FORCE

OPTICAL BROADCAST SYSTEMS

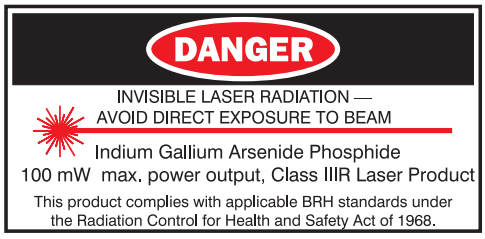
Model 3000 Long Range L-Band Fiber Optic Link

Installation Guide and User Manual

I0M3000
Revision 5.4, June 2006

Laser Safety Warning

The optical emissions from the units and connected optical fiber are laser-based and may present eye hazards. Follow all safety precautions.



Technical Support

If you encounter any kind of problem after reading this manual, contact your local distributor or a Force, Inc. Applications Engineer. To reach technical support:

On the Web:	http://www.forceinc.com
By Phone (Monday through Friday 8:00 am to 5:00 pm EST):	USA (800) 732-5252 TEL (540) 382-0462
By Fax:	(540) 381-0392
By Email:	csr-sales@forceinc.com

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Contents

Product Specifications

Optical and RF Characteristics

SM Fiber	Min.	Typ.	Max.	Units	Notes
Tx Optical Output Power	+2	+3	+4	dBm	1
CWDM/DWDM Optical Output		+3		dBm	1, 2
Rx Optical Input Power	-15		+3	dBm	
Optical Loss Range	0		18/60	dB/km	
Conventional Wavelength	1280	1310	1340	nm	
Conventional Wavelength	1520	1550	1580	nm	
Impedance		75		Ohms	3
Impedance		50		Ohms	3
VSWR (Tx) (75 Ohm)		1:1.2			
VSWR (Rx) (75 Ohm)		1:1.4			
Frequency Range (standard)	950		2150	MHz	
Flatness (950-2150 MHz)		±1.25	±1.75	dB	4
Flatness (@ any 36 MHz)		±0.25		dB	4
Intermodulation Products		-55		dBc	5
Noise Figure (@ -20 dBm in, max. optical loss)			46	dB	6
Noise Figure (@ -50 dBm in, max. optical loss)			19	dB	6
CNR (@ 36 MHz/30 km, 1310 nm, -20 dBm in)		37		dB	
CNR (@ 36 MHz/50 km, 1550 nm, -20 dBm in)		37		dB	
RF Input Signal Range (small aperture, total power)	-50		-20	dBm	7
RF Input Signal Range (large aperture, total power)	-30		0	dBm	7
AGC Output Signal Range (total power)	-25		-10	dBm	
Rx Automatic/Fixed Gain Control		15		dB	8
Rx Manual Gain Control		46.5		dB	9

Electrical Characteristics (Note 10)

	Min.	Typ.	Max.	Units	Notes
3RU Rack-mount Configuration					
Power Supply Voltage		+20		Volts DC	
Tx Supply Current (DWDM Tx w/LNB)		0.7		A	
RX Supply Current		0.25		A	
Stand-alone Configuration					
Power Supply Voltage		+20		Volts DC	11
Power Supply Current		1.5		A	

Physical Characteristics

	Min.	Typ.	Max.	Units	Notes
3RU Rack-mount Configuration					
Module Weight (Tx or Rx)		8		oz.	
		227		g	
Module Dimensions (Tx or Rx)		5.06 x 1.39 x 12.00		in.	
		129 x 35 x 305		mm	
Stand-alone Configuration					
Module Weight (Tx or Rx)		2		lbs.	
		0.91		kg	
Module Dimensions (Tx or Rx)		4.36 x 1.26 x 11.50		in.	
		111 x 32 x 292		mm	

Environmental Characteristics

	Min.	Typ.	Max.	Units	Notes
Operating Temp. Range (DWDM)	0		+40	°C	
Operating Temp. Range	-10		+55	°C	
Storage Temp. Range	-40		+60	°C	
Humidity (RH, non-condensing)	5		95	%	

Specification Notes

1) Force does not recommend applying multi-wavelength 3000 systems with DSF (dispersion-shifted fiber). Severe FWM (four-wave mixing) nonlinearities will result.
2) In CWDM and DWDM systems, Force recommends keeping the launch power per wavelength below +9 dBm to avoid SBS (Stimulated Brillouin Scattering).
3) The units may be ordered for 75 Ohm or 50 Ohm operation.
4) DWDM values will be slightly higher. Contact Force, Inc. for exact specifications.

5) The specification for intermodulation distortion (IMD) represents the inherent RF performance of the 3000 system. This value is typical for short fiber runs. Figure 1 shows the typical IMD performance of the 1550 nm, CWDM and DWDM units at distances to 100 km.

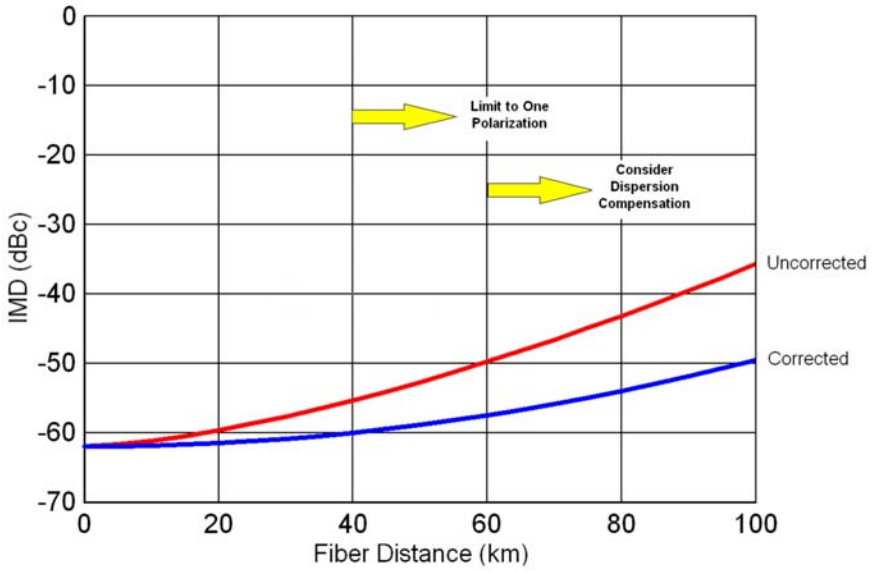


Figure 1 Typical IMD Performance vs. Fiber Length

Intermodulation distortion (IMD) is tested by injecting two -38 dBm tones at frequencies of 1000 MHz and 1001 MHz into a transmitter set in AGC mode using a short length of fiber. This assures a 30% OMI at the laser. The specification for IMD represents the performance of the 1310 nm units at any fiber distance and the performance of 1550 nm, CWDM and DWDM units at distances shorter than 20 km. At distances greater than 20 km, the IMD increases with fiber length as the laser chirp interacts with the fiber dispersion. The IMD increases steadily with distance. At distances greater than 40 km, Force recommends that only one polarization be transmitted unless dispersion compensation is used. At distances greater than 60 km, Force recommends that the use of dispersion compensation be considered. Contact Force, Inc. Application Engineers to have your specific application analyzed.

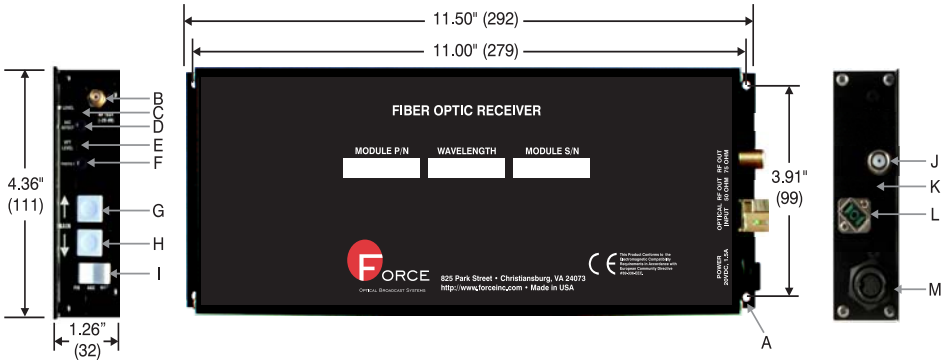
6) The noise figure is given for minimum and maximum power at maximum optical loss.
7) Small aperture or large aperture is specified when the unit is ordered.
8) In AGC/FIX mode, receiver output levels may be user-adjusted over a dynamic range from the set point +5 dB to -10 dB in 0.5 dB increments.
9) In manual gain control mode, receiver output levels may be adjusted within a dynamic range of 46.5 dB in 0.5 dB increments. Fixed and manual gain control specifications do not account for optical loss over time or temperature.
10) This product conforms to the Electromagnetic Compatibility Requirements in accordance with European Community directive #89-336-EEC.
11) Force, Inc. provides the Model PS3000 power supply for use with the stand-alone transmitter and receiver, which ships with the units.

Installation and Operation

General Installation Instructions

Installation of the Model 3000 normally requires only verification of signal inputs and outputs. Locate the equipment in an area that provides adequate lighting and is relatively free from dust. The 3RU configuration requires rear access for installation and maintenance. **Do not install the equipment near sources of excessive heat, such as furnace outlets or above heat producing units, such as large power supplies and tube-type equipment. Slots and openings in the rear panel are provided for ventilation. To protect from overheating, these openings must not be blocked. Observe temperature and relative humidity requirements specified on page 4.**

Stand-alone Receiver Description

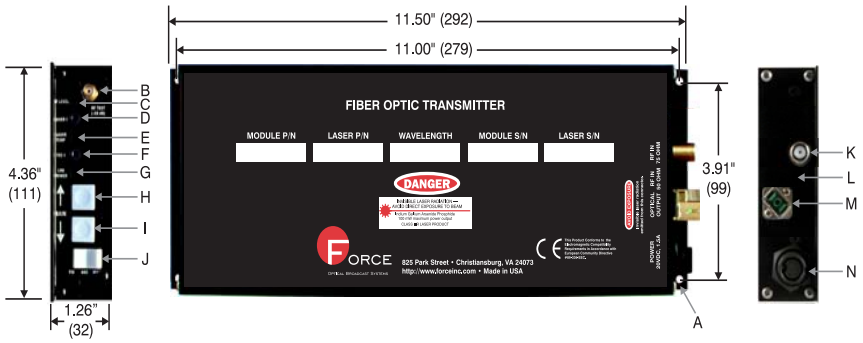


A. Mounting Holes (0.16" Diameter, 4 Places): Used to mount the stand-alone units during installation.
B. RF Test Point (-20 dB from output connection): Monitors the RF level. See page 14 for details. Terminate with provided 50 Ohm termination when not in use.
C. RF Level (Tri-colored LED): Indicates the receiver RF output level. See “LED Functions,” page 11.
D. AGC Detect (Test Point): Monitors the RF level with an optimum setting of approximately 1.7 Volts DC. See page 14.
E. Optical Level (Tri-colored LED): Indicates the receiver optical signal operating parameters. See “LED Functions,” page 11.
F. Photo I (Test Point): Indicates the received optical signal level over a 5 V range. See “Receiver DSP Circuit,” page 17 for details.
G. Gain Adjust Up Button: Adjusts the link gain up. When this button is held down, the gain will increase 2 dB per second. With each momentary push of the button, the gain will increase 0.5 dB.
H. Gain Adjust Down Button: Adjusts the link gain down. When this button is held down, the gain will decrease 2 dB per second. With each momentary push of the button, the gain will decrease 0.5 dB.
I. Gain Switch (Three Position Switch): When set to “FIX,” the unit’s gain is fixed at an optimum level for the case of low optical loss and a RF Input level of -20 dBm. When set to “ACG,” the unit is utilizing its automatic gain control. This maintains optimum performance across the allowable input range. When set to “MAN,” the gain can be adjusted over a range of 46.5 dB using the Up and Down buttons.
J. 75 Ohm (F Conn.): RF output for 75 Ohm signals.
K. 50 Ohm (SMA Conn. not shown): RF output for 50 Ohm signals.
L. Optical In (FC/APC or SC/APC connector): Receiver optical input.
M. Power Connector: Connects the unit to the Model PS3000 +20 Volts DC, 1.5 Amp power supply. This connector also contains the summary fault line.

Figure 2 Stand-alone Receiver

(Dimensions in parentheses are in millimeters.)

Stand-alone Transmitter Description



A. Mounting Holes (0.16" Diameter, 4 Places): Used to mount the unit during installation.

B. RF Test Point (-20 dB from RF input): Monitors the RF level. See page 14 for details. Install a 50 Ohm termination when not in use.

C. RF Level (Tri-colored LED): Indicates the RF level input. See "LED Functions," page 11 for details.

D. Laser I (Test Point): Monitors the laser current. (1 V = 20 mA). Nominal laser current is approximately 50 mA. See page 14, "Transmitter DSP Circuit."

E. Laser Temp (RGB LED): The LED's color indicates the laser operating temperature. See "LED Functions," page 11 for details.

F. TEC I (Test Point): Monitors the DWDM laser's TEC. See page 14. (DWDM versions only.)

G. LNB Power (Green LED): When LNB power is installed, this LED lights to indicate that the unit is providing +18 Volts DC. See "LED Functions," page 11 for details.

H. Gain Adjust Up Button: Adjusts the link gain up. When this button is held down, the gain increases 2 dB per second. With each momentary push of the button, the gain increases 0.5 dB.

I. Gain Adjust Down Button: Adjusts the link gain down. When this button is held down, the gain decreases 2 dB per second. With each momentary push of the button, gain decreases 0.5 dB.

J. Gain Switch (Three Position Switch): When set to "FIX," the unit's gain is fixed at an optimum level for the case of low optical loss and a RF Input level of -20 dBm. When set to "ACG," the unit is utilizing its automatic gain control. This maintains optimum performance across the allowable input range. When set to "MAN," the gain can be adjusted over a range of 46.5 dB using the Up and Down buttons.

K. 75 Ohm (F Conn.): RF input for 75 Ohm signals.

L. 50 Ohm (SMA Conn. not shown): RF input for 50 Ohm signals.

M. Optical Out (FC/APC or SC/APC connector): Transmitter optical output.

WARNING

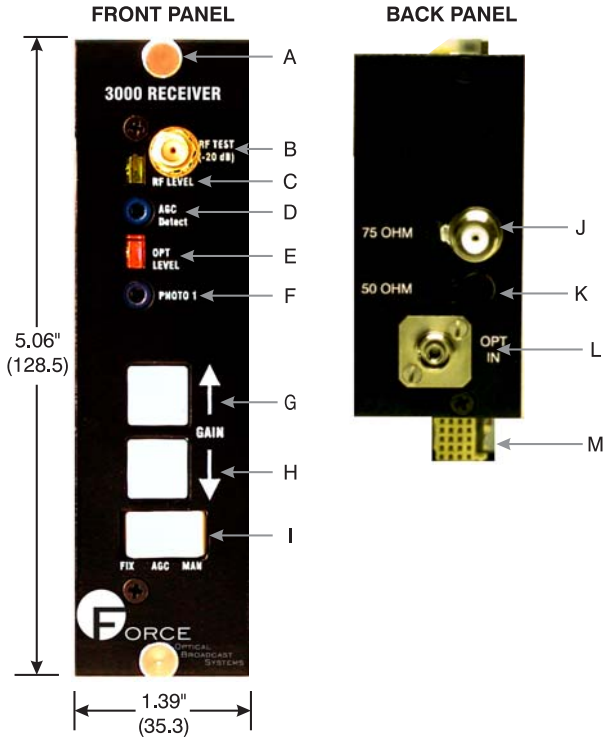
Invisible laser radiation emitted from this connector. Avoid direct eye contact with the beam.

N. Power Connector: Connects the unit to Model PS3000 +20 Volts DC, 1.5 Amp power supply. This connector also contains the summary fault line.

Figure 3 Stand-alone Transmitter

(Dimensions in parentheses are in millimeters.)

3RU Receiver Module Description.



A. Thumbscrews (2 Places): Used to secure the module top and bottom to the 3RU chassis

B. RF Test Point (-20 dB from output connection): Monitors the RF level. See page 14 for details. Terminate with provided 50 Ohm termination when not in use.

C. RF Level (Tri-colored LED): Indicates the receiver RF output level. See “LED Functions,” page 11 for details.

D. AGC Detect (Test Point): Monitors the RF level with an optimum setting of approximately 1.7 Volts DC. See page 14.

E. Optical Level (Tri-colored LED): Indicates the receiver optical signal operating parameters. See “LED Functions,” page 11 for details.

F. Photo I (Test Point): Indicates the received optical signal level over a 5 V range. See “Receiver DSP Circuit,” page 17 for details.

G. Gain Adjust Up Button: Adjusts the link gain up. When this button is held down, the gain will increase 2 dB per second. With each momentary push of the button, the gain will increase 0.5 dB.

H. Gain Adjust Down Button: Adjusts the link gain down. When this button is held down, the gain will decrease 2 dB per second. With each momentary push of the button, the gain will decrease 0.5 dB.

I. Gain Switch (Three Position Switch): When set to “FIX,” the unit’s gain is fixed at an optimum level for the case of low optical loss and a RF Input level of -20 dBm. When set to “ACG,” the unit is utilizing its automatic gain control. This maintains optimum performance across the allowable input range. When set to “MAN,” the gain can be adjusted over a range of 46.5 dB using the Up and Down buttons.

J. 75 Ohm (F Conn.): RF output for 75 Ohm signals.

K. 50 Ohm (SMA Conn. not shown): RF output for 50 Ohm signals.

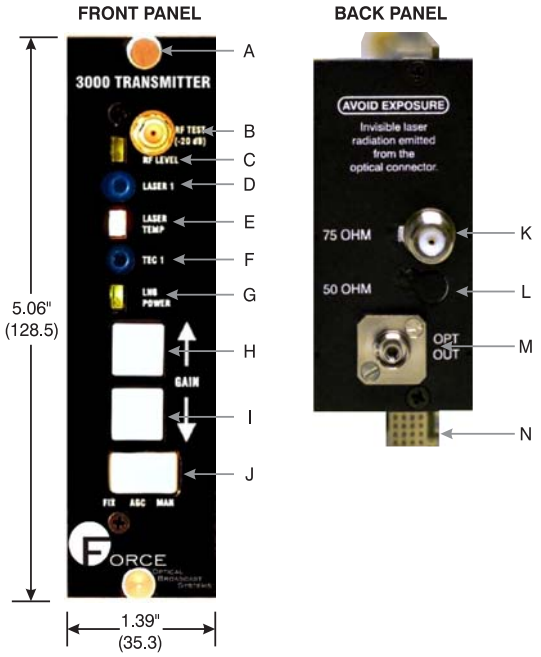
L. Optical In (FC/APC or SC/APC connector): Receiver optical input.

M. Backplane Connection: Inserts into the backplane of the rack chassis, allowing the chassis to provide power to the module.

Figure 4 3RU Receiver Front and Rear Panels

(Dimensions in parentheses are in millimeters.)

3RU Transmitter Module Description



A. Thumbscrews (2 Places): Used to secure the module top and bottom to the 3RU chassis.

B. RF Test Point (-20 dB from RF input): Monitors the RF level. See page 14 for details. Install a 50 Ohm termination when not in use.

C. RF Level (Tri-colored LED): Indicates the RF level input. See "LED Functions," page 11 for details.

D. Laser I (Test Point): Monitors the laser current. (1 V = 20 mA). Nominal laser current is approximately 50 mA. See page 14, "Transmitter DSP Circuit."

E. Laser Temp (RGB LED): The LED's color indicates the laser operating temperature. See "LED Functions," page 11 for details.

F. TEC I (Test Point): Monitors the DWDM laser's TEC. See page 14. (DWDM versions only.)

G. LNB Power (Green LED): When LNB power is installed, this LED lights to indicate that the unit is providing +18 Volts DC. See "LED Functions," page 11 for details.

H. Gain Adjust Up Button: Adjusts the link gain up. When this button is held down, the gain increases 2 dB per second. With each momentary push of the button, the gain increases 0.5 dB.

I. Gain Adjust Down Button: Adjusts the link gain down. When this button is held down, the gain decreases 2 dB per second. With each momentary push of the button, gain decreases 0.5 dB.

J. Gain Switch (Three Position Switch): When set to "FIX," the unit's gain is fixed at an optimum level for the case of low optical loss and a RF Input level of -20 dBm. When set to "ACG," the unit is utilizing its automatic gain control. This maintains optimum performance across the allowable input range. When set to "MAN," the gain can be adjusted over a range of 46.5 dB using the Up and Down buttons.

K. 75 Ohm (F Conn.): RF input for 75 Ohm signals.

L. 50 Ohm (SMA Conn. not shown): RF input for 50 Ohm signals.

M. Optical (FC/APC or SC/APC connector): Transmitter optical output.

WARNING

Invisible laser radiation emitted from this connector. Avoid direct eye contact with the beam.

N. Backplane Connection: Inserts into the backplane of the rack chassis, allowing the chassis to provide power to the module.

Figure 5 3RU Transmitter Front and Rear Panels

(Dimensions in parentheses are in millimeters.)

3RU Chassis Description

The Model 3000 transmitter and receiver each occupy one slot in the Model 3000 3RU rack chassis, which can house one or two power supplies. A DB-25 connector on the rear of the chassis may be used for fault monitoring. These summary faults are detailed on page 19. See IOM3000C for chassis specifications and details.

3RU Power Supply Description

Four power supply modules may be specified for use with the 3000C 3RU Chassis. The Model 3000UC-NN power supply provides universal AC power to the units installed in the chassis. The Model 3000UB-NN supplies universal AC power and adds SNMP or web-based system monitoring capability. Model 3000UE-NN provides -48 Volts DC, and the Model 3000UD-NN is the SNMP version, also providing -48 Volts DC. See page 18 for details on monitoring the system via the SNMP interface.

Regardless of the model ordered, one or two power supplies may be accommodated in the 3RU chassis. The power supplies feature a green “Power On” LED that indicates when the chassis is receiving power. A ground point on the front panel provides a common ground for all modules installed in the chassis. The power supplies meet UL and CE requirements. See IOM3000C for specifications and details.

Items Provided

The following is a list of items provided with each Model 3000:

Qty.	Mfr.	P/N	Description
AR	Force, Inc.	3000TX	Transmitter Module with Factory-installed Laser Cartridge
AR	Force, Inc.	3000RX	Receiver Module
AR	Any	Any	Active Device Receptacle Caps
1 per stand-alone unit	Force, Inc.	PS3000	Wall-mount Power Supply, +20 Volts DC, 1.5 Amps (Stand-alone Versions)

Items Required (Stand-alone Configuration)

Qty.	Mfr.	P/N	Description
AR	Force, Inc.	3001BR-NN	Remote SNMP Module
4 per unit	Any	Any	4-40 or 6-32 Panhead Mounting Screws with Lock Washers and Nuts
1	Any	Any	Straight Screwdriver
AR	Any	Any	9/125 μm Single-mode Fiber with Appropriate Optical Connectors.

Items Required (3RU Configuration)

Qty.	Mfr.	P/N	Description
AR	Any	Any	Standard EIA 19" Rack with Earth Ground (rack-mount configuration only)
AR	Force, Inc.	3000CB-NN	3RU Rack Chassis
AR	Force, Inc.	3000UX-NN	3RU Power Supply
AR	Any	Any	Three-wire Ground IEC Power Cord (AC Versions)
AR	AR	AR	14 AWG Stranded Copper Wire (UL 1061, 300V, 80°C) (DC Versions)
AR	Any	Any	9/125 μm Single-mode Fiber with Appropriate SC/APC or FC/APC connectors.

Inspection

Remove the units from their shipping container. Any in-shipment damage that may have occurred should be visually apparent. Look for bent or damaged connectors or mounting brackets. Claims for damage incurred in shipment should be made directly to the transportation company in accordance with their instructions. Save the shipping cartons until installation and performance verification are completed.

Stand-alone Module Installation

The stand-alone modules may be mounted in any orientation on most flat, dry surfaces. Secure panhead screws through mounting holes provided at the base of the module. If the unit is placed in a location where temperatures may exceed 38°C (100°F), a good heat sink should be secured. The use of silicone thermal pads is recommended between the module and the plate to maximize heat transfer.

3RU Module Installation

The modules come pre-installed in the 3000 chassis (See IOM3000C for chassis details). Make sure that adequate space is available for cabling and safe access for inspection or troubleshooting. When replacing modules, align the top and bottom of the module with the module guides in the 3RU rack. Push the module firmly to engage the rear power plane connector.

3RU Connections

Connector Name/Location	Connector Type	Transmitter Function	Receiver Function
75 Ohm/Rear of Module	F Type	75 Ohm RF Input	75 Ohm RF Output
50 Ohm/Rear of Module	SMA	50 Ohm RF Input	50 Ohm RF Output
Optical Out/Rear of Tx Module	SC/APC or FC/APC	Optical Output	N/A
Optical In/Rear of Rx Module	SC/APC or FC/APC	N/A	Optical Input
RF Test Point/Front of Module	SMA	RF Level Monitor	RF Level Monitor

Stand-alone Connections

Connector Name	Connector Type	Transmitter Function	Receiver Function
Power	5-Pin Weather Tight	Power Input/Fault Summary	Power Input/Fault Summary
75 Ohm	F	75 Ohm RF Input	75 Ohm RF Output
50 Ohm	SMA	50 Ohm RF Input	50 Ohm RF Output
Optical Out	SC/APC or FC/APC	Optical Output	N/A
Optical In	SC/APC or FC/APC	N/A	Optical Input
RF Test Point	SMA	RF Level Monitor	RF Level Monitor

LED Functions

Location/Name	Color	Condition
Transmitter/RF Level	Green	RF input is within the normal operating range.
	Red	RF input exceeds normal operating range.
	Orange	RF input is below normal operating range
Transmitter/Laser Temp	Blue	Laser is cold.
	Green	Laser is at room temperature.
	Red	Laser is above normal operating temperature.
	Blinking	Software has detected a malfunction in the laser servo controller and the laser output can no longer be stabilized or the laser itself has malfunctioned. The color still indicates the laser temperature.
Transmitter/LNB Power	Green	LNB power is installed and providing +18 Volts DC.
	Dark	LNB power is installed and the LNB circuit is drawing more than the maximum rated current.
	Blinking once per Second	The applied load is close to the rated maximum current, and the circuit shuts down and then repeatedly tries to restore power.
Receiver/RF Level	Green	RF output is within the normal operating range (greater than -25 dBm and less than -10 dBm total RF output).
	Orange	RF output exceeds normal operating range (less that -25 dBm total RF output) OR optical modulation index (OMI) has decreased to a level that affects the system performance (transmitter RF input is below the rated minimum level or RF input signal has been lost).
	Red	RF output is below normal operating range (greater than -10 dBm total RF output).
Receiver/Optical Level	Green	Optical level is within normal operating range.
	Orange	Optical level is below the optimum operating level.
	Red	Optical level exceeds the optimum operating level.

Initial Power-up

3RU Configurations

1. Locate the chassis and units in the proper environment as described in IOM3000C.
2. Clean the optical connectors. Download http://www.forceinc.com/techbull/optical-connector-cleaning.pdf for complete instructions.
3. Connect the transmitter and receiver optical ports to the optical cable.
4. Connect the companion Teleport equipment as required.
5. When all cable connections have been made, apply power to the unit. The green “Power” LED on the power supply front panel should light. See below for the normal LED power-up sequence.

Stand-alone Configurations

1. Connect the transmitter and receiver optical ports to the optical cable.
2. Clean the optical connectors. Download http://www.forceinc.com/techbull/optical-connector-cleaning.pdf for complete instructions.
3. Connect the transmitter and receiver optical ports to the optical cable.
4. Connect the companion Teleport equipment as required.
5. When all cable connections have been made, connect the power connector to the power source. See below for the normal LED power-up sequence.

LED Power-up Sequence (All configurations)

Transmitter LED Power-up Sequence

On power-up, the LASER TEMP LED will illuminate blue, while the RF LEVEL and LNB POWER LEDs will remain unlit. Within one second the LNB POWER LED will turn green, provided that the optional LNB power circuitry is installed and operating properly. Be aware that the LNB POWER LED will be green whether or not the transmitter is providing current to an LNB load. Approximately two seconds after initial power-up the LASER TEMP LED will go dark momentarily and then both the LASER TEMP and RF LEVEL LEDs will relight. The colors of these two LEDs indicates the suitability of the RF input signal and the laser temperature. A flashing RF LEVEL indicates that the optimum optical modulation index (OMI) has been exceeded. A flashing LASER TEMP LED indicates either an excessive OMI level or a laser circuit control loop failure. The significance of the LED colors and of flashing LEDs is described on page 11.

Receiver LED Power-up Sequence

There are nine possible color combinations that a receiver’s two front panel LEDs may assume on power-up, all of which may be valid under the right conditions. In the simplest case, that in which the receiver is not optically connected to a transmitter, both LEDs will illuminate orange. It becomes much more difficult to predict the initial states of the LEDs if the receiver is connected to a transmitter. In this situation, the transmitter’s RF input level, the gain control modes of both the transmitter and receiver, and the optical loss between the transmitter and receiver must all be considered when deciding what states the receiver’s LEDs should assume on power-up. Although it is possible to obtain usable electrical signals from a receiver when the received optical power is outside the normal operating range (i.e., when the OPT LEVEL LED is not green), it cannot be guaranteed that the performance of the link will meet the published specifications. In any case, the DSP will set the LEDs to their appropriate states, based on the link conditions, within two seconds of application of power to the unit. The significance of the LED colors are described on page 11.

Transmitter Operation

Connect the transmitter module to the optical fiber before applying power to the unit. This limits any exposure to the invisible laser output. The 3RU transmitter module has been designed to be hot-swappable and has built-in protection against over and under voltage conditions and short circuit conditions internally or on the RF input cable. The power will fold back to limit the effects on adjacent modules, and the module and optional LNB power will be reset when the condition is corrected. The module may be ordered to provide +18 Volts DC at 350 mA to the RF input connector. The LNB power is independent of the module power system and there is a front panel LED that illuminates green when the LNB power is installed and operational.

Transmitter Gain Sequence and User Controls

The overall structure of the transmitter is shown in Figure 6. This drawing details the gain and attenuator structure of the transmitter and describes the operation of the various gain modes.

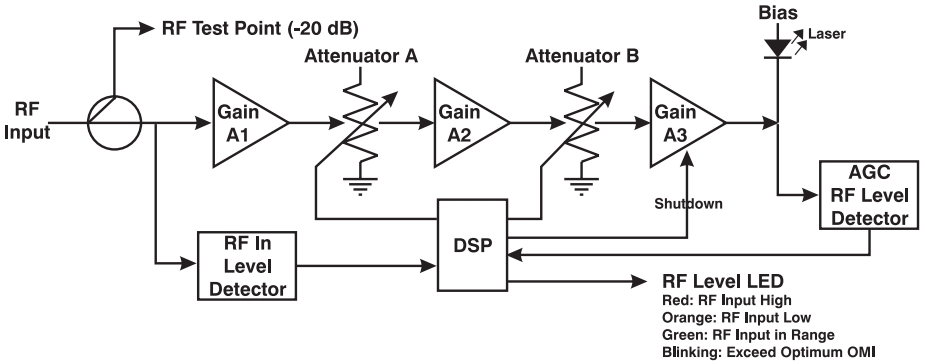


Figure 6 Transmitter Gain and Attenuator Structure

Table 1 3000 Transmitter and Attenuator Control vs. Selected Mode

Mode/Range	Attenuator A	Attenuator B
FIX Mode	Fixed at Factory Settings	Fixed at Factory Settings
AGC Mode	Automatic Software Control	Automatic Software Control
MAN Mode	User Control, Full Range	User Control, Full Range
Attenuation Range	0-31 dB	0-15.5 dB

A) In the FIX gain mode, Attenuators A and B are set to factory determined values appropriate for -20 dBm transmitter RF input level and low optical loss.

B) In the AGC gain mode, Attenuators A and B are controlled by software. They are adjusted to try to achieve the optimum OMI for the laser. As the RF input level increases, the software increases the attenuation to keep the laser OMI optimum.

C) In the MAN gain mode, Attenuators A and B are controlled by the user. The software accepts commands from the UP and DOWN buttons and translates those commands into specific attenuator settings.

The transmitter has three main modes of operation, which are controlled by the unit's rocker switch. It controls the system mode and the amount of RF gain required to drive the laser-based optical output. Three choices are fixed gain (FIX), automatic gain control (AGC), and manual gain control (MAN) operation. The UP/DOWN buttons are used to adjust the gain settings. In manual mode the user has 46.5 dB of adjustment. Protection circuits are included to protect the laser from RF overdrive conditions and resultant laser failures.

Fixed Gain Mode

The FIX mode is factory set to provide the optimum optical modulation index (OMI) with the maximum RF drive levels. It is intended for short fiber runs only (<2 km). In this mode, the transmitter expects an RF input level of -20 dBm. The optical loss is assumed to be less than 1 dB, which will give the receiver an RF output level of -15 dBm, assuming that the receiver output level trim is set a 0 dB (receiver mode is set at FIX). In the case of 1 dB of optical loss, switch the receiver from AGC to FIX and tap the Gain UP button four times to achieve a -15 dBm RF output. In the case of 2 dB of optical loss, switch the receiver from AGC to FIX and tap the Gain UP button eight times to achieve a -15 dBm RF output. Figure 7 illustrates the FIX mode.

NOTES:
1) The FIX gain mode is recommended for ***short fiber runs only*** (< 2 km).
2) The receiver RF output level can be adjusted up by 5 dB and down by 10 dB.

Figure 7 Model 3000 In FIX Gain Mode

Automatic Gain Control (AGC) Mode

In the AGC mode the DSP controls the RF drive to maintain the laser optimum OMI by controlling the gain of the device. The user can adjust the gain over a dynamic range from the set point +5 dB to -10 dB in 0.5 dB increments.

When the mode is changed from automatic gain control (AGC) to manual (MAN) the attenuator settings that are determined by the DSP in AGC mode are used as the initial settings in MAN mode. This enables the user that wants to use MAN mode to let the DSP determine the optimal settings for the current RF input.

Manual Gain Control Mode

In MAN mode, the user controls the gain by activating the UP/DOWN buttons. Each activation of the UP/DOWN buttons will raise or lower the gain by 0.5 dB. An RF LEVEL LED will light orange when the RF level is low, green when the RF level is in the normal operating range, and red when the level is too high; in this case, the laser protection circuits activate. The protection includes disabling amp A3 in Figure 6, page 13. When the RF Level LED blinks green, the laser OMI exceeds the recommended value. To set the optimal transmitter gain in manual mode first apply the desired RF input to the transmitter when the mode is set to AGC. The system will determine the optimum settings. Then switch from AGC to MAN mode. This will set the initial manual settings to those the DSP calculated in AGC mode. After 30 seconds of button inactivity the new manual settings are saved to flash memory. If a power cycle occurs the system upon power up will restore the last saved settings.

RF Level LED and RF Test Point

Details of all of the transmitter RF Level LED modes are shown in Table 2.

Table 2 Transmitter RF Level LED Modes

Tx Gain Mode	Version	Orange	Green	Blinking Green	Red
MAN	Small Aperture	<-50 dBm	>-50 dBm & <-20 dBm	RF input conditions for green and OMI exceeds optimum value.	>-20 dBm
	Large Aperture	>-30 dBm	>-30 dBm & <0 dBm		>0 dBm
AGC & Fix	Small Aperture	<-50 dBm	>-50 dBm & <-20 dBm	Never	>-20 dBm
	Large Aperture	>-30 dBm	>-30 dBm & <0 dBm	Never	>0 dBm

The RF TEST point allows the user to monitor the RF input to the transmitter, reduced by 20 dB attenuation, without disturbing the signal path. The RF TEST connector should be terminated with the provided 50 Ohm SMA termination at all times when not in use.

In order to monitor the signal at the RF TEST connector using 75 Ohm equipment, Force, Inc. recommends using a male SMA to male SMA adapter (Pasternack PE9069) and a 50 Ohm SMA female to 75 Ohm F female matching pad (Pasternack PE7078). The amplitude will be reduced an additional 6 dB, so the test point will be approximately 26 dB below the transmitter input level. Pasternack Enterprises can be found at www.pasternack.com.

Transmitter DSP Circuit

The transmitter uses a powerful DSP system which monitors and controls key operating parameters. In addition, switches, LEDs and test points provide the user flexibility and visual aid during setup and operation.

The DSP circuit monitors and controls the laser operation by controlling the laser current, RF drive/OMI, operating temperature, and in the case of dense wavelength-division multiplexing (DWDM) lasers, the thermal electric cooler current (TEC I) and the operating wavelength. The units contain test points to monitor the laser current (LASER I) and the thermal electric cooler current (TEC I). The laser current is scaled at 1 Volt DC and equals 20 mA with a full scale reading of 100 mA. Nominal laser current is approximately 50 mA. The

TEC I test point is nominally centered at +1.5 Volts DC (when the temperature of the laser is at or near room temperature) and will vary ±1 Volt depending on the laser temperature and the current required to maintain the correct wavelength. The DSP will shut down the laser current and TEC circuit if the operating conditions go outside of programmed limits to protect the laser from damage. A multi-colored laser temperature LED (LASER TEMP) indicates the laser operating temperature. When the laser is cold the LED illuminates blue; at normal room temperature it will be green, and at elevated temperatures it will be red. This is a multi-color device, so the hues will vary between these colors depending on the actual room temperature. If there is a laser fault, the LED will flash. The color of the LED still represents the laser temperature.

The DSP also monitors the transmitter's operating temperature and operating voltages. In the 3RU configuration, if there is a fault in the operation of the monitored functions that are beyond the DSP control, it will send an alarm signal to the chassis fault monitor connector. A fault condition is defined as a normally closed dry contact closure.

Receiver Operation

Connect the receiver to the optical fiber before the transmitter is powered to limit any exposure to the invisible laser output. The 3RU receiver module has been designed to be hot-swappable and has built-in protection against over and under voltage conditions and short circuits by folding back power to limit the affects on any adjacent module's operation. The module power will reset when the condition is corrected.

Receiver Gain Sequence and User Controls

The overall structure of the receiver is shown in Figure 8. This drawing details the gain and attenuator structure of the receiver and describes the operation of the various gain modes.

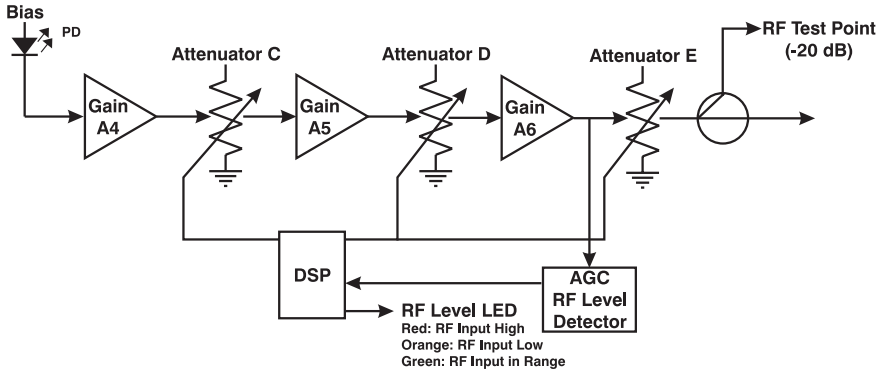


Figure 8 Receiver Gain and Attenuator Structure

Table 3 Receiver and Attenuator Control vs. Selected Mode

Mode and Range	Attenuator C	Attenuator D	Attenuator E
FIX Mode	Fixed at Factory Settings	Fixed at Factory Settings	User can adjust +5/-10 dB
AGC Mode	Automatic Software Control	Automatic Software Control	User can adjust +5/-10 dB
MAN Mode	User Control, Full Range	User Control, Full Range	Fixed at 0 dB
Attenuation Range	0-31 dB	0-15.5 dB	+5/-10 dB

A) In the FIX gain mode, Attenuators C and D are set to factory determined values appropriate for -20 dBm RF input level to the transmitter and low optical loss. The user still has control of Attenuator E which allows the output level to be increased by 5 dB or lowered by 10 dB.

B) In the AGC gain mode, Attenuators C and D are software controlled. Attenuators C and D are adjusted in the receiver to try to achieve a -15 dBm RF level at the input to Attenuator E. It's very important to note that the -15 dBm controlled value is not the output of the receiver, it is the input of Attenuator E. The user still has control of Attenuator E which allows the receiver RF output level to be increased by 5 dB or lowered by 10 dB relative to the -15 dBm controlled value.

C) In the MAN gain mode, Attenuators C and D are controlled by the user. The software accepts commands from the UP and DOWN buttons and translates those commands into specific attenuator settings. The user has no control of Attenuator E in the MAN mode. It is set to 0 dB.

The receiver has three modes of operation, which are controlled by the unit's rocker switch. The modes are fixed gain (FIX), automatic gain control (AGC), and manual gain control (MAN) operation. The UP/DOWN buttons are used to adjust the gain settings.

Fixed Gain Mode

In the fixed mode the gain has been set to work with a transmitter using the optimum optical modulation index (OMI) and zero optical loss to provide the optimum receiver operating point (nominally -15 dBm output) for intermodulation distortion (IMD) products. The buttons serve as a user adjustment after the control point. The UP/DOWN buttons allow the user to adjust for 5 dB additional output to 10 dB less output in 0.5 dB steps. Any change to Attenuator E by the user is saved to flash memory after 30 seconds of button inactivity. The saved value will be restored upon a power cycle of the unit or re-entering to FIX mode.

Automatic Gain Control (AGC) Mode

In AGC mode, the DSP controls the gain to maintain the optimum RF output for IMD products over the optical dynamic range of 18 dB. The UP/DOWN buttons operate in the same fashion as in FIX mode Any change to Attenuator E by the user is saved to flash memory after 30 seconds of button inactivity. The saved value will be restored upon a power cycle of the unit or re-entering AGC mode.

Manual Gain Control Mode

In the manual mode (MAN), the UP/DOWN buttons control the gain over a 46.5 dB range in 0.5 dB steps. The user may optimally set the receiver gain by following the steps below.:

1. Ensure the optical cables are clean and connected.
2. Ensure that the desired RF input is applied to the transmitter.
3. Switch the receiver mode control to AGC. This allows the system to calculate the optimum level applied to Attenuator E.
4. Press and hold the Gain UP button until the RF Level LED just turns red.
5. Now repeatedly tap the Gain DOWN button until the RF Level LED goes solid green. At this point, the RF level is -10 dBm.
6. Finally, tap the Gain Down button ten more times. This will set the receiver output RF level to -15 dBm.
7. Switch to manual mode. After 30 seconds of button inactivity the settings are saved to flash memory. Upon a power cycle these settings are restored.

RF Level LED and RF Test Point

Details of the receiver RF Level LED modes are shown in Table 4.

Table 4 Receiver RF Level LED Modes

Orange	Green	Red
RF_{Out} <-25 dBm OR OMI Failure	-10 dBm > RF_{Out} > -25 dBm AND OMI in Range	RF_{Out} > 10 dBm

The RF TEST point allows the user to monitor the RF output from the receiver, reduced by 20 dB attenuation, without disturbing the signal path. The RF TEST connector should be terminated with the provided 50 Ohm SMA termination at all times when it is not being used. In order to monitor the signal at the RF TEST connector using 75 Ohm equipment, Force, Inc. recommends using a male SMA to male SMA adapter (Pasternack PE9069) and a 50 Ohm SMA female to 75 Ohm F female matching pad (Pasternack PE7078). The amplitude will be reduced an additional 6 dB, so the test point will be approximately 26 dB below the receiver output level. Pasternack Enterprises can be found at www.pasternack.com.

Receiver DSP Circuit

The receiver uses a powerful DSP system which monitors and controls key operating parameters. In addition, there are switches, LEDs and test points to provide the user flexibility and visual aid during setup and operation.

There are two LEDs and three test points that are useful in setting up the receiver. The optical level (OPT LEVEL LED) gives a visual indication of the optical input by illuminating orange below -15 dBm optical input, green when between -15 and +3 dBm, and red above +3 dBm input. The hysteresis built into the optical level LED helps prevent the LED from chattering. Details of the receiver Optical Level LED modes are shown in Table 5.

Table 5 Receiver Optical Level LED Status

Orange	Green	Red
Optical $Level_{In}$ <-15 dBm	+3 dBm > Optical $Level_{In}$ > -15 dBm	Optical $Level_{In}$ > +3 dBm

The photo current test point (PHOTO I) delivers 0 to +5 Volts DC and can be used to monitor the optical input signal level. Figure 9 shows the typical behavior of the PHOTO I test point. During installation the PHOTO I can be used to optimize the optical signal by peaking the voltage reading to obtain the best carrier-to-noise ratio. The RF LEVEL LED illuminates orange when the RF detector input is below the optimum level, green when at the optimum level (very narrow range in AGC mode reflecting its hysteresis), and red when over the optimum level.

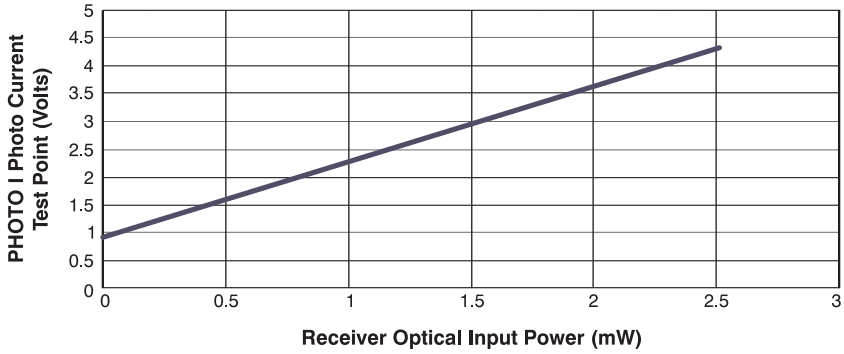


Figure 9 Photo I Test Point

The AGC DETECT test point can be used to monitor the RF level. The optimum set point is +1.85 Volts DC. This voltage varies somewhat from unit to unit. With no RF input, the AGC DETECT test point typically drops below +1.20 Volts DC. An RF TEST point (50 Ohm SMA connector) can be used with external equipment to monitor the module RF output attenuated by 20 dB. This test point should be terminated with the provided 50 Ohm SMA termination when not being monitored by external test equipment.

The DSP also monitors the receiver operating temperature and operating voltages. In the 3RU configuration, if there is a fault in the monitored functions that is beyond DSP control, it will send an alarm signal to the chassis fault monitor connector. A fault condition is defined as a normally closed dry contact enclosure.

SNMP Capabilities

The 3000 series boards are capable of Simple Network Management Protocol (SNMP) monitoring and control over an Internet Protocol (IP) network when used with a SNMP enabled power supply, Model 3000UB-NN or Model 3000UD-NN (refer to IOM3000C for more information) or Model 3001BR-NN Remote SNMP Module (contact the factory for more information). Refer to SNMP manager software MIB browser for more information. Table 6 lists the monitoring capabilities of the 3000 transmitter and receiver. Table 7 and Table 8 give information on SNMP monitoring specific to the transmitter and receiver.

Table 6 Monitoring Capabilities for the Model 3000

Common		
Serial Number	Lists the serial number of the addressed card.	
Uptime Time	Displays the number of seconds the addressed card has been running since power-up.	
Model	Displays the model number.	
Slot ID	Displays the slot number of the board.	
Firmware Version	Lists the firmware version.	
Fault Status	**Tx**	**Rx**
	System Over Temp	System Over Temp
	Laser Over Temp	
	RF Input High	RF Input High
	RF Input Low	RF Input Low
	Laser Power Failure	Optical Input High
	Laser Under Temp	Optical Input Low

Table 7 Transmitter Specific Monitoring Capabilities for the Model 3000

Parameter	Description
Laser Status	Laser Status
Attenuator(s)	Reports the attenuation of the addressed card.
Laser Temp	Reports the laser temperature.
Board Temp	Reports the system board temperature.
Laser Wavelength	Reports a code that maps to a laser wavelength.
RF Level Status	Lists the RF Level status of the addressed card.
	Within Spec
	High
	Low

Table 8 Receiver Specific Monitoring Capabilities for the Model 3000

Parameter	Description
Board Temp	Reports the system board temperature.
Attenuator(s)	Reports the attenuation of the addressed card.
RF Level Status	Lists the RF Level status of the addressed card.
	Within Spec
	High
	Low
Optical Level Status	Lists the Optical Status of the addressed card.
	Low
	High
	Within Spec

Table 9 lists the controlling capabilities of the transmitter and the receiver.

Table 9 Control Capabilities of the Model 3000 Transmitter and Receiver

Parameter	Transmitter Control				Receiver Control			
Laser Control	Decreases the output of the laser.				N/A			
Attenuators	ATTEN	MAN	FIX	AGC	ATTEN	MAN	FIX	AGC
	A	Control	N/A	N/A	C	Control	N/A	N/A
	B	Control	N/A	N/A	D	Control	N/A	N/A
					E	N/A	Control	Control
Reset	Initiates a hardware reset on the board.				Initiates a hardware reset on the board.			

Summary Fault Alarms

Table 10 lists the different conditions that cause the summary fault to trigger. The summary fault is routed to the back plane for rack-mounted systems and routed out of the power connector for stand-alone systems (refer to IOM3000C for detailed information). A fault condition is defined as a normally closed dry contact closure.

Table 10 Summary Fault Alarms

Transmitter Summary Faults	Receiver Summary Faults
System Over Temp	System Over Temp
RF Input High	RF Output High
RF Input Low	RF Output Low
Laser Power Failure	Optical Input High
Laser Over Temp	Optical Input Low

Troubleshooting

Common problems include lack of continuity in the optical fiber, lack of power, reversed power (stand-alone units only), or improper input levels. The units are designed to work with a 75 Ohm system or a 50 Ohm system depending on the model ordered. A number of indicator LEDs on the units may assist in troubleshooting. These allow the user to quickly assess the nature of any major unit malfunctions.

Problems and Comments

Problem	Check	Comments
No optical power out of transmitter. (3RU Rack-mount Configuration)	If the unit is receiving power (chassis "Power On" LED is green), check the transmitter "Laser Temp" LED. If this is LED is dark, the laser may be in danger of overheating. Remove power from the unit immediately.	If the transmitter "Laser Temp" LED is green, contact Force, Inc. for additional instructions.
No optical power out of transmitter. (Stand-alone Configuration)	Check transmitter power connection.	Verify that the power connections are firmly made, and verify the integrity of the power cord. Be sure that that the primary power source has not been inadvertently turned off and that no fuses have blown in the unit or at the power source.
	If the unit is receiving power, check the "Laser Temp" LED. If this is LED is dark, the laser may be in danger of overheating. Remove power from the unit immediately.	If the transmitter "Laser Temp" LED is green, contact Force, Inc. for additional instructions.
Flashing Laser Temperature LED on the transmitter.	Laser Power Failure or Exceeded Allowable OMI – reduce gain.	If reducing the gain of the transmitter does not rectify the issue the transmitter may be in need of factory repairs. Contact Force, Inc. for additional instructions.

Problem	Check	Comments
Flashing RF Level LED on the transmitter only.	Exceed optimum OMI – reduce gain.	If reducing the gain of the transmitter does not rectify the issue the transmitter may be in need of factory repairs. Contact Force, Inc. for additional instructions.
No optical power at the receiver.	Check power at the transmitter.	If there is power at the transmitter, verify proper fiber is connected to the receiver, and ensure the integrity of the fiber.
No signal out of receiver.; "RF Level: LED is unlit.	Verify the input signal at the transmitter.	The transmitter "RF Level" LED should be green. If the LED is dark, the signal input has fallen outside of the ±1.25 dB range. If the transmitter "RF Level" LED is green, the receiver may be in need of repairs. Contact the factory for additional instructions.
Signal out of receiver is distorted.	Verify input signal at the transmitter. The transmitter "RF Level" LED should be green.	A larger signal will cause distortion, and may destroy the transmitter.
	Verify fiber size.	Use single-mode fiber only.

Cleaning

If the link needs to be cleaned, avoid the use of all solvents and use low-pressure clean air to remove loose dirt. Use low-pressure clean air to clear the connectors of any debris. Dirty or scratched connector end faces will greatly reduce the unit's performance. Do not try to use fluids or high-pressure air to clean out the optical ports. Foam-tipped swabs such as the 2.5 mm Mini Foam Swab offered by Fiber Instrument Sales (P/N F1-0005) may be saturated with denatured alcohol* and inserted into the optical port for cleaning. DO NOT INSERT A DRY SWAB INTO THE OPTICAL PORT AS THIS MAY DAMAGE THE FIBER END FACE. Many fiber optic installations experience degraded performance due to dirty optical connector end faces. Download http://www.forceinc.com/techbull/optical-connector-cleaning.pdf for complete instructions.

Warranty and Return Policy

Warranty

Force, Incorporated standard products are warranted to be free from defects in materials and workmanship, meeting or exceeding factory specified performance standards for a period of three (3) years from date of purchase.

Force Obligations

Force will, at its discretion and expense, repair any defect in materials or workmanship or replace the product with a new product. Force will, upon receipt of the return, evaluate the product and communicate to the customer the nature of the problem, and determine if the claim falls under warranty coverage.

If during the warranty period, Force is unable to repair the product to the original warranted state within a reasonable time, or if subcomponents of the unit have been obsoleted or discontinued, then Force has the option to provide an equivalent unit.

Exclusions

This warranty does not extend to any product that has been damaged due to acts of God, accident, misuse, abuse, neglect, improper system design or application, improper installation, improper operation or maintenance, or connection to an improper voltage supply.

The Force warranty does not cover fuses, batteries, and lamps. Modifications or alterations of Force products (including but not limited to installation of non-Force equipment or computer programs), except as authorized by Force, will void this warranty. Removal or breaking of the seals on the product will also void the warranty. In addition, cost of repair by unauthorized persons within the warranty period of the product will not be covered by Force, Incorporated. Such repairs will void the warranty.

Force, Incorporated makes no other representation or warranty of any other kind, express or implied, with respect to the goods, whether as to merchantability, fitness for a particular purpose, or any other matter. Force, Incorporated's liability shall not include liability for any special, indirect or consequential damages, or for any damages arising from or attributable to loss of use, loss of data, loss of goodwill, or loss of anticipated or actual revenue or profit, or failure to realize expected savings, even if Force, Incorporated has been advised of the possibility of such damages. This warranty constitutes Force, Incorporated's entire liability and the customer's sole remedy for defects in material and workmanship.

Product Return Policy

Customers will be permitted to return products for credit, repair, or replacement only after receiving authorization from the Customer Service Manager (CSM) and only with a valid Return Material Authorization

(RMA) number. The criteria determining whether a product is covered under this policy are described below and RMA numbers will be issued only under these guidelines. For Return Requests that do not comply with the following criteria, the CSM must have approval from the VP Operations, or designee prior to issuing an RMA number.

Products Returned for Credit - Non Distributor

Customers will be allowed to return product for credit only under the following conditions:

- Products are current standard Force products as per the price list.
- Products are in new, unused, and undamaged condition and are in the original packaging.
- Products were originally shipped to the customer requesting Return Authorization.
- Request for return is for a valid reason as determined by Force, Inc.
- Products were shipped to the customer less than 3 months prior to return request.
- Customer receives proper Return Material Authorization prior to returning the product.
- Customer pays return freight and insurance if requested by Force, Inc.

Customers will be issued a credit for the original selling price of the product less a 20% restocking charge after verification that the product meets the criteria as stated above. Payment to customers with no outstanding balance will be made 30 days after requested by customer.

Products Returned for Repair or Replacement

Force's response to a customer product return request will be based upon whether or not the product is still part of Force's standard product offering and whether or not the product is still under warranty. A product will be considered active if it is currently part of Force's standard product offering. Active products are denoted in Force's current price list. Obsolete products are not considered active. A product is considered under warranty in accordance with "Force, Inc. Product Warranty"

Prior to receiving an RMA number, the customer will be asked to discuss the reason for the return with Technical Support to try to resolve the problem. This discussion will be documented to aid with troubleshooting and repair of the product. Any detail the customer can provide will expedite the process once the product is received.

The criteria denoted above will cause any incoming returns to fall into one of the following categories:

A. The product is currently active and is under warranty.
B. The product is currently obsolete, but is still under warranty.
C. The product is active, but out of warranty.
D. The product is obsolete and out of warranty.

Active Product Under Warranty

Force will honor the warranty for these products. As a result, product(s) should be accepted upon return for rework or repair in accordance with Force's warranty policy.

Obsolete Product Under Warranty

Force will honor the warranty for these products. As a result, product(s) should be accepted upon return for rework or repair in accordance with Force's warranty policy.

Active Out of Warranty

Force will accept return of product under this category as long as the sale of the product occurred less than five (5) years prior to the return request. The product serial number should aid in determining the age in cases where information is not in the data base. Rework or repair will be in accordance with Force's warranty policy and will include an evaluation charge, which will be quoted to the customer prior to the return of the product. The evaluation charge is 20% of the current list price of the product or a minimum of $250 whichever is greater. The customer will either need to provide a purchase order number (with approved credit) or a credit card number before receiving an RMA number. Force cannot guarantee its ability to repair or rework the

product. If costs to repair the product exceed the evaluation charge, the customer will be notified of such charges and instruction to proceed with repairs will be indicated either by a P.O. number or credit card authorization.

Obsolete Product Out of Warranty

Force is not obligated to accept requests for product under this category. The CSM, with prior approval from Operations will be responsible for approving return requests for products falling under this category.

Receiving an RMA for Returns

Customers requesting RMA numbers for any reason will be instructed as to how and where to ship the products being returned, and will be directed to show the RMA number on all external packaging and documentation. The CSM is responsible for providing any necessary instructions to the customer to ensure proper handling of the retuned material. Upon receipt of the product, all Force personnel are to process the return as per SP002,"Handling of Customer Returns". Contact the factory at USA (800) 732-5252 or TEL (540) 382-0462 to request an RMA.

Repair Service

For equipment repair or technical assistance, contact Customer Service (800) 732-5252 (USA) or (540) 382-0462. A Returned Material Authorization (RMA) number must be issued by Customer Service before the return of a failed unit. Units should be returned in their original shipping carton, if available. Always include a complete description of the failure or observed anomalies, and include the unit's model number and serial number, which are located on the product label.

Shipping and Handling Precautions

The units are, in general, very rugged and can withstand the stresses of most shipping and handling circumstances. However, the following precautions should be taken:

1) When the units are shipped they should be wrapped in a protective material, such as bubble wrap, to protect against excessive jarring and to prevent damage to the external finish of the units. Always use packing material to separate multiple units that are packaged together.
2) Care should be taken not to drop or strike the units in any way, especially around the optical connectors.
3) The units should never be submersed in any liquid. **SEVERE SHOCK HAZARD!**

Storing the Unit

If a unit is to be out of use for an extended period of time, the following steps should be taken to ensure the preservation of the unit:

1) The storage temperature range is -40°C to +60°C. Allow time for unit to restore to room temperature (and dry out) before power is applied.
2) A low humidity environment is preferable for long term storage.
3) All connectors should be covered with active device receptacle caps.