Application Note

RF over Fiber Optics In-Building Transport for Distributed Antenna Systems (RFoF DAS)

Provided by

OPTICAL ZONU CORPORATION

Last Updated Jun. 8, 11

Application Note

GENERAL DESCRIPTION

Optical Zonu's RF over Fiber Optics OZ600 and OZ810 stand-alone modules are high performance broadband optical transceivers with very wide Dynamic Range designed for the transport of Analog RF signals for variety of communications markets, such as Cellular, WiMax, GSM and GPS. They are designed to carry any RF signals within the 47 MHz to 2.7 GHz bandwidth range over single mode fiber optic cable. The transceiver features a high performance InGaAs Photodiode and a linear Isolated FP or DFB Laser operating at 1.3 µm (A) and 1.5 µm (B) over 9/125 µm single-mode optical fiber.

These simple plug and play devices are housed in ruggedized compact boxes measuring approximately 3 x 5 x 1.5 inches. An optional integrated WDM allows bidirectional traffic to be transmitted over a single strand of fiber (instead of two), thus allowing you to preserve your fiber inventory and plan for future expansion. The standard optical connector is SC/APC (FC/APC is available upon request) for low back reflection applications and the RF interface is via a 50 Ohms SMA connector. All OZ600 and OZ810 models come equipped with Manual Gain Control.

Optional features of the OZ810 include an extended bandwidth range of 10 KHz to 3.3 GHz, Automatic Gain Adjust with wide dynamic range, CWDM wavelength Lasers, multimode fiber compatibility, RS232 data modem, internal transmitter LNA, and an alternate power supply option.

The OZ600 and OZ810 RFoF transceivers are excellent alternatives to coaxial cable systems, offering significant improvements in the transport of RF signals in their native format reliably in many optical networks across a broad range of frequencies. They are an ideal choice for many DAS applications.

FUNCTIONALITY and HOW IT WORKS

The incoming RF signal is input to the Transmitter Module, which contains RF signal conditioning, provides complex impedance matching between 50 Ohms input impedance and the Laser, Laser Bias Control, APC, Monitoring and Alarm electronics. The transmitter module utilizes an Intensity Modulation scheme to convert RF to light, which is transported through an optical fiber into the Optical Receiver. The Receiver Module converts the modulated light back into an RF signal. The recovered RF signal is again complex impedance matched and amplified before it becomes available at the output of the receiver.

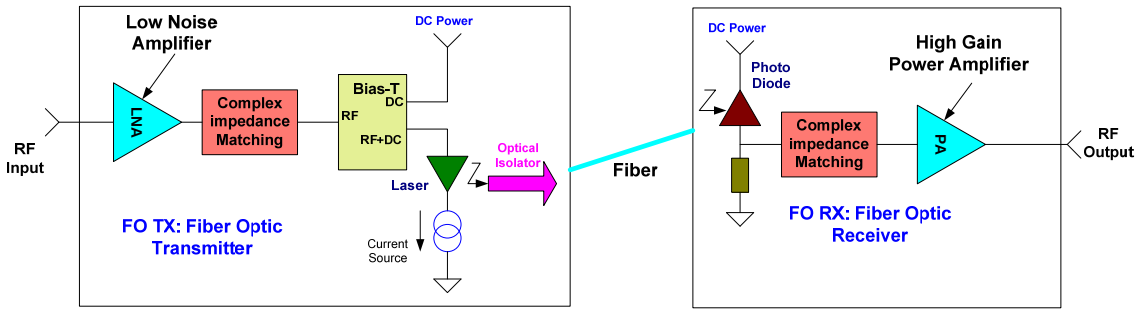


Figure 1

The distance between transmitter and receiver can range from 1 meter to over 20 Km depending upon the system specification, frequency of operation and type of Laser used in the transmitter. Modules which will be covered in this application note are OZ600 and OZ810 the stand-alone modules and the rack-mountable OZ9000 series, within which multiple bidirectional RF transceiver modules may reside.

This application note also describes the connectivity between two OZ600 or OZ810 modules, or multiple OZ600/OZ810 combinations with one OZ9000, to enable multiple configurations such as point-to-point, and point-to-multipoint connections, respectively.

Application Note

POINT-TO-POINT SINGLE FIBER LINK

This segment addresses applications in which two stand-alone transmitters such as the OZ600 or OZ810 are used to connect two remote locations to one another. The OZ600 and OZ810 are packaged in rugged dust-tight cast metal housings with internally integrated WDM for bidirectional transmission over a single SMF-28 optical fiber. Each module at the two locations are identical but each has different Lasers to accommodate traffic over a single strand of optical fiber. Normally, we populate these modules with Isolated DFB Lasers operating at 1.3 µm (A) and 1.5µm (B).

The maximum RF input signal into the transmitter is +10 dBm and the RF interface is via a 50 Ohms SMA connector. The standard optical connector is SC/APC (*FC/APC is also available upon request*) for low back reflection applications. The module is powered through its DB-9 port and a power supply of +12 V DC is required to operate it safely. Optional RS232 data modem, alarm and monitoring functions are all also available through a DB-9 connector. A Manual Gain Control via a potentiometer, accessible from the top of the box by a small screw driver (or "twiker"), to ease field integrations, is also available.

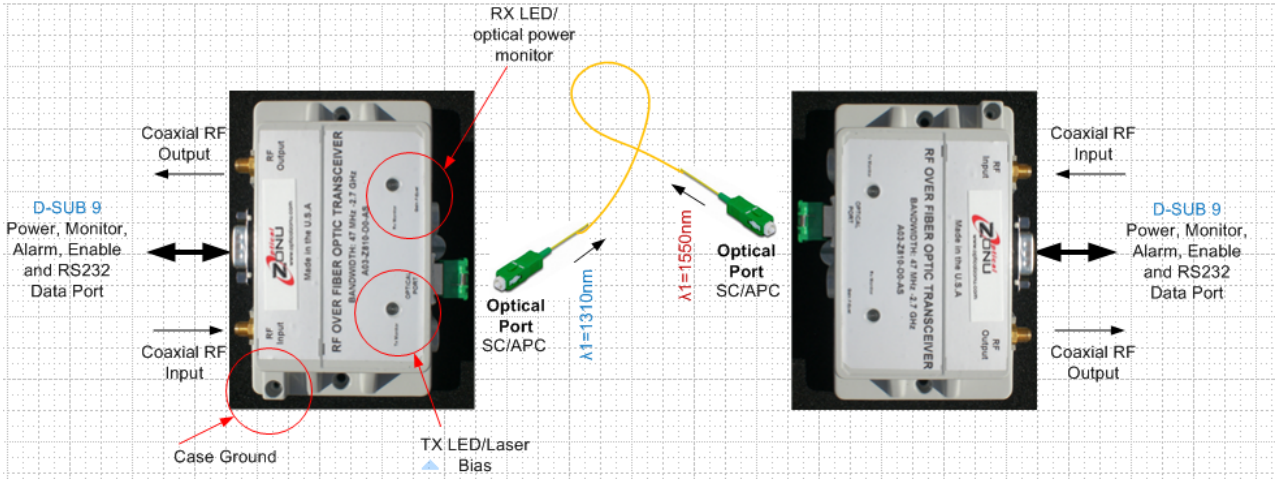


Figure 2

LED Indicator lights

OZ600 and OZ810 also have two dual-color LED indicators onboard. One of them monitors Laser Bias current and the other monitors PD/RX receive optical power. The table below describes the topology.

Note: The Laser Bias LED will only turn **RED** when the Laser draws excessive current. Otherwise it will stay **GREEN**, even if the laser is disabled.

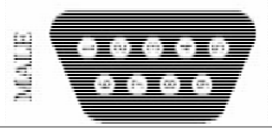
Application Note

LED Indicators	Green	Red
Transmitter	Laser Bias Current Normal <110 mA	Laser Bias Current Fault
Receiver	Input Optical Power Normal > -10 dBm	Input Power Fault

Figure 3

DB-9 Configuration

+12 V DC is provided to the OZ810 via the DB-9 (male) connector with the following pin-out configuration:



DB-9 CONFIGURATION	
PIN	FUNCTION
1	Laser Enable (+12 v = Laser ON)
2	Data INPUT (Tx RS232)/ OR NC
3	Data OUTPUT (Rx RS232)/ OR NC
4	+12 volts (400 mA max)
5	Ground
6	Laser Bias Monitor (0.1 V = 10 mA)
7	Laser Bias Alarm (open collector, 25 mA)
8	Received Power Monitor (1V = 1mW)
9	Received Power Alarm (open collector, 25 mA)

Figure 4

1. Pin 1 is Laser Enable and **must be pulled to +12 Volts for the module to be operational** (*Please ignore this only if you're using the manufacturer's original power supply with DB-9 plug*). The +12 Volt enables the bias current to be supplied to the Laser and hence create output light. Be aware that if the Laser Enable is not supplied the LED indicator representing transmitter proper operation will remain **GREEN**. (Refer to Figure 3.)
2. Pins 2 and 3 of the DB-9 are RS232 Data Input and Output signals respectively. The RS232 logic levels are ± 12 Volts.
3. Pin 4 provides +12 Volts to the module which typically draws less than 300 mA for the standard model with LNA or RS232 options.

Application Note

4. Pin 5 is Ground. On the box there is also a Ground screw mount that can be used for even better grounding. Refer to FIGURE-2.
5. Pin 6 of the DB-9 connector is Laser Bias Monitor, which monitors Laser Bias Current. The output impedance of this port is 10K Ohms and may only be probed with a high impedance multimeter, otherwise a false measurement will result.
6. Pin 7 of the DB-9 connector is Laser Bias Alarm. The interface circuit is an Open Collector output, which is used to connect an external load such as a relay or LED. Care must be taken when connecting this port to an external load to limit the current to no more than 25 mA through the use of a limiting resistor. The threshold level for the alarm to trip is typically 110 mA.
7. Pin 8 of the DB-9 connector is Receiver Power Monitor, which is basically a built-in optical power meter. For every 1 mW of optical power, you should measure 1 Volt at this pin. The output impedance of this port is 10K Ohms and may only be probed with a high impedance multimeter, otherwise a false measurement will result.
8. Pin 9 of the DB-9 connector is Received Power Alarm. The interface circuit is an Open Collector output, which is used to connect an external load such as a relay or LED. Care must be taken when connecting this port to an external load to limit the current to no more than 25 mA using a limiting resistor. The Threshold level for the alarm to trip is typically -10 dBm input optical power.

Application Note

POINT-TO-POINT SINGLE FIBER LINK with OZ9000

This segment addresses applications in which one or multiple stand-alone OZ600 or OZ810 combinations are used to connect to a central site of OZ9000 multi-channel rack-mounted local units with multiple transceivers built into the OZ9000 chassis. At the central office the transmitter built into the OZ9000 will have a Laser wavelength of 1310 nm to accommodate the bidirectional operation over a single optical fiber. You may populate the OZ9000 with up to five (5) transceivers, where each transceiver is capable of carrying an individual RF signal over single mode fiber optic cable.

The OZ9000 chassis is powered by AC 110 V to 240 V using built-in universal dual power supplies. An optional RS232 data modem, alarm and monitoring functions are all also available through a DB-25 connector.

LED Indicator lights

There are 4 LED lights located on the front panel of the OZ9000. Two of them indicate the working status of the RF modules and other two show the status of the internal AC-DC power supplies.

Two LEDs under ALARMS show the combination status of all transmitters and receivers alarms. For example: If all the transmitter bias currents are lower than 110 mA (typically 35 mA), then all transmitters are considered to be working normally and the TX LED will be ON, with the color **GREEN**. If any of the transmitters draws excess current beyond 110 mA, then the TX LED will be OFF indicating one or more transmitters are faulty. To check each transmitter's status, a skilled technician needs to remove the chassis cover and look at each individual transmitter's LED. Any transmitter module that has its LED turned ON to **RED** indicates a fault condition.

In the case of the RX LED, if all receivers inside the chassis receive optical power greater than -10 dBm, then all the receivers are working properly and the RX LED will be ON with the color **GREEN**. If any of the receivers detects optical power lower than -10 dBm, then the RX LED will be OFF signaling one or more receivers are faulty. To find out which receiver is faulty, a skilled technician needs to remove the chassis cover and

look at each individual receiver's LED. Any receiver module that has its LED turned ON to **RED** signals a fault condition.

The two LEDs under POWER are both dual color. They monitor the status of the main and backup power supplies. Under normal conditions both LEDs should be ON and remain **GREEN**.

Note: The individual transmitters and receivers inside the chassis will also have the same LED alarm configuration as is shown in Figure-3. The Laser Bias LED will only turn **RED** when the Laser draws excessive current. Otherwise, it will stay **GREEN**, even if the laser is disabled.

Application Note

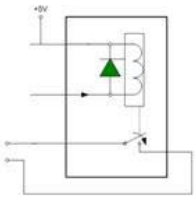
Application Note

OZ9000 chassis DB-25 pin-out Configuration

The DB-25 does not provide power to the module but rather it provides an interface port to connect to all of the dry contact relays built into the OZ9000. At maximum transceiver capacity there will be 10 pins dedicated to dry contact for transmitters and 10 pins dedicated to dry contacts for the receivers. The table below describes the pin-out configurations for all modules inside. Pins 12, 24 and 25 are I^2C pins dedicated to the options for remote monitoring and control via the I^2C interface (contact the factory for more details). PIN 13 is a +12 V output for measurement purposes of the internal +12 V power supply.

2 CHANNEL OZ9000			3 CHANNEL OZ9000		
DB25	RIBBON		DB25	RIBBON	
1	RX 1	Alarm Dry Contact (7 mA)	1	RX 1	Alarm Dry Contact (7 mA)
24			24		
2	RX 2		2	RX 2	
25			25		
3	NC		3	RX 3	
16			16		
4	NC		4	NC	
17			17		
5	NC		5	NC	
18			18		
6	TX 1		6	TX 1	
19			19		
7	TX 2		7	TX 2	
20			20		
8	NC		8	TX 3	
21			21		
9	NC		9	NC	
22			22		
10	NC		10	NC	
23			23		
11	GROUND		11	GROUND	
13	12 V		13	12 V	
24	IIC	OPTIONA	24	IIC	OPTIONAL
12	IIC		12	IIC	
25	IIC		25	IIC	

4 CHANNEL OZ9000			5 CHANNEL OZ9000		
DB25	RIBBON		DB25	RIBBON	
1	RX 1	Alarm Dry Contact (7 mA)	1	RX 1	Alarm Dry Contact (7 mA)
24			24		
2	RX 2		2	RX 2	
25			25		
3	RX 3		3	RX 3	
16			16		
4	RX 4		4	RX 4	
17			17		
5	NC		5	RX 5	
18			18		
6	TX 1		6	TX 1	
19			19		
7	TX 2		7	TX 2	
20			20		
8	TX 3		8	TX 3	
21			21		
9	TX 4		9	TX 4	
22			22		
10	NC		10	TX 5	
23			23		
11	GROUND		11	GROUND	
13	12 V		13	12 V	
24	IIC	OPTIONAL	24	IIC	OPTIONAL
12	IIC		12	IIC	
25	IIC		25	IIC	



NOTE: The Two Port Floating Dry contacts, supplied for each Transmitter or Receiver module integrated inside the OZ9000 chassis, under Normal Conditions are open, but under Alarm Conditions, the two contacts are shorted together (closed).

Last Updated Jun. 8, 11

Application Note

OZ9000 Internal Architecture Drawing

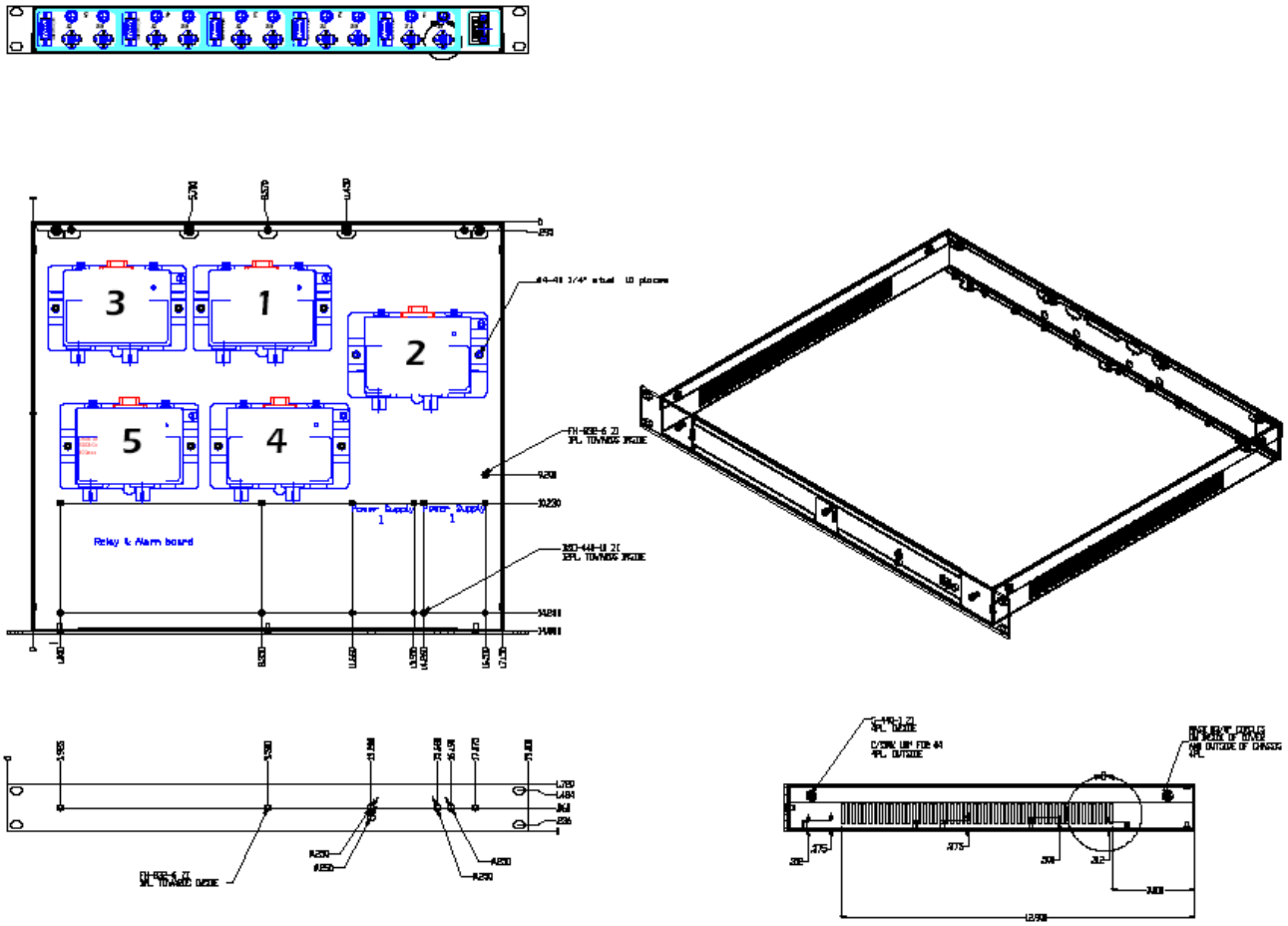


Figure 5

Transmitter Alarm and Monitoring equivalent circuit diagram

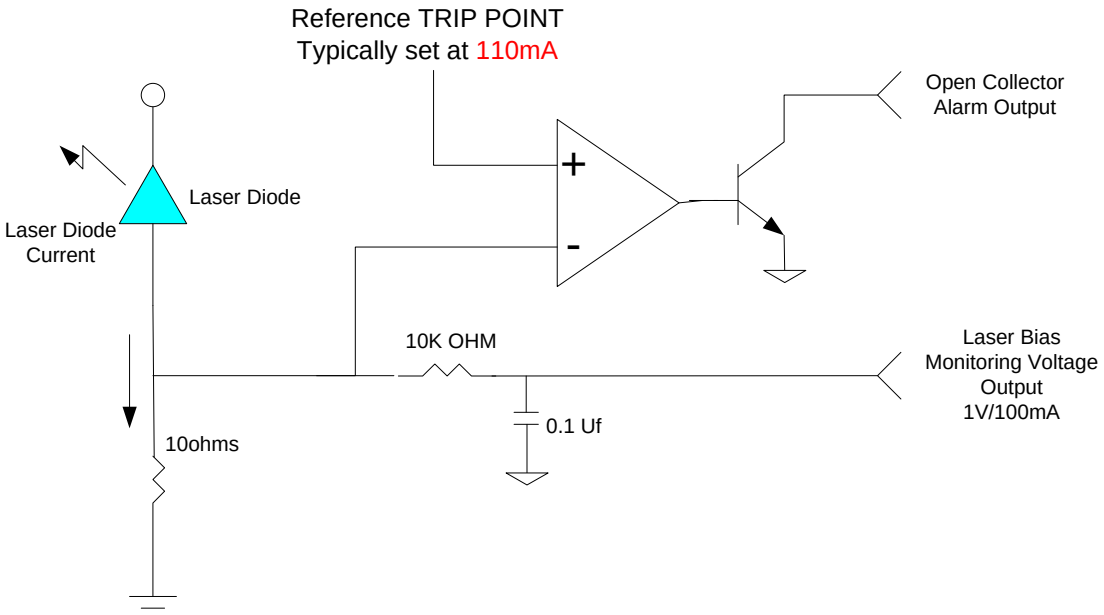


Figure 6

Receiver Alarm and Monitoring equivalent circuit diagram

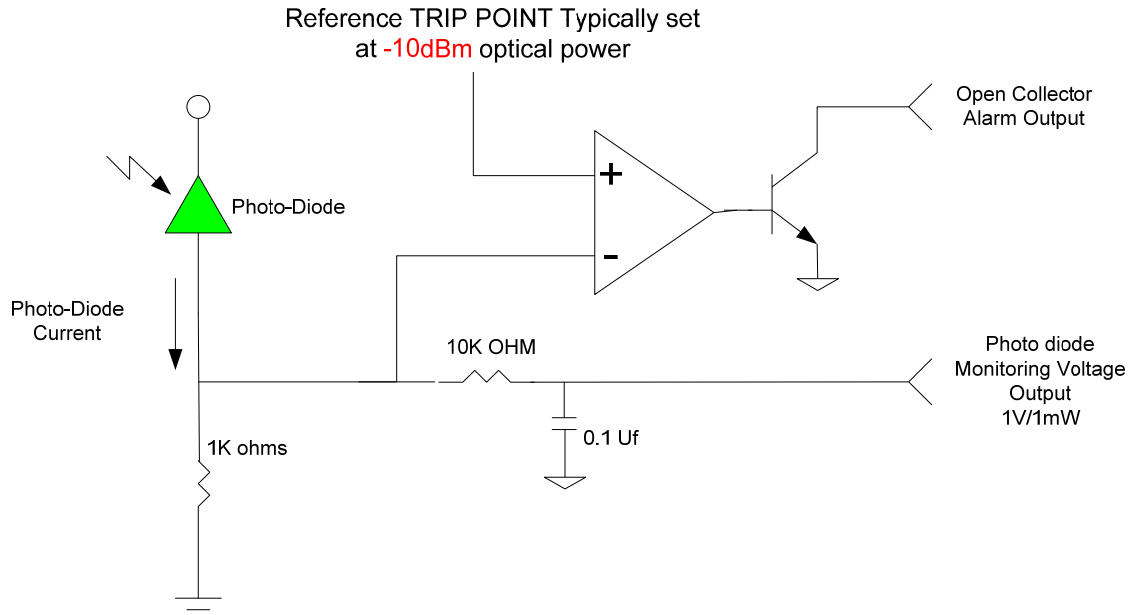


Figure 7

Application Note

ELECTRICAL SAFETY

Connecting and Disconnecting RF Connectors

This product uses SMA RF connectors. To connect a cable to the module, screw the cable connector onto the module connector to finger tightness, then use an SMA torque spanner to tighten the connector to the specified torque. To remove the connector, loosen the connector with an 8 mm spanner then remove the connector using fingers only. Other important suggestions are listed below:

- Use power supplies that provide current protection. Set the current compliance to somewhat higher than your desired operating current to avoid unforeseen inrush currents.
- Even though the OZ600 and OZ810 current consumptions are relatively low, we still recommend good heat sinking if the unit will operate in a high ambient temperature environment.
- At the receiver end, if possible, apply the bias to the modules before you input the light. Also, remove the light before you remove the bias.

ESD Precautions

Precautions for handling electro-static sensitive devices should be observed when handling all OZC modules. Technicians should ensure that they use effective personal grounding (e.g. ESD wrist strap etc.) when servicing the equipment. Any equipment or tools used should be grounded to prevent static charge buildup. Best practices should be observed at all times. For reference see the relevant standards, including EN 61340-5-1, “Protection of Electronic Devices from Electrostatic Phenomena – General Requirements”.

Application Note

OPTICAL FIBER SAFETY, HANDLING AND CLEANING

Safety

Never look into the end of an optical fiber directly or by reflection, either with the naked eye or through an optical instrument.

- Never leave equipment with radiating bare optical fibers accessible – always cap the connectors.
- Do not remove equipment covers when operating.
- Adjustment, maintenance and repair of the equipment should only be carried out by suitably qualified personnel.

Handling

This product is supplied with angle-polished connectors (APC) and these must not be confused with standard flat, spherical or "super" polished connectors. These connector types are not interchangeable and mating one with the other will damage both the cable and the equipment. The specification of the optical connector is critical to the performance of the complete fiber optic link.

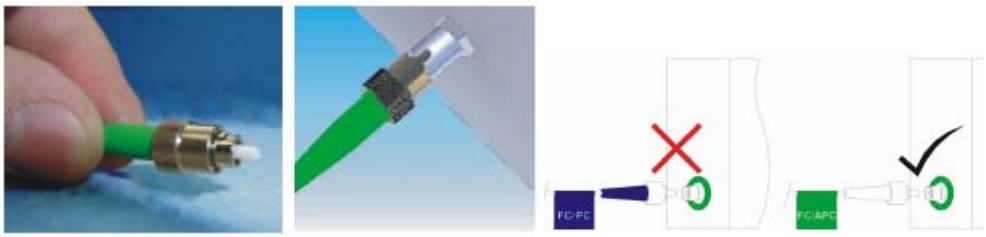


Figure 8

To connect FC/APC optical connectors, remove the dust caps and align the white ceramic center ferrule on the cable connector with the mating receptacle. There is a key (lug) on the side of the ferrule, which must match the keyway (gap) in the receptacle shroud. When they are aligned, gently push the plug home and finger tighten the knurled collet nut onto the threaded receptacle. Disconnection is the reverse of connection; replace the dust caps on both the receptacle and the cable plug.

Application Note

Ensure that all mating connectors are matched types. All Optical Zonu equipment uses APC connectors. Minimum Bend Radius of a simplex patch cable is typically 30 mm. At this radius there will be only a very small increase in loss due to the bend (~ 0.05dB).

Cleaning

Optical connectors **MUST** be cleaned before use. Most performance issues are due to dirty fibers. For more details please read the cleaning instruction which accompanies the connector cleaning kit you use.

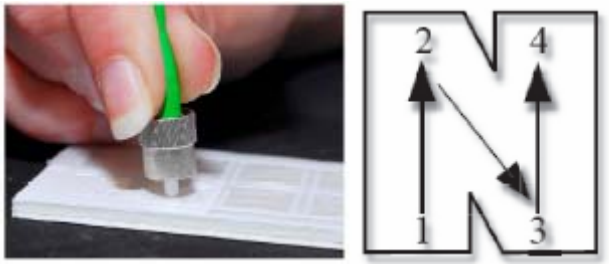


Figure 9

- Peel the plastic cover from an unused “N” cleaning pad.
- Hold the connector between your thumb and forefinger.
- Clean the connector using firm pressure by swiping in a pendulum motion through each segment of the “N” shape, following the diagram.
- Do not swipe over the same space twice.

Before connecting optical fibers to the module or to each other, ensure that the mating connectors are clean.

Application Note

Handling and Cleaning Fiber Optic Connectors

- Minimum radius curvature is 1.5 inches – make sure fiber is not pinched or sharply bent.
- Always keep the connector with the plastic cover.
- Never touch the fiber tip.
- Optical Zonu RF over Fiber transceivers have SC/APC optical connectors. They must mate ONLY with SC/APC connectors and adaptors (plastic color is **GREEN**). Optional FC/APC connectors are available upon request.
- Always clean both sides of the mating surfaces. For blind connectors use either a special tool OR clean the connector, to be inserted, very well.
- Dry cleaning, no special solutions or cleaner, is the preferred method.
- If a tool is used please the follow manufacturer's direction explicitly.
- On a cleaning pad, use a "Figure 8" motion, ensuring that the tip of the ferrule is always parallel to the cleaning pad.

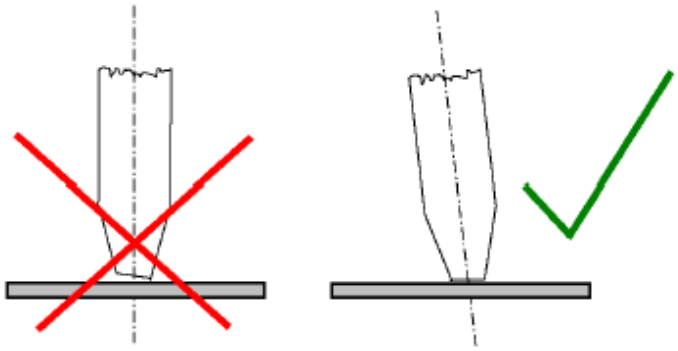


Figure 10

Connecting and Disconnecting Optical Connectors

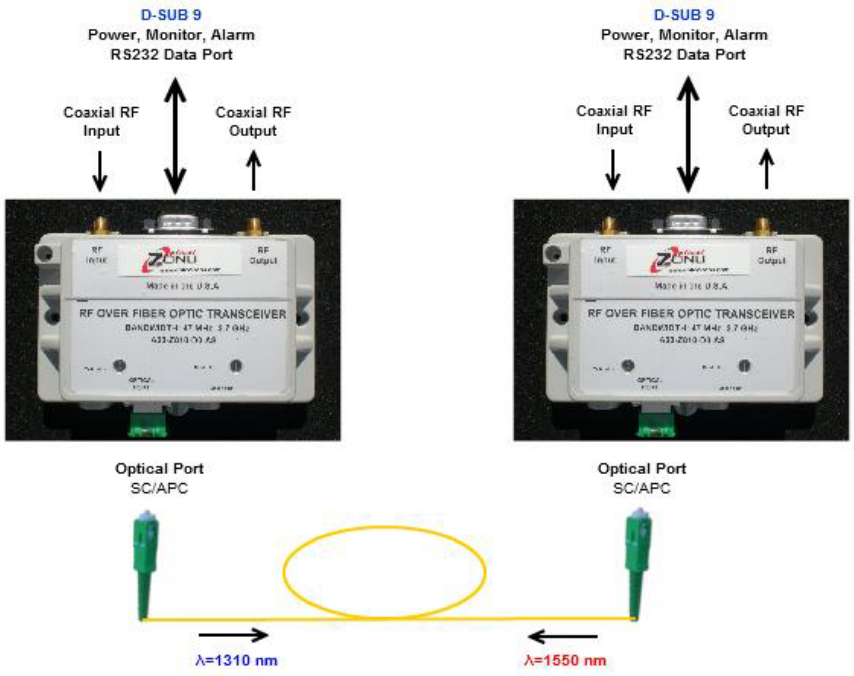
Only connect SC/APC cable to SC/APC modules and FC/APC cable to FC/APC modules. Locate the connector key. Align key and keyway. To connect SC/APC, gently push the plug into the adapter until a click is heard and the connector locks. To disconnect SC/APC just pull the "square" collar back.

To connect FC/APC optical connectors, remove the dust caps and align the white ceramic center ferrule on the cable connector with the receptacle. There is a lug on the side of the ferrule, which must match the gap in the receptacle shroud. When they are aligned, gently push the plug home and finger tighten the knurled collet nut onto the threaded receptacle. To disconnect, unscrew the knurled collet on the plug and gently withdraw the plug. Replace the dust caps on both the receptacle and the cable plug. (Keep in mind Minimum Bend Radius of Fiber Optic Cable is 50 mm.)

Application Note

ORDERING INFORMATION

1 Channel Point-to-Point Bidirectional Single Fiber Link



PART NO. S03-0810-W-SC-01

This set up includes the following parts:

- OZ600 or OZ810 RF over Fiber Optics Standalone Transceiver with λ 1310 nm isolated DFB Laser and built-in internal WDM.
- OZ600 or OZ810 RF over Fiber Optics Standalone Transceiver with λ 1550 nm isolated DFB Laser and built-in internal WDM.
- 2 units of AC to +12 V DC power adaptors with DB-9 connectors.

Please contact factory at 818 780 9701 ext. 23 for more info.

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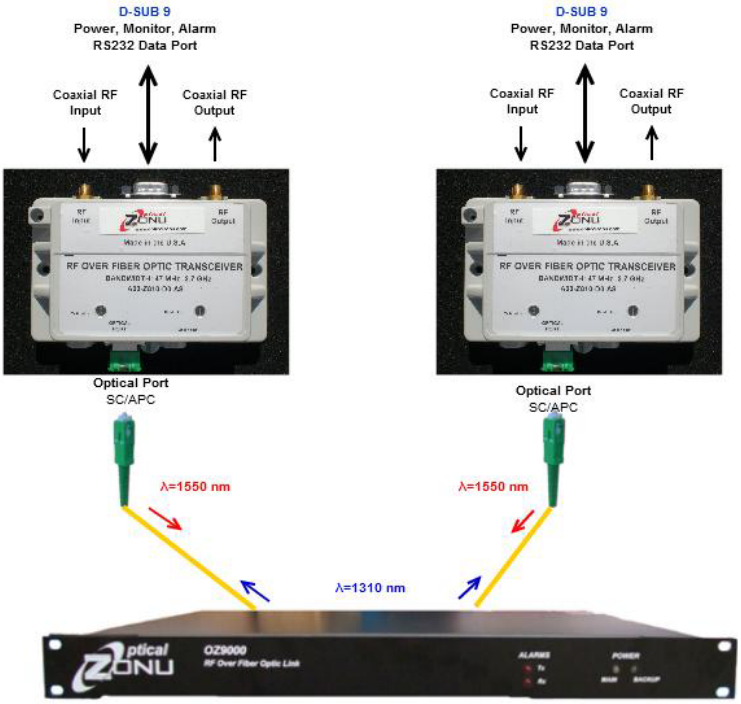
2-Channel Point to Multi-Point Bidirectional Single Fiber Links



PART NO. S03-9502-W-SC-01

This set includes the following parts:

- OZ9000 1U – 19 inches Chassis with 2 units of RF over Fiber Optics Transceivers with λ 1310 nm isolated DFB Lasers. Each transceiver has built-in WDM to allow single fiber functionality. This is a designated head-end module. OZ9000 is powered with 110 - 240 V AC and it has dual power supplies for redundancy. Alarm and Monitoring functions run through the DB-25 connector.
- 2 units of OZ600 or OZ810 stand-alone transceivers with λ 1550 nm isolated DFB Lasers and built-in internal WDMs.
- 2 units of AC to 12 V DC power adaptors with DB-9 connectors.

Please contact factory at 818 780 9701 ext. 23 for more info.

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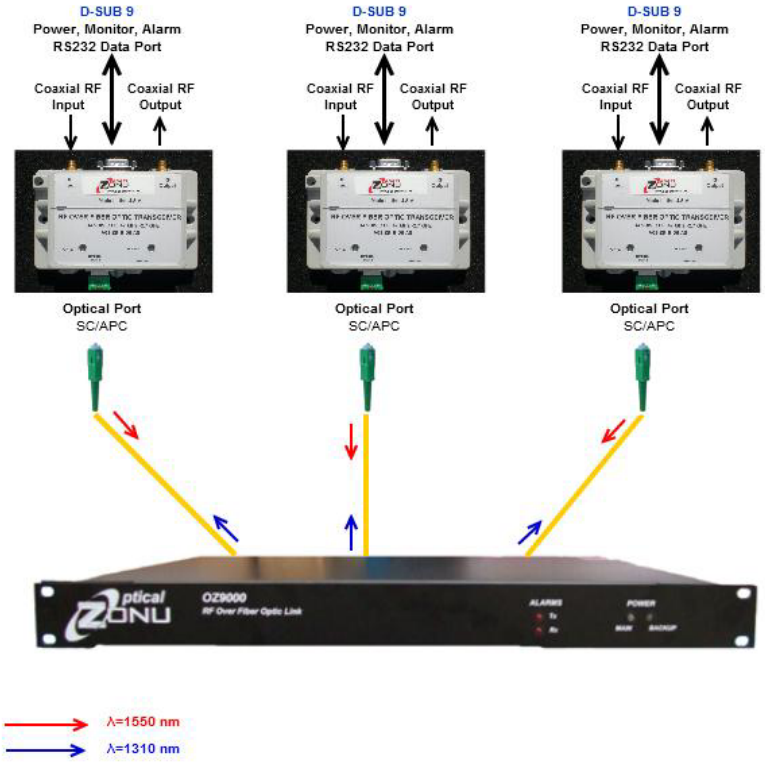
Application Note

3-Channel Point to Multi-Point Bidirectional Single Fiber Links



PART NO. S03-9503-W-SC-01

This set includes the following parts:

- OZ9000 1U – 19 inches Chassis with 3 units of RF over Fiber Optics Transceivers with λ 1310 nm isolated DFB Lasers. Each transceiver has a built-in WDM to allow single fiber functionality. This is a designated head-end module. The OZ9000 is powered with 110 - 240 V AC and it has dual power supplies for redundancy. Alarm and Monitoring functions run through the DB-25 connector.
- 3 units of OZ600 or OZ810 stand-alone transceivers with λ 1550 Nm isolated DFB Lasers and built-in internal WDMs.
- 3 units of AC to 12 V DC power adaptors with DB-9 connectors.

Please contact factory at 818 780 9701 ext. 23 for more info.

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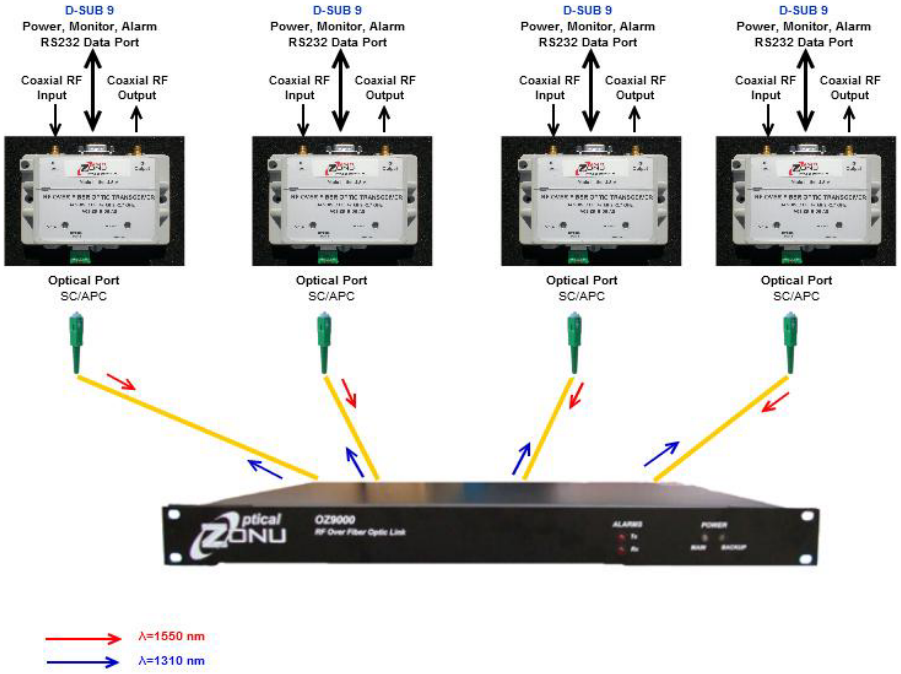
Application Note

4-Channel Point to Multi-Point Bidirectional Single Fiber Links



PART NO. S03-9504-W-SC-01

This set includes the following parts:

- OZ9000 1U – 19 inches Chassis with 4 units of RF over Fiber Optics Transceivers with λ 1310 nm isolated DFB Lasers. Each transceiver has built-in WDM to allow single fiber functionality. This is a designated head-end module. OZ9000 is powered with 110 - 240 V AC and it has dual power supplies for redundancy. Alarm and monitoring functions run through the DB-25 connector.
- 4 units of OZ600 or OZ810 stand-alone transceivers with λ 1550 nm isolated DFB Lasers and built-in internal WDMs.
- 4 units of AC to 12 V DC power adaptors with DB-9 connectors.

Please contact factory at 818 780 9701 ext. 23 for more info.

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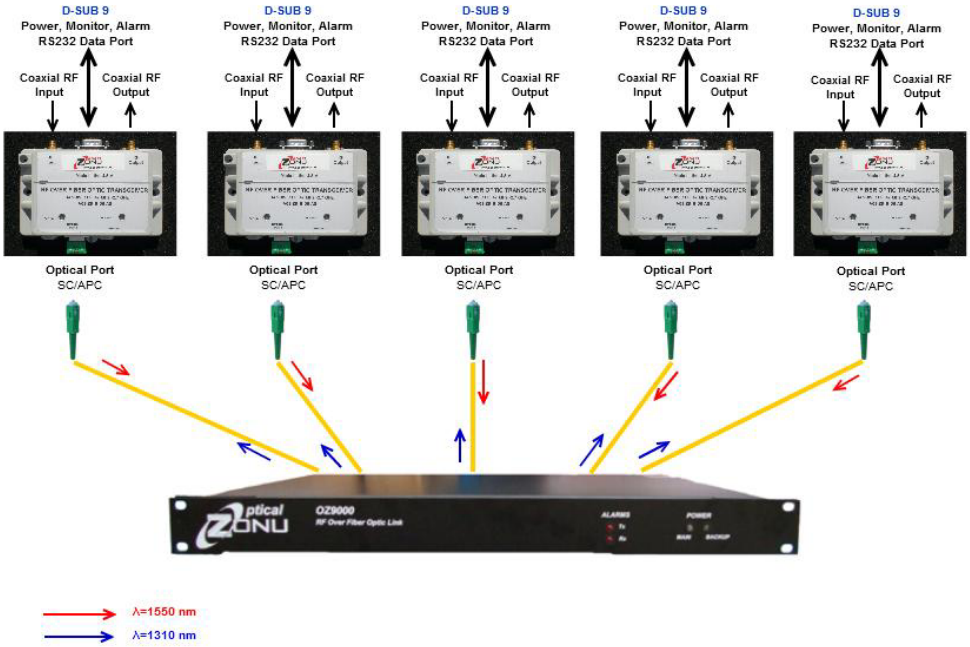
5-Channel Point to Multi-Point Bidirectional Single Fiber Links



PART NO. S03-9505-W-SC-01

This set includes the following parts:

- OZ9000 1U – 19 inches Chassis with 5 units of RF over Fiber Transceivers with λ 1310 nm isolated DFB Lasers. Each transceiver has built-in WDM to allow single fiber functionality. This is a designated head-end module. OZ9000 is powered with 110 - 240 V AC and it has dual power supplies for redundancy. Alarm and Monitoring functions run through the DB-25 connector.
- 5 units of OZ600 or OZ810 stand-alone transceivers with λ 1550 nm isolated DFB Lasers and built-in internal WDMs.
- 5 units of AC to +12 V DC power adaptors with DB-9 connectors.

Please contact factory at 818 780 9701 ext. 23 for more info.

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