RFOptic Operating Manual

12/18/20/30/40/67GHz RFoF Link



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1 Introduction

The RFoF transceiver is an electric-optic-electric signal converting device set. The Transmitter unit (Tx) converts the analog RF input signal into an optical modulated signal at wavelength of 1550nm. The optical signal is transmitted on an optical fiber (not supplied) which connects the transmitter and the receiver units. The receiver unit (Rx) converts the optical signal back into an electrical RF signal.

1.1 Unpacking & Inspection:

The transceiver is shipped in a package designed to provide maximum protection. If the shipping carton is damaged during shipping, notify immediately your shipping department, who may want to contact the carrier. Save the shipping box for future transportation or storage needs.

Remove and identify the following units:

- Transmitter unit
- Receiver Unit

1.2 Safety considerations

The Transmitter is a Class 1 laser source at 1550nm. The invisible light, output from the transmitter can be hazardous if viewed directly by the eye. The optical power from the laser diode may cause retinal or coronal damage. Always observe the following precautions for safe use of the transmitter:

a. Never look directly into the operating transmitter output or an output of a fiber connected to the transmitter when the distance of the output is less than 50cm from your eye.
b. Never look into the operating transmitter output or an output of a fiber connected to the transmitter using optical instruments (a microscope etc.)
c. When a transmitter includes a pre-amplifier and is not mounted on a proper heat sink its case temperature may reach TS3 levels and should be only handled by skilled personal.
d. Make sure your power supply is grounded.
e. Do not use the transceiver in a manner not specified by the manufacturer.
f. Do not open the units. There are no serviceable parts inside the units. Warrantee will be discarded if units are opened not by the manufacturer.

Because of size constraints, laser safety labeling is not affixed to the module but attached to the outside of the shipping carton.



1.3 RFoF connectors and LED

On the front side of both units, Tx and Rx, there are optical connector and RF connectors, and DB15 connectors on the back side. In addition, there is an indicator (Green/Red/Blue) which is explained below.

Blue Light: (Blinking, Tx only) indicates that the Tx is stabilizing, and is off line.
Red Light: (Blinking) indicates an optical power problem, RFoF initialization (less 1 minute), or Rx unit is not connected with a fiber to the Tx unit.
Green Light: Indicates that the Tx unit optical power is within acceptable limits.

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On the Rx, Green indicates that sufficient optical power is arriving and detected by the Rx unit photodiode, indicating continuity of the fiber link, and proper function of the receiver.

1.4 Connections:

The RFoF HF modules use a Dsub 15pin male cable to supply DC power and provide USB interface as well as optional user controls. Use #26 wires to both Vdc pins (1, 6) and to both GND pins (2, 7) to minimize voltage drop over the power supply wires The connections to this connecter are listed below.

The following table defines the power and control interfaces to the RFoF HSFDR series links which use a 15pin Dsub HD connector. This table is common for both Tx and Rx modules.

Function	**Pin Number**	**Wire Size & color**
Vdc (+5.0V to +5.5V)	1	#20 or #18, Red
Vdc (+5.0V to +5.5V)	6	#20 or #18, Red
GND	2	#20 or #18, Black
GND	7	#20 or #18, Black
USB_Dp	4	#24 Green (USB cable)
USB_Dm	9	#24 White (USB cable)
USB_Host (+3.3V to +5V)	14	#24 or #20 Red (USB cable)
USB_GND	15	#24 or #20 Black (USB cable)

Special function pins normally not connected

External Red LED	3	
Reserved – do not connect	5	
External Red LED	8	
Reserved – do not connect	10	
External Control 1	11	
External Control 2	12	
Ext LED Blue / External Control 3	13	

Links are supplied with suitable connector cable which is wired as defined above and can be used to construct a mate with the recommended power supply using the following parts;

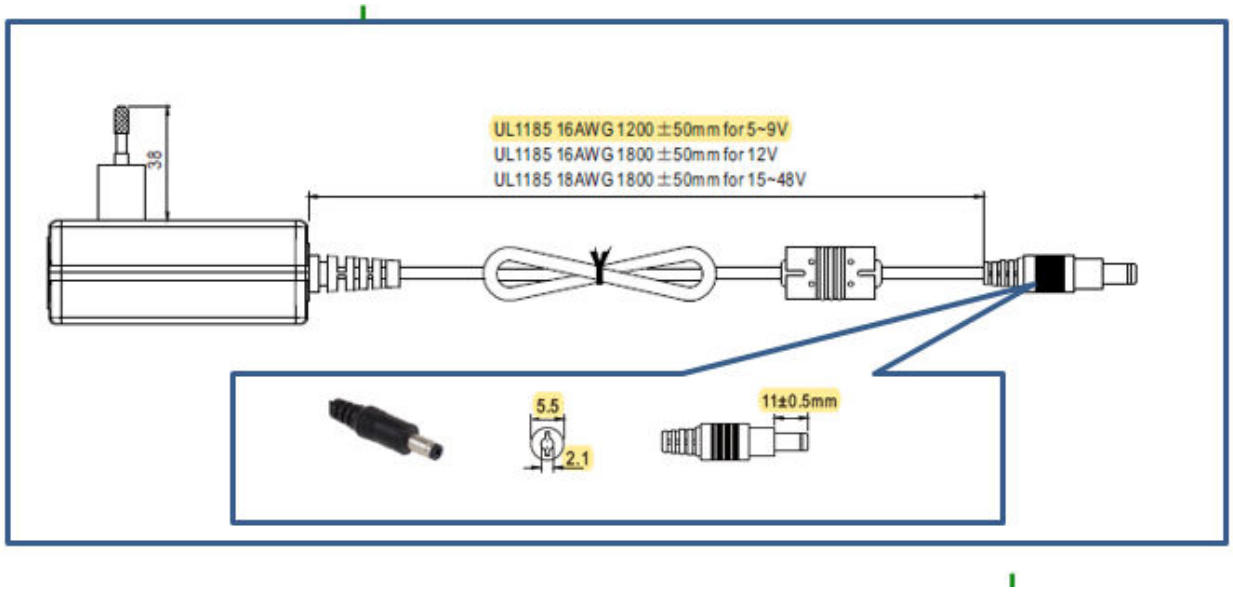
Part	Part Number
Dsub 15p High Density Male connector crimp through hole	9561005601
Dsub Backshell p9 Tpo Entry Plastic shell grey	977-009-010R031
5.5mm, 2.1mm DC Female Barrel Jack for cable	
USB 2.0 #24 Male to Male cable 1.5m (6ft) or shorter	

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1.5 Recommended power supply

The Mean Well GSM25 series power supplies are AC-DC wall mount single output power supply adaptor with output voltage of 5Vdc at 2.5A recommended for powering all the variants of the RFoF HSFDR series links. The GSM25E05-P1J has a 2 pin Euro plug an AC input and works over a wide input voltage range of 80VAC ~ 264VAC. GSM25U05-P1J is its North America 2 blade AC power plug version. The P1J suffix specifies the DC output as a UL1185 16AWG 1200±50mm wire with 5.5/2.1/11 termination as shown below.



1.6 RF and Optical interfaces

For frequencies below 20GHz the RFoF links are normally supplied with SMA Female standard connectors. Higher frequency links are normally supplied with 2.92mm connectors.

RFoF HSFDR links are normally supplied with FC/APC interface. SC/APC optical interface can be supplied upon request.

Do not connect the optical cable during operation.

All connections Power, RF and optical should be connected before turning on the power.

Only Single Mode Fiber (SMF) can be used to connect the fiber between the Tx and Rx units.

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2 Operation

This section describes the unpacking and initial setup of the RFoF HSFDR links including requirements on thermal management of the units as applicable.

2.1 Getting started

2.1.1 Power and heat sink requirements for RFoF HF modules

The power requirements of the RFoF HF series depend on module configuration. The modules operate from a +5V supply. Transmitters in basic configuration require 1.5A power supply minimum rating. When an optional RF amplifier is integrated within the transmitter module then the current requirement can go up to 2A.

The RFoF HF receiver modules require less than 0.1A in their basic configuration and up to 1A if an optional RF amplifier is integrated inside the module. Due to their power consumption it is necessary to mount the RFoF HF Transmitter modules on a suitable heat sink to maintain reasonable operating temperatures. Similarly, when RF amplifiers are integrated into the Receiver it is appropriate to use a similar heat sink mounting.

Transmitter Module:
a. On power application the Tx module begins a temperature stabilization procedure (up to 1 minute). During this procedure the panel indicator blinks blue.

b. Once conditions are ready to Link activation the built in Laser will turn on automatically and the panel indicator will be steady green.

c. If the Laser optical power falls below the operating threshold, then the panel indicator will be blinking red. In such case it is recommended to disconnect the module and allow it to return to room temperature before reapplying DC power. If such problem persists, contact RF Optic technical support.

Receiver Module:
On power application the Rx module panel indicator will be green if the module receives sufficient optical power to exceed its threshold or red if the optical power it receives is below the optical threshold. Once conditions are ready to Link activation the built in Laser will turn on and the panel indicator will be steady green.

2.1.2 Optical connectors

Connect the optical fiber connectors to the fiber output of the Tx unit and the optical input of the Rx unit using a Single Mode Fiber. Make sure the connectors are FC/APC (GREEN). Using FC/PC (BLACK) connectors will attenuate the optical power by 0.3dB for every connector.
Verify that the connectors were fully inserted into the receptacle, and the key is in its position.
Always clean the fiber ends prior to insertion into the receptacle in the instrument. Dust particles damage the polished glass surfaces of the fibers when making a physical contact of the connectors.

2.1.3 RF input and output

Connect the coaxial cables with SMA/2.92mm connectors to the RF input in the Tx unit and the RF output in the Rx unit.

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2.1.4 RF input power levels

Upon startup the Tx module requires a short stabilization period of about 10s. The stabilization period might reach 15s for very cold or very hot ambient temperatures. It is required to maintain an RF input power that is no higher than the IP1dBc of the link during this initial stabilization period to insure correct stabilization. During operation it is acceptable to inject higher power into the RFoF Tx module input as long as it is well below the No-Damage level but it is expected that the Tx operation will be unstable during such high RF power application. Once RF power is restored to normal operating levels which do not substantially exceed the IP1dBc of the RFoF link then the stability condition will be restored automatically.

2.2 Maintenance and service

The transceiver is designed to be maintenance free. There are no user-serviceable parts inside the units. No further calibration is required for the transceiver to meet its accuracy specifications over the life time of the product. If the need for factory servicing should arise, please contact RF Optic service.

2.3 PRECAUTIONS

1. Keep all fiber connectors covered with a cup when the fiber is not connected.
2. Clean the fiber end faces with alcohol or acetone before connecting the fiber to the Tx or Rx units.
3. Strictly keep all laser safely instruction considerations described in section 1.3, and use heatsink as described in section 2.1 above!



3 RFoF App

3.1 Software installation

The RFOptic configuration tool does not require installation, simply copy the executable and help file to any computer running a Windows OS and run it. There is no need for special driver for this application. When a Host identifies the RFoF module it will automatically activate a stock Plug-and-Play Operating System driver.

3.2 RFoF HF Configuration Tool window

Module identification

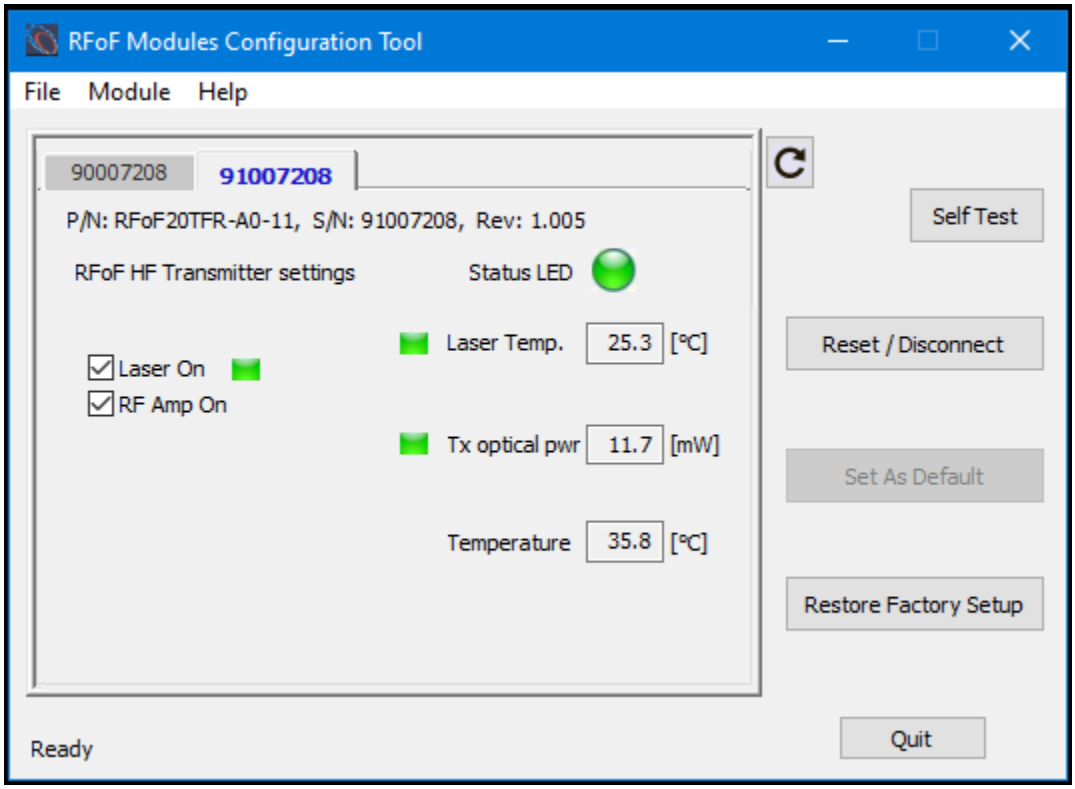
The App window displays properties of RFoF modules which are powered up and attached by USB cable. The App automatically identifies the type and identity of the module including: Type Transmitter or Receiver, Serial number, Part number and Production data. When a module is connected to a host (PC, tablet or Laptop) the panel indicator flashes blue to indicate that a USB connection was made. Note that a special driver or installation is not required for this application. When a Host identifies the RFoF module it will automatically activate a stock Plug-and-Play Operating System driver.

Module data

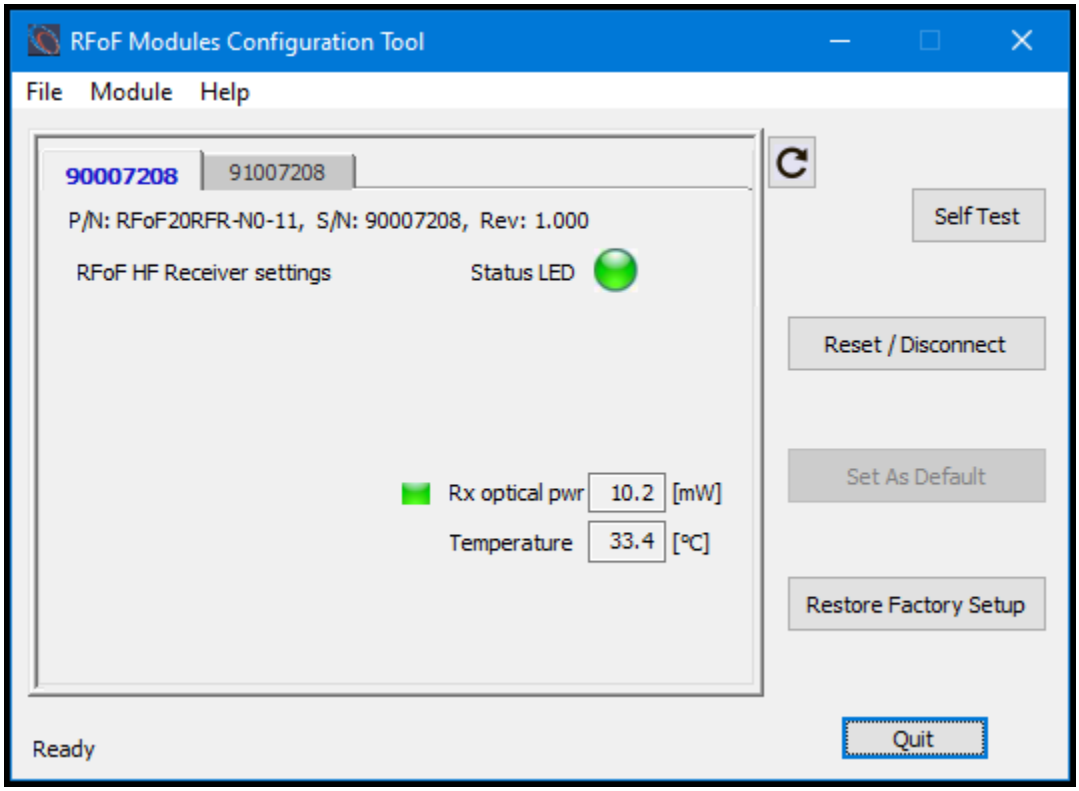
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The App reads the current configuration parameter values of the module as well as the operational conditions. These parameters are displayed in a Tab for each connected module. Module operating parameters and attenuation settings. Additionally, for Transmitter modules the Laser state (On/Off), and LNA state are shown. Module operating conditions include the optical power level and optionally the RF level and RF test signal status.

Screenshots of the App for RFoF HF Transmitter and Receiver modules:



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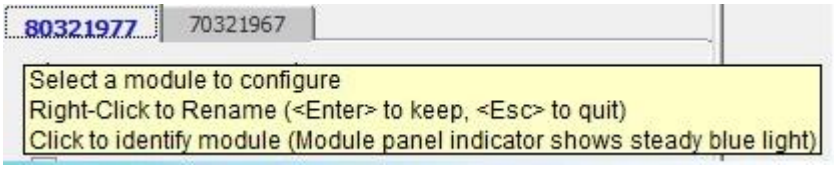
Built-In-Test diagnostics

Diagnostic features can be activated by the Self-Test button that activates the BIT capability of the module. It reads the current state of the module and verifies that the module is operating within specifications. The test is initiated and result reported for the selected module.

Default Setup

Buttons on the right enable the redefinition of the Power On default state of the module and can restore the module setup to the factory settings. A Reset/Disconnect button provides a software equivalent to power cycling the module for those cases where the module power plug is inaccessible.

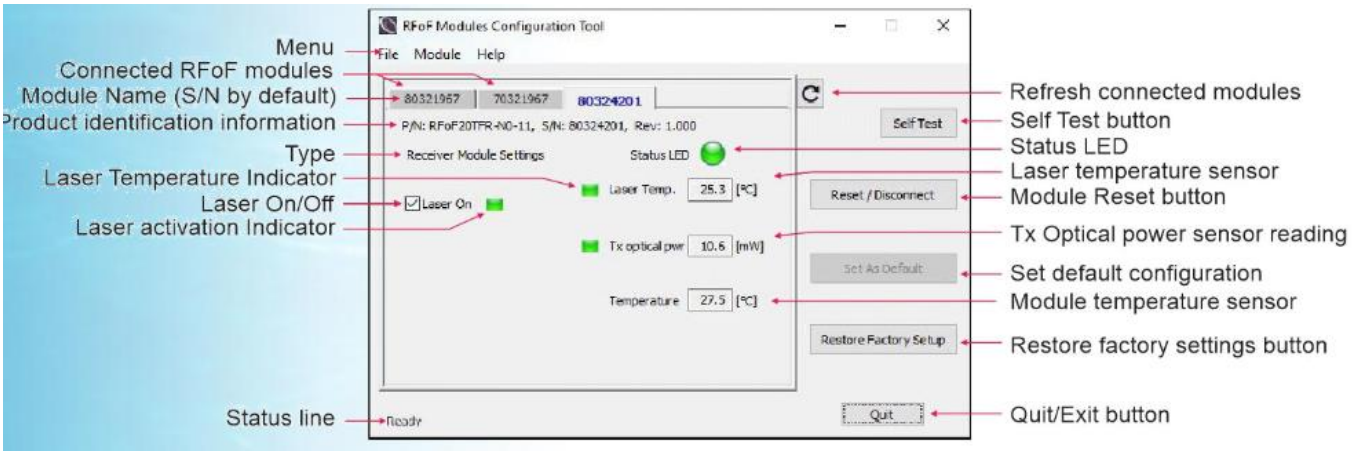
The elements of the App window are highlighted below for a Transmitter module. For a Receiver module a field that displays the Rx optical power is shown along with the interior temperature of the module. The App features on screen tips which display when the pointer hovers over any of the controls for a few seconds. The following sample shows the tip for the module Name Tab header which is discussed below.



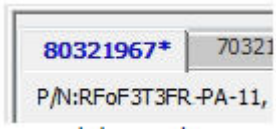
The tips provide usage information about each of the fields or controls.

3.3 Control and information elements

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- **Module Name Tab header** - The module name is set to the serial number of the module by default. An Asterisk is appended to the module name whenever there is an unsaved (As default) modification to the module settings.



A module can be renamed by right-clicking on the name field. A new name (32 characters maximum) can be saved by pressing the [Enter] key. Alternately use the [Esc] key to leave the name unchanged.

A modified name is only used for the current session of the App. Use the 'Set As Default' to preserve the name for future sessions.

Click on the module name field to make the panel LED indicator of the module show steady blue light for a couple of seconds to positively identify the active module with which the RFOptic configuration App is communicating. When several modules are connected by USB, the application will display each module in a separate tab with the active module showing a light background while other tabs are grayed out. Click on one of the gray tabs to select a different active module.

- **Module information, Module Type** - These lines show the module type (Transmitter or Receiver), part number (P/N), module Serial number (S/N) and Revision.
- **Status LED** -The status LED replicates the panel LED of the module. It is green for normal operation of the module and blinks red in case of a fault. The LED turns to blue when the module is addressed by the software for module identification and blink fast in cyan during firmware update. In transmitter modules it will blink blue during the Laser setup period and will alternate blink green and red when the laser is at the operating conditions but the is turned off
- **Laser On/Off** - The checkbox option is only available for Transmitter modules. When activated it schedules the laser to turn On once its temperature reaches the target temperature (set to 25C by default). This stabilization procedure depends on the ambient temperature and takes about 10s to 30s
- **Laser activation indicator** - This indicator is dark when the Laser is set to Off, It turns amber when the Laser is scheduled to turn on and to green when the laser is actually on.
- **Tx Optical power** - Sensor reading of the output optical power of a Transmitter module.
- **Rx Optical power (not shown)** - Sensor reading of the input optical power reaching the Receiver.

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- **Laser temperature** - Sensor reading of the Laser temperature within the transmitter. The laser temperature is maintained by the module near 25C. Significant deviation from this value indicates a failure that must be addressed quickly to avoid damage to the Laser.
- **Laser temperature indicator** - The laser temperature indicator is dark when the laser control is off. It turns amber when the control is operating to bring the laser to its operating conditions, and to green when the laser is locked into its operating range.
- **Self-Test** - Button that activates the BIT capability of the module. This test is automatically done on module power up and when a module USB port is connected. The result of the test is displayed in the Status line and by an Icon next to the button.
- **Reset / Disconnect** button -Resets the module. This is a software equivalent to power cycling of the module. The module reverts to its default settings.
- **Set As Default** button -Saves the module settings as the Defaults. Saved defaults will be restored if the module is Reset or power to the module is cycled.
- **Restore Factory Setup**-Restore the factory configuration parameters of the module.
- **Status line** -The status line displays messages concerning the App state and module
- **Status LED** -Shows the state of the modules panel LED during normal operation. The LED is Green when all is ok, It blinks in red when there is a loss of optical power. It is also possible to adjust the level at which this Optical Power Level Alarm (OPLA) will become active.
- **Quit / Exit** button -Quits the configuration App. Any changes made for each module and were not saved will remain in effect until the DC power of the module is turned off

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4 Troubleshooting Guide

This section lists several potential issues that might occur with RFoF modules and a step by step guide for identification of the cause and resolution.

4.1 Module LED is dark

When powered RFoF modules are properly powered the panel LED never remains dark. If the LED is dark it is an indication that the module is not receiving proper DC power. This can be caused by these reasons:

- Power is not connected to the RFoF module.
- The DC power source is not connected to a working outlet.
- The DC power source is unable to power the module due to a current limit.
- The DC power source is wired incorrectly or is outside the operational voltage range 4.8V to 5.4V maximum.

Troubleshooting steps

1. If a standard DC power supply is used
   - Verify that the power supply is connected to a working outlet.
   - Connect the power supply to the module and verify that the LED is not dark.
2. If a non-standard DC power supply is used
   - Check the physical connection and wiring polarity.
   - Verify that the power supply is connected to a working outlet.
   - Verify that the current limit is at least 2A per module (this current is required to accommodate the consumption of an RF amplifier if integrated and the the rush current at the start-up of the module).
   - Verify that the Voltage in the range of voltage range 4.8V to 5.4V maximum.
   - Connect the power supply to the module and verify that the LED is not dark.

4.2 Transmitter module LED is Red

When a Transmitter RFoF module LED is not green it is an indication that the Laser is not working properly. This can be caused by these reasons:

- The DC power source is unable to power the module due to a current limit.
- The Laser was turned off using the RFoF Control software. In this case the status LED will alternate blink red and green.
- The Laser has not reached its operating conditions.

Troubleshooting steps

1. If a non-standard DC power supply is used
   - Verify that the DC power supply capable of delivering 5V DC and has a current limit of 2A or more.

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2. If a standard power supply is used or the DC power source is verified good

- Turn on the Laser using the RFoF control software

3.Wait for the Laser setup process to complete.

- At startup the Laser setup process may take 10 to 30 seconds at room temperature, more at ambient temperatures that significantly differ from 25C.
- If using the RFoF config software it is possible to follow the stabilization process with the sensor displays.
- If the setup process takes an inordinate amount of time please contact RF Optic technical support and report the issue along with the conditions (ambient temperature and power supply voltage and current consumption if available for further assistance).

4.3 Transmitter module LED is Green but Receiver's LED is blinking RED

When a Transmitter RFoF module LED is green it is an indication that the Laser is working properly. When the Receiver module is blinking red it is an indication that the Receiver is not detecting sufficient optical power. This can be caused by these reasons:

- The fiber link between the Transmitter and the Receiver modules is defective or broken.
- The fiber used to connect the Transmitter module to the Receiver modules is an incompatible type.
- The fiber link between the Transmitter and the Receiver modules is not connected or not connected properly. The fiber interfaces of the Transmitter module and/or the Receiver module are dirty.

Troubleshooting steps

1. Inspect the connecting fiber.

- Look for any sharp bends or kinks which might result from a crack or break of the inner core. Note that the fiber should be relaxed and not knotted or bent sharply.
- If in doubt try a different fiber link and a short one to eliminate this potential cause.
- You must use a Single-Mode fiber with APC connectors suitable for your link (typically SC/APC push to connect or FC/APC screw on connection).

2. Check the connections on either side of the fiber.

Verify proper fiber connections. On both ends of the fiber check that the mating connector key is inserted into the mating slot and that the collar is closed moderately tight

Note that in many cases over tight connections could feature a significantly higher loss because the fiber ends jam into each other and are pushed out of alignment.

Disconnect the DC power from the modules to avoid eye injury from the Class3 laser and visually inspect the interior of the FC/APC female receptacle for debris or dust. If any dirt is found, please use a proper fiber cleaning tool kit to clean the tips of both ends of the connecting fiber and both panel connectors of

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the modules as needed. Do Not use any abrasive materials or oils to clean with nor any material which might leave some residue.

4.4 Transmitter LED is Green; fiber connection is verified but Receiver module LED is blinking RED

Check the optical properties of the link for invalid configuration. The RFoF link performance can be measured by optical sensors in the end modules using the RFoF control software or calculated using RF Optic's Link simulation tool found on RF Optic's website. Possible causes can be:

- The parameters of the Transmitter and/or the Receiver modules were set to incorrect values.
- The fiber interface between the Transmitter module and Receiver module has substantial optical losses.

Troubleshooting steps

1. Power up and Connect both Transmitter and Receiver modules to a computer running the RFoF control software.

- Connect both Transmitter and Receiver modules to a DC power sources.
- Connect the Transmitter to the Receive using a single-mode fiber with appropriate APC connectors.
- Connect both modules with a micro-USB cable to a computer that is running the RFoF control software and evaluate the measured optical power reported at each end of the optical link.
- This procedure can be performed on one module at a time if both modules are not accessible simultaneously.

2. Check the Transmitter module parameters.

- In the RFoF control software, select the Transmitter module.
- Verify that the module is operating properly by clicking the Self Test button - a Green check mark should display next to the button.
- Verify that the Transmitter laser is On - that the checkbox Laser On is checked, the Laser status indicator is Green.
- Verify that the Tx Optical Power reading is reasonably close to the ATR data of the particular module. RFoF HF modules have a wide range of configurations each with different output optical power.
- Record the Transmitter module optical power for later reference.

3. Check the Receiver module parameters and fiber connection quality. For this test both Transmitter and Receiver modules must be powered, Transmitter Laser is On and it is connected to the Receiver module with a proper optical Fiber.

- In the RFoF control software, select the Receiver module.
- Verify that the module is operating properly by clicking the Self Test button - a Green checkmark should display next to the button.

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- Verify that the Optical power as reported by the software is above 0.1mW. If the optical power value is borderline or lower then the fiber connection is at fault.
- If a low optical power is reported by the Receiver module, replace the fiber connection between the modules with a short 0.5m {1.5ft} patch fiber and verify that the Receiver reports an optical power that is about 0.3mW lower than the optical power that was recorded for the transmitter in step 2.

4.5 Transmitter LED is Green and Receiver LED is Green but RF signal is not getting through the link.

Check the RF signal flow in the link using the RFoF control software. Possible causes can be:

- Broken or faulty RF connection.
- The input signal is too weak to be detected at the output of the link.

Troubleshooting steps

1. Inspect the RF signal source, connections and cables

- Connect both Transmitter and Receiver modules to a DC power source.
- Connect the Transmitter to the Receive using a single-mode fiber with appropriate APC connectors.
- Check that the signal source is connected to the RF input port of the Transmitter module.
- Verify that the RF coaxial cables and connectors of the connecting cables are appropriate for the frequency range and compatible with the RFoF modules.

2. Inspect the RF signal source, connections and cables

- Check that the signal source frequency and output level is appropriate for the RFoF link.

4.6 Module(s) fail to register in the RFoF control software

When powered RFoF modules are connected to a host PC/Laptop and the RFOptic configuration software tool is running, the modules would be automatically detected and added in separate tabs to the software. If a module is not automatically identified by the software or if the "RFoF module is not connected. Check USB and Power connections" notice is displayed on the bottom (status line) of the software window the problem may be easily corrected by following a simple set of troubleshooting steps. In most cases the failure to register is caused by one or more of these reasons:

- Power is not connected to the RFoF module.
- USB cable is damaged.
- RFOptic configuration Software is not running or not running properly due to an incompatible operating system such as Windows XP.
- Generic HID driver problem or USB hub problem.

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Troubleshooting steps

1. Connect the RFoF module to the power, and verify that the module is powered:
    - If the LED on the RFoF panel is 'On' (any color), then the module is getting power.
    - If LED is not lit, then check for a problem with the DC power supply or its connection to the module.

In all the following tests it is assumed that the RFoF module is powered and LED is 'On' and the PC software is running.

2. Connect each of the RFoF modules Tx and Rx one at a time with the same USB cable.
    - If you do not receive the Notice (i.e. "RFoF module is not connected. Check USB and Power connections") for either RFoF Tx and Rx module than the issue was caused by bad USB cable or USB connection and is now resolved.
    - If the Notice is received with only one module the problem might be in that module.
    - If the Notice is received with both RFoF modules, go to Step #3.

3. Change the USB cable, and re-check both RFoF Tx and Rx modules - this clarifies if a problem exists on the PC, or the module/USB cable:
    - If the Notice disappears and Software recognizes all the connected modules, than the issue is resolved, and the former USB cable was bad.
    - If the Notice is still received, then go to Step #4.

4. While software is running on PC and the USB cable is connected between the RFoF module and PC – disconnect power to the module, and reconnect power after 10 seconds.
    - That should allow the computer to “forget” the RFoF module, so when it reconnects the RFoF module should re-register in the software.
    - If the Notice disappears and Software is registered, than the issue is resolved.
    - If the Notice is still received, then USB cable may be the problem, or PC USB HID driver may be problematic- see Step #5.

5. Check the HID driver which provides the USB interface on the PC:
    - Disconnect the USB cable from the RFoF module. Open Computer->Properties->Device Manager and look at the list of Human Interface Devices (HID), remember the number of USB items in the list. Now reconnect the USB cable, verify that a new HID device was added to the list of HID devices.
    - If a new device was added, then the HID driver of the computer is good and the problem lies with the software or the module. The problem can be traced further by examining the HID device properties and by using the RFoF Logfile trace (contact RF Optic for more information).

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- If device was not added, then the problem lies in the USB communication with the computer USB driver. oi may want to try to use the RFoF PC software on a different computer

4.7 Creation of a logfile for reporting a problem for further technical assistance and troubleshooting

The RFoF link modules operational parameters can be logged by the RFoF control software to improv technical support.

Logfile creation steps

1. Power up and Connect both Transmitter and Receiver modules to a computer running the RFoF control software.
    - Connect both Transmitter and Receiver modules to a DC power source.
    - Connect the Transmitter to the Receive using a single-mode fiber with appropriate APC connectors.
    - Connect both modules with a USB cable to a computer that is running the RFoF control software.
    - This procedure can be performed on one module at a time if both modules are not accessible simultaneously. In such case two logfiles will be created each should be renamed and e-mailed to RF Optic separately.

2. Activate the logfile and review the steps that demonstrate the problem with each relevant Transmitter and Receiver modules.
    - In the RFoF control software, select File->Logfile menu option - this menu item should now be checked.
    - In the RFoF control software, select the Transmitter module. Perform any action that demonstrates the problem.
    - In the RFoF control software, select the Receiver module. Perform any action that demonstrates the problem.
    - In the RFoF control software, unselect File->Logfile menu option - this menu item should not be checked now.
    - If you are using Outlook as your e-mail application, select menu Help->Email Log File to create a new e-mail message, add your problem description of the problem and send.
    - Manually create a support request e-mail: Navigate on the computer to the directory from which the RFoFconfig executable software was run and locate the Logfile named RFoFConfigTool.log that was just created, then e-mail this file along with a detailed description of the problem to support@RFOptic.com for technical support.

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