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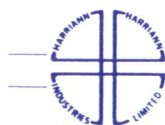
Issue Date: July 1993

TECHNICAL MANUAL

for

VLF/LF Active Vertical Antenna

Model AVA-3



HARRIANN INDUSTRIES LIMITED

telecommunications equipment

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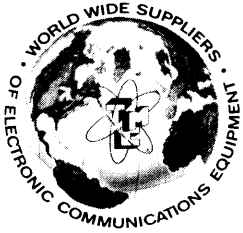
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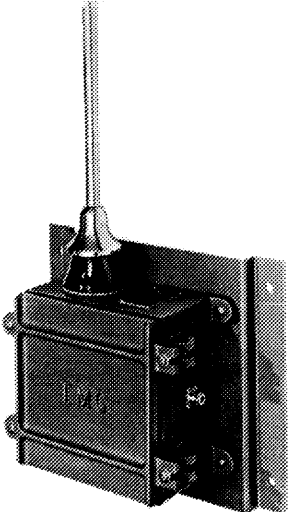
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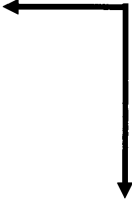
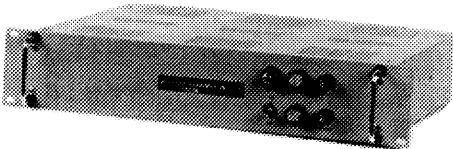
THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS

Model AVA-3 Active Vertical Antenna

VLf/LF ANTENNA (VAA-1)



POWER SUPPLY (PSP-11)



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Section 1 - General Description

1.1 Functional Description

The AVA-3 Active Vertical Antenna System is essentially an interconnection of two elemental subsystems: 1) an active vertical whip optimized for the 10-~~200~~ kHz LF region; and 2) a single-output coaxial power supply that provides operating voltages for the active whip over the RF input line.

1.1.1 LF Antennas

1.1.1.1 Model Designation

The model number assigned to the AVA-3 antenna/mast assembly is VAA-1.

1.1.1.2 Overview

The antenna assemblies are vertical receiving whips that are used in installations where a convenient broadband device is needed to provide a suitable mast for reception and an impedance match to a monitor receiver operating over a wide receiving range in the 10-~~200~~ kHz VLF/LF spectrum.

1.1.1.3 Physical Characteristics

The VAA-1 assembly is a vertical receiving antenna with an internal pre-amplifier, impedance matching device and low pass filter. It is designed to operate with any receiving device in the 10-~~200~~ kHz frequency range. The VAA-1 E-field mast is a 16-foot telescoping vertical constructed in three sections of seamless aluminum tubing. Since each section telescopes into the section supporting it, the overall length of the mast can be reduced from 16 feet to approximately six (6) feet in the field. In this manner the mast can be adjusted to the optimum length for the frequency of operation. As an alternative, stainless steel and fixed-length fiberglass antennas are available.

1.1.1.4 Component Assemblies

The VAA-1 antenna assembly consists of four sub-assemblies: the vertical monopole mast mounted directly on a machined post at the top of a cast aluminum case; an internal broadband matching network; a low-pass filter that suppresses out-of-band spurious from broadcast transmitters, etc.; and an RF pre-amplifier with optional overload sense control. The matching network, preamplifier and filter are all housed in the case that is weatherproofed for added protection against severe environmental conditions. A dessicant is used to keep condensed moisture inside the case at a minimum. Note that in the event of a power failure, the preamplifier is automatically bypassed so that communications can be maintained with minimal interruption of service.

1.1.1.5 Preamp Module

The preamplifier is a suggested, conservatively-rated linear network which delivers a nominal 20dB gain throughout the operating frequency range of 10-~~200~~ kHz. It is a broadband unit that accepts input from the receiving antenna and provides a 50-ohm unbalanced output to an associated receiving device. It has a wide dynamic range and low noise characteristic over this range.

NOTE: ANY FREQUENCY RANGE BETWEEN 10 MHz & 30 MHz CAN BE ORDERED. THIS UNIT IS 10 - ~~200~~ MHz AS USED BY D.O.I.

1.1.1.6 Bypass Module

The antenna assembly can be optionally equipped with an RF overload module that is used to detect high-energy fields from the antenna. This module is particularly useful in transmitter-receiver systems that utilize a common antenna. The module acts to by-pass the preamplifier circuits and prevent damage co-located transmitters.

1.1.1.7 Matching Network and Filter

The matching network used to couple the antenna to the preamplifier assembly has a frequency response which is flat within +/-1.0dB over the operating range. However, it is important to remember that impedance matching over such a wide frequency range, using a fixed-length antenna, is of necessity a compromise. In this case, the optimum match is provided at the approximate mid-point of the frequency band and the efficiency on either side of this point may vary. The low-pass filter provides attenuation of such out-of-band spurious as is found in areas where high-power broadcast-band transmitters are operating. This attenuation serves to lower the background noise floor and provide an improved signal-to-noise ratio in a narrower bandwidth.

1.1.1.8 Input/Output Characteristics

The input and output characteristic impedance is 50 ohms, with a VSWR better than 1.5-to-1. Optionally, 70 ohms impedance can be provided. A change in the characteristic impedance of the antenna will not adversely affect the operation of the preamplifier which provides a nominal 20dB gain across the frequency range.

1.1.1.9 RF Terminations

Input/output connectors, other than the N-type normally installed, may be substituted depending on the interconnect required at the receiving site. A wide range of terminating connectors are available including BNC, C and UHF.

1.1.2 System Power Supply

1.1.2.1 Model Designation

The dual-output power supply and regulator used to provide operating voltages for the VAA-1 antenna assemblies is assigned the model number PSP-11.

1.1.2.2 Overview

The power supply converts a 115/230-volt AC line voltage at 47-63Hz into a regulated (-)24-volt DC supply voltage which is passed to the VAA-1 assembly via the coaxial antenna line. All components used in the power supply are solid state.

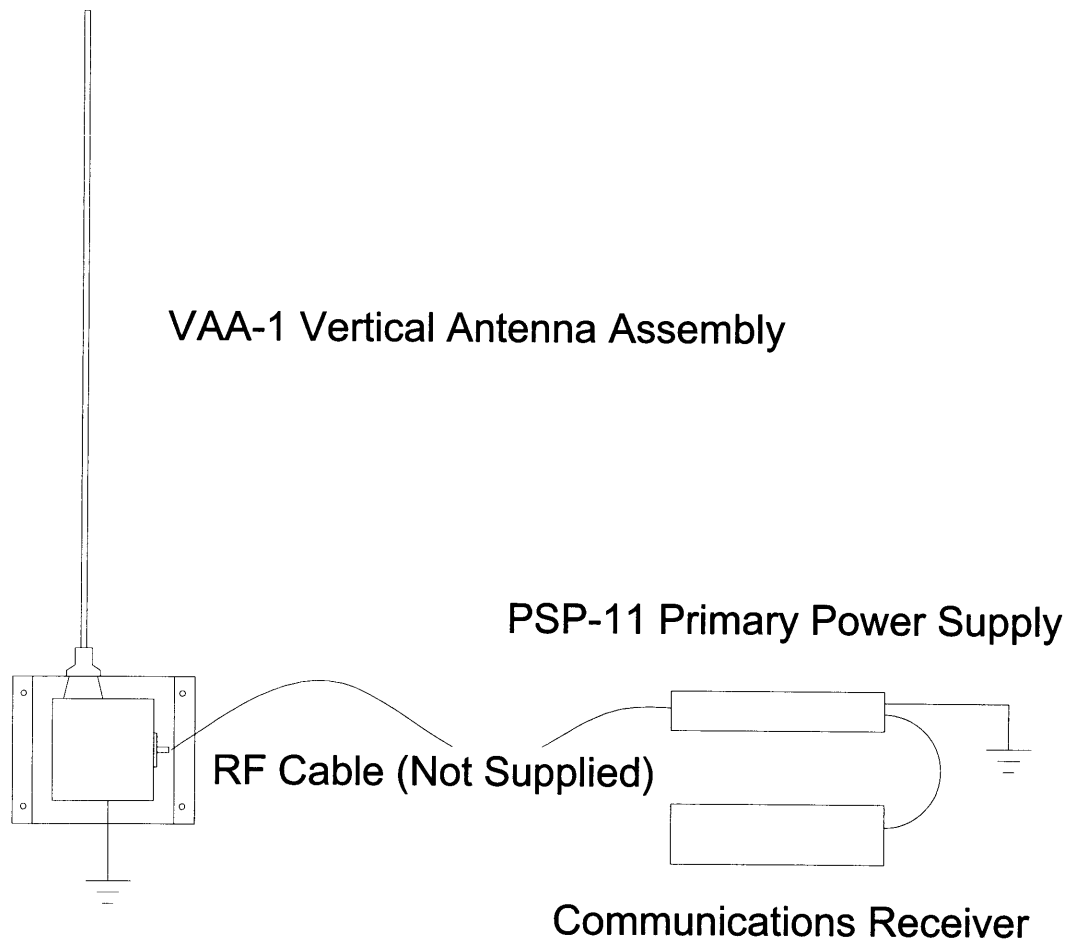


Figure 1.1 Typical Installation

1.2 Physical Description

1.2.1 PSP-11 Layout

The PSP-11 power supply both mount to a standard 19-inch rack. The operating controls are located on the front panel. The input connector, output connectors and primary power socket are mounted on the rear panel. All electronic components are mounted on printed circuit boards or in the case of larger power supply components, strapped down and securely fastened to an anodized aluminum chassis.

1.2.2 VAA-1 Case Layout (Internal)

The preamplifier, matching/filter network and optional overload control mount internally to a standard TMC cast-aluminum alloy case. There are no operating controls on any VAA-1 assembly, all of which are pre-set at the factory for optimum performance. The optional RF overload control module is mounted adjacent to the preamplifier assembly in the same case. The RF input connector is mounted on a plate securely attached to the side of the case. All circuits are mounted on printed circuit boards which are in turn securely fastened to the individual modules. Grounding is provided through the modules to the case which in turn is provided with an external ground lug. An internal spark gap assembly is provides protection of the multicoupler and personnel from lightning hazards.

1.2.3 VAA-1 Mast Layout

The antenna can be a 16-foot free-standing fiberglass, aluminum or stainless steel whip. The aluminum and stainless-steel antennas are telescopic (one section is inserted into the larger section supporting it) and the fiberglass antennas are in sections that screw securely together.

1.2.4 VAA-1 Antenna Mounting

The antenna is mounted directly to an insulated post on top of the cast aluminum case. Due to the placement of the input connector, the case may be mounted vertically (upright) to a horizontal plate for roof-top mounting, vertically to a pole using straps or vertically to a bulkhead using the mounting bolts provided.

1.2.5 Semiconductor Complement

A list of the semiconductors used in the AVA-3 are listed in Table 1.1.

Table 1.1 - Semiconductor Complement

PSP-11 Power Supply and Regulator	
Rectifier Bridge	NW10005
Bias Regulator	1N2986

1.3 Technical Specifications

Low Frequency (LF) Range 10KHz-200kHz; low-pass filtering is provided.

Input/Output Impedance Nominal 50 ohms, unbalanced. N-type connectors

Insertion Gain Nominal +20dB over operating range.

Frequency Response +/-1.0dB

Offband Rejection Greater than -60dB, DC to 10KHz

Noise Figure Less than +7dB, nominally +5dB.

Phase Differential +/-1 degree maximum, output-output

Desensitization For a 0.4-volt peak input, 10% removed from the operating frequency, a 100 microvolt received signal drops less than 3dB.

Intermodulation Distortion For 50-ohm units: Second order is greater than -60dB for a 0.4-volt input; Third order is greater than -65dB.

VSWR Input is better than 1.5-to-1.

Mean-Time-Between-Failure Nominal 50,000 hours (RADC reliability tables).

Cooling Convection, no fans or moving parts

Ambient Conditions -20oC to +50oC; Up to 95% R.H. Storage -40oC to +80oC

Primary Power 115VAC standard/230VAC optional, 48-400Hz, single phase. PSP-11 is a coaxial power supply that provides -24VDC operating voltage to the preamplifiers located at the base of the LF antenna assembly.

Power Consumption VAA-1 (10watts), PSP-11 (20 watts)

Antenna Mast	16-foot	32-foot	35-foot
Fiberglass	2.0 lbs	n/a	65 lbs
Aluminum	2.5 lbs	55 lbs	n/a
Stainless Steel	4.0 lbs	85 lbs	n/a

Size and Weight

VAA-1	Case: 9H x 11.5W x 5.5D inches Antenna: 2.0 dia inches x 16L feet (6'-4" collapsed)
PSP-11	3.5H x 19W x 7D inches, 4lbs (1.8kg)

Line Filters Greater than 40dB attenuation, 14kHz-150MHz.

Special Features

Monitoring Indicating fuseholders display status of primary power circuits. An optional LED indicator is provided when overload RF triggers the preamplifier bypass circuits, removing the VAA-1 preamplifier from the receive RF path.

Safety Fuse and front-end overload protection, preventing circuit failure from high RF voltages at the input. High voltage points are covered and labelled.

Components and Construction Totally solid state circuits mounted to an aluminum alloy chassis. External hardware is stainless steel. Track slides are optional and due to weight distribution, are usually not required.

Antenna Case Mounting Bulkhead or rooftop mount using 13 x 16-inch flanged plate. Optional pole mount direct to case.

1.4 AVA Product Group

AVA-1	LF/HF Active Receiving Antenna
AVA-1-4 [8/16/32]	LF/HF Active Receiving Antenna, 4, 8, 16 or 32-output
AVA-2	MF/HF Active Receiving Antenna
AVA-2-4 [8/16/32]	MF/HF Active Receiving Antenna, 4, 8, 16 or 32-output
AVA-3	VLF/LF Active Receiving Antenna
AVA-3-4 [8/16/32]	VLF/LF Active Receiving Antenna, 4, 8, 16 or 32-output
AVA-4-2X4 [8/16]	Dual-Input VLF/HF Active Receiving Antenna, 2Xn-output
AVA-5	VHF/UHF Active Receiving Antenna
AVA-5-8	VHF/UHF Active Receiving Antenna, 8-output

Input RF Filter Options: (excluding AVA-5 series)

Note: z=5 for 50-ohm operation; z=7 for 70-ohm operation.

/zF2	Low pass filter (fc=2MHz)
/zF4	Broadcast stopband filter (fo=1MHz)
/zF5	HF Bandpass filter, 2-32MHz
/zF6	LF Bandpass filter, 300-600KHz
/zF7	HF High pass filter (fc=2MHz)

Additional Options:

/A	Internal attenuator to reduce gain
/C	C-type coaxial output connectors
/N	N-type coaxial output connectors (standard)
/P	Coaxial power supply, Model PSP-11 (standard)
/T	RF overload transfer control
/U	UHF-type coaxial output connectors

When ordering, specify both model and option. Example: AVA-3/NP

Section 2 - Installation

2.1 Initial Inspection

2.1.1 General

Every AVA-3 undergoes a thorough testing and calibration prior to shipment. Upon receipt of the system, check each packing case and its contents for obvious damage. Unpack the equipment carefully to reduce the risk of damage and to avoid misplacing any parts shipped as loose items.

2.1.2 Damage By Carrier

With respect to equipment damage for which the carrier is liable, TMC will assist in describing methods of repair as well as furnishing replacement parts.

2.2 Loose Items Supplied

The following list itemizes those loose items supplied with the AVA-4 system.

Technical Manual	AVA-3	1 each	210325
Power Cable Assembly	PSP-11	1 each	CA555-4
RF Mating Connectors (For RG-8 coaxial cable)	PSP->VAA	2 each	UG 21B/U
Split Washer		4 each	LW537MSS
Plate Mounting Unit		1 each	MS543
Brackets for Mounting Unit		4 each	MS619
Lag Bolts		16 each	SC111-2
Machine Bolts		4 each	SCHH3716
Antenna Post		1 each	PO215

2.3 Mechanical Installation

The VAA antenna assembly is designed for mounting on a wall, roof, pole or vehicle. For pole mounting, two straps are required; the necessary lag bolts are provided as loose items. For vertical plane mounting or horizontal plane mounting, a universal mounting plate is provided. This is the configuration provided for in the standard VAA mount. Figures 2.1 and 2.2 depict installation details and outline dimensions, respectively, and should be studied to determine the best mounting for the desired location of the antenna.

Vertical Orientation

Horizontal Orientation

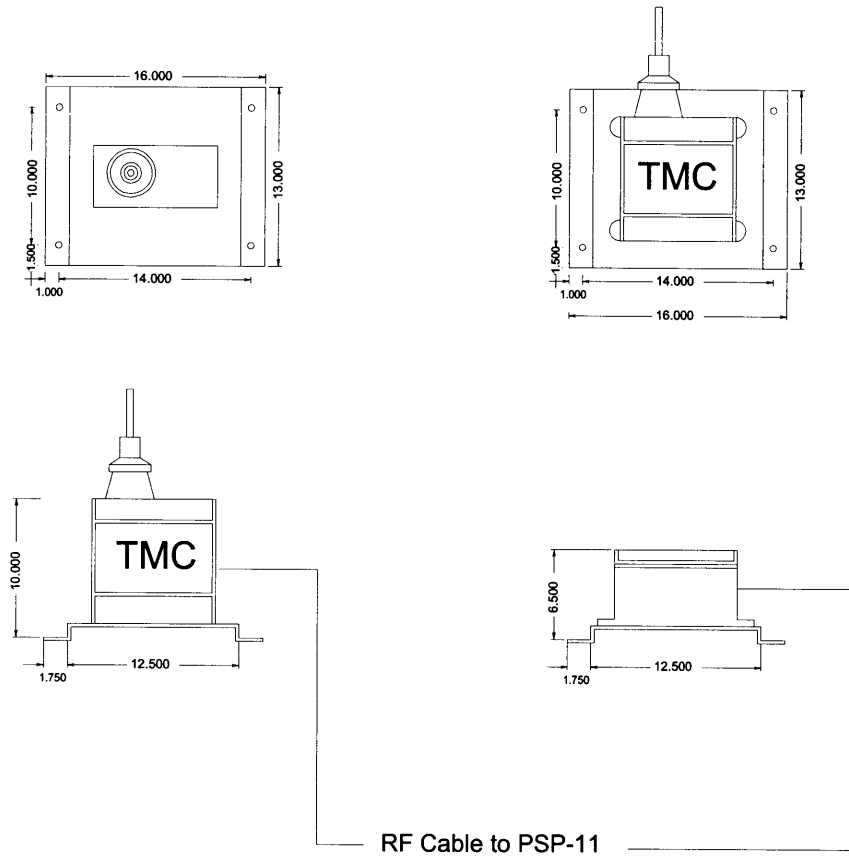


Figure 2.1 VAA-1 Antenna Installation

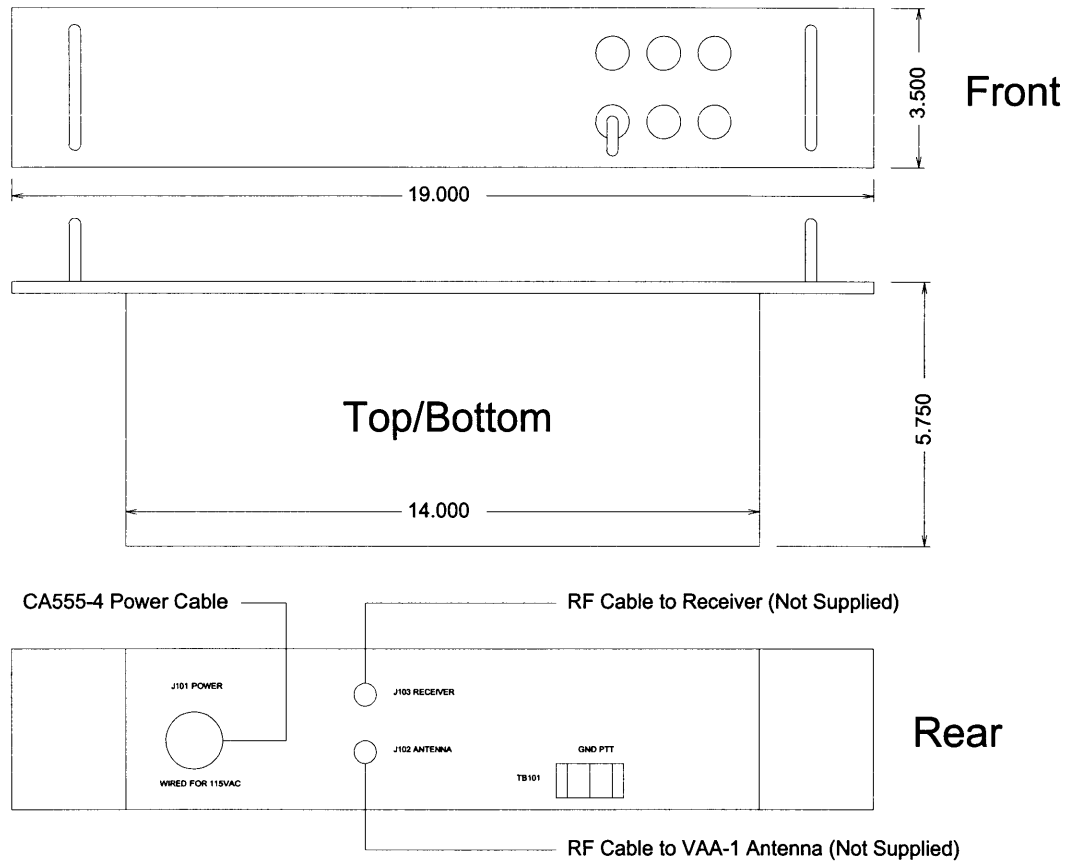


Figure 2.2 PSP-11 Power Supply Installation

2.4 Electrical Installation

2.4.1 Primary Power

The PSP-11 operates from a 115VAC, 48 to 400Hz power source. Optionally, the unit may be wired for 230VAC, which will be noted by a decal on the rear panel adjacent to the input power connector. Primary power is applied to the PSP-11 through connector J101 on the rear panel. The correct power cables are provided as loose items. See Figure 2.2 for a diagram of the electrical interconnections.

2.4.2 External Connections

Antenna

The LF antenna cables are fitted with N-type connectors to mate properly with the RF input jack on the PSP-11 unit. The N-type connector on the cable mates to J105 on the PSP-11. All jacks are located on the rear panel of the respective units.

Power

Connect primary power by plugging the supplied power cable assembly into POWER connector J101 on the rear panel of the PSP-13. Ensure that the plug is properly oriented with the socket; use the keyway as a guide.

Power Supply (RF) Outputs

Connect the RF coaxial outputs of the PSP-11 power supply to the RF coaxial cable terminated with N-type mating connectors (supplied as loose items). This cable is connected to J104 for the LF antenna. The cable terminate at the input connector on the VAA-1 antenna assembly. Mating connectors are also provided as loose items for the VAA end of the coaxial cable (supplied by the customer). All RF connections to the PSP-11 are made on the rear panel.

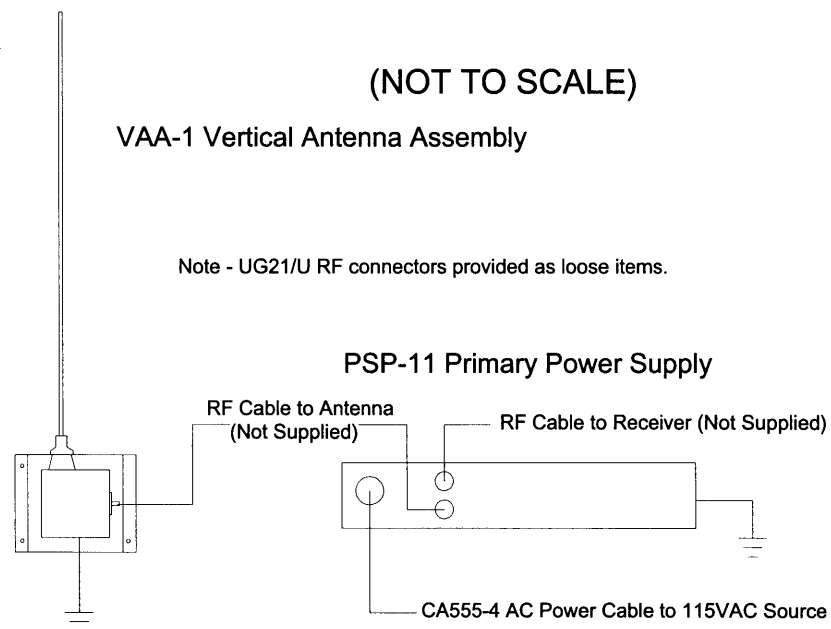


Figure 2.3 AVA-3 Interconnect Cabling

2.4.3 PSP Requirements

The PSP-11 power supply should be located in such a way that sufficient clearance is obtained at the rear of the unit for making all RF and AC power connections. The front panel controls should also be within easy reach of an operator. The solid state design of the unit reduces heat problems, allowing "stacking" of units, one above the other, in the same rack. Good installation practice dictates that to reduce the possibility of failure from heat-related stresses, the units should have at least one A-panel (1.75 inch) vertical spacing between them to allow dissipation of heat.

2.4.4 VAA Requirement

The antenna is extended or attached in sections, depending on the model selected. The fiberglass sections are screwed together while the aluminum and stainless sections are extended and secured by turning the bushings located along its length. Once extended, the antenna rod must be inserted onto the antenna post located on the top of the antenna case. Align the holes at the base of the rod with the holes on the post. Anchor the antenna with the bolts provided by inserting the bolts in the holes at right angles to each other. This procedure provides both mechanical and electrical connections.

2.4.5 Grounding

Connect the VAA outer case to a good physical ground, preferably a simple counter-poise or at least one eight-foot, copper ground rod imbedded in moist earth. The connector assembly on the side of the case is normally the best location to attach this ground. The PSP unit is grounded through the anodized aluminum chassis to the station grounding system.

2.5 Performance Check

2.5.1 PSP-11 Power Supply

When the appropriate power and RF connections have been made to the PSP-11, turn POWER ON by toggling the front-panel switch 1S1. The POWER lamp will light, indicating that the PSP-11 is operating and voltages are supplied to the VAA-1 antenna assembly. No further checks are required.

2.5.2 VAA-1 Antenna

When the appropriate electrical connections have been made to the VAA-1 antenna, it is fully operational and ready for immediate operation. Since all components are fixed, no adjustments are needed and no further checks are required.

Section 3 - Operation

3.1 Controls and Indicators

Table 3.1 contains a list of the operating controls and indicators that are located on the front panel of the PSP-11 power supply unit.

Table 3.1 Controls and Indicators

Power ON/OFF switch	Controls primary power application
POWER lamps	Lights when primary power is applied and switch is turned ON.
FUSE holder/indicator	Indicates failure of fuse by illumination of the fuseholder.
SPARE fuse	Two spare fuses are contained in spare fuseholders located on the front panel.
TRANSMIT indicator (Optional)	An LED indicator is provided on the front panel of the PSP-13. It fires when high RF is detected at the antenna or the PTT line is grounded. The RF overload control circuit is triggered to remove the VAA networks from the received RF signal path.

3.2 Procedures

After connecting the antenna cables, communication receivers and power supply, and turning on the POWER switch, no further operating procedures are required. The AVA-3 is now fully operational without further adjustment.

Section 4 - Principles of Operation

4.1 General

4.1.1 Capabilities

The AVA-3 VLF/LF Active Receiving Antenna is a broadband monopole antenna system designed to couple one antenna operating the VLF/LF region to the antenna input of a communications receiver operating in that region.

4.1.2 Input/Output

Both the input and the output impedance of the system is a nominal 50 ohms. The standing wave ratio characteristic is better than 1.5-to-1 the frequency range.

4.1.3 Salient Performance Features

The AVA-3 provides a nominal insertion gain of 2-dB from the antenna input to the connected receiver. The complete system is designed to ensure minimum noise generation while providing a high degree of intermodulation rejection. The Technical Specifications listed in the previous section outline these characteristics in detail.

4.2 VAA-1 Antenna Assembly

4.2.1 Capabilities

The VAA-1 consists of a receiving RF preamplifier, a matching/filter network and an E-field probe. The preamplifier provides a nominal +20dB gain between the antenna and the receiving device at 50 ohms characteristic impedance. The standing wave ratio is typically better than 1.5-to-1.

4.2.2 Location and Features

The preamplifier is mounted on a printed circuit card which is securely fastened to a tin-plated steel module. It is a low-noise, wideband device with a 50-ohm impedance and a nominal voltage gain of +20dB. Figure 2.1 depicts its location in the mounting case. The module along with the matching/filter network are sealed in a cast aluminum case.

4.2.3 Power Distribution

Operating voltage for the preamplifier module is derived from the PSP-11, an optional -24vdc regulated power supply located at the receiver cabinet. The DC voltage is heavily decoupled to prevent distortion from the rectified power supply.

4.3 PSP-11 Power Supply

4.3.1 Location and Features

The components comprising the power supply are all chassis mounted to a standard 19-inch rack panel. Optionally, the PSP-11 can be mounted in a smaller module for customized fitting to a primary chassis or cabinet.

4.3.2 Circuit Analysis

Primary power is supplied directly to the main power ON/OFF switch. When this switch is in the ON position, power is supplied through two fuses F1/F2 to the power transformer T1 and the front panel indicator lamp DS101. The secondary of transformer T1 produces 29vac, which is full-wave rectified by bridge rectifier CR101, and filtered by capacitors C101 and C102. The -28vdc output is regulated by a 28-volt Zener and fed to a decoupling circuit. This latter circuit is designed to present a direct short to any RF coming from the antenna and to prevent any low-frequency power supply hum from entering the RF path to the antenna. The incoming RF at J102 is shunted directly to the receiver via J103 through C104.

Section 5 - Maintenance

5.1 General

5.1.1 Test Equipment Required

This section describes preventive maintenance, trouble-shooting and repair procedures for the AVA-3. The following equipment is suggested in order to perform these procedures properly:

- Function Generator, HP Model 3312A or equal
- Oscilloscope, HP Model 54501A or equal
- Digital Multimeter, HP Model 3468A or equal

5.1.2 Component Location

For aid in the location of components, refer to Section 6.

5.2 Preventive Maintenance

5.2.1 General Cleaning Methods

Preventive Maintenance for the AVA-3 consists of such routine functions as visual inspection and cleaning. Periodic cleaning is recommended as dust may build up on components, reducing efficiency and possibly causing circuit failure. To facilitate cleaning, use a vacuum cleaner or a low-pressure filtered compressed-air supply.

5.2.2 Visual Check and Adjustment

A simple visual check when either the power supply or the antenna assembly is opened for servicing or cleaning will often reveal potential trouble spots. Signs of trouble may be found in discoloration, warped printed circuit cards and damaged wiring or cabling. Any deteriorating component should be replaced. All hardware must be checked for tightness during inspections.

5.2.3 Dessicant Replacement or Restoration

The dessicant package held in place inside the VAA-1 case by a flexible metal strap should be changed every six months. If this is not possible, the bag should be removed from the case and dried in an oven for one hour at a temperature of 250oF to remove residual moisture.

5.3 Troubleshooting

5.3.1 General Failure Symptoms

During operation of the AVA-3, the following failure symptoms may be observed:

- No signal output from a connected receiver
- Weak or noisy signal from a connected receiver

5.3.2 Fault Localization

The primary objective of the troubleshooting procedure is to localize the fault to a particular section of the coupler unit. Table 5 provides a guide to locating and correcting the possible failures.

Table 5.1 Troubleshooting Procedures

Symptom: No signal output from a connected receiver

Possible Cause:	Receiver failure
Remedial Action:	Refer to receiver manual
Possible Cause:	Interconnect cable - power supply to receiver
Remedial Action:	Check RF cable between receiver and power supply Check RF cable between power supply and antenna Look for short (ground to center conductor) and repair
Possible Cause:	Power supply failure
Remedial Action:	If POWER ON lamp 1DS1 is not illuminated, check for power input failure. If POWER ON lamp is on, check indicating fuses 1F1/1F2 and replace with spare if necessary. If both fuses are intact, proceed to check transformer 1T1, bridge rectifier 1Z1 and voltage regulator 1A1. -29vDC should be available on the regulator board.
Possible Cause:	Failure of input preamplifier
Remedial Action:	If DC is present at the output of the regulator and at the preamplifier, possible failure of a component in the preamplifier or failure of the input antenna circuit is indicated. For repair of the preamplifier, removal and testing of module 1A2 or 1A3 is necessary.

Symptom: Weak or noisy signal from a connected receiver

Possible Cause:	Receiver noise
Remedial Action:	Refer to receiver manual
Possible Cause:	Noise on system ground
Remedial Action:	The AVA-3 is grounded at the antenna (VAA-1) and the power supply (PSP-11). Determine which ground is noisier and isolate that unit so that the second ground becomes a single system ground point.

5.4 Repair

Repair work generally consists of replacing the defective component. The following cautions should be observed:

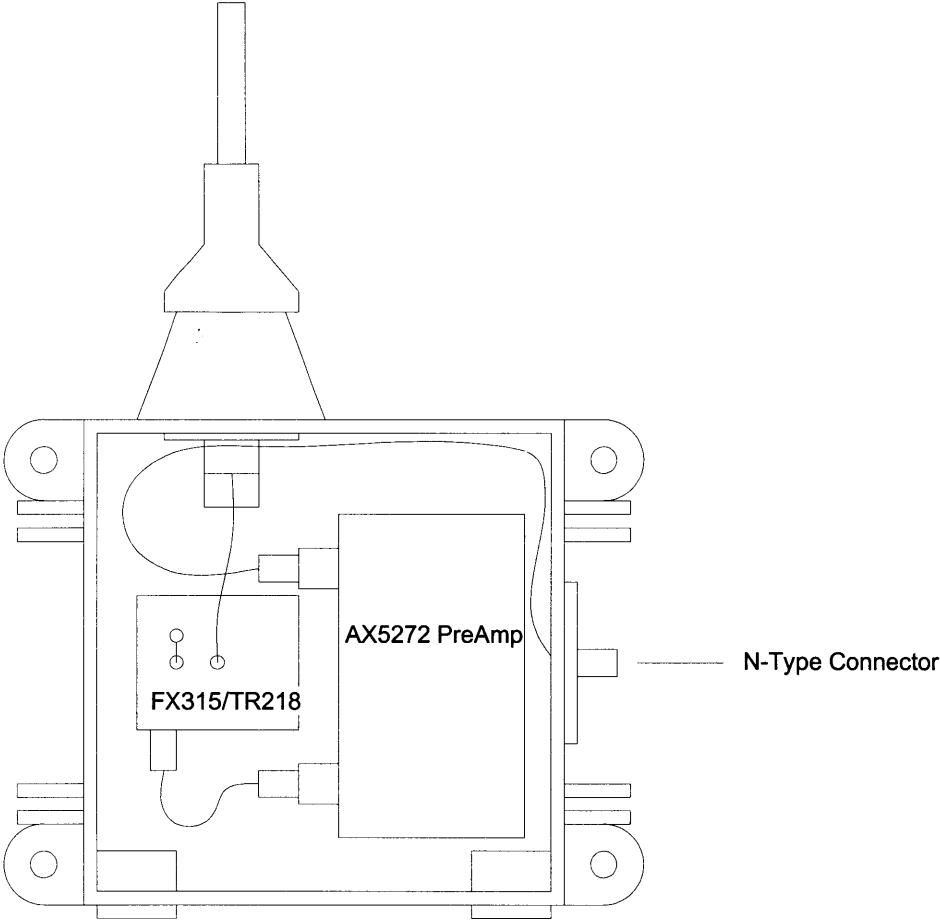
- Make sure the replacement component is an exact duplicate of the defective one. This is particularly important in the preamplifier.
- Place any new component in the same location as the component it replaces. The dressing of any wires should not be altered.
- Observe standard practice when replacing semiconductor components by using a low-wattage soldering iron and appropriate heatsink tools.
- Avoid damage to the printed circuit wiring when handling or repairing amplifier and regulator modules.

5.5 Adjustments

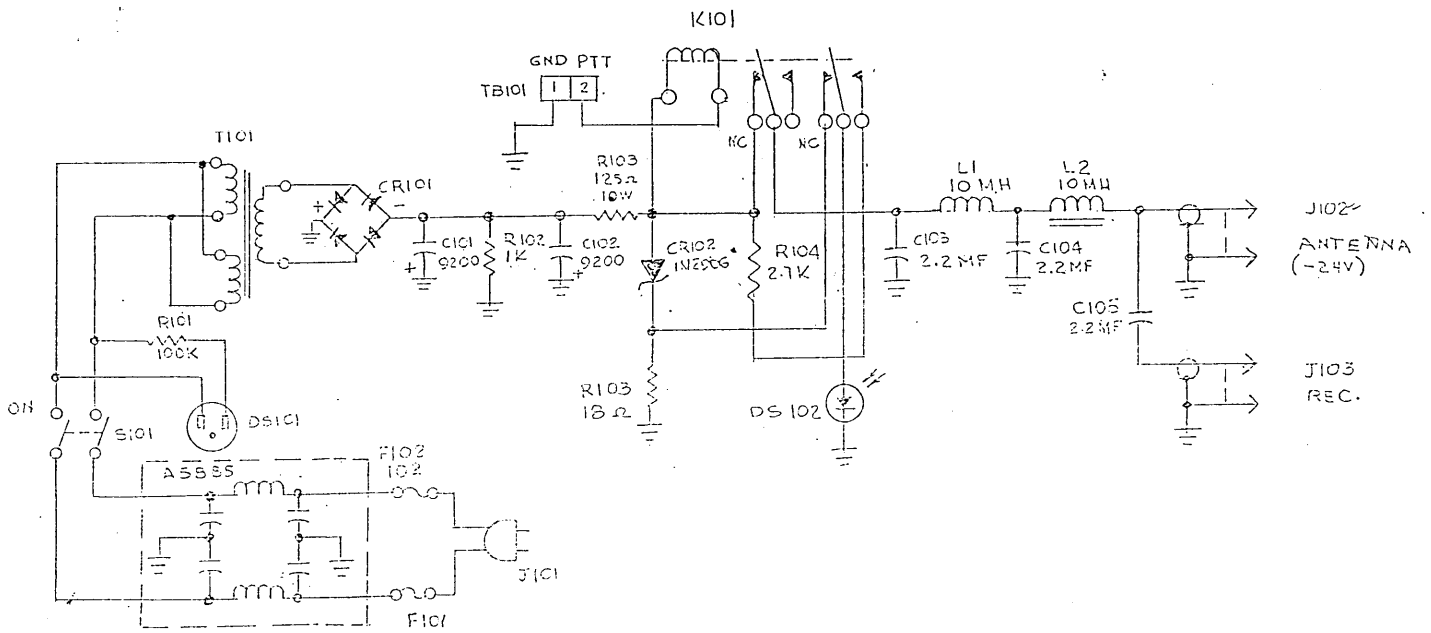
The preamplifier and power supply do not require any adjustment since all components are of fixed values.

Section 6 - Parts List and Diagrams

6.1 Vertical Antenna Assembly, VAA-1



6.2 System Power Supply, PSP-11



Item/Part Number	Rev	Description	Qty	Notes
PSP-11		Coaxial Power Supply		
1N2986		Diode	1EA	
A5885		Line Filter Assbly, PSP-11	1EA	
BI100-51		Lamp, Glow	1EA	
BI132		Lamp, Incandescent	1EA	
CA1903		Cable Harness	1EA	
CC131-53		Capacitor, Fixed	3EA	
CE112-20		Capacitor, Electrolytic	2EA	
CK2309		Scematic Diagram	1EA	
CL502		Coil Assembly, RF Tuned	2EA	
CU139-1B		Clamp	2EA	
CU145B1		Clamp	2EA	
DD146		Rectifier, Semiconductor Devce	1EA	
FH103		Fuseholder	2EA	
FH104-3		Fuseholder	2EA	
FU102-5		Fuse, Cartridge	2EA	
FU102-1		Fuse, Cartridge	2EA	
HA102-1BN		Handle	2EA	
JJ135		Connector, RF	1EA	
MS7242/LD3171		Panel, Front	1EA	
MS7241/LD372		Chassis & Cover	1EA	
PX337-2		Insulator, Therm., Strip	1EA	
RC20GF104J		Resistor, Fixed, Composition	1EA	
RC20GF272J		Resistor, Fixed, Composition	1EA	
RC42GF102J		Resistor, Fixed, Composition	1EA	
RC42GF180J		Resistor, Fixed, Composition	1EA	
RL116DC2C24A		Relay, Armature	1EA	
RW109-10		Resistor, Fixed, Wire-Wound	1EA	
ST22K		Switch, Toggle	1EA	
TF443		Transformer	1EA	
TM100-2		Terminal Board, Barrier	1EA	
TS106-2		Light, Indicator	1EA	
UG58A/U		Connector, Receptacle, RF	2EA	

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	VDA	VOA		Directional/Omnidirectional VHF Antennas
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	PL	ES	SW	Plugs, Switches, End Seal Assemblies

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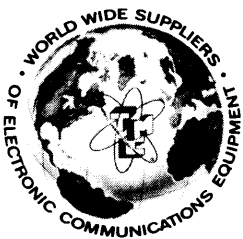
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