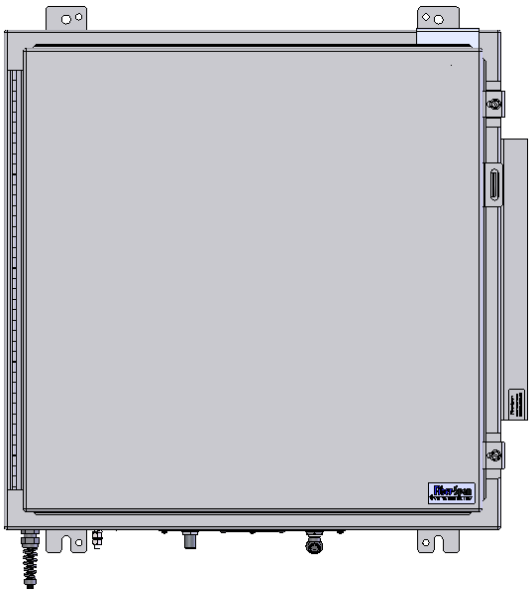
User Manual

FS31R-15C VHF RRU

162 – 175 MHz Fiber-Fed Remote Repeater Unit (RRU)

4 Watts Linear Output Power



Version 3

5/1/2012

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2. Introduction

The FS31R-15C Very High Frequency (VHF) Fiber Optic Remote Repeater Unit (FO-RRU) is a linear 4 Watts (36 dBm) RF power amplifier covering the frequency range from 162 to 175 MHz. The unit offers fiber input / output interface for long haul operation through a single mode fiber medium.

Device improves in-building wireless coverage enhancement to eliminate dropped calls and poor reception by amplifying and re-broadcasting a cell tower signal throughout a building.

While the fiber section is bandwidth unlimited, the internal RF components are optimized for best operation in the VHF bandwidth. RF has a separate input and output port to accommodate simplex application; however this product series can contain a duplexer for a bi-directional configuration ensuring uplink and downlink into a distributive antenna system (DAS).

3. Revision History

Version	Description	Date	Author
1	Draft release	5/1/2012	C.M.
2	Update FCC Statement	24-May-12	J.S.
3	Changed MPI distances to 1.5 and 2.5 meters	31-May-2012	J.S.

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5. Warnings

Invisible laser radiation exits from areas labeled “Aperture”

By connecting all the fiber connector ends of the optical link before applying power to both

Figure 1: Laser Warning Label

fiber transceiver unit and remote fiber node, it will prevent exposure to invisible laser radiation.

Follow and comply with all site safety policies, local codes and rules ordinances.

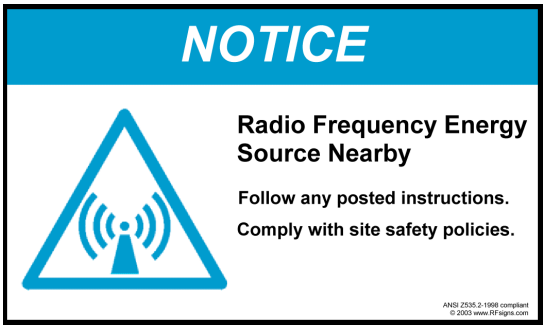

Figure 2: Radio Frequency Notice

*** Pay special attention to statements with an exclamation point symbol next to it. ***

Terminate every RF port with a 50 Ohm load.

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While in operation do not touch heat sink as surface is very **HOT**.

Device maximum composite optical input level is 7 dBm.

Only a qualified technician shall be allowed to operate the unit, after reading and understanding all the guidelines in this manual.

6. Main Product Name

There are two (2) main product versions:

Model Prefix	Model Midfix	Version
FS31R-15C	WM	Wall Mount
FS31R-15C	RM	Rack Mount

7. Sub Product Name

Major Internal Parts:

Part Number	Description	Quantity
180-0113	Gigabit Media Converter	1
180-0117	SFP Module	1
290-0310	DL Variable Digital Amplifier	1
290-0311	UL Variable Digital Amplifier	1
305-0359	Micro-Processor Computer	1
305-0361	Controller Board	1
390-0063	Dual WDM	1
495-0098	VHF High Power Amplifier	1
530-0169	VHF Duplexer	1
650-0043	12 Volt Fan (2 as inlet, 2 as outlet)	4

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Part Number	Description	Quantity
290-0061	Fiber Optic Transmitter / Receiver	1

The main parts are the same for the wall mount and rack mount versions excluding the RF cable interfaces and wiring harnesses that vary in length. Some or all the parts are subject to change without notice for the purpose of improving the product functionality.

8. System Application

The RRU is mounted in a strategic remote location where signal communication is poor or none available determined by the system engineer assessment and is part of a large system configuration with a headend. Integrated at the headend are elements that transmit, receive, condition and transport signals simultaneously via two (2) dedicated single mode fiber medium into an RRU and signal distributed and repeated for every remote unit.

One (1) fiber medium is for the downlink path and the other fiber medium is for the uplink path optical interface ports RRU which is design for long haul up to 10 dBo of optical loss translating into a useable uninterrupted fiber-distance of 28.5 Kilometers.

Downlink signals at the headend are condition by the base station unit (BSU) which accepts an input power from the RF source between 0 dBm to 30 dBm and outputs signal levels of 0 dBm with nominal at -10 dBm into the fiber transmitter unit.

A network management system (NMS) controls and configures the main elements the headend location as well as the RRU hardware via dedicated Ethernet LAN internet connections within the same fiber backbone. Lost of communication to and from the system is reported and logged with the NMS.

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9. Startup Checklist

The rack mount version unit has a VAC inlet that comes with a six (6) feet 3 prong VAC cord and the wall mount version unit has an embedded six (6) feet 3 prong VAC cord that plugs to a common house hold AC outlet.

To protect the device RF output port, it includes a 50 Ohm load terminator that should **not** be removed until the RF output cable is ready to connect to it.

10. Installation

10.1. Connecting RF

Follow these steps for connecting and disconnecting RF cables to the unit.

Sequence to connect:

1. Connect output load to the unit.
2. Apply power to the device.
3. Verify RF signal source is turned off.
4. Connect RF Input to the unit. (*when fiber-fed, connect optical input to the unit*).
5. Turn on the RF signal source input.

Sequence to Disconnect:

1. Turn off the source RF input.
2. Disconnect the RF Input connection of the unit. (*when fiber-fed, disconnect optical input to the unit*).
3. Un-apply power to the unit.
4. Disconnect the output load of the unit.

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10.2. Mounting installation

In a well structured support wall that it is reinforced with a 1 inch thick plywood of additional backing, mount the enclosure using four (4) socket head cap screws size **3/8"-16, 1-1/2** inch length to bear the enclosure weight (80 lbs).

11. Block Diagram

The FS31R-15 rack mount and wall mount unit internal parts are the same without internal duplexer is shown in Figure 3: Remote Repeater Unit (RRU) Block Diagram. Unit choices are with internal or external duplexer.

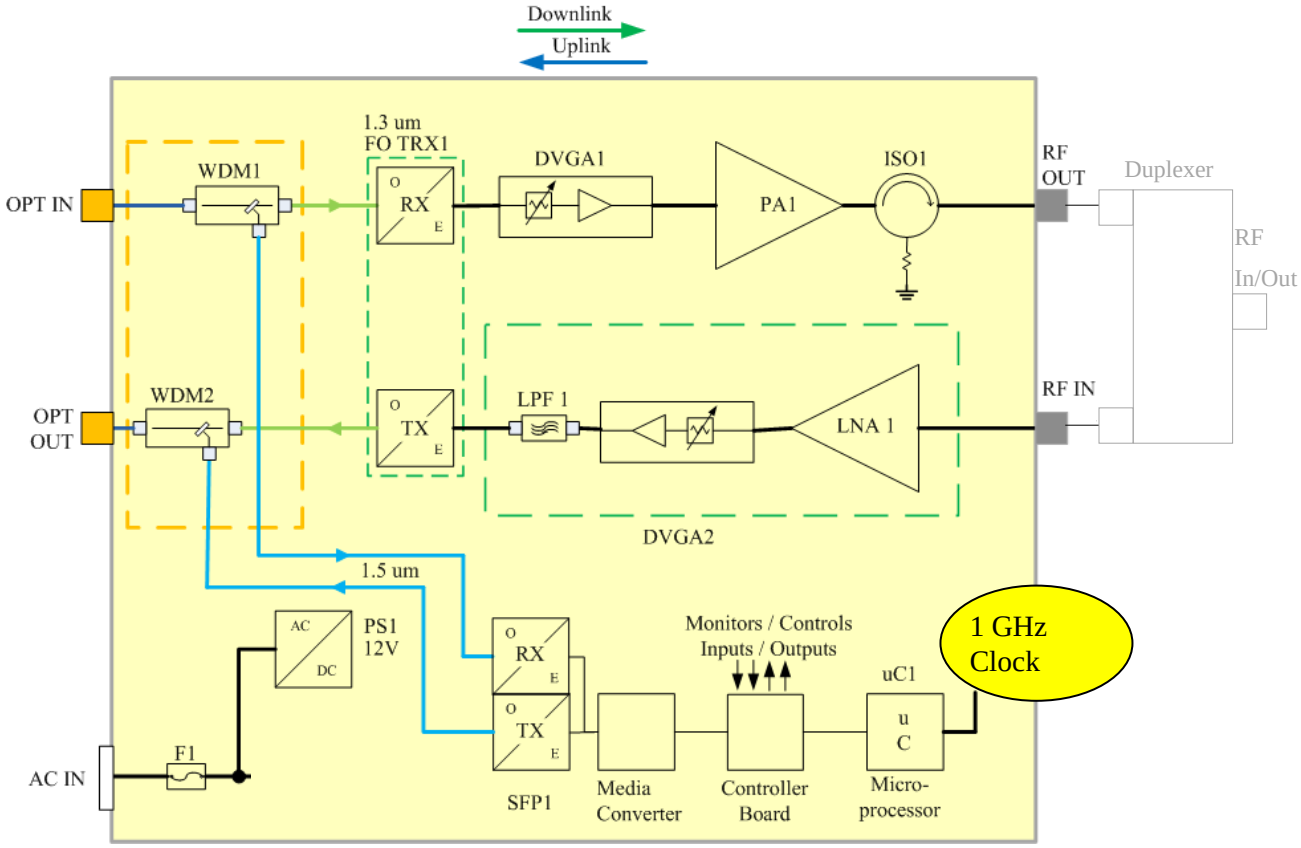

Figure 3: Remote Repeater Unit (RRU) Block Diagram

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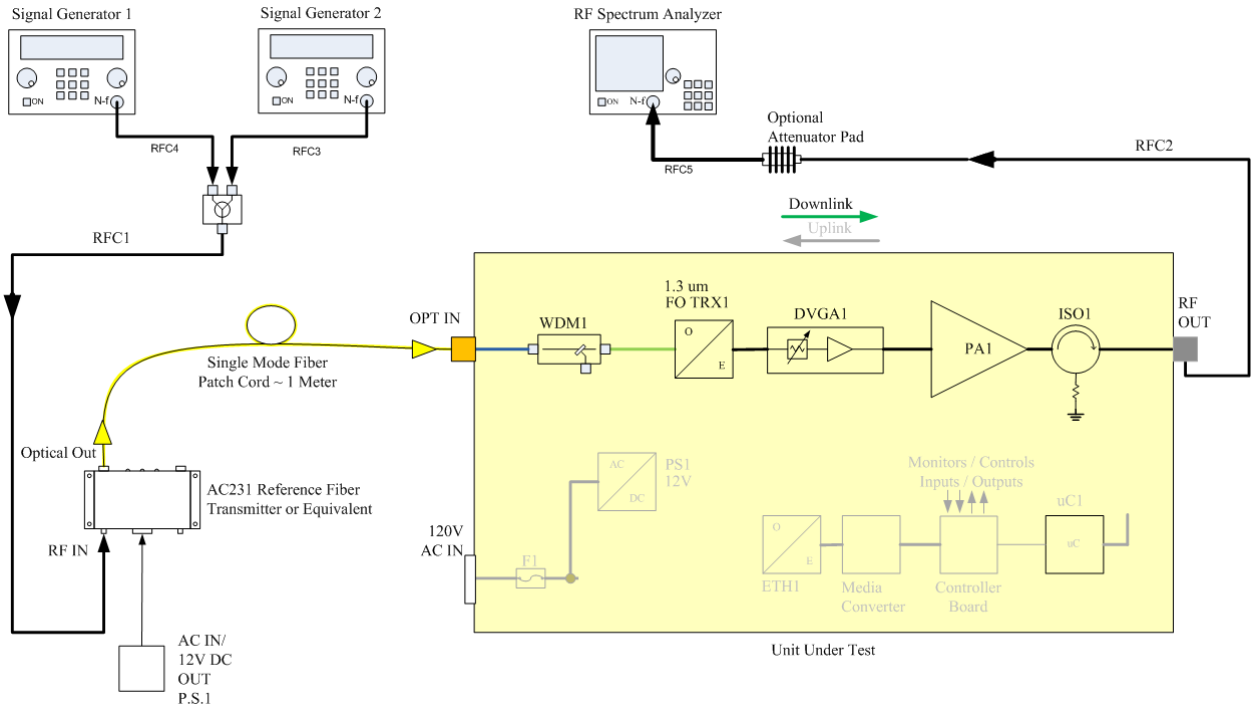

Figure 4: UUT Downlink Test Setup Block Diagram

12. Specifications

12.1. Electrical

Dowlink Path

RF Parameters	Acronym	Min	Typical	Max (1)	Units
Composite RF Input (2)	RFin		-15	-10	dBm
Frequency	Freq	169.5625	--	173.825	MHz
Flatness	Flts	--	--	+/- 2.0	dB
RF Gain (3)	RFG	48	50	56	dB
Output Intercept Point	OIP3	56.5	61.0	--	dBm
Output Noise	O.N.	-114	-90	-75	dBm/1Hz

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Composite RF Out and Automatic Level Control	ALC	36.0		37	dBm
Forward Power Alarm	FPM	39		40	dBm
Test Frequencies	F1/F2	172.000 – 172.500			MHz

Calculated Values

Spur Free Dynamic Range	SFDR		100		dBm/2/3 Hz

Uplink Path

RF Parameters	**Acronym**	**Min**	**Typical**	**Max (1)**	**Units**
RF Input (4), (5)	RFin	-80	-55	-19	dBm
Frequency	Freq	162.175		166.4375	MHz
Flatness		--	--	+/- 2.00	dB
RF Gain (3)		-7		56	dB
RF Out			0	3	dBm
Output Noise			-115		dBm/$^{2/3Hz}$
Test Frequencies	F1, F2	164.000 – 164.500			MHz

Calculated Values

Spur Free Dynamic Range	SFDR		100		dBm/2/3 Hz
Noise Figure	NF		2	8	--

(1) The electrical test conditions specified in this section is with a reference calibrated in factory unit using a 1 meter single mode fiber patch cord as the fiber medium equivalent to 0 dBo optical loss.

(2) RF Input level is using a reference transmitter.

(3) RF Gain measurement criteria are with attenuators at minimum attenuation.

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(4) Uplink RF input level at -20 dBm triggers the squelch and RF will shut off.

(5) Factory test RF input level into reference fiber transmitter is -19 to -23 dBm.

RF Gain Adjustment

RF Gain has a wide adjustment range thus it is set to the minimum value of 37dB at 0 dBo loss and increases proportionally as the fiber medium optical loss goes up.

Normalization of the Link RF Gain due to increase in optical loss:

Increase up the **RF Gain** by **2** (dB) for every **1** (dBo) of fiber medium optical loss.

Before verifying the RF Gain maximum level is attainable, decrease the RF input level by 20 dB, hence to -57 dBm, so that no compression of signal occurs.

12.2. Mechanical

Wall Mount Version

Allow at least 20 inches of space from the front of the unit (not including enclosure depth) for opening the door.

Rack Mount Version

Allow at least 20 inches of space from the front of the unit for installation and removal of the rack mount.

12.3. Tools

Tools	Purpose
Medium/ Large hand held flat head screwdriver	For opening front door of wall mount

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12.4. On Site Requirements

For each RRU a three (3) wire (Hot, Neutral, and Ground) 120 VAC wall outlet including a separate earth ground bus bar that connects to the unit chassis.

Two 9/125 um single-mode fiber strands with SC/APC connectors, one for the downlink path and the other for the uplink path.

A unit as a simplex configuration requires two (2) high quality RF cable with N-Male connector that attaches from the DAS to the RF Input and Output port.

A unit as a duplex configuration requires only one (1) high quality RF cable with N-Male connector that attaches from the DAS to the bi-directional RF In/Out port.

13. General Precautions

- Allow at least 6 inches of space into the air inlet and outlet of the unit, for proper air flow through the fan(s).
- Do not change any of the parameters unless instructed to do so by an authorized supervisor and you are a qualified technician to operate device.
- Do not attempt to move product without the proper tools and man power, because product is heavy.
- Terminate all the unit RF ports with a 50 Ohm load prior to powering up.

14. Maintenance

Periodically check and clean the unit fan(s) inlet and outlet by removing lint, dust and dirt with a lightly damped cloth. Air-in-a-Can is also a good product to have as part of a maintenance kit that includes an extended nozzle for hard to reach places.

Do not hose the unit with water as it is not waterproof.

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Unit can be cleaned without being turned off, but do not disrupt or touch any moving mechanism in a way that can stall the motor.

Replace a fan immediately upon fan alarm indicator turning on. Shut off the unit to preserve the lifespan when a fan or fans cannot be replaced immediately.

14.1. Preventative Measure for Optimal Operation

Optical Maintenance

Once optical connectors are secured the ports no maintenance is required. However when necessary to unplug it, immediately cap the tip with cover, This prevents scratching exposed glass tip which deteriorates performance and possibly becoming unusable.

Figure 5: SC/APC Connector with cap

Guidelines for using SC/APC Connectors and Adapters

Warning! Improper maintenance and installation of optical connectors and adapters can permanently damage parts, and seriously degrade performance of fiber optic devices. All installation personnel using Fiber-Span equipment equipped with optics should review this document. Fiber-Span is not responsible for damage caused by improper use of optical equipment.

Maintenance

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1. Clean SC-APC connectors and Adapters with isopropyl alcohol (99%), dust free fiber optic cleaning tissues and 2.5mm mini-swabs.
2. While performing these steps protect connector tips from scratching.
3. Clean the inside of the fiber optic adapters and bulkheads using a swab lightly moistened in isopropyl alcohol.
4. Gently insert swab into the adapter orifice until the back-stop is reached, rotate swab clockwise several times. Discard swab after each use.
5. Lightly moisten a dust free fiber optic cleaning tissue with isopropyl alcohol.
6. Hold pre-moisten tissue touching connector tip (end face) and gently swipe connector in a figure "8" motion several times.
7. Always keep exposed connector tip and adapters covered with protective cap.

Figure 6: SC/APC Adapter

Figure 7: SC/APC Connector

Installation

8. Align connector key (alignment post) with notch on the adapter or bulkhead.
9. After assuring keys align, push connector forward into adapter or bulkhead until connector clicks. Click indicates connector has been seated properly.

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10. Always install SC/APC connectors into adapter or bulkhead by hand.

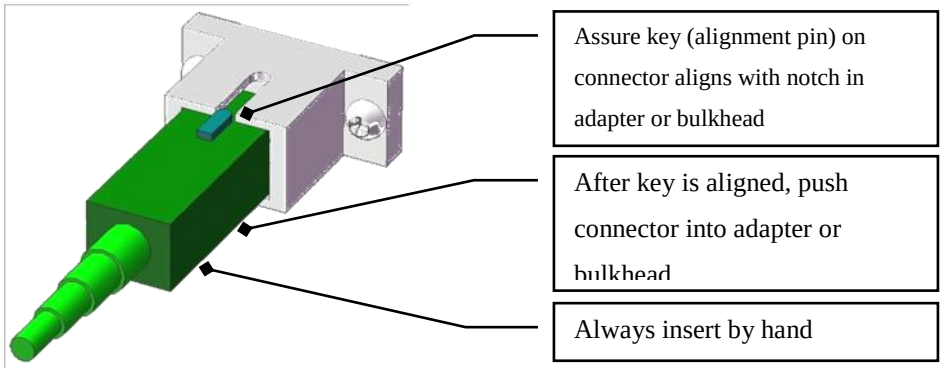

Figure 8: SC/APC Connector attaching to Adapter

Initial signal testing as a baseline and periodic signal level testing thereafter, will provide a historical log for keeping track of signal quality so that if required fine tuning of the system can be achieved for optimum performance.

15. Factory Settings

Tuning and testing performed at factory are:

Two tone test (TTT) that consist of:	S-Parameters
RF Input (dBm)	S21
RF Output (dBm)	S11
RF Gain (dB)	S22
Output Third Order Intercept (dBm)	
Output Noise (dBm/ 1Hz)	
Calculated Values	
Spur Free Dynamic Range (SFDR)	
Noise Figure (NF)	

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Monitors and Controls

Fiber Transmitter FOTX	Fiber Receiver FORX	RF Power Amplifier
• Optical power • TX Set-point • Laser Bias • Temperature Alarm	• Optical minimum input threshold	• DL Attenuation Range • UL Attenuation Range • Automatic Level Control • Forward Power Monitor • Sensitivity

16. Outline Drawing

Enclosure Type	Size inches (mm)
Rack Mount	19 x 18 x 6.95 (465.1 x 457.2 x 6.95)
Wall Mount	20 x 20 x 9 (508 x 508 x 238.5)

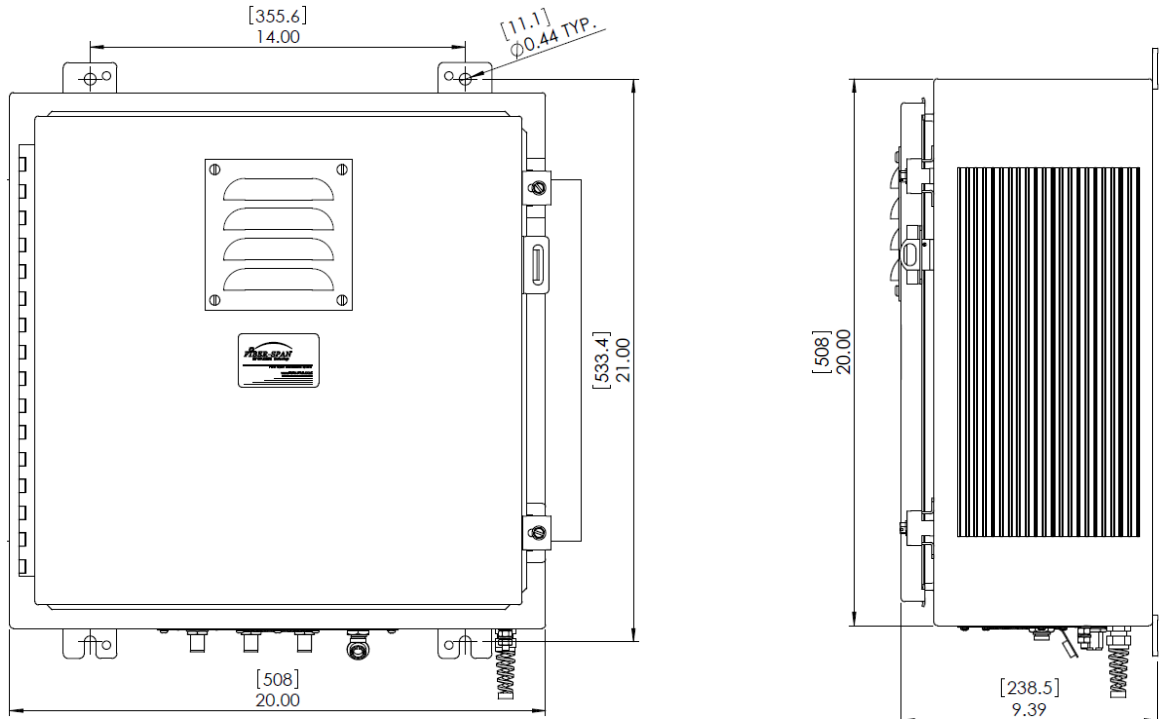

Figure 9: Wall Mount

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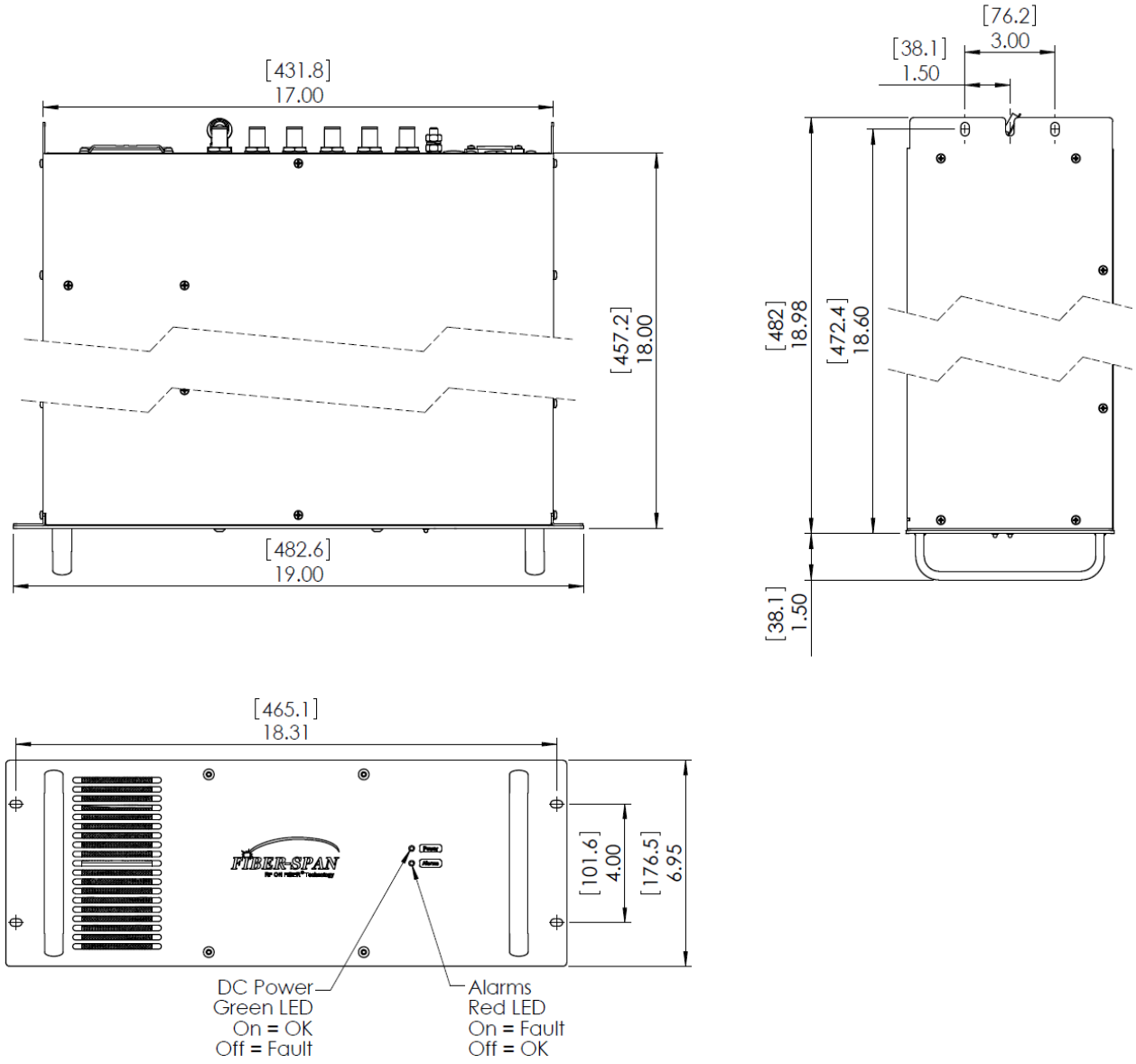

Figure 10: Rack Mount

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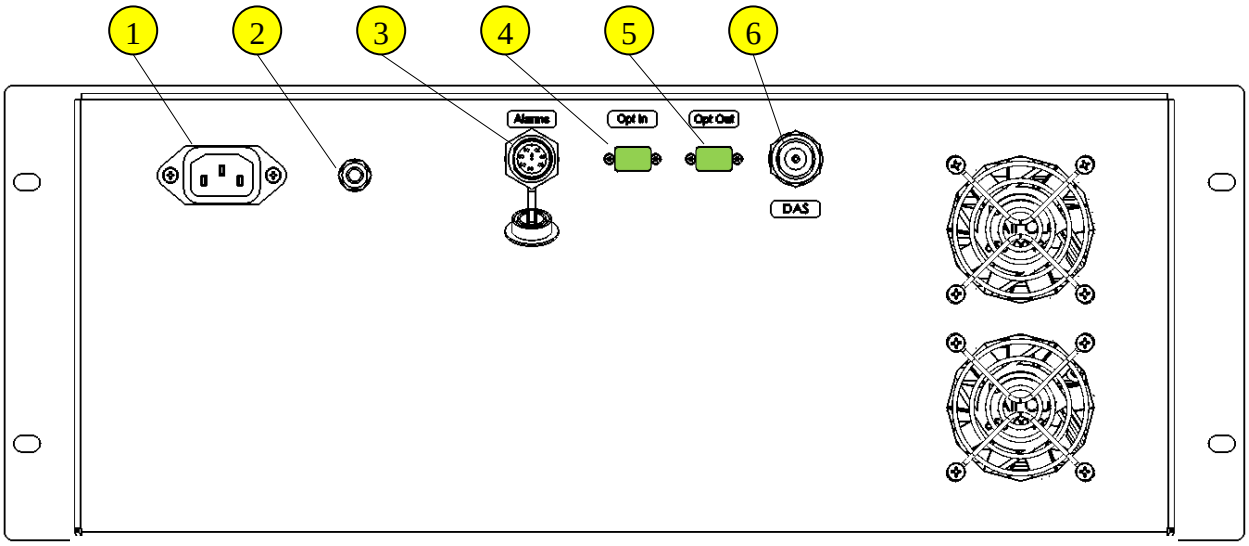
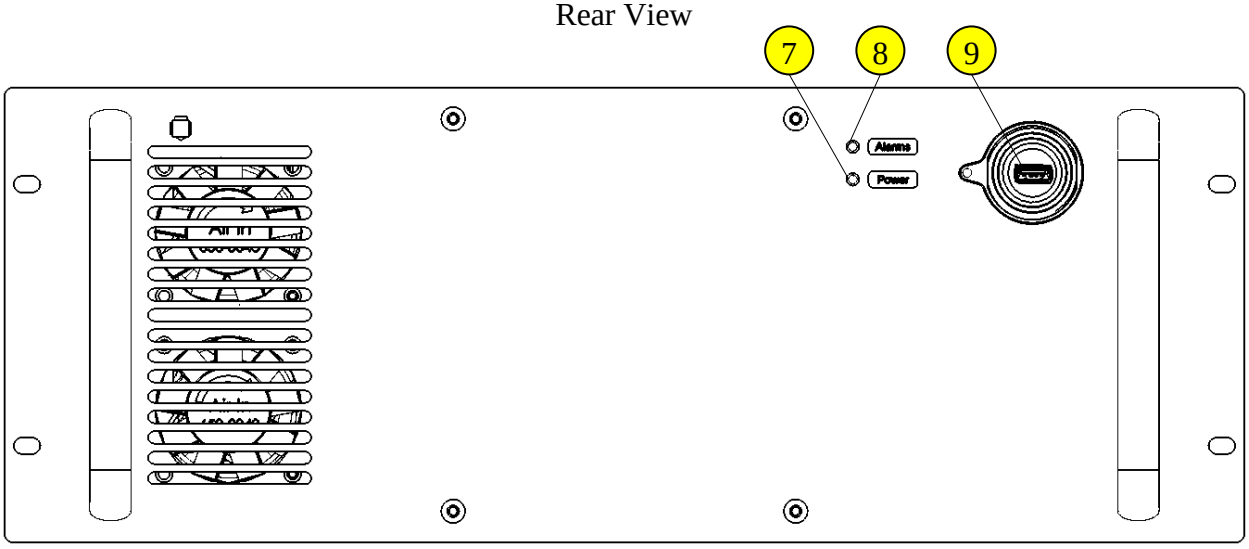
17. Front / Rear Panel Ports and Interfaces

Rack Mount



Rear View



Front View

1. VAC In Inlet
2. Ground Lug
3. Circular Alarm Connector
4. Optical Input Port
5. Optical Output Port
6. RF In / Out Port
7. Power LED Indicator

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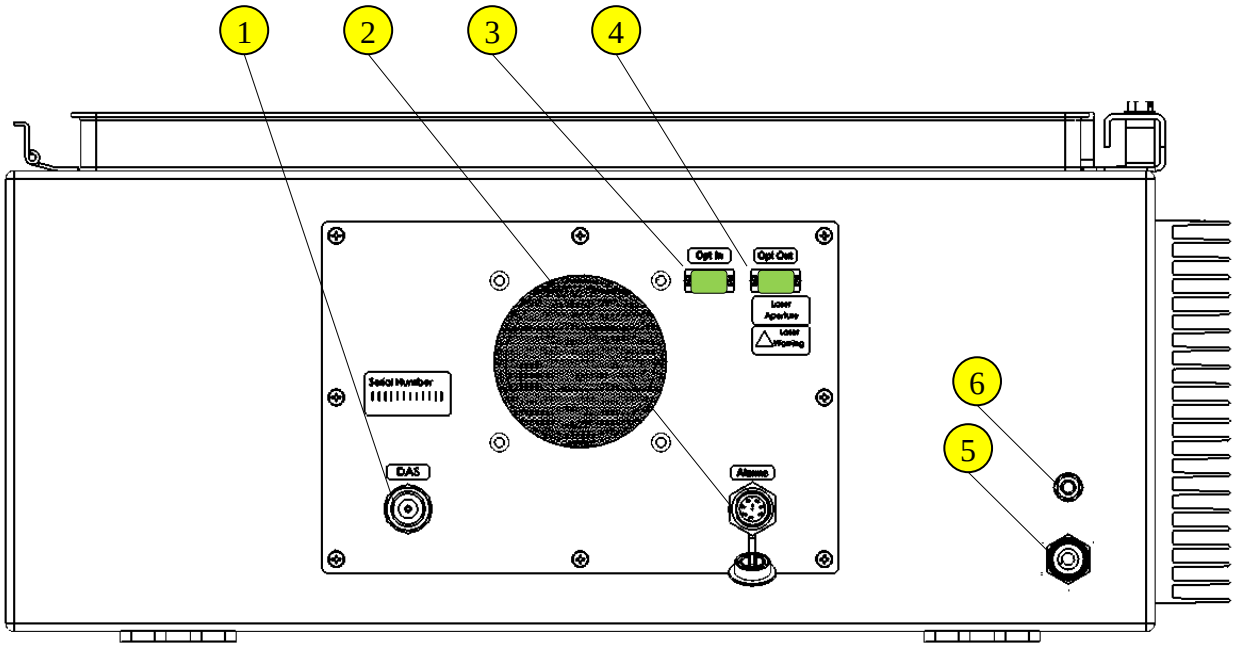
8. Alarm LED Indicator
9. USB Port

Wall Mount



Bottom View

Bottom Panel Ports and Interface

1. RF In / Out Port
2. Circular Alarm Connector
3. Optical Input Port
4. Optical Output Port
5. VAC Cord
6. Ground Lug

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18. FCC Statement

Manufacturers Notes

"Changes or modifications not expressly approved by the manufacturer could "Void" the user's authority to operate the equipment".
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

This device has been designated to operate with the antennas having a maximum gain of [9] dBi for a 1.5 meter distance and antennas having a gain greater than [15] dBi at 2.5 meters distance are strictly prohibited for use with this device. The required antenna impedance is [50] Ohms.

To improve and correct equipment performance the following can be performed.

1. Re-orient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a different circuit from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/RF technician for help.

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19. Warranty

19.1. General Warranty

The RFN carries a standard warranty period of one (1) year unless otherwise indicated on the shipping packages as noted in the purchase order agreement.

19.2. Limitations of Warranty

The warranty is limited to the repair or replacement of the defective product. Fiber-Span will decide which remedy to provide for defective components as its own discretion. Fiber-Span shall have a reasonable time after determining that a defective product exists to repair or replace the problem unit. The warranty applies to repaired or replaced products for the balance of the applicable period of the original warranty or ninety (90) days from date of shipment of a repaired or replaced component, whichever is longer.

The Fiber-Span standard warranty does not cover products which have been received improperly packaged, altered, or physically damaged. For example, broken warranty seal, labels exhibiting tampering, physically abused enclosure, broken pins on connectors, any modifications made without Fiber-Span authorization, will void all warranty.

19.3. Limitations of Damages

The liability for any defective product shall in no event exceed the purchase price for the defective product. Fiber-Span has no liability for general, consequential, incidental or special damages.

19.4. Return Material Authorization (RMA)

No product may be returned directly to Fiber-Span without first getting an approval from Fiber-Span. If it is determined that the product may be defective, you will be given an RMA number and instructions in how to return the product. An unauthorized return, i.e., one for which an RMA number has not been issued, will be returned to you at your expense. Authorized returns are to be shipped to the address on the RMA in an approved shipping container. It is suggested that the original box and packaging materials should be kept if a defective product needs to be shipped back to Fiber-Span. To request an RMA, please call 908.253.9080.

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20. Company Information

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Appendix A FS31R-15C RRU Media Converter

This section calls out the hardware needed and explains how to connect the media converter section of the Remote Repeater Unit (RRU) for approving its functionality.

Hardware Needed

1. One media converter (for use as reference) including its power supply.
2. One SFP module.
3. Two 9/125 um single mode fibers SC/APC-to-LC/PC (1 meter length).
4. Three Ethernet cables (RJ45 connectors).
5. One PC or Laptop.

How to connect:

1. Before applying power, connect all three Ethernet cables;
    a. Connect Cable 1 from PC to RRU USB port.
    b. Connect Cable 2 from reference media converter to Switch.
    c. Connect Cable 3 from Switch to Local Area Network (LAN).
2. Using two single mode fiber patch cable (~1 meter length), connect the fiber cable end to RRU optical out port and the other cable end to the media converter input. Connect the other fiber cable to the RRU optical in port and the other cable end connect it to the media converter output.
3. Always terminate RRU RF port with a 50 Ohm Load.
4. Apply power to the media converter and the RRU.

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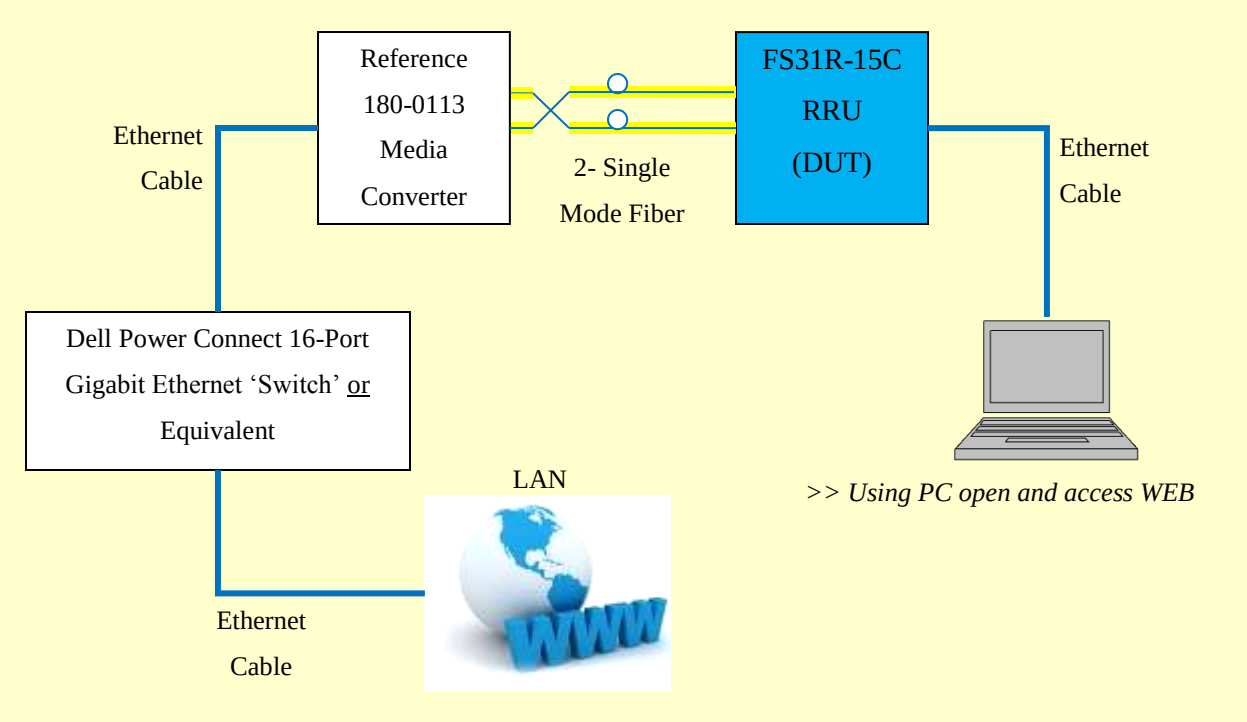

Figure 11: RRU Media Converter Test Setup Block Diagram

Turn on the PC and open an internet browser. Using a search engine like Google, check on the internet for the today's news. If you are able to do so, the media converter section is functioning properly.

With this step the fiber medium has been proving to work at 0dBo, now replace both fiber cables with two 10 dBo single mode fiber patch cables and retest.

Troubleshooting Tip

The optical transceivers in-use has a high sensitivity margin that operates from 0 to 10 dBo optical loss this is not expected to be an issue. Upon encountering an issue, check that the fiber cables are not kinked or bend excessively. If issue continues, unplug every optical connector and

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re-clean tip with isopropyl alcohol until the internet is accessible. Another problem can be that the fiber cables are incorrectly crossover.

The fiber path of the RRU transmitter side connects to the Receiver side on the reference media converter and the fiber path of the RRU receiver side connects to the transmitter side of the reference media converter.

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