Bi-Directional Amplifier Systems
Installation and Operation Manual

Model Series 850622

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1. BDA Functions

1.1 EMR Bi-Directional Amplifier Functions

EMR Bi-Directional Amplifier (BDA) systems, provide effective, reliable RF communications coverage in areas that would otherwise suffer intermittent communications or none at all. Lack of coverage is typically a result of absorption or reflection of RF signals due to terrain shielding, building materials, or free space path loss. EMR BDA systems allow for seamless, un-translated communications between RF repeaters and portable/mobile radios into areas shielded from adequate RF coverage ensuring personnel reliant on portable radio coverage can communicate effectively and without interruption.

The BDA system provides two way (uplink and downlink) filtering and amplification of RF signals in buildings, tunnels, or areas that are shaded from adequate RF signal coverage. In addition to the repeater, other devices needed for a distribution system include transmission line, power splitters, hybrid couplers, directional couplers, and indoor antennas. The use of radiating cable can be recommended for applications involving tunnels and long corridors. The choice of distribution method depends on the nature of the structure in which signal enhancement is required. Standard units have a maximum 1.5 MHz passband when transmit to receive offset is at least 5 MHz. Custom passbands are available.

EMR BDA systems are stand-alone units encased in a NEMA 4 enclosure to provide a degree of protection against environmental elements such as dust and water. The BDA operates on 115 VAC. Other options for power include 220 VAC, 13.6 VDC and battery backup. Instructions on installing the EMR battery backup option (Model UPS/BATT4, not included unless ordered) are outlined in this manual.

Figure 1.1 is a functional block diagram of a standard BDA feeding a coaxial DAS showing all major components. Figure 1.2 is a functional block diagram showing the BDA Fiber Head-End Unit.

As an option, a RF over Fiber (RFoF) transceiver unit may be installed to carry RF signal via fiber optic cable over long distances to a remote Fiber System Head End. As shown in Figure 1.2, the downlink and uplink signals of the repeaters are routed to the local RFoF unit which connects via fiber to the BDA containing the remote RFoF unit. The input/output of the RFoF unit connects to the downlink/uplink section of the BDA, respectively.
1.1. EMR BI-DIRECTIONAL AMPLIFIER FUNCTIONS  SECTION 1. BDA FUNCTIONS

**Figure 1.1:** Block Diagram: EMR Standard BDA System.

*Optional step attenuators installed at UL/DL amplifier input for attenuating signal.*

**Figure 1.2:** Block Diagram: EMR Model BDA Fiber Head-End Unit.

*Preinstalled step attenuator at DL amplifier output for attenuating power to Fiber MUX.*

**Optional step attenuator at UL amplifier input for attenuating signal.*
2. BDA Installation

2.1 BDA Installation

Installation of the BDA system involves attaching the BDA unit with suitable fasteners to a wall or panel, connecting the outside (donor) antenna to the Source N connector, the DAS to the Distribution N connector and applying power to the unit. Mechanical specifications and the location of the BDA must be taken into consideration before proceeding with the installation.

2.2 NEMA 4 Enclosure

EMR BDA units are mounted within an enclosure designed to house electrical and/or electronic equipment. This provides a degree of protection with respect to harmful effects on the equipment due to dust and the ingress of water (rain, sleet, snow, splashing water, and hose directed water).

The enclosure is NEMA 4 rated for indoor/outdoor use with 16 gauge continuous seam welded steel construction. Base and door bonding studs are built in for grounding. Keyed latch and hinge cover allow for a water-resistant seal. External mounting brackets are included for mounting the box to a wall or panel without having to remove the cover exposing the internal components to the environment.

![Figure 2.1: BDA location of mounting tabs.](a) Front view. (b) Back view.

2.3 BDA Mounting Location

There are several criteria that should be considered when evaluating where to mount the BDA system.
2.4 Mounting the BDA

Mounting hardware is not included with EMR BDA’s. It is recommended using 3/8" diameter steel bolts, flat washers, and a lock washer under the nut.

It is strongly suggested that the technician consult with a local building inspector, architect, or engineering consultant for advice on how to properly mount objects of this particular size, type, and weight.

2.5 BDA RF Input/Output Connections

Two N female bulkhead connectors are located on the bottom of the NEMA 4 enclosure. One is labeled “Source” and the other “Distribution”. Source will be routed to the roof mounted antenna while Distribution is routed to the DAS and Service Antennas. The cable for this application should be a high quality double-shielded RF coaxial cable. Radiating cable should never be connected directly to either BDA N Female connection ports, nor should radiating cable for the DAS be used within 50 feet of the BDA head-end. Flexible, double-shielded, high-quality coaxial jumper cables are acceptable for connecting to more rigid cable sections.
2.6 Supplying Power to the BDA

Only after the BDA is properly mounted and connected to both 50 Ohm Source and Distribution is power to be applied to the BDA. EMR BDA units are designed to be connected to 115/220 VAC (unless requested otherwise), single phase, 50–60 Hz and comes equipped with a power cord. An LED on the front of the power supply provides indication that the unit is functioning normally when AC power is supplied and the LED is lit.

2.6.1 Battery Backup Option

For units ordered with the DC input option: The BDA is wired with the "13.6 VDC IN" port mounted at the bottom of the NEMA enclosure. A connector is supplied for the customer to solder the +/- of the DC power. This connector then plugs into the DC in Port.

![Battery backup connector assembly](image1)

**Figure 2.2:** Battery backup connector assembly.

![BDA bottom view: Battery backup power input connector](image2)

**Figure 2.3:** BDA bottom view: Battery backup power input connector.
3. BDA Description

3.1 Description of BDA Components

Internal component specifications of EMR BDA systems vary depending on their application. All specifications are subject to change without notice provided the changes or modifications do not affect product performance.

3.1.1 Description of Master Amplifier

The EMR RF Power Amplifier Module is designed for use in class B bi-directional system applications and is suitable for use in both analog and digital modulation schemes. These units use a rugged high performance integrated MOSFET RF transistor for maximum reliability. Typical amplifier gain is 75 dB, with a maximum output of +37 dBm at which point the amplifier will go into Power Control. Power Control provides up to 30 dB of gain reduction to protect the PA from damage due to high input signal levels.

![Master Amplifier](image)

*Figure 3.1: Master Amplifier*

3.1.2 Description of Multi-Pole RF Filters

The RF filters utilized in EMR class B bi-directional systems are each multi-pole bandpass and pass notch filter assemblies. The filter configurations are designed to meet several requirements necessary to ensure reliable communications are attained when installed in a bi-directional system. Specifically, the filters need to provide low insertion loss (in order to maximize system gain) while providing high attenuation (to prevent oscillation between the uplink and downlink amplifiers within the bi-directional system).
3.1. Description of Step Attenuator

In a BDA system, a step attenuator can provide protection to the uplink amplifier from high RF signal levels and protection to the downlink amplifier from the source.

A step attenuator is required and comes pre-installed in BDA systems containing an RFoF unit as a means to attenuate the UL/DL signal levels to protect both the BDA and RFoF unit.

Step attenuators are an optional upgrade in standard BDA systems and may be preinstalled in the BDA system upon request.
3.2 Description of BDA Optional Upgrades

A variety of optional upgrades are available for EMR BDA systems. These vary widely on the application and are subject to change based on components involved in the BDA system.

3.2.1 Description of Battery Backup Option

The EMR Battery Backup (Model UPS/BATT4) is an optional upgrade that allows the unit to operate on 12 volt battery power. If AC power is lost the BDA will continue to operate until the battery charge is depleted.

If the unit is equipped with the EMR battery backup option, the battery and filtered battery charger are supplied in a separate NEMA housing. A cable is supplied to connect the battery power from the Battery Backup NEMA housing to the BDA NEMA housing.

![Battery Backup Unit and Battery Backup Cable](image)

(a) Battery Backup Unit.  (b) Battery Backup Cable.

**Figure 3.4:** Model UPS/BATT4.

3.2.2 Description of BDA Power Monitor Option

The EMR BDAMON02 Series BDA Power Monitor is an optional upgrade consisting of a microprocessor controlled unit which monitors power supply, primary AC voltage, battery DC voltage, DC current, and door status alarm for up to four RF amplifiers installed in any EMR signal enhancement system. Monitoring features available vary based on the relevant hardware configuration of the BDA. The BDAMON interface is accessed via a web browser and IP/DNS configurable for remote access and messaging for up to 5 email addresses.
The BDAMON02 unit comes pre-installed in the BDA system when ordered as an upgrade. When the BDA system is plugged into a reliable power source the power indicators on the monitor unit will light/glow. An ethernet cable is connected to the ethernet port located at the base of the BDA enclosure to connect the unit to the internet. The door alarm switch triggers an audible and LED alarm as the door opens. The time of opening is recorded and a notification message sent to configured email or SNMP trap. Once triggered, the alarm must be reset from the web interface or reset button on the front of the monitoring unit before the door is closed.
4. BDA Setup

4.1 BDA System Gain Setting

Standard EMR BDA systems ship with system gain fixed between 60 and 65 dB while high gain versions allow for gain adjustment in the field. In variable gain units, if deciding to increase gain above the factory gain setting, remember that the antenna decoupling measured between the Donor Antenna and the Service Antennas must be taken into consideration. As a reminder, the minimum target antenna decoupling is 15 dB more than the BDA system gain setting.

![Diagram](image1)

**Figure 4.1:** Typical test equipment configuration to set BDA Downlink gain.

![Diagram](image2)

**Figure 4.2:** Typical test equipment configuration to set BDA Uplink gain.

Prior to adjusting system gain, it is important to take into consideration the signal level coming from the repeater(s) and the portables. Since the BDA is in power control at -28 dBm, the maximum input signal level into the BDA should never exceed -15 dBm. Greater than 0 dBm in may result in damage to the BDA.

It is important to note that increasing gain above factory setting risks oscillation between the uplink and downlink amplifiers. Doing so could result in generating excess noise causing reduced system coverage and/or damaging the BDA. It is strongly recommended that gain not be increased from factory setting.
4.2 Setting Attenuation

Before the installation of the BDA, signal levels should be checked to confirm that they will not exceed the recommended input levels. If recommended levels are exceeded, attenuation must be applied to the input of the respected uplink and/or downlink amplifier.

A step attenuator comes pre-installed in the BDA containing the Fiber-to-RF unit for attenuating the Uplink signal level to protect the RF-to-Fiber unit.

![Diagram of BDA setup showing step attenuator](image)

**Figure 4.3:** Unit shown is the remote RFoF BDA to coaxial DAS. Step attenuator is preinstalled at UL amplifier output for attenuating power to a Fiber MUX unit with optional step attenuator for attenuating DL signal.

![Diagram of optional step attenuator installation](image)

**Figure 4.4:** Optional step attenuator installation at UL/DL amplifier input for attenuating signal.

4.3 Testing Antenna Decoupling

To prevent feedback and subsequent system oscillation it is crucial to test the system for decoupling between the Donor Antenna and the Service Antennas. As a rule of thumb, there should be at least 15 dB more decoupling between the Donor Antenna and any of the Service Antennas than there is gain in the BDA. If this lower limit is not met, the system may generate unwanted noise and the very real possibility of damage to the BDA.

The following is a suggested list of equipment to adequately test antenna decoupling:
4.4. BASE LINE PERFORMANCE SURVEY

- A calibrated signal generator which can provide a minimum signal level of 0 dBm and operate at the frequencies of interest.
- A calibrated Spectrum Analyzer that can accurately measure signal levels as low as -100 dBm at the frequencies of interest.

![Diagram of test equipment configuration](image)

**Figure 4.5:** Typical test equipment configuration for measuring antenna decoupling.

As seen in Fig 4.5, generate a signal using the signal generator to the donor at 0dBm, then with the spectrum analyzer to measure the decoupling.

Example: 62 dB (System Gain of BDA) + 15 dB = 77 dB. The measured signal should read at least -77 dBm.

4.4 Base Line Performance Survey

Once the BDA and DAS are installed it is good practice to test and document the performance of the newly installed BDA system for future reference. This will make future expansion and troubleshooting of the system much easier. Such tests are often performed by using two of the portable radios that would normally access the system and documenting the location within the building as well as the DAQ, or signal level in dBm for each point tested.
A. Appendix

A.1 Warranty Information

EMR Corporation, hereinafter called EMR, warrants that all equipment of its manufacture shall be free from defects in design, material, and workmanship for a period of 5 years from date of shipment unless otherwise covered by special warranty.

If any such product, entirely or in part, fails to produce the performance as set forth in the brochure, quotations, or literature provided by EMR, such product will be replaced or repaired at EMR’s expense provided that the failure was not the result of alteration, misuse, tampering, misapplication, shipping damage or vandalism. If a product failure is found to be the fault of EMR, the cost of transportation to the EMR factory and its return will be borne by EMR. A reasonable charge for travel and subsistence costs will be invoiced when on-site repairs by EMR personnel is necessary.

Should EMR supply components not of its own manufacture, but specified by a customer, the warranty shall reflect the original manufacturers warranty only.

EMR is not liable for damage caused by lightning or other natural disasters.

It is understood that this statement constitutes EMR’s entire and only warranty, there being no other warranties expressed or implied in law, or in fact, including implied warranties of fitness.

In no event shall EMR be liable for damages, installation costs, or expenses, of any nature, resulting from the purchase or use of EMR products; whether or not they are used in accordance with instructions. This warranty is in lieu of all other warranties either direct or implied including any implied warranty or merchantability of fitness.

A.1.1 Unpacking

All claims for damage or loss in transit must be made promptly by the buyer against the carrier (typically within 1-5 days of receipt of the product). All claims for shortages must be made within 30 days of the shipment date of all materials from EMR Corporation.