-mode Plant Fiber**
- Launch fiber from Zinwave equipment is OS1 Single-mode – Zinwave connector is SC/APC
- Receive fiber into Zinwave equipment is OM1 or OM3 multi-mode – Zinwave connector is SC/UPC

These configurations allow connection to **any** intermediate fiber plant without regard to connector type. It should be noted that UPC connectors can be mated to PC connectors as both have “flat” faces but APC connectors MUST be mated to APC as these have angled faces

5.2 Use of Single Mode or Multimode Fiber cable

Optical fiber cable is generally available in two types: single mode and multimode.
Single mode optical fiber cables, due to the very small core size (9 µm) transmit a single ray of light whilst multimode optical fiber cable, with a larger core size (62.5 µm or 50 µm), carries multiple light rays with different reflection angles within the fiber core .



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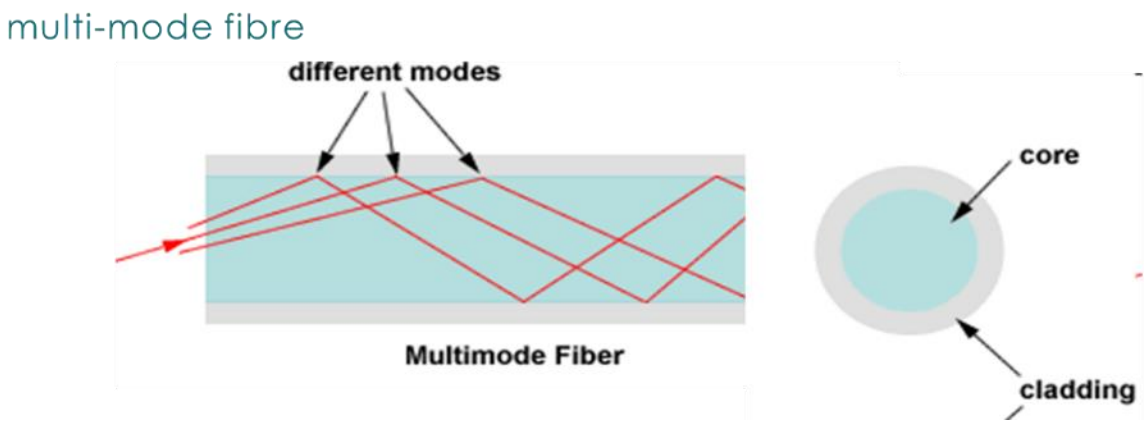


The presence of multiple modes in a multimode fiber means that multimode fiber installations are more prone to internal reflections (return loss) which affects performance of the system.
The majority of reflections occur at points of fiber connection within the whole system. This includes **OM** and **RU** but more importantly at intermediate connections such as patch panels and fiber splices

Guide to Fiber Colours

Buffer/jacket colour	Meaning
Yellow	single-mode optical fiber
Orange	62.5 µm multi-mode optical fiber
Light Blue/ Aqua	50/125 µm micrometre multi-mode

5.3 Fiber optic Connectors

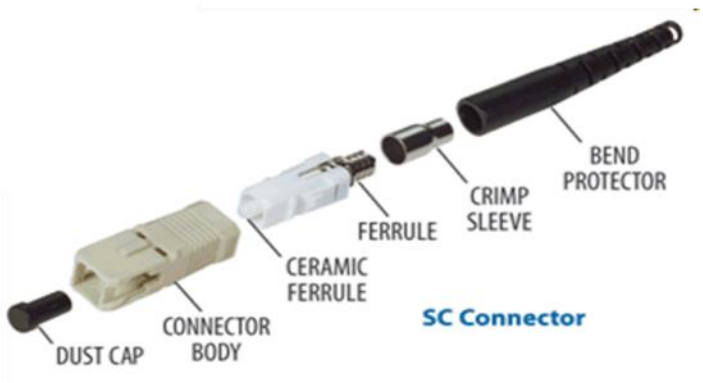
A fiber optic connector consists of two key elements.

- Connector body Type
- Ferrule Type

There are a wide variety of connector body types used in infrastructure cabling some of the most common types are shown below.

There are two main groupings standard and Small Form factor. The small form factor connectors have a 1.25mm ferule compared to the ferule size in “standard connectors of 2.5mm.

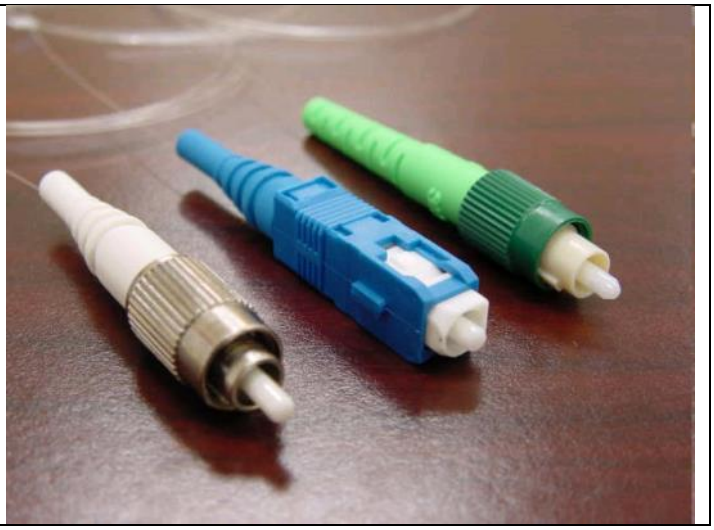
Zinwave recommends the use of APC connector type



Type		Description	Cable Type	APC
SC		SC is a snap-in connector that is widely used in single mode systems for its excellent performance. It's a snap-in connector that latches with a simple push-pull motion. It is available in both PC, UPC and APC	Single Mode and Multimode	Yes
FC		Commonly used in single mode networks and is available in PC, UPC and APC variants. It has an outer body that screws in to hold the ferule firmly in place. It has a key ensuring that the fiber is correctly aligned.	Single Mode and Multimode	Yes
ST		Popular connector for multimode networks. It has a bayonet mount and a long cylindrical ferrule to hold the fiber. The main body is spring loaded and can cause problems (high loss) if not seated properly.	single mode and multimode	No
LC		LC is a new connector that uses a 1.25 mm ferrule, half the size of the ST.	single mode and multimode	YES
MTRJ		MT-RJ is a duplex connector with both fibers in a single polymer ferrule. It uses pins for alignment and has male and female versions. Multimode only	Multimode only	NO

5.4 Ferrule Types

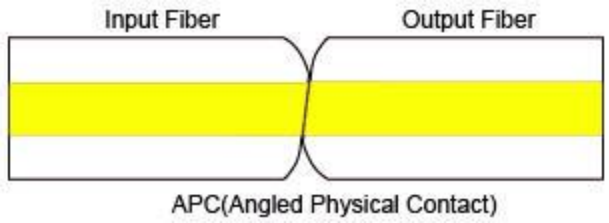
As shown above some of these connectors can be designated either APC or PC, this refers to the Ferrule within the connector body. The TIA 568 colour code for connector bodies and/or boots is:

Green	Single mode APC (angled) connectors	
Blue	Single mode (UPC)	
Beige	multimode	

Attaching a connector to an optical fiber cable will cause some of the light traversing that optical fiber to be lost. Regardless of whether the connector was installed in the factory or the field, its presence will be responsible for some light being reflected back towards its source, the laser. This is known as return loss (RL) and high levels of unwanted reflections can degrade the signal's performance.
The amount of optical return loss generated is related to the type of polish that is used on the connector. There are three basic types of polish:

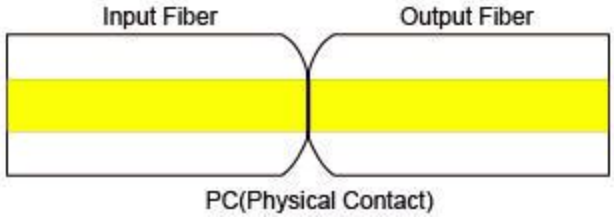
- APC
- UPC
- PC

5.4.1 APC (Angled Physical Contact)



The "angled physical contact" (APC) connector is best as it offers the lowest return loss characteristics of connectors currently available. In an APC connector, the end face of a termination is polished precisely at an 8-degree angle to the fiber cladding so that most RL is reflected into the cladding where it cannot interfere with the laser source.
As a result, APC connectors offer a superior RL performance with atypical back reflection of better than 60dB

5.4.2 UPC (Ultra-polished Physical Contact)

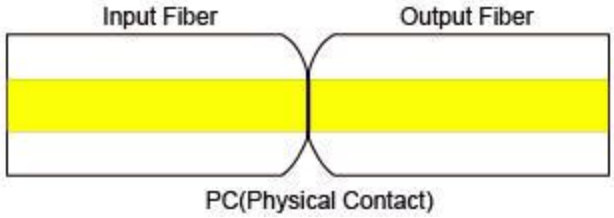


Typical Back Reflection: <-35dB for single mode fiber

UPC connectors are very similar to PC connectors in that the ferrules faces are flats but have a much better return loss, which can be better than 50 dB. This performance is due to an improved polishing technique applied to the face and to the curvature at the ferrule end. The rounded finish created during the polishing process allows fibers to touch on a highpoint near the fiber core where light travels UPC polish is available for almost all single mode connectors--namely FC, SC, ST, but, unlike PC connectors, is not available for multimode fibers.

When using UPC connectors it is essential to confirm optical back-reflection levels using an OTDR as described in the sections below.

5.4.3 PC (Physical Contact)



Typical Back Reflection: <-35dB for single mode fiber

The “physical contact” (PC) connector is probably the most common type of ferrule face. It is available on both single mode and multimode fibers but due to the flat face has reduced eturn loss and is more prone to dirt and poor connections

When using PC connectors it is essential to confirm optical back-reflection levels using an OTDR as described in the sections below.

CAUTION: 

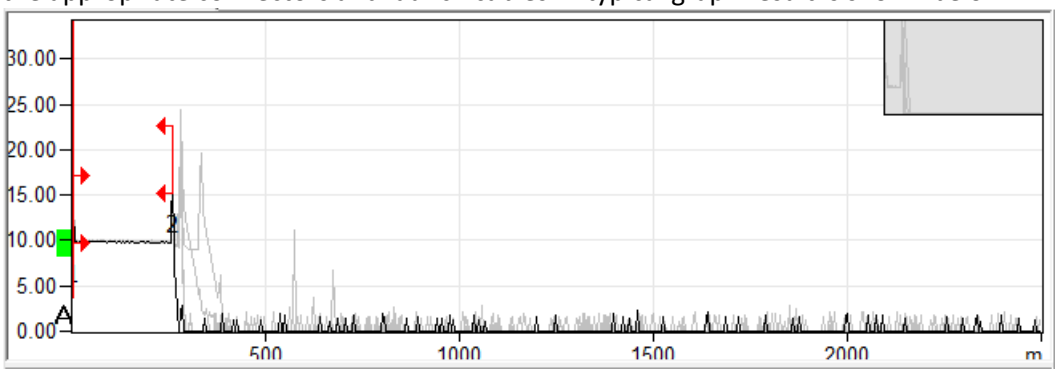
NOTE: UPC can be mated to PC connectors as both have flat faces but APC connectors can only be connected to APC connectors due to the face angle

5.4.4 Effects of Back Reflections on system performance

In presence of high levels of back reflection due to poor Return loss the Zinwave system performance is degraded. The effects of this can be easily seen on the system and diagnosed using appropriate test equipment. The effects of back reflection can be seen by looking at the level of the noise floor. In cases where there are high levels of back reflection, the noise floor in either the downlink or the uplink can vary significantly (10-15dB). It may also show as increased levels of harmonics which will also vary in level by significant amounts.

5.4.4.1 How to diagnose an optical link with an OTDR

The best way to check the return loss of a fiber link is to use an Optical Time Domain Reflectometer with the appropriate connectors and launch cables. A typical graph result is shown below:



The graph shows the performance of fiber along its length. In this case the first horizontal line represents the first 250m of fiber in the launch box. Each of the subsequent peaks relates to the situations where internal reflection has occurred along the fiber length. This could be connectors, splices or even damaged cables. Generally the highest peak shows the worst case of back reflection and hence source of return loss and potential interference, depending on the OTDR used results, can be displayed in a tabular form giving distances and the relevant reflection or return loss.

Type	No.	Loc.	Loss	Refl.
→	1	0.0000	- - -	-54.3
⊢	(0.2566)		0.088	
⎍	2	0.2566	- - -	-39.3

In the example above a single reflection of -39.3dB is present. In this case the -39.3dB reflection is at the PC/PC interface at the end of the link and in a link with multiple connections there will be an event for each connection.

It should be noted that the OTDR is not able to distinguish between 2 reflections very close to each other over long lengths of cable and in the case of two reflections close together, only the worst reflection will be shown. However this will allow installers to identify where in the overall fiber link the problem occurs.

5.4.5 Fiber Inspection and Cleaning

5.4.5.1 Inspection

The optical fiber connection has two basic performance indicators: Insertion Loss and Return Loss. Poor performance in either of these areas will degrade the overall system performance

Insertion loss

The optical loss can be seen for each link by looking at the status page of the web GUI and examining each connection in turn or alternatively making a dump of the entire system data and examining it through the layout tool.

This can be caused by a number of problems (most of which can be resolved simply):

- Incorrectly mated connectors: An incorrectly mated connector will cause either a misalignment of the optical fiber or an air gap between the two ferrule faces. In either case a high insertion loss will be seen.
- Dirty Connectors: dirt on the face of optical connectors will cause higher insertion loss, which can be reduced by careful cleaning of the fibers.
- Poor splice assembly. In some cases infrastructure will include splices. These can, if done poorly, show up as high insertion loss. (They will also cause poor return loss). If the insertion loss is due to a poor splice then it must be remade correctly.

Optical Return Loss (Back Reflections)

This is easily tested by using an OTDR instrument, although the symptoms as described above can be seen by looking at the RF output with a spectrum analyser. The cause of poor back reflections can be caused by:

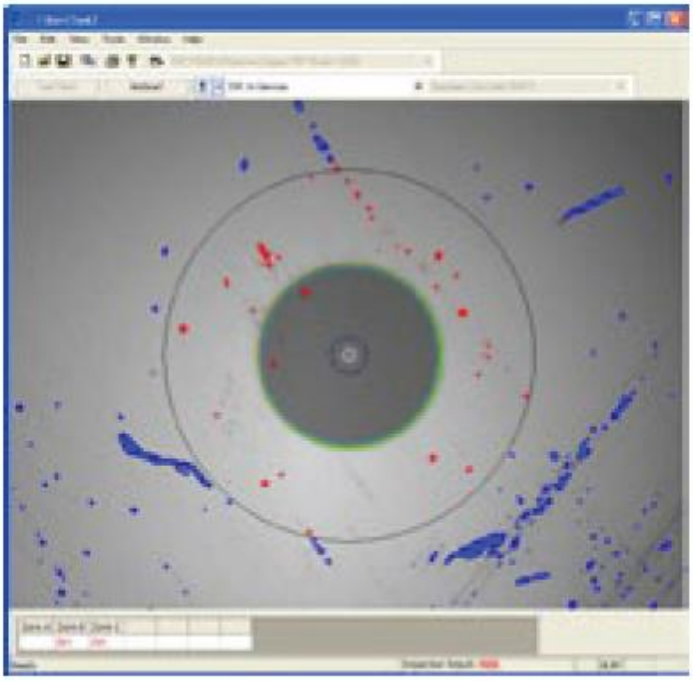
- Poor or incorrect connector types. APC connectors will not cause back reflections but with PC connectors careful attention must be paid to the return loss specification and great care must be taken when handling connectors to ensure that dirt is not present which can also affect return loss
- Tight fiber bends: If a fiber is bent too tightly then it is possible to cause internal reflections. When installing fibers, and particularly when storing excess fiber, always observe the minimum bend radius specified. These are easily seen with a VFL (visual fault locator). These usually use a visible red laser which will clearly show up fiber breaks, severe bends and faulty connectors
- Dirty fibers (Causing Loss and Back Reflections issues)

5.4.5.2 Cleaning Fibers

Clean fibers are important in all installations but in multimode installations this is even more important. Ideally all fibers should be visually inspected as this gives a very clear indication of dirt on fibers.
There are many optical inspection tools such as the one shown below:

With the inspection tool shown above which connects to a PC the image of the fiber can be captured and examined prior to cleaning.

Note that special tips are required to inspect APC connectors due to the angle of the connector face



However, the fiber must be clean enough so that <-30dB ORL threshold is maintained on the optical link.

Dry Cleaning – This is the most common type of cleaning method. Normally, just a single-click cleaner device is used or the dry cloth. This method is effective for new/better maintained fibers.
Wet Cleaning – This method is more effective on used or poorly maintained fibers which require a great deal of cleaning. If the dirt cannot be removed by using dry cleaning methods, special wet wipes, usually alcohol based, can be used to clean the face followed by ideally a dry wipe action such as single-click cleaner to effectively wipe off the dirt speckles.

6 Making the signal connections

CAUTION: 

Observe safety precautions when working with fiber cables and devices (see *Optical Safety Precautions on page 6*).

CAUTION: 

Both transmit and receive are SC Connectors.

All optical devices require a Zinwave patch cord irrespective of the existing or installed fiber and connector type.

Connecting Fiber Cables

*UNItivity platform uses fiber optic cables to connect UNIhub (**OM**) and **RU**. As with any fiber based system the use of fiber optic cable calls for careful attention to cleanliness and good installation practice.*

UNItivity platform will achieve optimal performance when using single mode cable and APC connectors but can, with careful consideration, be used with multimode fibers.

*The Infrastructure Cable between UNIhub (**OM**) and **RU** must meet the following specifications:*

Maximum Optical Loss 5dBo

Minimum Optical Return Loss 30dB

This can be guaranteed with single mode fiber and APC connections throughout the installation.

6.1 Connecting UNIhub to the fiber infrastructure

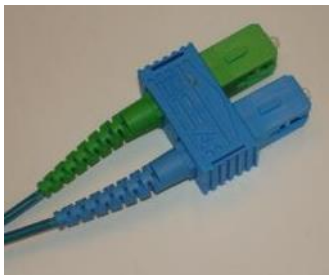
Follow these instructions for each Optical Module in the UNIhub

CAUTION:

OM's use Single Mode on Transmit (APC) and Multimode on the receive direction (PC).

Both transmit and receive ports are SC Connectors

All **OM's** and **RU's** require a Zinwave patch cord irrespective of the existing or installed fiber and connector type.



- Remove the protectors from the SC connectors on the **OM** and the Zinwave patch cord.
- Plug the green/blue end of the Zinwave SC optical patch cable into the **OM**. It is vital that you fit this connector the right way up (blue tag at the top, as shown). Incorrect installation will damage the ends of the fiber.
- Connect the other end of the patch cable to your fiber infrastructure (this will usually be via a fiber patch panel).

6.1.1 Connecting UNIhub to an RU

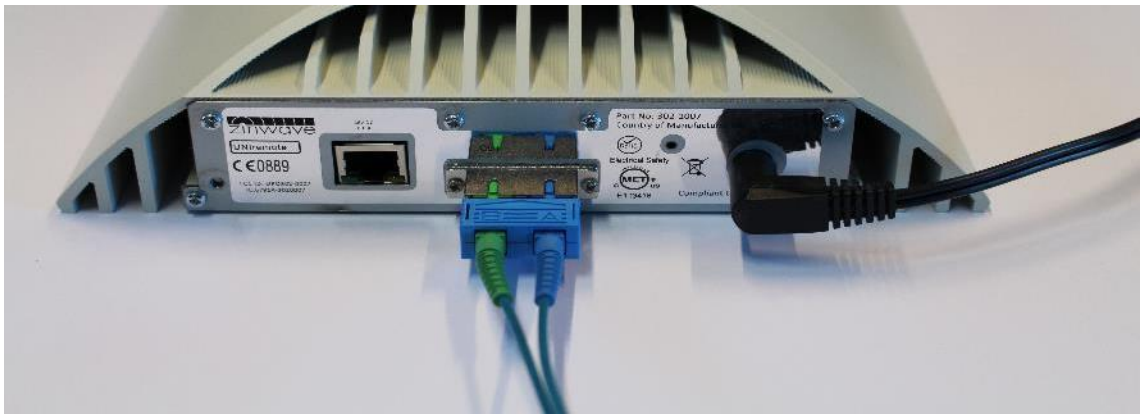
OM's use Single Mode on Transmit (APC) and Multimode on the receive direction (PC).

CAUTION:

Both transmit and receive are SC Connectors.

All optical devices require a Zinwave patch cord irrespective of the existing or installed fiber and connector type.

- Install fiber-optic cable of sufficient length to reach the **RU**. The cable must be terminated in a standard SC connector (you will use a Zinwave patch cord to connect from your fiber cable to the RU).
- Remove the protectors from the SC connectors on the fiber infrastructure cable and the Zinwave patch cord.
- Plug the green/blue end of the Zinwave SC optical patch cable into the **RU**. It is vital that you fit this connector the right way round (as shown below). Incorrect installation will damage the ends of the fiber.
- Connect the other end of the patch cable to your fiber infrastructure cable.



6.1.2 Connecting an RU to Antennas

The **RU** has separate connectors for transmit and receive antennas.

As stated previously, the choice of antenna will depend upon the RF coverage and planned design for a building. This may involve using extension cables where antennas are distant from the **RU**.

When connecting cables to the **RU** careful attention should be paid to the mechanical stress placed on the connector from using large inflexible cable. Short flexible jumpers should be used where appropriate.

- It is important to ensure that adequate isolation exists between Tx and Rx antennas
- Connect the two N-type male connectors to the top of the RU.
- If you haven't already done so, feed the RF extension cables through from the **RU** to the Antenna.
- Connect the two N-type female connectors to the Antenna RF tails.

6.2 Connecting SM Inputs

You can connect SM inputs (e.g. BDA, BTS, WLAN access point) only to the **PH**: When connecting cables to the **SM**, careful attention should be paid to the mechanical stress placed on the connector from using large inflexible cable.

Short flexible jumpers should be used where appropriate.

- Make N-type male connections to the N-type female connectors on the **SM** (on the rear of the **PH**).

7 Antennas

UNItivity can use a variety of antennas connected to the **RU** via coaxial cable. The choice of Antenna will depend on the service requirement within the operational bandwidth of the system.

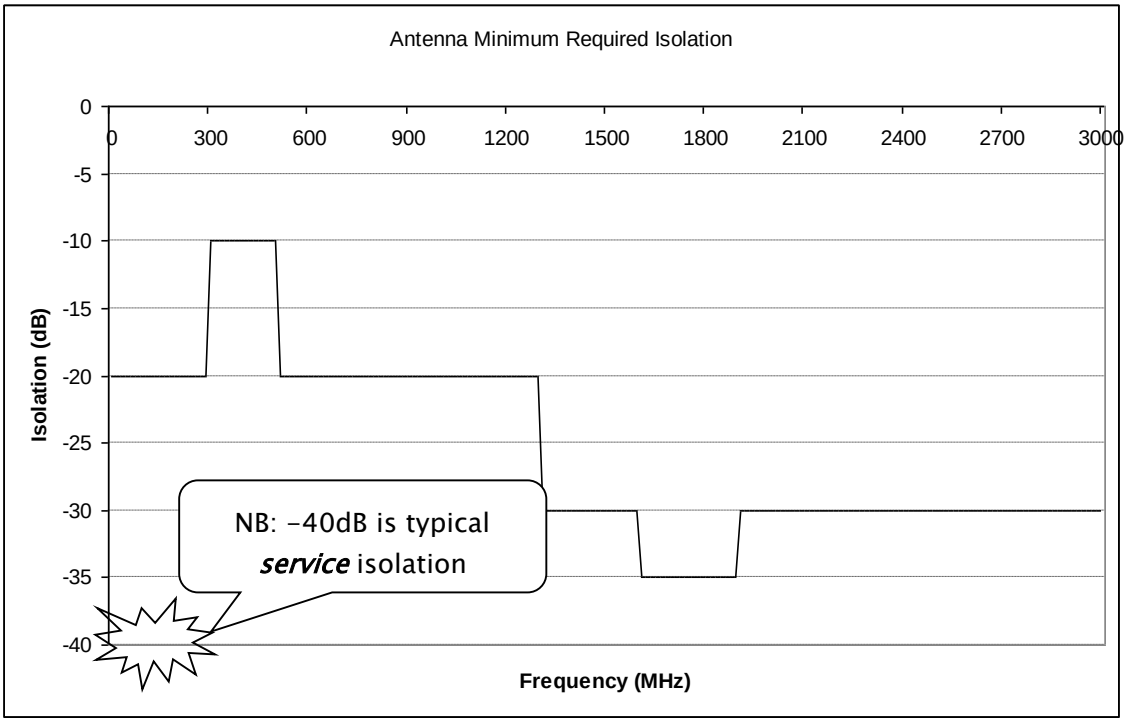
7.1 Installation of two antennas

As mentioned above, a pair of off-the-shelf antennas can be used to provide separated transmit (TX) and receive (RX). Any type or frequency of antennas can be used as long as they support the services carried by the UNItivity and can be installed to provide sufficient isolation between TX and RX.

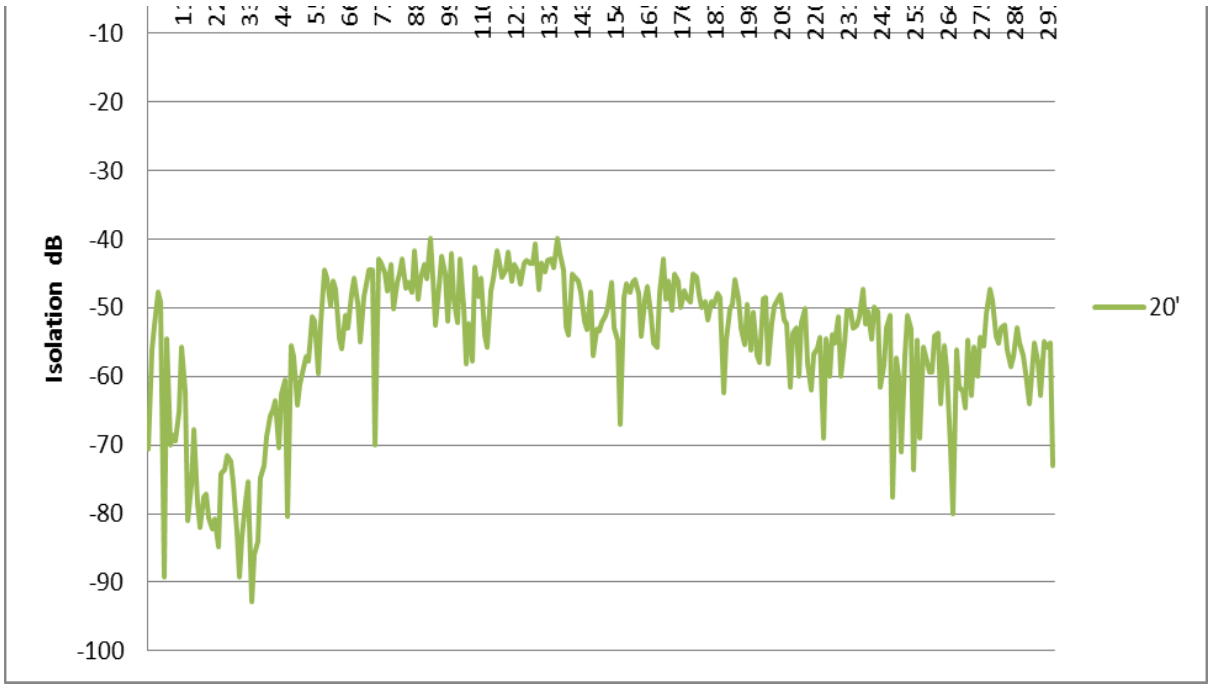
7.1.1 TX-RX isolation

The minimum isolation between TX and RX required for correct operation of UNItivity in both the uplink and downlink service bands is usually 40dB (this requirement should be confirmed for any given installation within the Zinwave Coverage Tool). However, performance (uplink noise and downlink inter-mode interference) of the system can be improved if greater isolation is achieved. Isolation between the antennas is achieved by separating them at a sufficient distance to achieve at least 40dB at the lowest frequency service in use.

In addition to the 40dB service isolation described above, a minimum isolation must be achieved within the entire UNItivity passband according to the graph below:



It has been found empirically that omni-directional antennas supporting the Cellular bands from 700MHz and above require a horizontal separation distance of approximately 20'. An example of the isolation that can be achieved using a wideband (LTE, CELL, PCS, AWS) antenna is shown below:



It can be seen that the isolation improves with frequency due to the increasing propagation loss, so that the PCS and AWS bands have isolation in excess of 45dB when the CELL band is below 40dB.

Although this distance provides a rule of thumb for initial planning, the particular antennas in use and the environment in which they are installed will affect the isolation. It is therefore recommended to check the measure the isolation of each antenna pair (see isolation measurement section below) prior to enabling service operation.

With directional antennas care should also be taken to ensure the high-gain propagation direction is oriented towards the coverage area and the low-gain ("null") propagation direction is oriented towards the 2nd antenna. The effect of this null will be to reduce the distance between the antennas required to achieve the 40dB isolation.

7.1.2 Uplink/Downlink Balance

Care should be taken not to separate the two antennas by so much distance that the path difference between TX and RX to the mobile affects system performance. Some services are more affected by uplink/downlink path difference than others, especially those using high dynamic range mobile power-control such as WCDMA.

There are two WCDMA system effects to be aware of when testing a separated antenna coverage area:

1. When the mobile is close to the TX antenna but some distance from the RX antenna, the initial call-setup power that the mobile transmits will be lower than expected by the BTS. It is likely that the BTS will fail to receive the initial call-setup attempt so the mobile will transmit again at a higher power level. The mobile will continue to ramp up its power level until the BTS receives and acknowledges the message. This effect can cause longer initial setup times close to the TX antenna and in extreme cases may cause the mobile to timeout during call setup. In order to compensate for this effect the balance of gain between uplink and downlink can be adjusted to increase the uplink gain. This is usually done in the head-end by moving attenuation from the uplink to downlink paths. However, in some case the UL/DL balance setting can also be used within the UNItivity platform if the uplink gain is not already at maximum.

2. When the mobile is close to the RX antenna but some distance from the TX antenna, the initial call-setup power that the mobile transmits will be higher than expected by the BTS. As long as the mobile power does not overload either the **RU** or the BTS input then this should not cause a call setup failure.

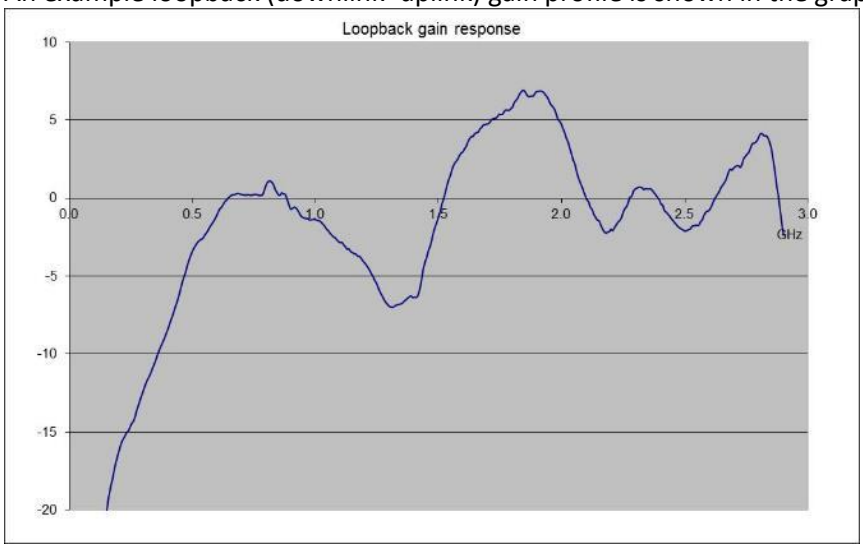
Note that the path difference between TX and RX at the edge-of-cell is likely to be much smaller than near the antennas due to the effect of the indoor propagation conditions. Where there are no line-of-sight differences between TX and RX the edge-of-cell path difference will be less than 3dB for most services.

7.1.3 Isolation Measurement Techniques

The most accurate way of measuring the antenna isolation, is to disconnect the cables at the **RU** antenna ports and connect these directly to either a network analyser or a spectrum analyser with a tracking generator. Every antenna in the installation should meet the requirements of the TX-RX Isolation section above.
Where many antennas within an installation are being checked it is recommended to enter a test mask in the test equipment.

Where it is not possible to access all antennas in this way, it is possible to check the isolation using measurements at the UNIhub. However, in this case the gain profile of the uplink and downlink paths must be removed from the measured values in order to reveal the actual antenna isolation. It is recommended that a single path is measured with either a known good antenna or a fixed attenuator in order to obtain this “loopback calibration” result. Then all individual antennas can be compared to this known good result to identify and problem locations.

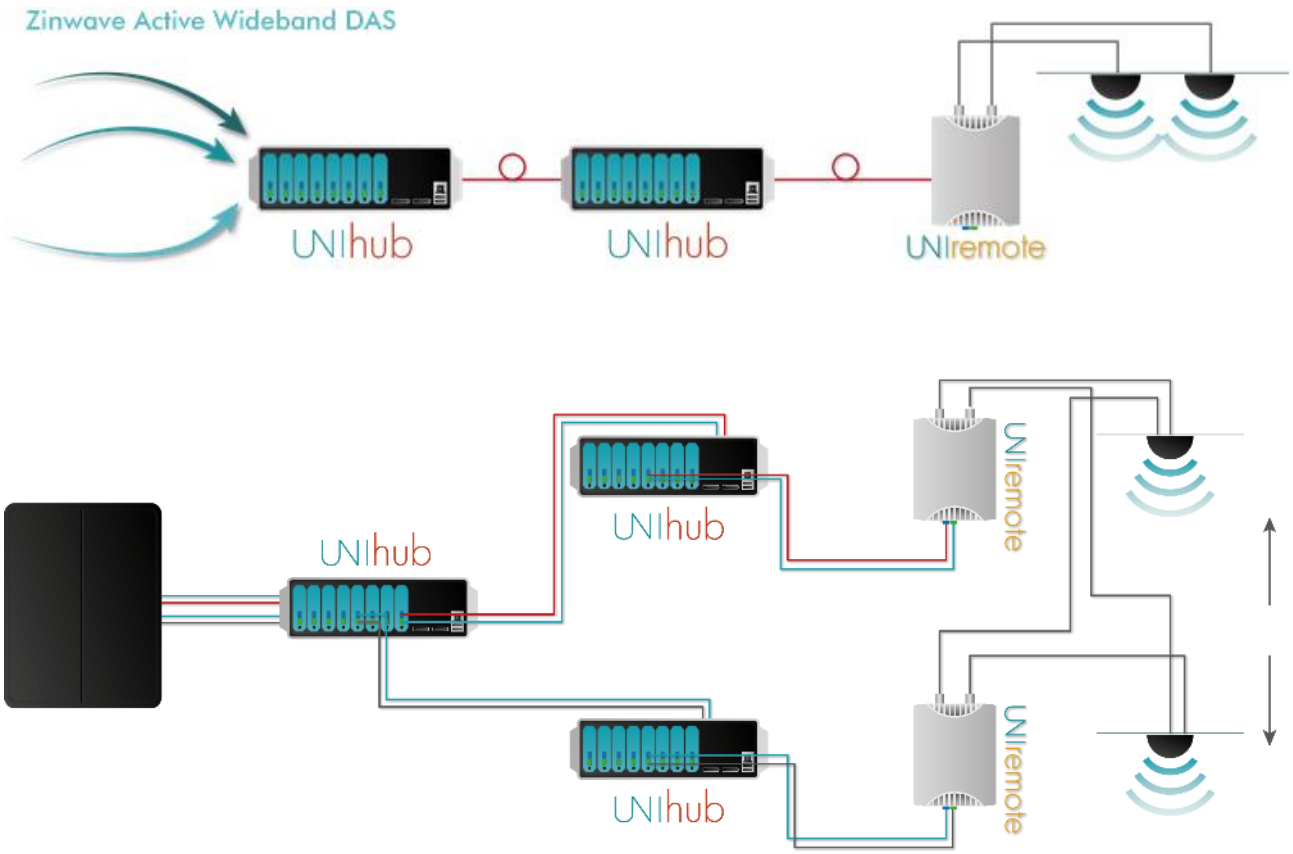
An example loopback (downlink+uplink) gain profile is shown in the graph below:



This graph was obtained by injecting a signal into a double-star system with 1 **RU**. The **RU** had a 50dB attenuator connected between TX antenna output and RX antenna input. The test signal was injected into the **SM** input and the resulting signal was measured at the **SM** output. The system settings were set such that the downlink gain was 25dB (nominal) and the uplink gain was also 25dB (nominal). Therefore the nominal loop gain was +25+25-50 = 0dB. The differences from this nominal 0dB that are due to the system gain variation would then have to be subtracted from the gain variations that would be measured if the 50dB attenuator was replaced with an antenna.
It is also possible to measure multiple antennas simultaneously as long as the “combining gain” of multiple antennas is taken into account (approximately 5dB for 8x **RU** and 10dB for 64 **RU** or more generally 2.4*ln(N) for N* **RU**). This method produces a much less accurate result but is a quicker way of verifying a larger number of antennas simultaneously.

8 UNItivity platform support for MIMO services

The next generation of high data-rate services such as WiMAX and LTE provide various MIMO options. Where base stations (BTS) are deployed to provide in-building coverage, these options can be used to increase the overall capacity or coverage of the system.
Typically BTS signals are distributed inside buildings via a Distributed Antenna System (DAS) which has multiple antenna locations to provide multiple copies of each signal. In the case of MIMO each antenna location will require 2 or more independent signals from the same BTS. The figure below shows a comparison between the UNItivity architecture required to support a traditional single signal (SISO) BTS and a dual-transceiver (MIMO) BTS:



In the diagram only a single antenna location is shown but the architecture can be extended to multiple **SH** (up to 8 per **PH**) and multiple **RU** (up to 8 per **SH**). The MIMO architecture shown can support up to 32 antenna locations per **PH** and up to 4 independent MIMO signals (although only 2 signals are shown).

The following considerations should be taken into account when implementing a MIMO architecture with the UNItivity platform:

- The separation between the dual-port antennas at the same location needs to be sufficient to provide both MIMO diversity (using guidelines provided by the BTS manufacturer) and TX-RX isolation. Each antenna pair provides at least 40dB of isolation between the TX and RX ports of the same **RU** and the separation must provide the same or better isolation between TX and RX ports of **RU** A and B.
- The difference between the two path distances (which may affect time delay) between the BTS and the antennas at any given location must be within the guidelines provided by the BTS manufacturer. This can be achieved by ensuring that the connecting fiber paths from UNIhub to the **RU** are by multi-core fibers with the same overall distance including the length of any patch cords. Ideally the coaxial connection to the MIMO antenna pairs should also be connected directly to the **RU** using their integrated flying leads to ensure no delay is introduced in the final coaxial stage.

9 Abbreviations

µm	Micron, $1x10^{-6}$ metres
A	Amp
AC	Alternating Current
APC	Angled Physical Contact
AWS	Advanced Wireless Services
BDA	Bi-Directional Amplifier
BTS	Base Transceiver System
CAT-5	Category 5
CE	Conformity European
Coax	Coaxial
DAS	Distributed Antenna System
dB	Decibel
dBm	Decibel referenced to a milliwatt
dBo	Decibel reference to Optical loss / gain
DC	Direct Current
EIAJ	Electronic Industries Association of Japan
EMS	Element Management System
EN	European Norm
FCC	Federal Communications Commission
FDA	Food and Drug Administration
FDD	Frequency Division Duplex
FSL	Free Space Loss
GSM	Global System for Mobile Communication
HW	Hardware
kg	Kilogram ($1x10^3$ grams)
km	Kilometre ($1x10^3$ metres)
IEC	International Electrotechnical Commission
ISM	Industrial Scientific and Medical
LED	Light Emitting Diode
m	Metre ($1x10^3$ millimetres)
LTE	Long Term Evolution
mm	millimetre
MHz	Megahertz
MM	Multimode
MMF	Multimode Fiber
nm	Nanometre ($1x\ 10^{-9}$ metre)
PC	Physical Contact
PCS	Personal Communications System
PH	UNIhub configured as a Primary
PSU	Power Supply Unit
RF	Radio Frequency
RJ45	Registered Jack 45
UNIremote	UNIremote
Rx	Receive
SC-APC	Standard Connector/ Angled Physical Contact
SH	UNIhub configured as a Secondary
SM	Single Mode
SMF	Single Mode Fiber
SMR	Specialized Mobile Radio
SNMP	Simple network Management Protocol
Tx	Transmit
Tma	Maximum ambient temperature
TDD	Time division duplex
UMTS	Universal Mobile Telephone System
V	Volt
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local area network

10 Revision History

Version	Date	Author	Changes
Version 1.0	Oct 2015	BA/MC	Revisions to reflect introduction of UNIhub and UNIremote with internal 48V PSU.
Version 1.1	Jan 2016	BA	Revisions to reflect introduction of V4 UNIremote and software Version 4.51