FS51C Channelized BDA Product Series

User Manual

FS51C-85-USR

Part of Fiber-Span's FS51C Series family of products

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Version B

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Revision History

Version	Author	Description	Date
A	Carlito Muniz	Initial Release	March 5, 2009
B	CM	Additional notes added	April 14, 2009

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1 Company Info

Fiber-Span is a premier provider of advanced RF ON FIBER ® technologies and solutions for fiber optic based transmission of high fidelity radio-frequency wireless voice, data and multiservice networking applications. Fiber-Span's proprietary RF/Fiber Optic transceivers, transmitters and receivers are rugged, compact OEM modules and subsystems designed for easy integration into commercial cellular, GSM, PCS/PCN, M/LMDS, WLL, IF, satellite terminal or distinctive antenna system configurations. Fiber-Span is addressing public safety needs by providing fiber optic wireless solutions for police, fire, emergency, first responder and Homeland Security radio systems applications. Fiber-Span's solutions for Defense and Military organizations are also leading the way by providing reliable and secure communications links for ground, airborne, shipboard, radar, telemetry, GPS and intelligence solutions in the HF/UHF/VHF and microwave radio frequencies. Fiber-Span's evolving class of product addresses the growing demand and movement toward the convergence of wire line and wireless networks, and the requirement for high performance, high bandwidth RF ON FIBER ® solutions and networks. Fiber-Span's customers are global wireless communication systems original equipment manufacturers (OEM), radio frequency (RF) system integrators, and military system architects. More information about Fiber-Span products is available from the contact info listed below.

To support the Public Safety, Government and Military Market, Fiber-Span has diversified its Product Line to include Class A Channelized BDAs because emergency communication depends on it.

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2 Product Intro

This manual covers the Class A Channelized BDA Product Line. All primary frequency bands for public safety are accommodated with the product series such as VHF, UHF and the 800 MHz Bands. The Class A Channelized Bi-Directional Amplifier (BDA) is a 2 Way Uplink & Downlink Full Duplex system that uses a low isolation duplexer to minimize space required. To use the Trunked Repeater Technology very low RF Delay is required and ranges from 32u to 120u second delay. Using the correct filtering technology has to offer is design and implemented into the circuitry to minimize time and provide the most dense adjacent channels possible for the high demand of communication.

The main function of a Class A Channelized BDA is to provide a constant channel frequency RF output level while preventing other undesired channel frequencies from passing through the Trunked Channel Card.

3 Description

The most popular configuration (but not limited to) is an 8 Channel Bi-Directional Amplifier, consisting of 8 Uplink and 8 Downlink Channelized amplifier configurations. A combination of a Trunked Channel System (TCS) and Broadband (BB) can be implemented to accommodate your needs and budget. Each Trunked Channel Card (TCC) is "Field Programmable" to allow for on the fly frequency setting, sensitivity and threshold change. The software "FS51C-xx-SFT1", (xx= band) selection is used to control frequency, sensitivity, RF level output and threshold adjustment. Each channel can be independently programmed for "Key" time out and shutdown. The TCC front panel has a "Lock" and "Key" illuminator for visible approval.

The 8 Channel Up/Down BDA configuration fits in 16U rack spacing. The rack spacing mentioned does not include duplexer or custom configurations. All major RF Ports, Communication Ports and Indicators are visible and accessible via the front panel. Power and Alarms are connected via the rear panel.

Each major section is defined as a "Cluster". A "Cluster" is defined as a 1U RF Splitter, 3U Card Cage /w 12V Power Supply, xTCC Cards, x= 1 or up to 8 TCC cards and a 1U RF Combiner. The 3U RF Power Amp is not part of the Cluster.

See Figure 1 typical system architecture.

3.1 Theory of Operation

8 Channel Bi- Directional Amplifiers (CH-BDA)

The eight channel bi-directional amplifier utilizes 16 trunked channel card of synchronized down-up conversions. The multi-channel booster is divided into two independent 8 channel systems (8 high bands and 8 low Bands) for full duplex operations. Downlink signals are received from a "Donor Antenna" (DA). 8 selected frequencies are processed (filtered and amplified), and rebroadcast on radiating cable. The frequencies can also be joined with a Duplexer located on the end to be rebroadcast with a "Coverage Antenna"(CA). Conversely, uplink signals induced onto radiating cable are similarly processed and rebroadcast on the "Donor Antenna". The downlink channels are the high band signals (850-869 MHz), and the 8 uplink channels are low band (820-824 MHz).

Each system consist of a LNA/8-way splitter, 8 channel modules (down-up converters with synthesized LO), 8-way combiner, and RF power amplifiers with an 8-way power combiner. In addition a duplexer combines the uplink RF output and downlink RF input to a common "Off the Air" antenna.

The RF signal flow of the two systems is identical. RF band pass filters internal to the system modules determine high band or low band operations. (Refer to system block diagram Figure1):

DUPLEXER (DUP):

The duplexer allows for full duplex operation, simultaneous transmit and receive into a common antenna port. The pass/reject filtering of the duplexer provides band pre-selection, minimal insertion loss between the antenna port to the two ports, transmit and receive ports, and provides high isolation between the transmit and receive ports. For proper operations, the uplink Booster Amp (BA), is connected to the DA, and the downlink BA's transmit and receive ports to the

radiating cable or the CA.

DUPLEXER CONFIGURATION:

UPLINK BA: The antenna port of the duplexer is connected to the “Off the Air” antenna. The duplexer transmit port (low band) is connected to the uplink RF power amplifier output port. The duplexer receive port (high band) is externally cabled to the downlink BA’s LNA/8 way splitter for processing of the
downlink signals. The uplink BA’s LNA/8 way splitter (receive port) is externally cabled to radiating cable for processing and broadcast the uplink signals on the “Off the Air” antenna.

DOWNLINK BA: The uplink duplexer’s receive port is externally cabled from the uplink BA to the Downlink BA’s input, LNA/8 way splitter, for processing of the outbound signals. The downlink RF output is externally cabled to inject the downlink signals onto the radiating cable.

LNA/8-WAY SPLITTER (SPL):

The LNA/8-way consists of a low noise amplifier with band pass filter, to provide band pre-selection and amplification of the received signal, and an 8-way splitter. In the LNA module, the operational band is selected by helical band pass filters. For low band, uplink operation, the filter is centered at 821.5 MHz. For high band, downlink, operation, the filter is centered at 866.5 MHz. The 8-way splits the LNA output to the inputs of the 8 channel modules.

Splitter output port “1” goes to the input of TCC channel module “1”, “2” to the input of TCC channel module “2” and the sequence repeats through all 8 channels.

CHANNEL MODULE (TCC):

The CHANNEL MODULE is a synchronized down-up converter to provide a high degree of filtering and hard limiting of a channel frequency, with a micro-controller to monitor and control the module functions.

CHANNEL MODULE: The TCC module consists of 3 components:

1. The input board provides for additional channel pre-selection and amplifier of the received RF signal. Down conversion of the signal received to an IF of 90 MHz, two cascade crystal filters provides a high degree of filtering.

2. The output module provides hard limiting of the IF, eliminates the requirements of an Automatic Gain Control (AGC) loop. An analog Receive Signal Strength Indicator (RSSI) from the IF is compared to a threshold setting to produce a logic output, RSSI KEY. This signal is monitored by the micro-controller to produce the key line and key line time-out functions. Keying the final stages of the output module and the final RF power amplifier prevents unwanted spurious outputs when no sign carrier is detected. In addition, the output module provides the up conversion and filtering to the original frequency. With hard limiting at the IF frequency, a constant output level verssus the input level is produced.

3. A dual output synthesized Local Oscillator (LO). Synchronized conversions mean that the frequency received equals the frequency transmitted. The synthesizer output (Fc+90Mhz) determines the channel frequency and is programmable in 12.5Khz steps to produce the 25Khz channel spacing over the pre-selected band. A Time Clock Oscillator (TCO) of 8 MHz provides the reference oscillator to the Phase Lock Loop (PLL).

MICRO CONTROLLER (MC): The controller performs 4 functions:

- Programs the TCC module synthesizer to the desired frequency and monitors lock detect for fault detection.
- Monitors the carrier detects, RSSI KEY, and generates the key line function.
- Performs the key line time out and delay functions, the time-out timer.
- Interface to the operator. Using a laptop computer and Fiber-Span proprietary software, the operator can program the channel frequency and time-out functions.

8-WAY COMBINER (CBR):

The 8-way combines the eight TCC outputs to one. 8-way's pre-driver adds additional filtering of the channel modules output, and amplifies to a sufficient level to drive the power amplifier.

RF POWER AMPLIFIER (PA):

The final RF power amplifier consists of two pre-driver amplifier stages and a final hybrid class (A) RF power module. To "key off" the power amp, the second pre-drive amplifier is controlled (on/off) by the microcontroller output, key line, from the associated channel module. Programmable input attenuators allow for control and setting of the final output power per carrier.

See Figure 1 for a typical system architecture.

3.2 Product Applications

The Channelized BDA is used in the following applications:

1) Underground parking structures
2) Large buildings
3) Tunnels
4) Sports stadiums
5) Shopping malls

3.3 System Channel(s) Expandability

The system architecture is expandable and additional TCC cards can be added to accommodate more frequency channels. When the channels exceeds 8 a second "Card Cage Cluster (CCC)" will be required adjacent to the existing CCC. A 2 Way RF Splitter and 2 Way RF Combiner is used to interface with the extended hardware to a common port that will be fed into the RF Power Amp. The configuration is adapted to both uplink and downlink paths.

Table 1

Signal Direction	Port Label	Port Label
Downlink Path	DL RF In	DL RF Out
Uplink Path	UL RF In	UL RF Out

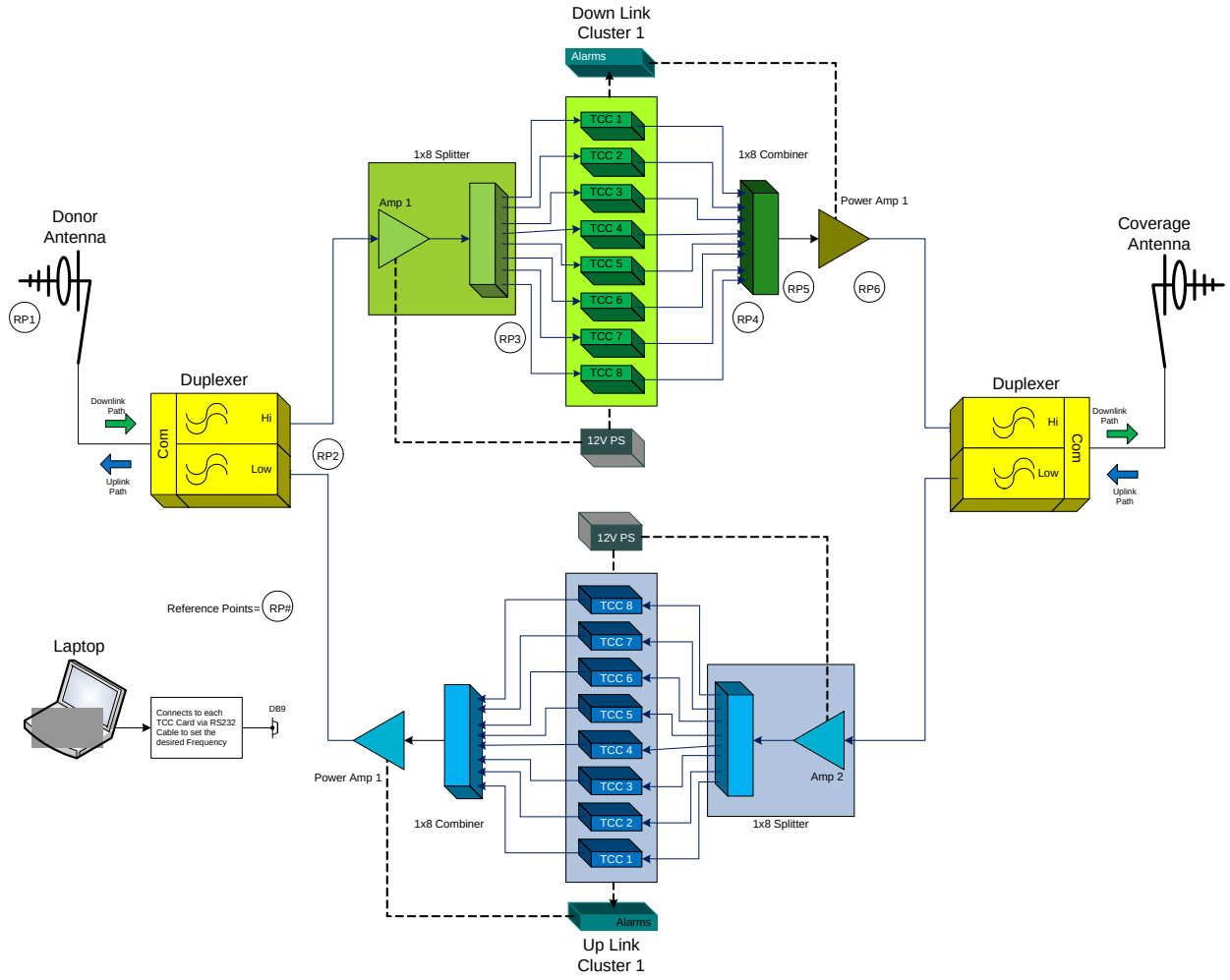


Figure 1

Figure 1 shows a typical 8 Channel, Channelized BDA Uplink/ Downlink System Architecture

4 Product Frequency Options

4.1 VHF

Available products sold for VHF frequency bands.

4.2 UHF
Available products sold for UHF frequency bands.

4.3 800
Available products sold for 800 frequency bands. This user manual covers the 800 MHz band.

5 Detailed Description
This section deals with the components (variations) that are assembled to make up the Channelized BDA main subassemblies:

5.1 Uplink Hardware
1. One 1 x 8 Way RF Splitter (SPL)
2. Eight Trunked Channel Cards (TCC) inside Card Cage w/ 12 Volt Power Supply
3. One 1 x 8 Way RF Combiner (CBR)
4. One RF Power Amp (PA)

5.2 Downlink Hardware
1. One 1 x 8 Way RF Splitter (SPL)
2. Eight Trunked Channel Cards (TCC) inside Card Cage w/ 12 Volt Power Supply
3. One 1 x 8 Way RF Combiner (CBR)
4. One RF Power Amp (PA)

One Duplexer is used for both Uplink and Downlink Channelized BDA.

6 TCC RF Signal Spectrum

6.1 Before Signal Conditioning
Figure 2 graph displays the “Off-the-Air” RF signals picked up from the Donor Antenna. The RF Signals will be transported until they have reached the RF Input of the RF “Common” port Splitter. After the RF Splitter, each corresponding TCC card will accept one of the many channel frequencies.

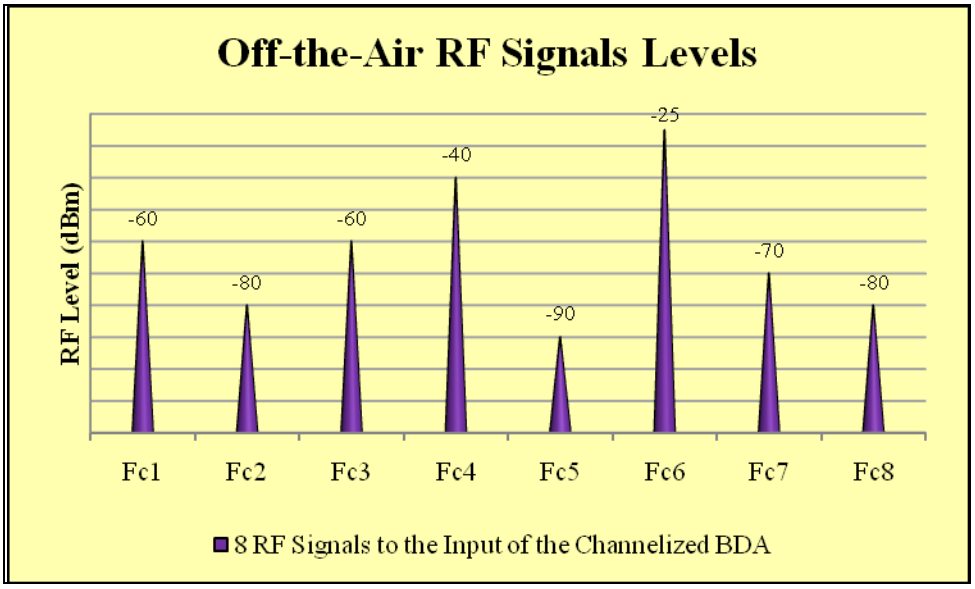


Figure 2

6.2 **After Signal Conditioning**

Figure 3 graph displays the Normalized RF Signals conditioned by the TCC cards. All the channel frequencies are present at the “Common” RF Combiner port. RF Signals will then be transported to the RF Input of the Power Amp where they will be amplified at the desired Automatic Level Control (ALC).

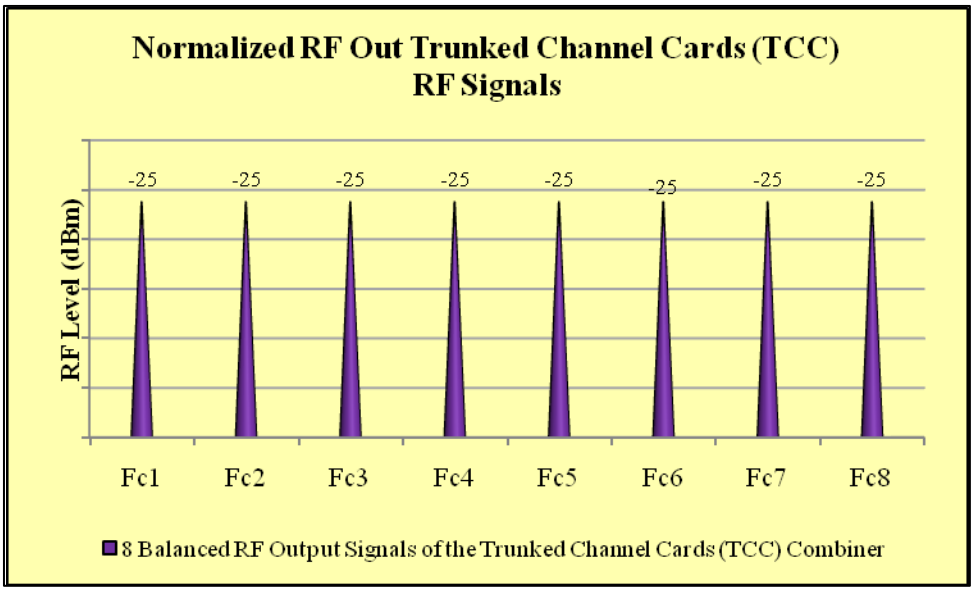


Figure 3

7 Cautionary Notes

WARNINGS:

1) **TCC Cards are Not Hot Swappable. Turn Off Card Cage prior to removing or installing card(s).**
2) **Confirm RF levels do not exceed unit capability prior to connecting.**
3) **All RF ports must be properly terminated prior to applying power to the external equipment.**
4) **Always connect the RF Outputs of a unit first then connect the RF Inputs.**
5) **Unused RF ports should be terminated with 50 ohms. Failure to properly terminate an RF port may result in damage to the unit.**
6) **It is recommended that the entire manual be read prior to installing the unit by an authorized technician.**
7) **Always turn "Off" equipment prior to installing or removing the TCC cards, RF Splitters, RF Combiner or Active hardware from the chassis. Product is "Not" Hot Swappable.**
8) **Electrostatic Discharge ESD**

Use precautions when touching equipment. Make sure body has been statically discharged by grounding yourself to an ESD grounding strap. This will prevent damage to sensitive components inside the unit.

8 Contents

Included with the 8 Channel Up/Down Channelized BDA when shipped:

- Outline Drawing
- Test Data
- Software (Controls Sensitivity, Threshold and Levels)
- Software Operational Manual (OPM)
- User Manual (this manual)

9 Installation Procedures

Fiber-Span's Channelized BDA is made to operate in an internal or external environment such as a telecom room or an outside dwelling. It is recommended that the temperature inside the room does not exceed +60°C or be below -20°C. The humidity must be 10% to 95%.

9.1 Connectorization

The Channelized is supplied with an N-female (see Figure 4) connector on all the main port(s). Between the “RF Splitter”, “TCC Cluster” and “ RF Combiner” the RF connections are “SMA-female” It is recommended that a 3 ft jumper cable is used in a (S) shape as a strain relief to connect the main TX and RX ports to the coaxial cable going into the “Non Fiber-Span equipment”. This will avoid the likelihood of the RF port to strip. See figure 8 for connector types, make sure the RF cable connector is aligned with the unit port when threading. Soft jaw connector pliers are commonly used when tightening the RF cable connector.

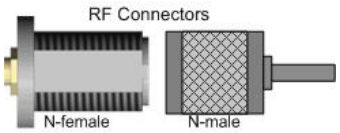


Figure 4

9.2 Grounding

The Channelized BDA Cabinet has a main separate ground lug. Common ground connections are via the VAC Ground strip. Do not use plastic or nylon washers between any mounting screws which attach the hardware to the cabinet.

9.3 Hardware required

All “Hardware Kit” to make up a Channelized BDA is included. Foreign RF Cables and third party products are not included; however, are offered by Fiber-Span at a nominal cost.

10 RF Level calculations

Downlink and Uplink desired RF Input to Power Amp use the following calculation to determine nominal RF levels into the input port of the RF Power Amp (PA)

Step 1:

Equation 1: RF input level to PA per Channel = PA RF ALC Level (dBm) – PA Gain

ALC	*minus*	*PA Gain*	*equals*	*RF Input to PA(dBm)*
30	-	*60*	=	*-30*

Step2:

Equation 2: When the RF Level to the input of the PA is higher than desired, a PAD can be inserted in series to the PA RF Input port.

PA RF Input	*minus*	*PAD value*	*equals*	*New RF Input to PA(dBm)*
-20	-	*10*	=	*-30*

A Class A Channelized BDA is limited to an RF Output Power of 5 Watts Composite. Calculating Composite Output Power. The PA has a Variable Control circuitry that is set to 5 Watts composite at the "Factory".

Ideal input RF Level to a PA with a RF Gain of 60 dB is (-) 30 dBm per Channel. For a popular 8 Channelized BDA the composite output power is calculated as follows:

Equation 3:

	Total Channels	*multiply by*	*equals*	*RF Power to PA increase by*
LOG	*8*	*10*	*=*	*9.03dB*

11 Specifications

11.1.1 RF Specifications

Parameters	Units	Min	Typical	Max
Frequency Range Uplink	MHz	806		824
Frequency Range Downlink	MHz	850		869
Channel Bandwidth (Uplink & Downlink)	KHz		25	
Channel Spacing	KHz		25	
RF Frequency Accuracy	--	Tracks input signal exactly		
Adjacent Channel Selectivity	--	70 dB @ + - 17.5 KHz Fc		
RF Output Power (Downlink)	dBm/ Carrier	+25		
RF Output Power (Downlink)	dBm/ Carrier	+25		
Variation of Output Power w/ Input Level	dB	+0, -1.0 in either direction		
Passband Ripple Across Full Band	dB			2
Passband Ripple Across and 100 KHz segment	dB			0.1
Amplifier Input Port No Damage	dBm			-10
Propagation Delay	micro seconds			120
Intermodulation/ Crossmodulation Distortion at Full Output Power	dBc			-60
Channel to Channel Isolation	dBm			-70
Minimum High Band Signal to produce +25 dBm output to Radiating Antenna	dBm			-95

Cable				
Low Band Signal to produce full output	dBm			-90
AGC Control Range (Uplink & Downlink)	dB		80	
Duty Cycle	--	Continuous		
RF Spurious Output, less than 800 MHz, but greater than 1GHz	dBc			-60
RF Spurious Output for frequencies ranging from 800-1000 MHz	dBc			-85
System Noise Figure	dB		9	10
Input/ Output VSWR	--			1.35:1

11.1.2 Visual Indicators & Alarms

Product	Description	Type
Trunked Channel Card (TCC)	"Key" On: Enabled	Illuminators: Green LED
	"Lock" On: Channel Recognition	
Power Amp	On: indicates unit powered up	Illuminator: Green LED
TCC Alarm Output	Rear Panel; Open Collector Low: Channel Lock, Open Collector Hi: Channel Non-Recognition	Open Collector
Power Amp	Rear Panel; Input Hi: Disabled/ Low: Enabled	TTL Input w Internal Pullup Resistor

11.1.3 Mechanical Specifications

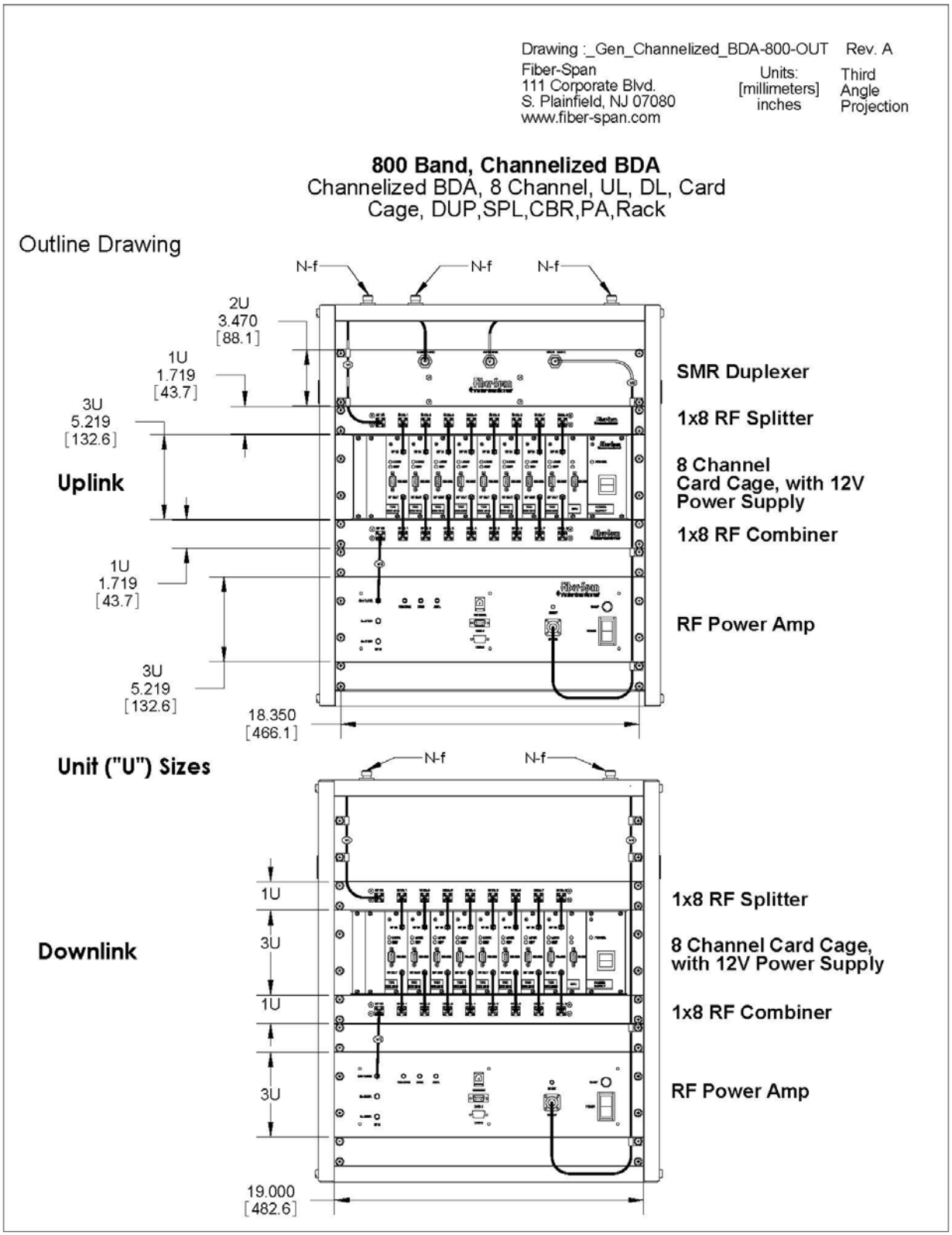
"U" Spacing: 1 Card Cage Cluster /w RF Power Amp	8U minimum Rack Space Required (RSR)
Dimensions inches/(mm): 1Downlink/ 1Uplink, 8 Ch-BDA	19(482.6)W x 31.5(800.1)H x 18(457.2)D
Weight (lbs/kg), Card Cage Cluster /w Power Amp	42/19
RF Connector Type(s)	Main External Connections: N-female, within Cluster of equipment SMA-female

VAC Input Power	95 – 132 VAC, 45-64 Hz
Power Amp AC Supply Protection	Fuse, 1A, 3AG, 250V, Slow-Blo
PA Cooling	Rear Exhaust Fan
Cluster Cooling	Air Convection

11.1.4 Environmental Specifications

Operational Temperature Range	-20 to +60 °C
Storage Temperature Range	-40 to +85 °C
Humidity	10 to 95% non-condensing

12 Outline Drawing



13 Troubleshooting

Problem 1: No RF Output Signal from the Power Amp.

Solution 1a: Confirm Input and Output RF cable into the Power Amp are not kinked or broken.

Solution 1b: Check the "Enable" alarm wire harness from the TCC Card Cage is wired to the rear of the Power Amp alarm input.

Problem 2: No RF signal level output from the RF Combiner.

Solution 2a: The RF Combiner has internal active components, confirm it is powered by +12 Volts from the Card Cage output voltage header in the rear panel.

Solution 2b: The RF Combiner has in-line external RF cable connections. The common port that goes into the Power Amp and 8 Input RF cable one for each channel path. Check and confirm the path in question has the RF cables properly secured , tested and are known to work properly. Each RF Combiner channel path can be independently tested. See Figure 6 for detail Test Point (TP) to assist in trouble shooting.

Problem 3: No RF Signal from the Trunked Channel Cards (TCC).

Solution 3a: Verify the TCC card has been inserted correctly in the track and is secured and keyed to the back panel header.

Solution 3b: Verify the Card Cage power supply is "On". The Power supply has a visual indicator to confirm it is On.

Solution 3c: See the Operational Manual FS51C-xx-SFT1, Run the program and read the channel frequency to confirm it is the correct corresponding frequency. If not the desired channel frequency, write the corresponding frequency. For additional information see the diagnostic software mentioned above.

13.1 **RF Level Measurements**

When the RF Levels are not meeting specifications, each section from within the Cluster can be diagnosed to determine the root cause of the failure.

RF test equipment is required to troubleshoot the Channelized BDA:

1. A signal generator used as a source.
2. A RF spectrum analyzer to view the RF output signal(s).
3. Optional Pad(s). Used when source RF levels cannot be adjusted to optimum levels or to prevent exceeding the RF input levels to the spectrum analyzer.

4. 3 RF cables (1 meter length), N-female to N-female. Match one end connector to the equipment you are using.

5. Software

13.2 **One-Channel (Path) Ch-BDA Block Diagram**

Figure 5 shows 1 Channel path mapping to assist problematic TCC card and the associated products within the Cluster and PA.

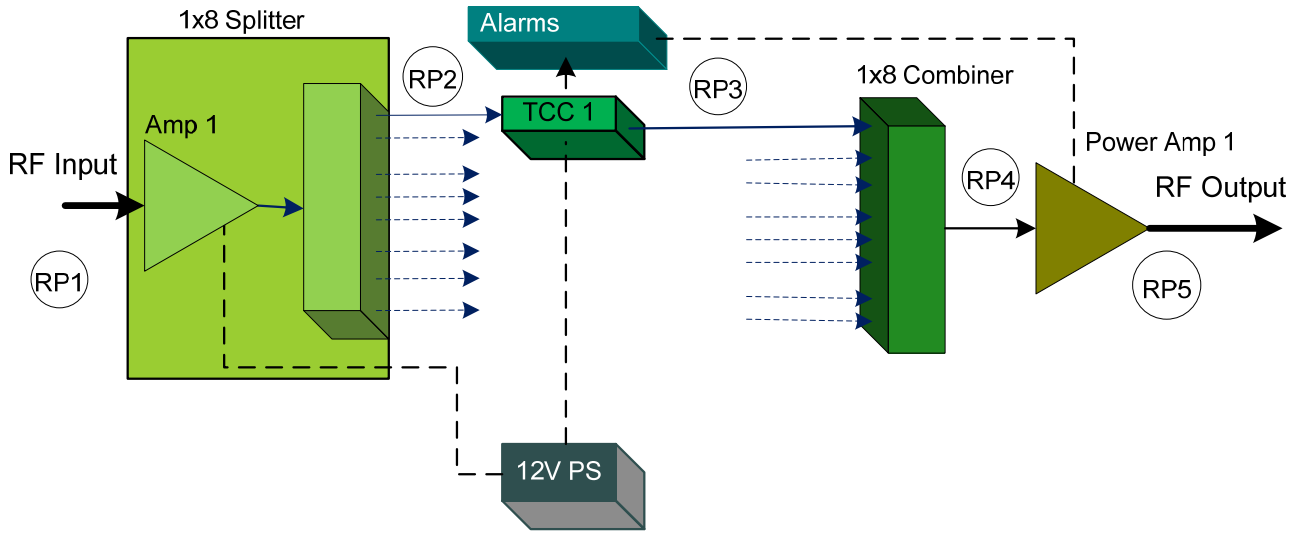


Figure 5

Reference Points	Description	RF Level(s) range	Units
(RP1)	Main RF Input to the Cluster RF Splitter. Confirm reference signal present.	-80 thru -20	dBm
(RP2)	RF Input to TCC Card 1.	-70 thru 0	dBm
(RP3)	RF Input to Combiner.	-38 +/- 2	dBm
(RP4)	RF Input to PA.	-25 +/- 2	dBm
(RP5)	Main RF Output of PA	30 +0/-1	dBm Composite

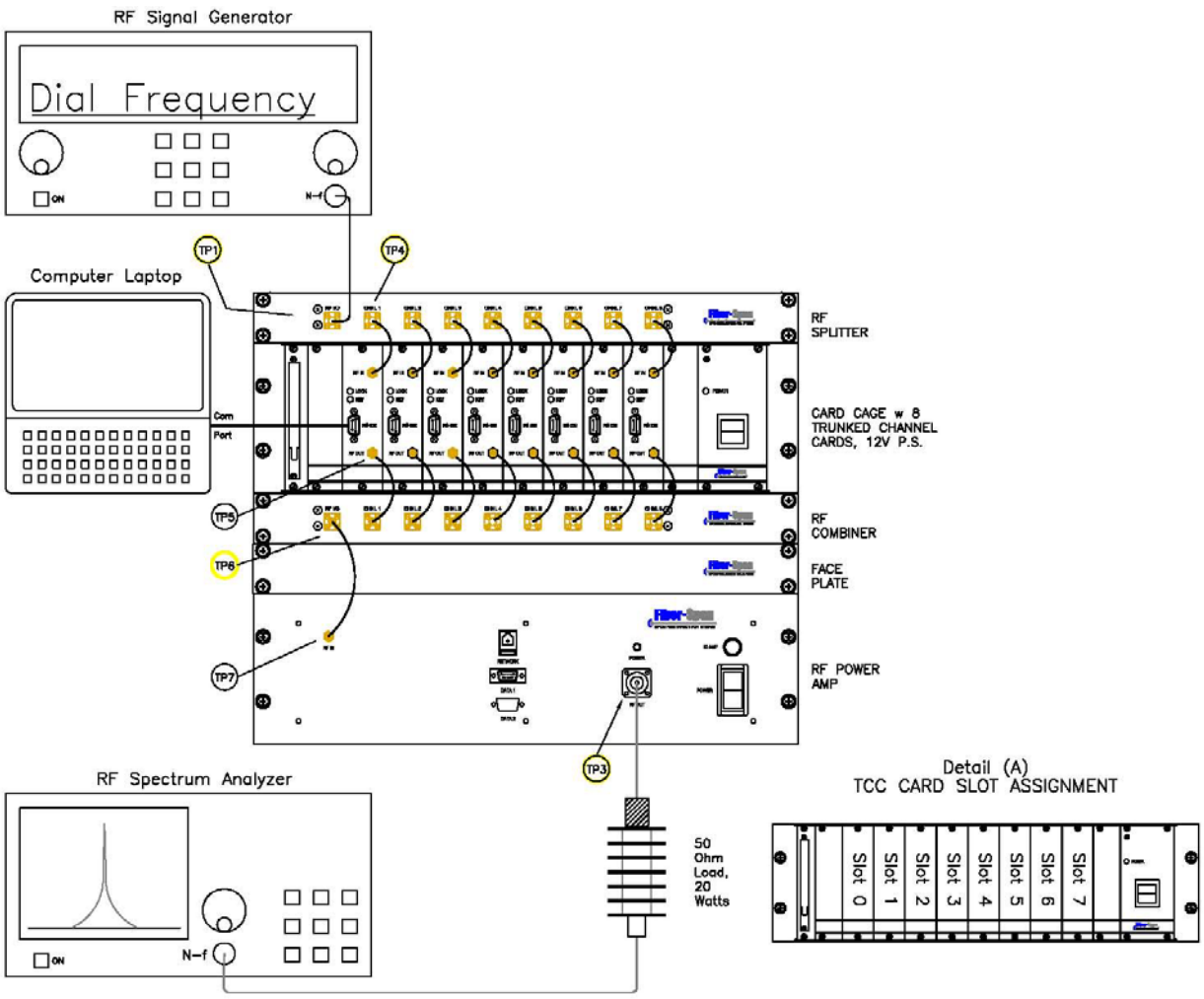


Figure 6

Figure 6 illustrates an 8 Channel BDA with the Test Equipment Setup (TES).

Most analyzers can accept a 20dBm composite RF input signal level. However, Fiber-Span recommends verifying the specifications of your analyzer prior to connecting it to the PA Output port.

Set the signal generator and spectrum analyzer to the center frequency of the downlink or uplink frequency spectrum.

Set the RF output level of the signal generator to -80dBm. Connect the Spectrum Analyzer to the “In-Line” 20dB PAD that connects to the PA Output; turn “On” the Spectrum Analyzer. Turn “On” the Device Under Test (DUT). Make sure the RF Splitter and RF Combiner are “On” and connected to the rear panel of the 3U Card Cage Power Header. Run the software, set the sensitivity to Key “On” at -80. See the FS51C-xx-SFT1, User Manual also included for additional instructions for setting the frequency and threshold values.

When all of the Cluster section functions properly, confirm all the RF cables are not faulty that interface and route the path in question.

14 FCC Required Statement

14.1 Manufacturer 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 his own expense.

This device has been designated to operate with the antennas having a maximum gain of [9] dBi for a 1 meter distance and antennas having a gain greater than [15] dBi are strictly prohibited for use with this device. The required antenna impedance is [50] ohms.”

Equipment manufacturers shall provide proper values of x and y to comply with the applicable RSS.

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

1. Reorient 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/TV technician for help.

15 Glossary

The following is a list of abbreviations and terms used throughout this document.

Abbreviation/Term Definition	Definition
AGC	Automatic Gain Control
ALC	Automatic Level Control
BA	Booster Amp
BB	Broad Band
BDA	Bi-Directional Amplifier
CA	Coverage Antenna
CBR	Combiner
CCC	Card Cage Cluster
DA	Donor Antenna
DAS	Distributed Antenna System
DL	Downlink
DUP	Duplexer
DUT	Device Under Test
GPS	Global Positioning System
HW	Hardware
IF	Intermediate Frequency
LNA	Low Noise Amp
LO	Local Oscillator
MC	Micro Controller
OPM	Operational Product Manual
PA	Power Amp
PLL	Phase Locked Loop
PS	Power Supply
RF	Radio Frequency
RSR	Rack Space Required
RSSI	Receive Signal Strength Indicator
SPL	Splitter
SW	Software
TCC	Trunked Channel Cards
TCO	Time Clock Oscillator
TES	Test Equipment Setup
TP	Test Point
UL	Uplink
V	Volts
VSWR	Voltage Standing Wave Ratio

16 Warranty Information

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

16.1 Warranty Limitations

The warranty is limited to the repair or replacement of the defective product. Fiber-Span will decide which remedy to provide for defective components at 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 the 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.

16.2 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.

16.3 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 908-754-0646.