

WiBa OPERATOR'S MANUAL

2.7 GHz, Wideband ("WiBa") Fiberoptic Link

Model	Description
10381	Tx, Un-amplified, 10 to 2700 MHz, 50Ω
10382	Tx, Amplified, 10 to 2700 MHz, 50Ω
10383	Tx, Un-amplified, 10 to 2500 MHz, 75Ω
10384	Tx, Amplified, 10 to 2500 MHz, 75Ω

Model	Description
10481	Rx, 10 to 2700 MHz, 50Ω
10482	Rx, Double*, 10 to 2700 MHz, 50Ω
10483	Rx, 10 to 2500 MHz, 75Ω
10484	Rx, Double*, 10 to 2500 MHz, 75Ω
10485	Rx, 10 to 2700 MHz, 50Ω, Hi Optical Power Low Gain
10486	Rx, Double*, 10 to 2700 MHz, 50Ω, Hi Optical Power Low Gain
10487	Rx, 10 to 2500 MHz, 75Ω, Hi Optical Power Low Gain
10488	Rx, Double*, 10 to 2500 MHz, 75Ω, Hi Optical Power Low Gain

*The 10482/4 includes 2 receivers in a single plug-in module.

Model	Description
3581	Tx, Un-amplified, 10 to 2700 MHz, 50Ω
3582	Tx, Amplified, 10 to 2700 MHz, 50Ω
3583	Tx, Un-amplified, 10 to 2500 MHz, 75Ω
3584	Tx, Amplified, 10 to 2500 MHz, 75Ω

Model	Description
4581	Rx, 10 to 2700 MHz, 50Ω
4583	Rx, 10 to 2500 MHz, 75Ω
4585	Rx, 10 to 2700 MHz, 50Ω, Hi Optical Power Low Gain
4587	Rx, 10 to 2500 MHz, 75Ω, Hi Optical Power Low Gain



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1. WARNINGS, CAUTIONS, LIABILITY, WARRANTY AND GENERAL NOTES

Safety Considerations

When installing or using this product, observe all safety precautions during handling and operation. Failure to comply with the following general safety precautions and with specific precautions described elsewhere in this manual violates the safety standards of the design, manufacture, and intended use of this product. Ortel assumes no liability for the customer's failure to comply with these precautions.



The fiberoptic laser transmitter used in Ortel's WiBa link contains a class IIIb laser product as defined by the U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration. This laser product complies with 21 CFR, Chapter I, Subchapter J of the DHEW standards under the Radiation Control for Health and Safety Act of 1968. The laser module certification label is located immediately adjacent to the optical output connector and also shows the required DANGER warning logotype.

The laser operates at nominally 1310 nm or 1550 nm (depending on the model) with less than 30 mW optical output. The typical optical output for this product is less than 10 mW. The protective laser plug-in module housing prevents a user from being exposed to hazardous optical output levels. Since there is no human access to the laser output during system operation, no special operator precautions are necessary when fiber is connected to the transmitter and receiver.

During installation, service, or maintenance, the service technician is warned to not look directly into the fiber connector or the fiber, which is connected to the fiber connector before it is connected to the fiberoptic receiver. The light emitted from the fiberoptic connector or any fiber connected to the connector is invisible and may be harmful to the human eye. Use either an infrared (IR) viewer or fluorescent screen for optical output verification. All handling precautions as outlined by Federal agencies or other authorities of class IIIb lasers must be observed.

Do not attempt to modify or to service the laser diode module. Return it to Ortel for service and repair. Contact the Ortel Customer Service Department for a return authorization and further instructions.

Electrostatic Sensitivity

Observe electrostatic precautionary procedures. Semiconductor laser transmitters and receivers provide highly reliable performance when operated in conformity with their intended design. However, a semiconductor laser may be damaged by an electrostatic charge inadvertently imposed by careless handling.

Static electricity can be conducted to the laser chip from the center pin of the RF input connector, and through the DC connector pins. When unpacking and otherwise handling the transmitter, follow ESD precautionary procedures including use of grounded wrist straps, grounded workbench surfaces, and grounded floor mats.

Exposure to electrostatic charge is greatly reduced after the transmitter has been installed in an operational circuit.

Service

Do not attempt to modify or service any part of the system other than in accordance with procedures outlined in this Operation Manual. If the system does not meet its warranted specifications, or if a problem is encountered that requires service, return the apparently faulty plug-in or assembly to Ortel for evaluation in accordance with Ortel's warranty policy.

When returning a plug-in or assembly for service, include the following information: Owner, Model Number, Serial Number, Return Authorization Number (obtained in advance from Ortel's Customer Service Dept.), service required and/or description of the problem encountered.

Warranty

Ortel warrants to the original purchaser all standard products sold by Ortel to be free of defects in material and workmanship for one (1) year from date of shipment from Ortel. During the warranty period, Ortel's obligation, at our option, is limited to repair or replacement of any product that Ortel proves to be defective. This warranty does not apply to any product that has been subject to alteration, abuse, improper installation or application, accident, electrical or environmental over-stress, negligence in use, storage, transportation, or handling.

This warranty is the only warranty made by Ortel and is in lieu of all other warranties, expressed or implied, except as to title, and can be amended only by a written instrument signed by an officer of Ortel. Ortel sales agents or representatives are not authorized to make commitments on warranty returns.

Limitations of Liabilities

Ortel's liability on any claim of any kind, including negligence, for any loss or damage arising from, connected with, or resulting from the purchase order, contract, or quotation, or from the performance or breach thereof, or from the design, manufacture, sale, delivery, installation, inspection, operation or use of any equipment covered by or furnished under this contract, shall in no case exceed the purchase price of the device which gives rise to the claim.

EXCEPT AS EXPRESSLY PROVIDED HEREIN, ORTEL MAKES NO WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, WITH RESPECT TO ANY GOODS, PARTS AND SERVICES PROVIDED IN CONNECTION WITH THIS AGREEMENT INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. ORTEL SHALL NOT BE LIABLE FOR ANY OTHER DAMAGE INCLUDING, BUT NOT LIMITED TO, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH FURNISHING OF GOODS, PARTS AND SERVICE HEREUNDER, OR THE PERFORMANCE, USE OF, OR INABILITY TO USE THE GOODS, PARTS AND SERVICE.

Ortel will not be responsible for loss of output or reduced output of opto-electronic devices if the customer performs chip mounting, ribbon bonding, wire bonding, fiber coupling, fiber connectorization, or similar operations. These processes are critical and may damage the device or may affect the device's output or the fiber output.

Ortel test reports or data indicating mean-time-to-failure, mean-time-between-failure, or other reliability data are design guides and are not intended to imply that individual products or samples of products will achieve the same results. These numbers are to be used as management and engineering tools, and are not necessarily indicative of expected field operation. These numbers assume a mature design, good parts, and no degradation of reliability due to manufacturing procedures and processes.

Ortel is not liable for normal laser output degradation or fiber coupling efficiency degradation over the life of the device.

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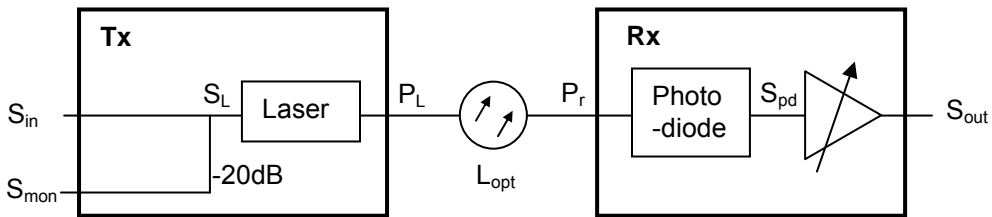
2. SCOPE

This document describes the primary procedures and information needed to install the Ortel “WiBa” fiberoptic transmitter and receiver models. Additional detailed product specifications may be found in the Product Marketing Datasheet, available at www.emcore.com.

Standard Link

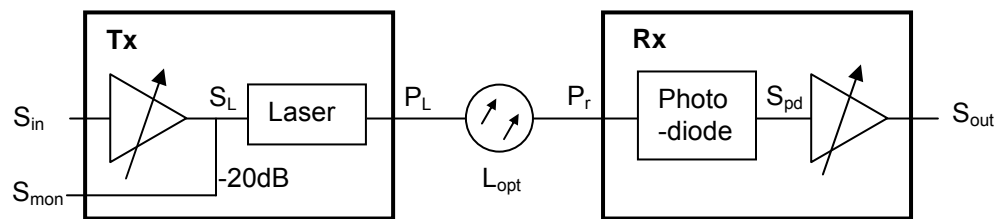
**Un-amplified 10381S/B and 10383B/F
Un-amplified 3581S/B and 3583B/F**

**10481S/B, 10482S/B, 10483B/F and 10484B/F
4581S/B, and 4583B/F**



**Amplified 10382S/B and 10384B/F
Amplified 3582S/B and 3584B/F**

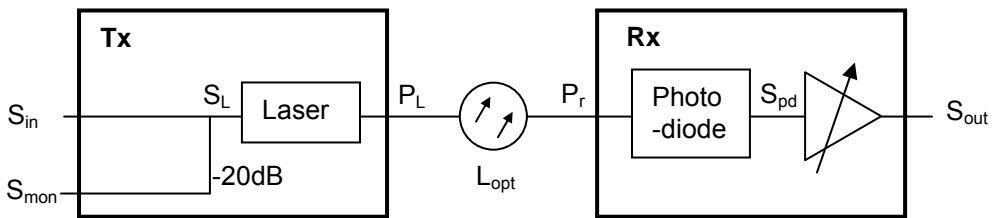
**10481S/B, 10482S/B, 10483B/F and 10484B/F
4581S/B and 4583B/F**



High Optical Power / Low Gain Link

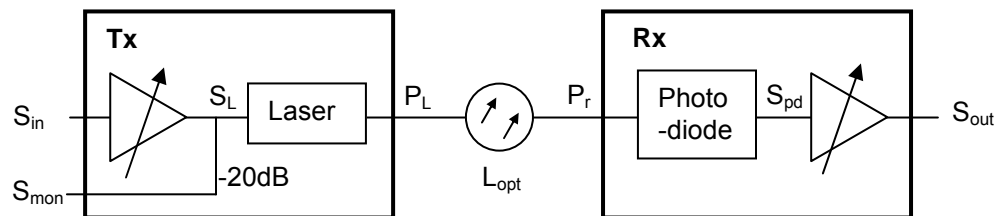
**Un-amplified 10381S/B and 10383B/F
Un-amplified 3581S/B and 3583B/F**

**10485S/B, 10486S/B, 10487B/F and 10488B/F
4585S/B, and 4585B/F**



**Amplified 10382S/B and 10384B/F
Amplified 3582S/B and 3584B/F**

**10485S/B, 10486S/B, 10487B/F and 10488B/F
4585S/B and 4587B/F**



3. MECHANICAL INSTALLATION

The WiBa products are mounted in either Ortel's Rack Mount Model 10990A 19 inch rack-mount chassis and powered with a Model 10901A and/or 10901B Power Supply, as shown below, or as a Flange Mount package. In the case of the Rack Mount system either of these power supplies provides enough current to drive up to eight WiBa transmitter (Tx) and/or receiver (Rx) plug-ins. The Tx and Rx may be inserted or removed while the power supplies are turned on, although it is advisable to have the RF connectors disconnected during installation and removal. DC monitoring pins are available at the back of the chassis. Except for systems using redundancy switches, these DC pins may be left disconnected. (Detailed descriptions of these pins can be found near the end of this manual.)



4. OPTICAL CONSIDERATIONS

4.1 Optical Fiber

Ortel Tx and Rx are designed for singlemode fiber at 1310 or 1550 nm, depending on the model. While many styles exist for the outer jackets and cables, the fundamental glass portion of the fiber is consistently 125 microns in total, with the inner 8-10 microns being the core that actually contains the light. As can be imagined with such a small core, cleanliness and care of the bare fiber and ends is critical.

Also critical is the bend radius. Like many types of RF cables, when an optical fiber is bent tighter than a roughly 1 inch (25 mm) radius, the light may escape, thus decreasing the RF gain of the link. Bends much tighter than 1 inch also may permanently damage some fibers. Thus when storing or installing fiberoptic cable it should be wound and bent in loose coils or turns. On the convenient side, optical fiber is immune to all electrical cross-talk and ground loops, therefore optical cables can be installed next to power and communication lines with no concern of signal degradation.

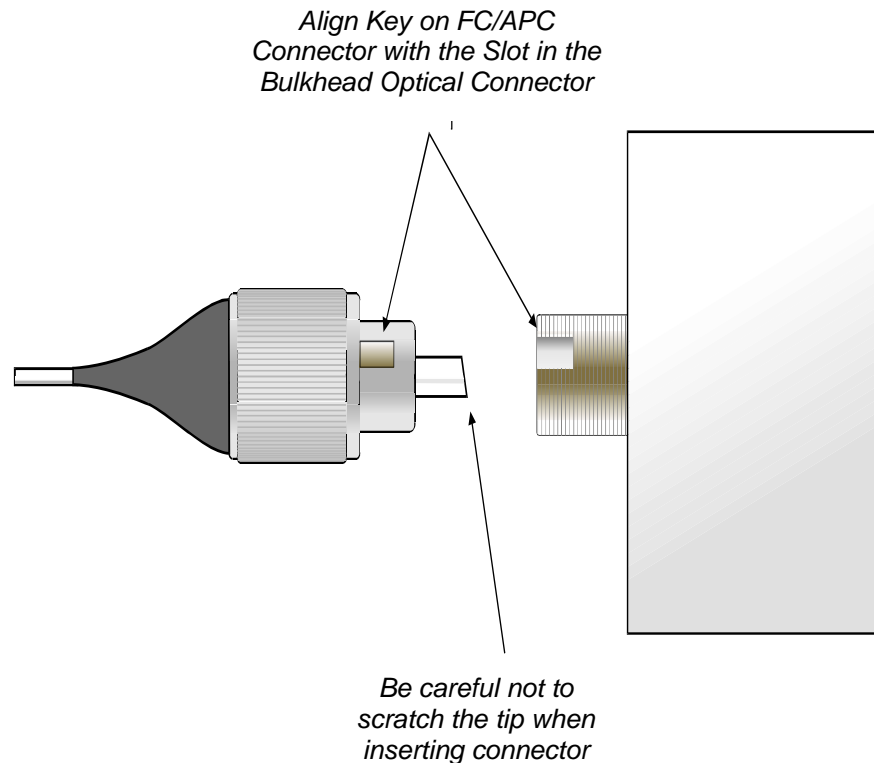
Finally, the fiber itself must be singlemode, not multimode. If a WiBa Tx and Rx are used with multimode fiber, then the RF gain, distortion, noise, bandwidth, and overall performance stability may suffer.

4.2 Optical Connector Styles

There are many optical connectors on the market. For high performance and high frequency RF applications, the connector must be for singlemode fiber and be repeatable, low loss and have a low optical return loss. The WiBa units are provided with either an FC-APC or an SC-APC connector. The first 2 letters indicate the mechanical housing style. The SC style uses a push-pull mechanism to mate, while the FC uses a threaded sleeve and an alignment key. This FC key can be tricky to align, so take care that it has actually slid into the mating notch prior to screwing down the housing, otherwise it may appear OK even though the key was out of the notch.

The last letters (“APC”) indicate the polish geometry and quality on the connector tip. “APC” stands for Angled Physical Contact. An 8 degree angle and a glass-to-glass contact characteristic of the APC reduces optical reflections to less than -60 dB, which can noticeably improve RF distortion and noise, especially for longer lengths of fiber. Other polish geometries, such as PC, SPC and UPC, have no 8-degree angle, so if mated directly to an APC will increase system RF losses by more than 20 dB. If your location uses both PC and APC connectors, it helps to label them because the outer housings of both styles look similar.

Non-APC connectors may be used for connections separate from the WiBa units themselves, although at the risk of some degradation of performance. The WiBa Tx includes an optical isolator that shields the laser itself from otherwise destabilizing reflections and a proprietary circuit that reduces double-back scattering noise in the fiber (a phenomenon somewhat similar to RF VSWR), so many applications do use non-APC connectors in the optical train with perfectly satisfactory results. If in doubt, installing APC down the entire length of fiber will give the best possible dynamic range.

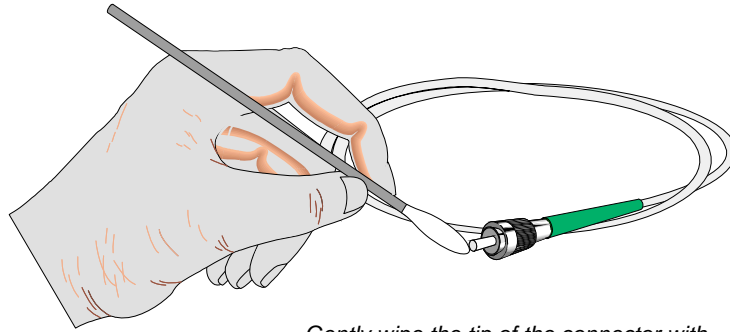


4.3 Cleaning Optical Connectors

CAUTION: Take care when working with fiber that may be carrying light. Looking directly into the connector or fiber may damage your eye.

Fiberoptic connectors on cable that come pre-terminated should have been cleaned and capped, so usually the installer can simply remove the cap and make the connection without cleaning. If in doubt, you may want to clean the connector before installation. Once the connection is made, there is no need to periodically clean the connector as long as it remains connected. The optical connectors of the Tx and Rx are recessed, hence generally stay clean with no manual cleaning required, although it is recommended to keep them covered when not in use.

When handling connectors, remember that the light comes from an aperture only 9 microns in diameter, so grease from your finger or small scratch can easily create loss and reflections. To clean, moisten a cotton swab with alcohol and gently wipe the tip of the connector several times. Allow to air dry.



Gently wipe the tip of the connector with a cotton swab soaked in alcohol. Air dry.

4.4 Detecting Optical Power

Because the light from the Tx is invisible infrared (IR), you will need an indirect method to detect it, the cheapest and easiest being an infrared fluorescence card. Such cards glow a red shape that shows approximately the power and shape of the beam. Clean connectors create a circular beam, while dirty connectors usually will emit a misshapen beam. Many distributors carry them, please contact Ortel at (626) 293-3400 ext. 3744 for this item. For a more quantitative measurement, an optical power meter with calibrated detector can be used. (In North America, Fiber Instrument Sales, EXFO at www.exfo.com, Newport at www.Newport.com and many other companies sell them.) Additionally, the WiBa Rx itself can be used. The back panel monitor pin indicates the current running through the Rx photodiode. This monitor reads about 0.9 V/mW at 1310 nm and 1.0 V/mW at 1550 nm.

4.5 Maximum Optical Power into Rx and Calculating Optical Loss

Determining the power into the Rx can be critical because the Rx works best with less than 3 dBm of optical power (2 mW optical power or about 2V on the monitor pin). As can be seen from the table below, while transmitters of the 0-3 dBm version can be connected directly to the receiver, the higher power 7-10 dBm style need to be attenuated for best performance.

Standard 10481, 10482, 10483 and 10484 Receivers

Tx Model 1038__01 Output	0 to 3 dBm (1 to 2 mW)
Tx Model 1038__05 Output	8 to 10 dBm (5 to 10 mW)
Tx Model 1038__15 Output	11 to 13 dBm (15 to 20 mW)
Rx Optimal Input	< 3 dBm (2 mW)

Tx Model 358__01 Output	0 to 3 dBm (1 to 2 mW)
Tx Model 358__05 Output	8 to 10 dBm (5 to 10 mW)
Tx Model 358__15 Output	11 to 13 dBm (15 to 20 mW)
Rx Optimal Input	< 3 dBm (2 mW)

High Power 10485, 10486, 10487 and 10488 Receivers

Tx Model 1038__01 Output	0 to 3 dBm (1 to 2 mW)
Tx Model 1038__05 Output	8 to 10 dBm (5 to 10 mW)
Tx Model 1038__15 Output	11 to 13 dBm (15 to 20 mW)
Rx Optimal Input	< 10 dBm (10 mW)

Tx Model 358__01 Output	0 to 3 dBm (1 to 2 mW)
Tx Model 358__05 Output	8 to 10 dBm (5 to 10 mW)
Tx Model 358__15 Output	11 to 13 dBm (15 to 20 mW)
Rx Optimal Input	< 10 dBm (10 mW)

The optical attenuation of a link will be a sum of the distributed fiber loss and discrete loss from components such as connectors, splitters and optical attenuators. Typical fiber losses less than 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm. For the Standard link short fibers contribute very little loss. If a 7-10 dBm Tx is to be connected to a receiver with little fiber a nominally 6 dB optical attenuator should be used. (In the extreme case of a 10 dBm Tx, the power is reduced to 4 dBm. Additional incremental losses in the system coupled with the fact that the Rx has some margin in performance will lead to good results.)

In the case of the High Optical Power / Low Gain link short fiber distances paired with a optical transmitter with 7 – 10 dBm output is not an issue.

Of note for fiber links, the incremental RF loss in dB is twice that of the incremental optical loss. Thus adding for example 1.5 dB extra optical loss would reduce the RF gain of the complete link by an additional 3 dB. (This peculiar relationship occurs because the RF current at the photodiode is directly proportional to the optical power at the photodiode, but the RF current is squared to give RF power, hence the factor of 2.)

$$\Delta\text{Gain}_{\text{RF}} = - 2 \times \Delta\text{Loss}_{\text{optical}}$$

The RF gain for a complete link in absolute terms may be specified using the TG & RG method.

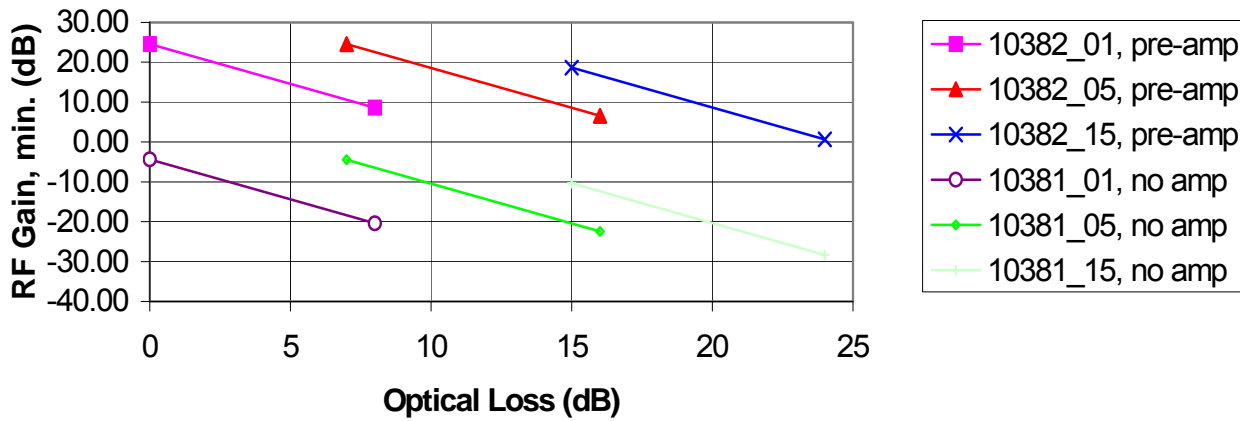
$$G = S_{\text{out}} - S_{\text{in}} = \text{TG} + \text{RG} - 2 \cdot L_{\text{opt}} + 10 \cdot \log (R_{\text{out}} / R_{\text{in}})$$

where TG is the Tx gain in dB·W/A, RG is the Rx gain in dB·A/W, L_{opt} is the total optical loss in dB, R_{in} is the Tx impedance, and R_{out} is the Rx impedance.

Link Gain specified for indicated Tx into Rx of same impedance with all amps set to maximum. For optimal performance, the total RF power into the laser (S_{L}) should be adjusted to +4 dBm or less, such as by decreasing the gain of the Tx amp. As a result, the link gain will be a function of the input RF power (S_{in}).

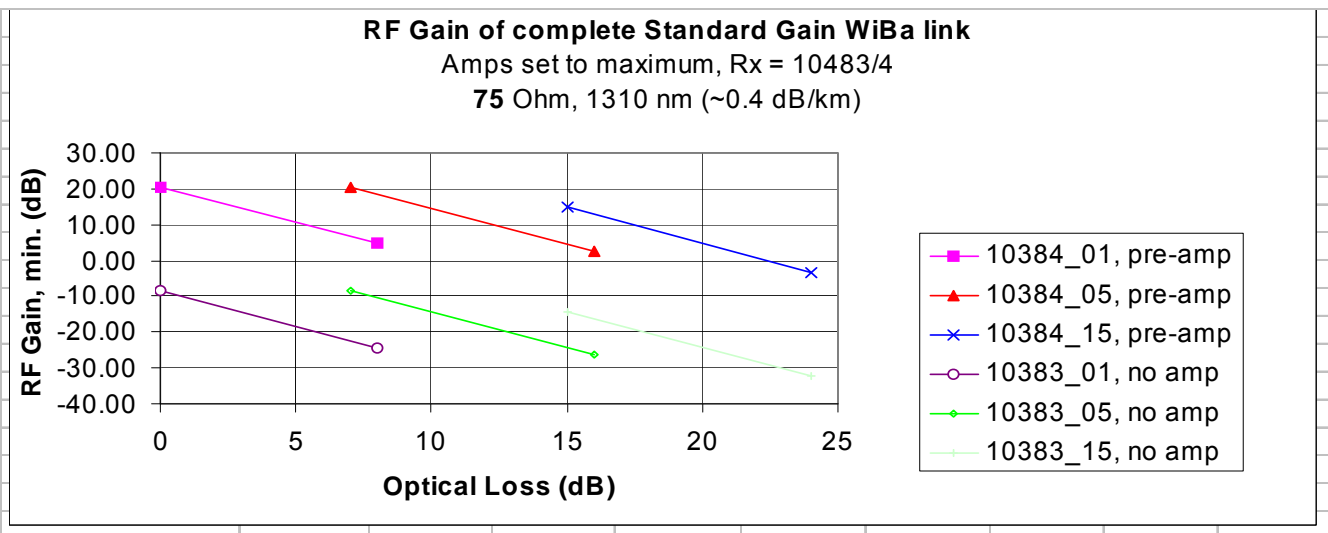
RF Gain of complete Standard Gain WiBa link

Amps set to maximum, Rx = 10481/2
50 Ohm, 1310 nm (~0.4 dB/km)



RF Gain of complete Standard Gain WiBa link

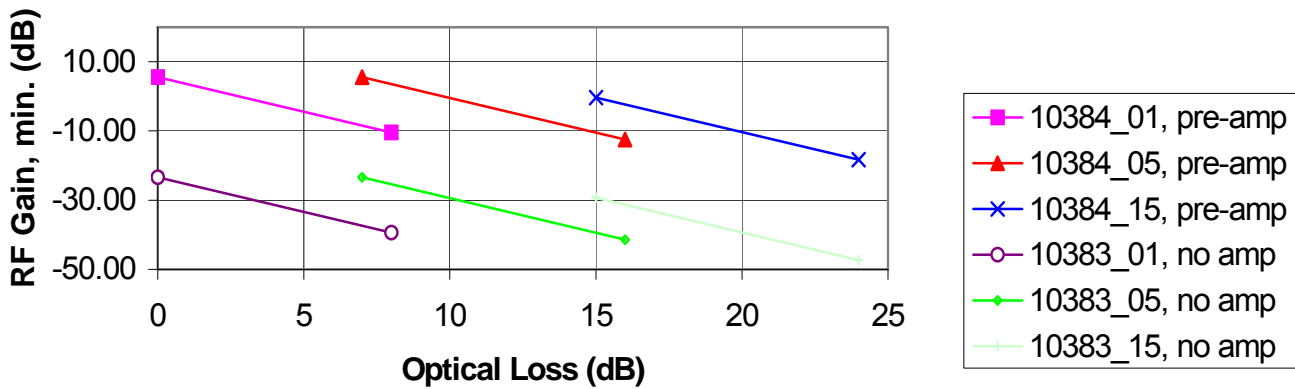
Amps set to maximum, Rx = 10483/4
75 Ohm, 1310 nm (~0.4 dB/km)



RF Gain of complete High Optical Power / Low Gain WiBa link

Amps set to maximum, Rx = 10485/6

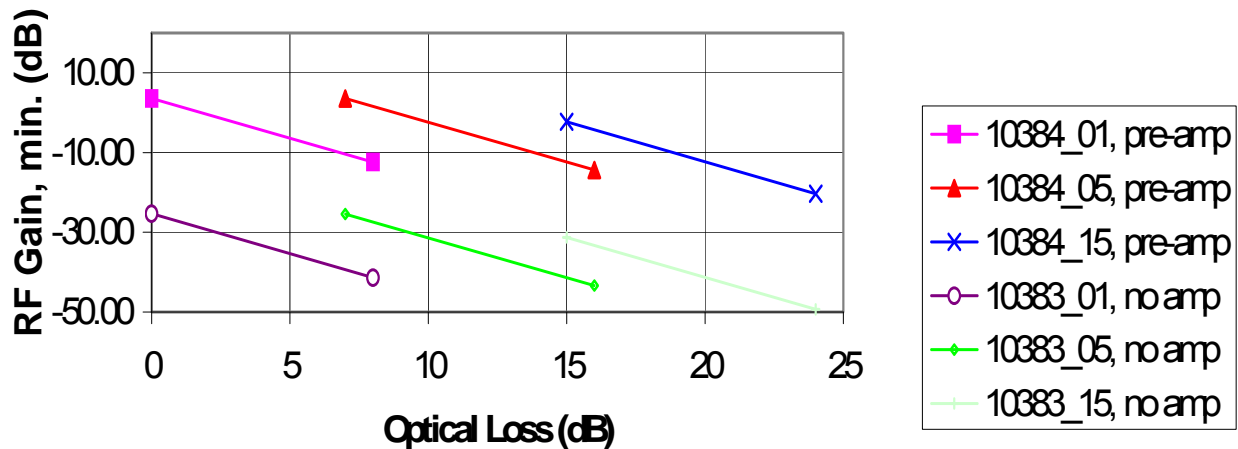
75 Ohm, 1310 nm (~0.4 dB/km)



RF Gain of complete High Optical Power / Low Gain WiBa link

Amps set to maximum, Rx = 10487/8

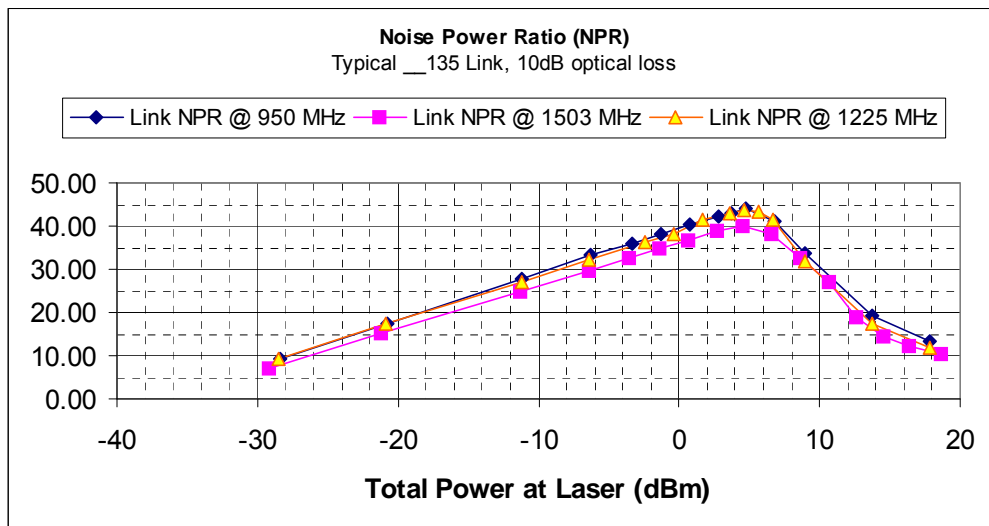
75 Ohm, 1310 nm (~0.4 dB/km)



5. RF OPTIMIZATION

In most WiBa Link installations, the RF power into the laser (S_L) is the most critical adjustment when optimizing carrier to noise and intermodulation products. When considered simultaneously, these noise and intermod contributions can be combined into a single quantity of Noise Power Ratio, or NPR, as shown in the graph below. As a general goal, Ortel recommends adjusting the total RF power in the range of 0 to 4 dBm by viewing the LED or monitoring the front panel RF connector. After the Tx RF power has been adjusted then the RF gain at the Rx can be adjusted to provide an RF level optimal for whatever component follows the WiBa Link.

<u>Tx "RF at Laser" LED</u>	<u>RF on laser (S_L)</u>
OFF	< -15 dBm
Amber	-15 to 0 dBm
Green	0 to 4 dBm
Red	> 4 dBm

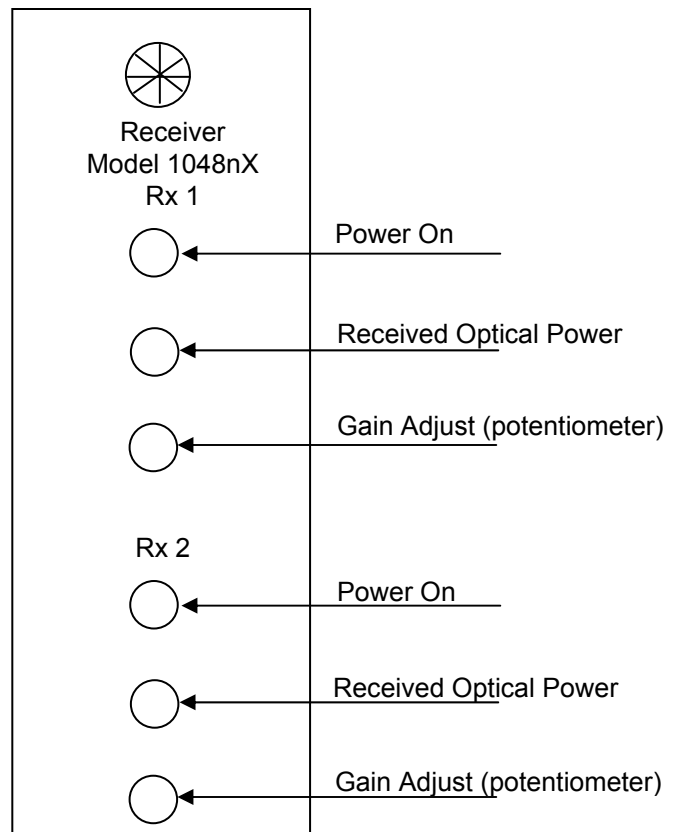
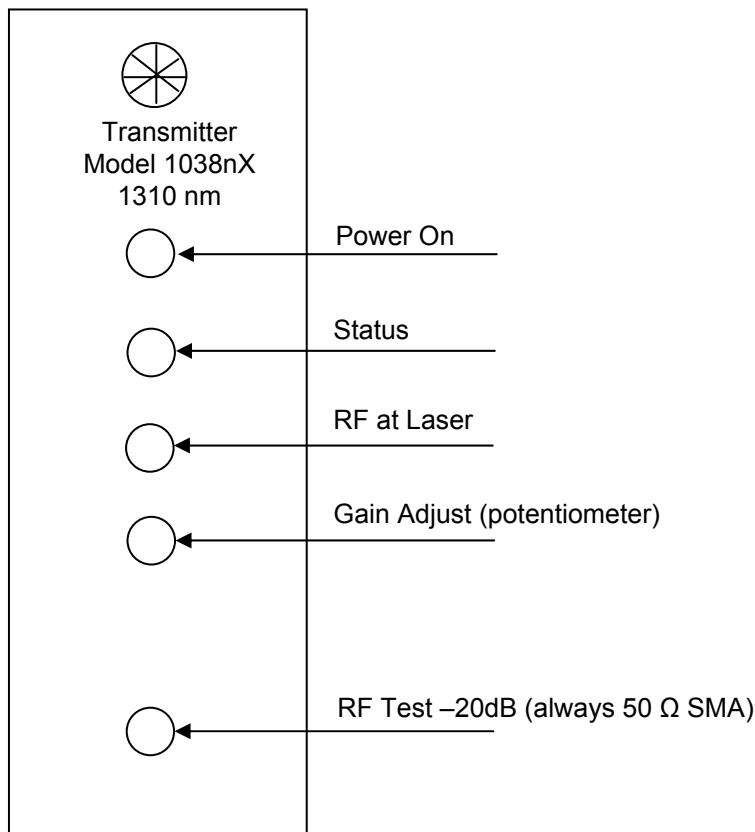


6. MONITORS

Once you have set-up the links as described in the previous sections, your system is ready for use. The following Monitors section describes details that are optional for most installations.

6.1 Front Panel Monitors

Monitor	Function
Power On LED (Tx & Rx)	Green if DC power is applied to unit
Status LED (Tx only)	Green if laser control parameters are within limits
RF at Laser LED (Tx only)	OFF → $S_L < -15$ dBm Amber → -15 dBm $< S_L < 0$ dBm Green → 0 dBm $< S_L < 4$ dBm (Optimum) Red → 4 dBm $< S_L$
RF Test SMA (Tx only)	-20 dB below the RF power into the laser (S_L)
Received Optical Power LED (Rx only)	OFF → Optical power at photodiode < -13 dBm (approx.) Green → Optical power at photodiode > -13 dBm (approx.)



6.2a Back-plane monitors and connections (with 10990A Chassis and 10901A/B Power Supply)

Transmitter:

Tx D-sub	10990A Chassis P20	10990A Chassis P11-P18	P11-P18 mate	Tx Pin Name	Details
1	2	--	--	+15 VDC	< 120 mA
2	1 (+5V)	--	--	+5 VDC	< 620 mA
3	3 (-15V)	--	--	nc	No Connect
4	4	--	--	POWER GND	--
5	--	1	5	REF GND	--
6	--	2	4	LASER TEMP MONITOR	0.75V if 25°C (normal setting)
7	--	3	3	LASER ALARM	TTL, ~0V if any of the set values exceeds defined limits TTL, ~3.3V if all values within defined limits
8	--	4	2	LASER CURRENT MONITOR	1 V / 100 mA
9	--	5	1	RF GAIN SETTING MONITOR	Voltage corresponding to gain setting of pre-amp. 0 to 15 volts; Arbitrary scaling. Not applicable for units without pre-amps.

Receiver:

Rx D-sub	10990A Chassis P20	10990A Chassis P11-P18	P11-P18 mate	Rx Pin Name	Details
1	2	--	--	+15 VDC	< 130 mA for single < 260 mA for double
2	1 (+5V)	--	--	+5 VDC	< 80 mA for single < 160 mA for double
3	3 (-15V)	--	--	nc	No Connect
4	4	--	--	POWER GND	--
5	--	1	5	REF GND	--
6	--	2	4	PDIM, Rx #1	1 V / mA
7	--	3	3	ALARM Rx #1	High (5V, transistor open) if optical power < -13 dBm (approx.) Low (Gnd, transistor short) if optical power > -13 dBm (approx.) (See schematic below)
8	--	4	2	PDIM, Rx #2 (nc for single)	Same as pin 6, but for Rx #2
9	--	5	1	ALARM Rx #2 (nc for single)	Same as pin 7, but for Rx #2

6.2b DC connections (Flange Mount)

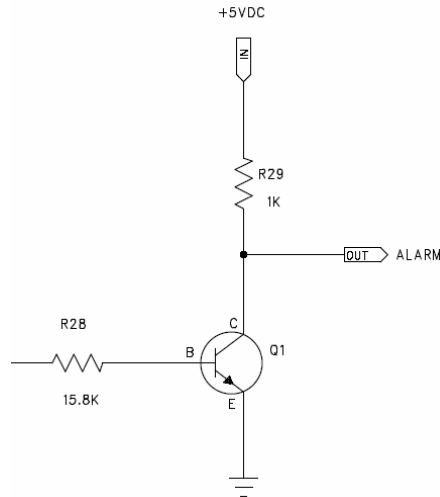
Transmitter:

Tx D-sub	Tx Pin Name	Details
1	+15 VDC	< 120 mA
2	+5 VDC	< 620 mA
3	nc	No Connect
4	POWER GND	--
5	REF GND	--
6	LASER TEMP MONITOR	0.75V if 25°C (normal setting)
7	LASER ALARM	TTL, ~0V if any of the set values exceeds defined limits TTL, ~3.3V if all values within defined limits
8	LASER CURRENT MONITOR	1 V / 100 mA
9	RF GAIN SETTING MONITOR	Voltage corresponding to gain setting of pre-amp. 0 to 15 volts; Arbitrary scaling. Not applicable for units without pre-amps.

Receiver:

Rx D-sub	Rx Pin Name	Details
1	+15 VDC	< 130 mA for single < 260 mA for double
2	+5 VDC	< 80 mA for single < 160 mA for double
3	nc	No Connect
4	POWER GND	--
5	REF GND	--
6	PDIM, Rx #1	1 V / mA
7	ALARM Rx #1	High (5V, transistor open) if optical power < -13 dBm (approx.) Low (Gnd, transistor short) if optical power > -13 dBm (approx.) (See schematic below)
8	nc	--
9	nc	--

Receiver Alarm Schematic



Model 10990A chassis & power supply monitoring and connections

The status of the Model 10901 power supply can be monitored from a pair of relays wired to a 9 pin in-line connector (P19) on the 3U chassis. The pinouts of the connector are described in Table 3-5. Another connector (P20) connects directly to the power supply in the "main" slot in the chassis, which is the farthest left slot when viewed from the back. This connector allows direct monitoring of the DC power voltages of the main power supply. This connector can also be used for powering the chassis via an external source (i.e. without a chassis-mounted 10901A or B power supply). The main power supply slot and P20 connect to the plug-ins through a set of diodes which allows for the power supply redundancy, hence neither the back-up power supply voltages nor the actual voltage at the plug-in can be monitored via P20 (voltage drops across the diodes must be accounted for).

POWER SUPPLY STATUS MONITORING VIA THE 10990A CHASSIS CONNECTOR (P19)					
Pin	Description	Main normal*	Main alarm*	Aux. normal*	Aux. alarm*
1	nc	--	--	--	--
2	nc	--	--	--	--
3	Aux. Status (normally closed)	--	--	low Z to center tap (relay closed)	high Z to center tap (relay open)
4	Aux. Status (center tap)	--	--	center tap	center tap
5	Aux. Status (normally open)	--	--	high Z to center tap (relay open)	low Z to center tap (relay closed)
6	Main Status (center tap)	center tap	center tap	--	--
7	Main Status (normally closed)	low Z to center tap (relay closed)	high Z to center tap (relay open)	--	--
8	Main Status (normally open)	high Z to center tap (relay open)	low Z to center tap (relay closed)	--	--
9	Ground	--	--	--	--

* Power supply status is determined by monitoring the power supply's +5V output only. The "Main" slot is the farthest left slot when viewed from the back.

10990A CHASSIS MATING CONNECTORS AND PINS		
Back Plane Connector	Mating Connector	Crimp Pins
P11-P18	Molex P/N 22-01-2057	Molex P/N 08-50-0114
P19	Molex P/N 22-01-2097	Molex P/N 08-50-0114
P20	Molex P/N 09-50-3031	Molex P/N 08-50-0108