Installation and Operating Manual

BDA-PS8NEPS-20/20-70-M
BDA-PS8-20/20-70-M
BDA-PS7W-20/20-70-M
BDA-PS9-20/20-70-M

Single Band Mini Bi-Directional Amplifier

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SAFETY OPERATION INSTRUCTIONS

BEFORE USE

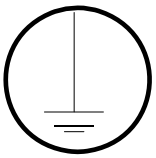
Review this manual and insure that all conditions are compatible with the amplifier's specifications. Safe operation may be impaired if this equipment is not used as intended.

GENERAL DESCRIPTION

This symbol is marked in the manual and denotes important safety operation instructions. Please read carefully before continuing.

This equipment is suitable for a wide variety of scientific, industrial, laboratory and communication applications where high levels of electromagnetic Radio Frequency (RF) energy are required. Therefore, the output of the amplifier must be terminated to an appropriate load, such as a high power attenuator, dummy load, a communication or radiation antenna. User must insure that radiated energy do not violate regulatory levels of electromagnetic interference.

PROTECTIVE GROUND



This symbol is marked on the equipment and denotes protective ground terminal.

This amplifier includes protective ground terminal. The equipment shouldn't be used if this protection is impaired. The supplied power cord must be used along with an uninterrupted external power source.

HAZARDOUS LINE AND RF VOLTAGES

This symbol is marked on the equipment where dangerous voltages are present. Use extreme caution.

Both RF input and output connectors should be terminated prior to the application of the external AC source. Otherwise, contact with the RF output center pin can be dangerous. Place the amplifier in the OFF position prior to connecting and disconnecting RF output load.

ELECTROSTATIC DISCHARGE (ESD)

This symbol is marked on the equipment where ESD sensitive devices are present. Do not handle without the proper protection.

MAINTENANCE

Maintenance, repair and calibration must be performed by qualified personnel only. Contact with the internal amplifier components maybe dangerous even when the equipment is in the OFF position.

CAUTION

This denotes a condition that may cause damage to the Amplifier if procedure is not correctly performed. Do not proceed until the indicated conditions are met.

FORCED AIR COOLING

Do not block the inlet and outlet of the internal cooling blowers. Otherwise damage may result to the amplifier.

OVERVIEW

The BDA assembly extends the coverage area of radio communications in buildings and RF shielded environments. The BDA has dual RF paths to extend coverage in two distinct frequency bands.

The unit features low noise figure and wide dynamic range. It is based on a duplexed path configuration with sharp out of band attenuation allowing improved isolation between the receiving and transmitting paths.

FCC NOTE

This is a Class B device. The product has been tested and found to comply with the Booster requirements per FCC Part 90.

The BDA-PS9-20/20-70-M BDA has been tested and found to comply with the Booster requirements per FCC Part 90 and Part 24.

IC NOTE

The product has been tested and found to comply with the Industry Canada (IC) RF Exposure Requirements, pursuant to IC RSS-131.
https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/cpc2105e.pdf/$FILE/cpc2105e.pdf

NOTE

The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.

RF EXPOSURE WARNING

An antenna must be installed so as to provide a minimum separation distance of at least 7.87 inch (20 cm) between the indoor antenna connected to the RF booster and the human user's body within the area. This assumes a typical wide-beam type antenna with gain of 0-2 dBi, VSWR ≤ 2:1, Zo= 50 ohms.
Use of unauthorized.antennas,cables and/or coupling devices not conforming with ERP/EIRP are not allowed.

GENERAL OPERATIONAL DESCRIPTION

The BDA Downlink path receives RF signals from the base station and amplifies and transmits them to the subscriber. The BDA Uplink path receives RF signals from the subscriber and amplifies and transmits them to the base station. The Uplink and Downlink occupy two distinct frequency bands. See table on page 6 for list of bands and corresponding band codes. Frequencies applicable to your unit will also be on unit's specification sheet.

The diplexer isolates the paths and route each signal to the proper amplifying channel.

An Automatic Level Control (ALC) allows for output power limiting. A variable step attenuator gives 0 – 30 dB of attenuation in 2 dB steps. The use of these controls is covered in the "OPERATION" section, later in this document.

The Mini-BDA can be used as a line amplifier. With an optional external bias-tee, the Mini-BDA will function with power coming from the In-building antenna.

Table 1

CODE	UPLINK BAND	DOWNLINK BAND
BDA-PS7W-20/20-70-M (US)	788-805 MHz	758-775 MHz
BDA-PS7W-20/20-70-M BDA-PS7-20/20-70-M (Canada)	798-806 MHz	768-776 MHz
BDA-PS8NEPS-20/20-70-M (US)	806-816 MHz	851-861 MHz
BDA-PS8-20/20-70-M BDA-NPSPAC-20/20-70-M BDA-SMR-0.15/0.15W-35-E BDA-SMR-0.5/0.5W-70-A (Canada)	806-824 MHz	851-869 MHz
BDA-PS9-20/20-70-M (US & Canada)	896-902 MHz	935-941 MHz

ELECTRICAL SPECIFICATIONS

Specifications	***Typical***
Frequency Range	See Table 1
Pass band Gain @ min attenuation	70 dB
Maximum RF Input Signal Level	-30 dBm
Variable Step Attenuator Range (2 dB steps)	0-30 dB
Pass band Ripple	±1.5 dB
Noise Figure @+25 °C at max gain	5.0 dB
IP3 [dBm] @ 2 Tones +17 dBm ***Uplink***	+37 dBm
Downlink	+37 dBm
Composite Output Power (Single Channel) ***Uplink***	+20 dBm
Downlink	+20 dBm
Isolation between Up/Down Link	+25 dBm
Input/ Output Impedance	105 dB (Min.)
VSWR (Input/Output)	50 Ohms
Power Supply	1.5: 1 (Max)
	110VAC/0.56Amp 240VAC/0.28 Amp 50 to 60 Hz Autoranging

MECHANICAL SPECIFICATIONS:

Size	: 10 x 6.2 x 3.0 inch
RF Connectors	: N-type Female
Weight	: 4.6 Lbs. approx.

**Note: May vary per unit, see spec for more accurate information specific to your SKU

ENVIRONMENTAL CONDITIONS

The unit is designed for indoor applications:

Operating temperature: - 30°C to +55°C
Storage temperature: - 50°C to +90°C

Standard Indoor BDA's are designed to operate in an indoor environment, within typical operating temperature range of -30°C to +55°C, with normal airflow on heat dissipation surfaces of the systems. The AC power supply should be conditioned for normal indoor appliance applications.

Standard Indoor BDA's are NOT designed for outdoor applications where the ambient temperature is outside the recommended range or inside an additional enclosure. This will prevent normal airflow on heat dissipation surfaces of the systems, damaging Amplifiers and the Main Power Supply.

Standard Indoor BDA's are NOT designed for the use with unstable power sources, i.e.: generators. Should these units fail due to conditions not within specified parameters, the warranty will void.

G-Wave may supply BDA's with additional protection designed for outdoor applications upon request

AVAILABLE, OPTIONAL FEATURES

The following options are available, (please review the specification provided with the unit, to verify the features included in your BDA)

- **Visual Alarms**

All G-Wave systems include local visual alarms as a standard. Local visual alarms are LED lights located in the unit that indicate various failures. For a list of corresponding alarms, please see Variable Gain Adjustment and LED Indicators.

- **DC28**

Powered DC Only @ + 28 VDC

- **ACSP**

AC Surge Protection and DC Line Conditioning (Required if powered by generator)

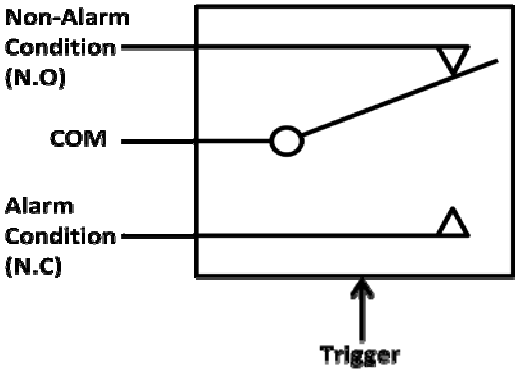
- **RM9**

9-Pin connector to enable remote alarming via dry contact. Alarms include: Uplink Amplifier Failure, Downlink Amplifier Failure, Uplink ALC, Downlink ALC.

ALARM CONDITIONS

The alarm monitors the current of both the uplink and downlink amplifiers. An alarm condition will occur if either the uplink or downlink amplifiers are over or under its current tolerance.

Additionally, each failure/alarm/indicator from the available features may be monitored via an audible alarm dry contact connector, 3 contacts per each alarm .The following diagram shows a Non Alarm condition. If an alarm occurs the trigger will switch the position of the relay, a short will be between COM and N.C.



(Relay Shown in Non-Alarm

BDA CONNECTIONS

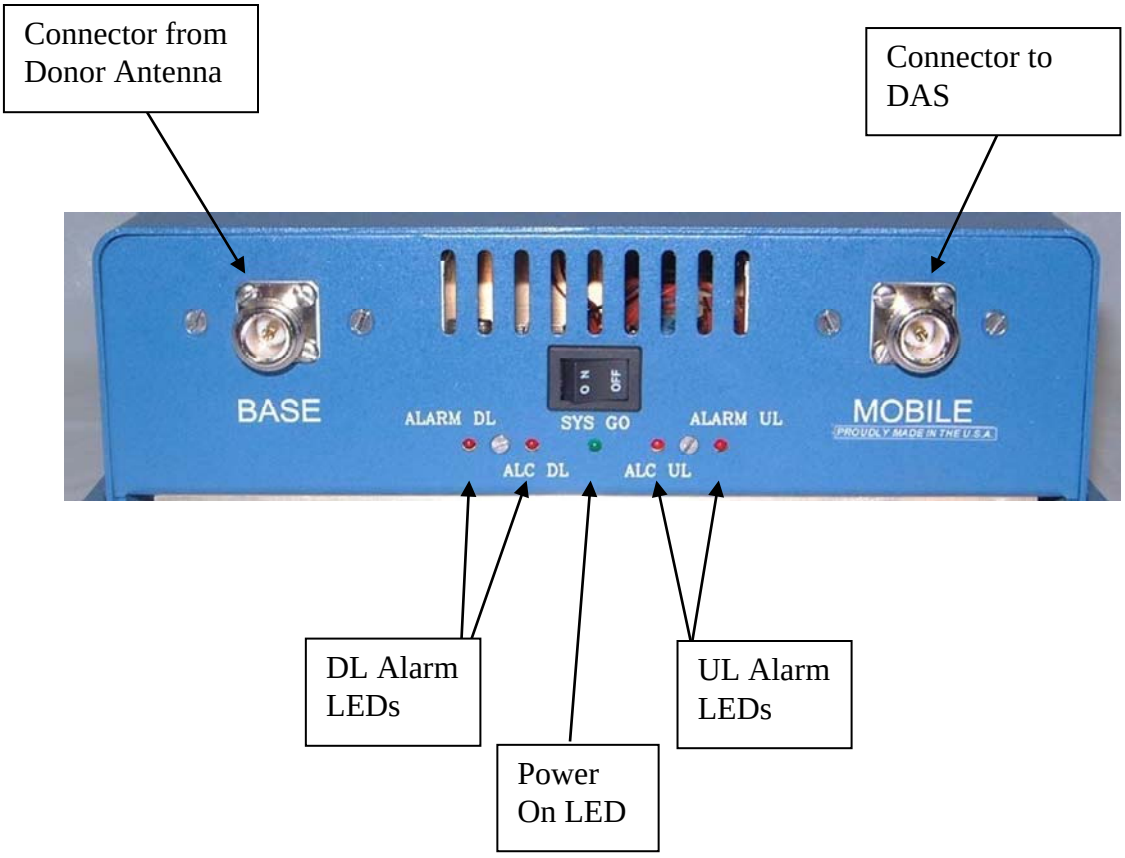
The BDA uses an external power supply which connects through a single pin 15V DC input located on the back of the unit.

A optional 9-pin D-Sub connector provides failure alarm output contacts.

The RF connections are made via two type “N” female connectors. The RF connector labeled “BASE” must be connected to the antenna pointing towards the base station. The RF connection labeled “MOBILE” must be connected to the antenna facing the area to be covered by the BDA.

The RF connections must be made through cables with characteristic impedance of 50 ohms.

The isolation between the base station antenna and the mobile antenna should be at least <u>15 dB higher than the BDA gain.</u> Isolation less than this value can cause gain ripple across the band. Isolation equal to or less than the BDA gain will give rise to oscillations which will saturate the amplifiers and possibly cause damage to the BDA.



BDA INSTALLATION

DO NOT APPLY A.C. POWER TO THE BDA UNTIL CABLES ARE CONNECTED TO BOTH PORTS OF THE BDA AND THE ANTENNAS.

1. Mount the BDA on the wall with the RF connectors pointing DOWN. Using appropriate screws and anchors, attach the BDA to the wall at the four mounting holes on the side flanges.

2. Ensure that the isolation between the donor antenna and the service antenna is at least 15 dB greater than the BDA gain. **(Use the higher of the Uplink and Downlink gains reported on the BDA test data sheet).**

3. Connect the cable from the donor antenna to the BDA connector labeled "BASE" and the cable from the service antennas to the BDA connector labeled "MOBILE".

4. Verify that both of the attenuator's are positioned to its maximum setting (30 dB) on the unit's front panel.

5. Connect the power cord to the BDA and then to the power source. Verify that the "Power ON" lamp is illuminated.

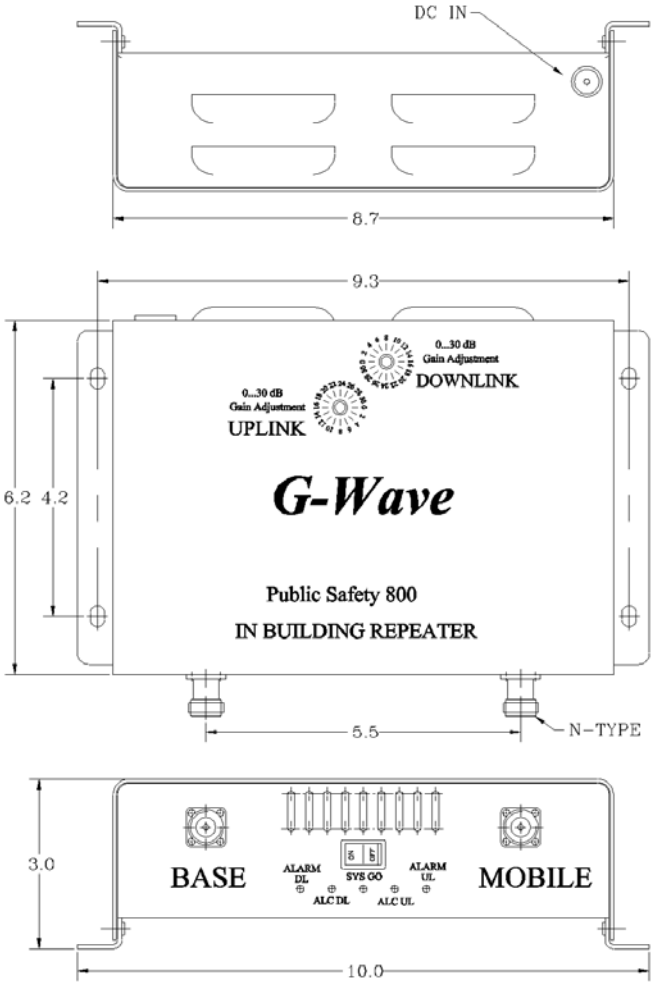
Installation of the BDA is now complete. To adjust the gain controls to suit the specific signal environment, refer to the next section (Operation) of the manual.

Note: For repeat installations of existing equipment, make sure the attenuation is positioned to its maximum setting (30 dB). After verification of the attenuation, follow the above steps starting with step 1.

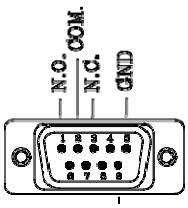
WARNING. This is NOT a CONSUMER device. It is designed for installation by FCC LICENSEES and QUALIFIED INSTALLERS. You MUST have an FCC LICENSE or express consent of an FCC Licensee to operate this device. You MUST register Class B signal boosters (as defined in 47 CFR 90.219) online at www.fcc.gov/signal-boosters/registration. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of $100,000 for each continuing violation.

WARNING. This is NOT a CONSUMER device. It is designed for installation by an installer approved by an ISED licensee. You MUST have and ISED LICENSE or the express consent of and ISED licensee to operate this device.

MECHANICAL OUTLINE



Alarm/Optional
Power Supply Pinout
(Relay States Refer To
NON Alarm Condition)



BDA OPERATION

ALC (Automatic Level Control)

To minimize intermodulation products, each amplifier in the BDA contains an ALC feedback loop. The ALC circuit senses the output power and limits it to the factory preset level as specified on each product specification.

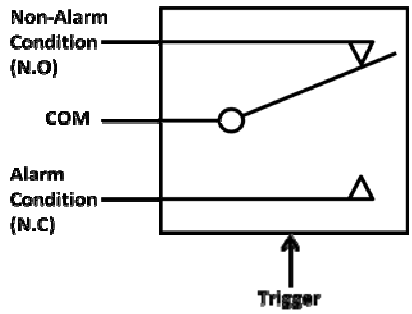
Each amplifier in the BDA contains an ALC feedback loop. The ALC circuit senses the output power and limits it to the factory preset level. A red indicator lamp is located on the interior panel of the BDA and illuminates when the output power exceeds the ALC set point.

To establish proper operating gain on the Uplink and Downlink paths, start with the Downlink. Observe the red indicator lamp on the Uplink amplifier. Units are shipped with maximum attenuation. Decrease attenuation one step at a time until the [DOWNLINK ALC] led is lit. Then, using the Downlink step attenuator, increase the attenuation until the LED turns off. Repeat the process for the Uplink. The level indicator is accurate to +/- 0.4 dB of the ALC set point. If a test radio is unavailable during commissioning to test the actual Uplink power, a safe rule of thumb on Uplink adjustment is to set the gain 10 dB lower than the Downlink path.

Operation of the BDA at maximum gain with greater than -30 dBm average power incident on either BASE or MOBILE port can cause damage to the BDA.

Figure 2a

Conditions for ALC Alarm The alarm monitors current of both uplink and downlink amplifiers. An alarm condition will occur if either uplink or downlink amplifiers are over its current tolerance/ ALC limitation.	**Conditions for Uplink/Downlink Alarm** These alarms monitor the status of the corresponding amplifier path. If either of these LEDs are on, and no other alarm LED are, this is an indication of amplifier failure, please contact G-Wave for an RMA.
Conditions for Donor Alarm The alarm monitors the connection of the BDA to the donor antenna. An alarm condition will occur if there is a disconnect at the donor antenna. Donor LED, UL/DL Amplifier LED will indicate and all amplifiers will shut down.	**Conditions for Mobile Alarm** The alarm monitors mobile antenna conditions to the VSWR. In the event a mobile antenna fails, this will generate reflected power to the amplifier. Mobile Alarm and Amplifier UL will indicate.

Conditions for DC Backup Alarm The alarm monitors the AC power. If the AC power fails and DC is connected, the DC Alarm LED will indicate DC power is drawn.	 (Relay Shown in Non-Alarm Condition)

VARIABLE STEP ATTENUATOR

BDA gain can be reduced by up to 30 dB in 2 dB steps using the variable step attenuator. Gain adjustment is made with rotary switches accessible via the access door of the BDA enclosure. Arrows on the shafts of these switches point to the value of attenuation selected. BDA gain can be determined by subtracting the attenuation value from the gain reported on the BDA Test Data Sheet for that side of the unit. The attenuators are labeled for Uplink and Downlink. (Figure 3a)

LEDs and Fault Alarms

ALARM LEDs

FAILURE	DL ALARM	UL ALARM	DONOR	EXTERNAL DC	ODSC*	MOBILE*
DONOR ANTENNA FAILURE	●	●	●			
DOWNLINK AMPLFIER FAILURE	●					
UPLINK AMPLFIER FAILURE		●				
EXTERNAL DC POWER IN USE				●		
*OSCILLATION DETECT	●	●			●	
*MOBILE ANTENNA FAILURE	●	●				●

*Oscillation Detect (ODSC) and MOBILE are optional features that may be populated into the O26 pin-out. These alarm contacts are not included as a standard and must be requested at time of order.

*G-WAVE amplifiers are shipped from the factory with 30 dB of attenuation dialed in. Units are **not** shipped with full gain to ensure input signal does not overdrive the ALC limitation of the unit.*

If the attenuation rotary switch is dialed to 30 – This indicates the unit has 30 dB of attenuation and is running on minimum gain potential of the system.

To add gain back to the system, dial back the rotary switch, slowly, (28, 26, 24, 22…) until the Downlink ALC LED turns on. This indicates the unit has reached maximum output power (per unit's specification).

*At this point, dial one step of attenuation back into the unit to turn the Downlink ALC LED **off**. At this point the Downlink path of the system has been commissioned.*

Repeat the above procedure on the Uplink path.

Warning!
Input Signal Level greater than -30 dBm may cause damage to the system.

LED INDICATOR DESCRIPTIONS AND FIELD TESTING

Alarm LED	Description	In Field Test
AC Power	Illuminates when the AC voltage is supplied, the unit is ON, and the AC/DC power supply is operating.	Disconnect AC Power Cable LED will turn off.
DL Alarm	Illuminates when the DL amplifier fails.	Disconnect Donor Antenna
UL Alarm	Illuminates when the UL amplifier fails.	Disconnect Donor Antenna
DL ALC	Illuminates when DL composite power reaches the ALC set.	Part of Commissioning Procedure. Enough Gain is required to reach ALC set limit.
UL ALC	Illuminates when UL composite power reaches the ALC set.	Part of Commissioning Procedure. Enough Gain is required to reach ALC set limit. **Rule of Thumb:** Dial 5 to 10 dB attenuation greater than DL set.
External DC **(Available if S1 Feature is selected)**	Illuminates when the BDA is operating from a DC source.	Disconnect AC Power cable while unit is connected to External DC Power Source.

DIAGNOSTICS GUIDE

The BDA provides long term, care-free operation and requires no periodic maintenance. There are no user-serviceable components inside the BDA. This section covers possible problems that may be related to the installation or operating environment.

Gain Reduction

Possible causes: Bad RF cables and RF connections to antennas, damaged antennas.

Occasional Drop-out of some Channels

Possible causes: One channel with very strong power dominates the RF output of the amplifier.

ANTENNA SEPERATION

BDA oscillation is caused by low isolation (antenna separation) between donor antenna and service antennas. The recommended isolation between those antennas is 15db above the system gain. The amount of isolation that can be achieved between antennas depends on several factors, such as the physical vertical and horizontal separation (distance between the antennas), polarization, radiation pattern of the antennas, the medium between the antennas, antenna gain etc.

Antenna isolation can most accurately be determined through on-site measurements An antenna isolation measurement configuration is illustrated in Figure 6, where two spatially separated antennas (service antenna #1 and donor antenna #2) are connected to a signal generator and signal analyzer.

A signal at center frequency is generated by the signal generator sent to the input of antenna 1; the output of the signal at antenna 2 is measured and recorded by the signal analyzer. With calibrated connection cables, by taking into account the cable loss, the difference of signal power level at the output of antenna 2 and that at the antenna 1 input is taken as antenna isolation.

(See Appendix 2 for analytical calculation)

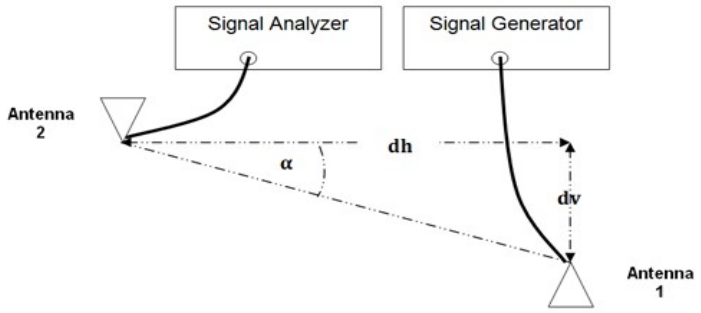


Figure 6

APPENDIX 1

Conditions for Donor Alarm (26-pin)

This functionality applies only for a Donor antenna with a DC short. Alarm monitors the connection of the BDA to the donor antenna. An alarm condition will occur if there is a disconnect at the donor antenna. Uplink and Downlink amplifiers will shut down. Donor Alarm, Current DL, and Current UL will indicate.

Test for DC short between male pin and outer shell of antenna connectors

Figure 7a

If the donor antenna does not short please connect G-Wave's special Donor Short Simulator.

Please note, if you intend to use other components (i.e. Lightning Protector) between the base port and donor antenna make sure they have an open short.

N Type Female/Female Donor Short Simulator

N Type Male/Female Donor Short Simulator

Figure 7b

Conditions for DC Backup Alarm

The alarm monitors the AC power. If the AC power fails and DC is connected, the DC Alarm LED will indicate DC power.

Conditions for Mobile Alarm *OPTIONAL

The alarm monitors mobile antenna conditions to the VSWR. In poor conditions, Mobile Alarm and Current UL will indicate.

APPENDIX 2

Analytical Calculation of Antenna Separation

The horizontal I_h and vertical I_v space antenna isolation for a scenario as in Figure 6 can be computed analytically, using the following equations:

$$I_h[db] = 22 + 20\log\left(\frac{dh \cdot f}{3 \cdot 10^8}\right) - GTx - GRx$$

*Under assumptions of far field condition)

$$I_v[db] = 28 + 40\log\left(\frac{dv \cdot f}{3 \cdot 10^8}\right) - GTx - GRx$$

$$I_{slant}\,[db] = (I_v - I_h) \cdot \frac{\alpha}{90°} + I_h$$

Antenna Separation variable definitions:

I_h [dB]	isolation between horizontally separated transmitter and receiver antennas
dh [m]	the horizontal distance from the centre of interferer antenna to that of the interfered with receiver antenna
dv [m]	the vertical distance from the interferer antenna to the interfered with receiver antenna, (measured from radiation center-to-radiation center)
f [Hz]	the wavelength of the interfered with system frequency band
GTx [dBi]	gain of the transmitter antenna
GRx [dBi]	gain of the receiver antenna
I_v [dB]	Isolation between vertically separated transmitter and receiver antennas.
α[°]	$\arctan(\frac{dv}{dh})$