rf/microwave instrumentation

Operating and Service Manual

150/150AW1000

Model

10046249

Part Number

Serial Number

160 School House Road, Souderton, PA 18964 • 215-723-8181 • Fax 866-859-0582 • www.arworld.us

rf/microwave instrumentation

Declaration of Conformity

Issue Date: December 2018
Model #/s: Model 150/150AW1000 Series
Type of Equipment: RF Broadband Amplifier
Function: Designed to be used in a RF immunity test system or for research. The unit is intended to amplify an RF signal and inject it into a load.

The equipment described above is declared to be in conformity with the following applicable national and international standards. The conformity is valid only when equipment is used in a manner consistent with the manufacturer's recommendations and the reference documents.

EMC:
DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use–EMC requirements–Part 1: General Requirements
SAFETY:
DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits
CENELEC EN 61010-1 Issued 2010/10/01 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
UL 61010-1 Issued 2012/05/11 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
CAN/CSA C22.2 #61010-1 Issued 2012/05/11 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
HAZARDOUS SUBSTANCES (RoHS 3):
DIRECTIVE (EU) 2017/2105 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 November 2017 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)
RECYCLING (WEEE):
DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast)
SUBSTANCES OF VERY HIGH CONCERN (REACH):
REGULATION (EC) 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Substances of Very High Concern Chemicals (SVHC)

Supporting documentation is held by AR RF/Microwave Instrumentation's Quality department in Pennsylvania, United States.

Place of issue: AR RF/Microwave Instrumentation
160 School House Road
Souderton, Pennsylvania 18964 USA

Authorized officer of the company:

Patricia Thrasher
Manager Quality, Customer Service, Purchasing

Instructions for European EMC Conformity

⚠ WARNING ⚠

It is the responsibility of the user of this equipment to provide electromagnetic shielding, filtering and isolation which is necessary for EMC compliance to Directive 2014/30/EU. The equipment must therefore be operated in a shielded area which provides a sufficient level of attenuation to meet the radiated emissions and immunity specifications. The following minimum levels are suggested for use in accordance with the rated power of the equipment.

Rated Power	Minimum shielding attenuation
100 watts	50 dB
101 - 1000 watts	60 dB
1001 - 10,000 watts	70 dB

Since this equipment is designed to generate high levels of Radio Frequency energy, it is also essential that the user read and follow the “Instructions for Safe Operation” in this manual. If other equipment is operated in the shielded room it may be disturbed by the amplifier.

⚠ ACHTUNG ⚠

Der Benutzer dieses Gerätes ist dafür verantwortlich, daß die elektromagnetische Abschirmung und Filterung gewährleistet ist, welche gemäß Richtlinie 2014/30/EU notwendig ist. Das Gerät muß deshalb in einem geschirmten Raum betrieben werden, welcher eine ausreichenden Schirmung bietet, um die Emissions- und Störfestigkeitsspezifkation einzuhalten. Es werden folgenden Minimalwerte der Schirmdämpfung und Filterung in den unterschiedlichen Leistungsklassen empfohlen.

Hochfrequenzleistung	min. Schirmdämpfung
100 Watt	50 dB
101-1000 Watt	60 dB
1001-10.000 Watt	70 dB

Falls andere elektrische oder elektronische Geräte gleichzeitig mit dem Gerät betrieben werden, kann es zu Beeinflussungen kommen. Da das Gerät zur Erzeugung von Hochfrequenzenergie dient ist es daher auch unbedingt notwendig, daß der Benutzer die Sicherheitsvorschriften in der Bedienungsanleitung liest und einhält.

⚠ AVERTISSEMENT ⚠

Il est de la responsabilité de l'utilisateur de cet équipement d'assurer la protection électromagnétique, le filtrage et l'isolation nécessaires, afin de se conformer à la directive 2014/30/EU concernant la C.E.M. Par conséquent, cet équipement doit être mis en fonctionnement dans une enceinte d'atténuation suffisante pour satisfaire aux spécifications d'émissivité et de susceptibilité. Pour une utilisation conforme, les niveaux d'atténuation minimums suivants sont suggérés en fonction de la puissance de sortie de l'équipement:

Puissance de sortie	Atténuation minimum de l'enceinte
100 Watts	50 dB
101 à 1.000 Watts	60 dB
1.001 à 10.000 Watts	70 dB

Puisque cet équipement est destiné à générer de forts niveaux R.F., il est essentiel que l'utilisateur se conforme aux instructions de sécurité indiquées dans ce manuel. Tout autre équipement en fonctionnement dans la cage de Faraday peut-être perturbé par 1'amplificateur.

INSTRUCTIONS FOR SAFE OPERATION

Observe the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

INTENDED USE

This equipment is intended for general laboratory use in generating, controlling, and measuring levels of electromagnetic Radio Frequency (RF) energy. Ensure that the device is operated in a location which will control the radiated energy and will not cause injury or violate regulatory levels of electromagnetic interference.

SAFETY SYMBOLS

These symbols may appear in your user manual or on equipment.

	This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information. The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.
	Dangerous voltages are present. Use extreme care.
	Indicates a terminal intended for connection to an external conductor for protection against electrical shock in case of a fault, or the terminal of a protective earth (ground) electrode.
	Indicates invisible laser radiation–do not view directly with optical instruments.
	Indicates frame or chassis ground connection terminal.
	Indicates alternating current.
	Indicates this product must not be disposed of with your other household waste.
	Indicates that the marked surface and adjacent surfaces can attain temperatures that may be hot to the touch.

EQUIPMENT SETUP PRECAUTIONS

Review the user manual and become familiar with all safety markings and instructions. Protection provided by the equipment may be impaired if used in a manner not specified by AR RF/Microwave Instrumentation (AR).

- Follow all lifting instructions specified in this document.
- Place the equipment on a hard, level surface.
- Do not use the equipment in a wet environment, for example, near a sink, or in a wet basement.
- Position your equipment so that the power switch is easily accessible.
- Leave 10.2 cm (4 in) minimum of clearance on all vented sides of the equipment to permit the airflow required for proper ventilation. Do not restrict airflow into the equipment by blocking any vents or air intakes. Restricting airflow can result in damage to the equipment, intermittent shut-downs or safety hazards.
- Keep equipment away from extremely hot or cold temperatures to ensure that it is used within the specified operating range.
- While installing accessories such as antennas, directional couplers and field probes, take care to avoid any exposure to hazardous RF levels.
- Ensure that nothing rests on your equipment's cables and that the cables are not located where they can be stepped on or tripped over.
- Move equipment with care; ensure that all casters and/or cables are firmly connected to the system. Avoid sudden stops and uneven surfaces.

BEFORE APPLYING POWER

Your AR equipment may have more than one power supply cable. Use only approved power cable(s). If you have not been provided with a power cable for the equipment or for any AC-powered option intended for the equipment, purchase a power cable that is approved for use in your country. The power cable must be rated for the equipment and for the voltage and current marked on the equipment's electrical ratings label.

Incorrectly installing or using an incompatible line voltage may increase the risk of fire or other hazards. To help prevent electric shock, plug the equipment and peripheral power cables into properly grounded electrical outlets. These cables are equipped with three-prong plugs to help ensure proper grounding. Do not use adapter plugs or remove the grounding prong from a cable.

Do not modify power cables or plugs. Consult a licensed electrician or AR trained service technician for equipment modifications. Always follow your local/national wiring rules.

Do not operate the equipment if there is physical damage, missing hardware, or missing panels.

SAFETY GROUND

This equipment is provided with a protective earth terminal. The mains power source to the equipment must supply an uninterrupted safety ground of sufficient size to attach wiring terminals, power cord, or supplied power cord set. ***DO NOT USE this equipment if this protection is impaired.***

INSTRUCTIONS FOR SAFE OPERATION

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of an RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the equipment. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

ACOUSTIC LIMITATIONS

If equipment noise exceeds 80dB, ear protection is required.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

ENVIRONMENTAL CONDITIONS

Unless otherwise stated on the product specification sheet, this equipment is designed to be safe under the following environmental conditions:

- Indoor use
- Altitude up to 2000m
- Temperature of 5°C to 40°C
- Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearly to 50% at 40°C.
- Main supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.
- Pollution degree 2: Normally non-conductive with occasional condensation. While the equipment will not cause hazardous condition over this environmental range, its performance may vary.

EQUIPMENT CONTAINING LASERS

AR Field Probes (FL/PL Series) and Field Analyzers (FA Series) are Class 1 laser products containing embedded Class 4 lasers. Under normal use, the laser radiation is completely contained within the fiber optic cables and poses no threat of exposure. Safety interlocks ensure that the laser is not activated unless the cables are properly connected. Always exercise caution when using or maintaining laser products. Do not view directly with optical instruments.

RF ANTENNAS

- This equipment (antenna or antenna assembly) may be heavy, requiring two persons to lift. Use caution when installing or removing unit. Follow all equipment setup and lifting instructions specified in this document.
- Ensure connectors are appropriate for intended operation. Connectors are specified in the user manual and product specification sheet.
- Do not exceed the maximum RF input level stated in the specifications. Refer to the user manual and product specification sheet to determine the applicable RF levels.
- Excessive RF input could damage the equipment or connectors, causing safety hazards.
- When in operation, the RF voltages on the antenna elements can be hazardous. Do not come into contact with the antenna or elements when the RF input connector is connected to a live RF source.
- To avoid injury to personnel and accidental damage to power amplifier or antenna, disable the RF output of power amplifier before connecting or disconnecting the input connection to the antenna.
- Perform periodic inspections of antenna and field probe systems to verify calibration due date, proper operation, and overall condition of equipment.

RACK MOUNTED TWT MODELS

Some TWT models are supplied without the removable enclosure offered for benchtop use. These rack-mountable models may be supplied with either carry handles or slides and front handles installed. Follow all lifting instructions specified in this document and installation instructions supplied in the TWT user manual.

LIFTING INSTRUCTIONS FOR AR EQUIPMENT

Because most products must be handled during distribution, assembly and use, the risk of serious injury due to unsafe product handling should be a fundamental consideration of every user. An authoritative guideline for eliminating unwarranted risk of injury caused by lifting is provided by the NIOSH Work Practices (Publication #94-110) available at:

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

In general, observe the following guidelines for lifting a weight of 50 lb or more:

- Use lifting eye (for floor standing) or side handles (table top) to lift unit only.
- Use equipment of adequate capacity to lift and support unit.
- If using forklift to move unit, be sure forks are long enough to extend beyond the side of the unit.
- For additional information, follow the link specified above.

TABLE OF CONTENTS

FIGURES

TABLES

1. GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Model 150/150AW1000 is a self-contained, broadband solid-state amplifier designed for laboratory applications where instantaneous bandwidth, high gain, and moderate power output are required. A **GAIN** control, which is conveniently located on the unit's front panel, can be used to decrease the amplifier's gain by 20 decibels (dB) or more. Solid state technology is used exclusively to offer significant advantages in reliability and cost. A Model 150/150AW1000, used with a frequency-swept signal source, will provide 150 watts of swept power output from .01–1000 megahertz (MHz). Typical applications include antenna and component testing, wattmeter calibration, and electromagnetic interference (EMI) susceptibility testing, as well as usage as a driver for frequency multipliers and high-power amplifiers. The Model 150/150AW1000 can be operated locally by using the unit's front panel controls, or remotely by using the unit's IEEE-488, RS-232 interface, USB, or Ethernet interface.

Special features incorporated into the Model 150/150AW1000 include the following:

- **A Control Panel** that allows both local and remote (via a computer interface) control of the amplifier (including adjustment of the amplifier's RF Gain during CW mode operation) and provides graphical displays of the amplifier's Forward and Reflected power levels.
- **A General Purpose Interface Bus (GPIB)/IEEE-488.2 interface** for remote control of the amplifier's operating functions.
- **RS232 serial communications** including both wire and fiber-optic ports for remote control.
- **USB Communication port** for remote control.
- **Ethernet Communication port** for remote control.
- **Protection** is provided by DC current limiting, over-temperature shut down and RF power limiting.

1.2 SPECIFICATIONS

Refer to the AR RF/Microwave Instrumentation Data Sheet at the end of this section for detailed specifications

1.3 POWER SUPPLIES

The Model 150/150AW1000 contains three switching power supplies. The input voltage range to the power supply is 100–240 VAC, 50-60Hz, selected automatically. The AC input power is approximately 500 watts.

PS1 is a multiple output supply. PS1 has a +5volt, standby supply for the A12 Control/Fault board and the A14 Interface board used for the remote interfaces. The -15V is supplied to all of the RF modules in the amplifier configuration. The +15V is supplied to the A2 module. The +24V DC is supplied to module A1 and cooling fans B1 thru B3.

PS2 supplies +32V to the A2 Module and the A9 Regulator Assembly.

PS3 is a single output supply. The +24 VDC output supplies voltage for modules A3, A6 and A7.

1.4 SPECIFICATIONS

Refer to the AR Data Sheet at the end of this section for detailed specifications. All voltage measurements referenced in this manual are Direct Current (DC) unless stated otherwise.

150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz
- Class A
- Portable
- Full VSWR-tolerant
- CE & RoHS compliant
- High Efficiency

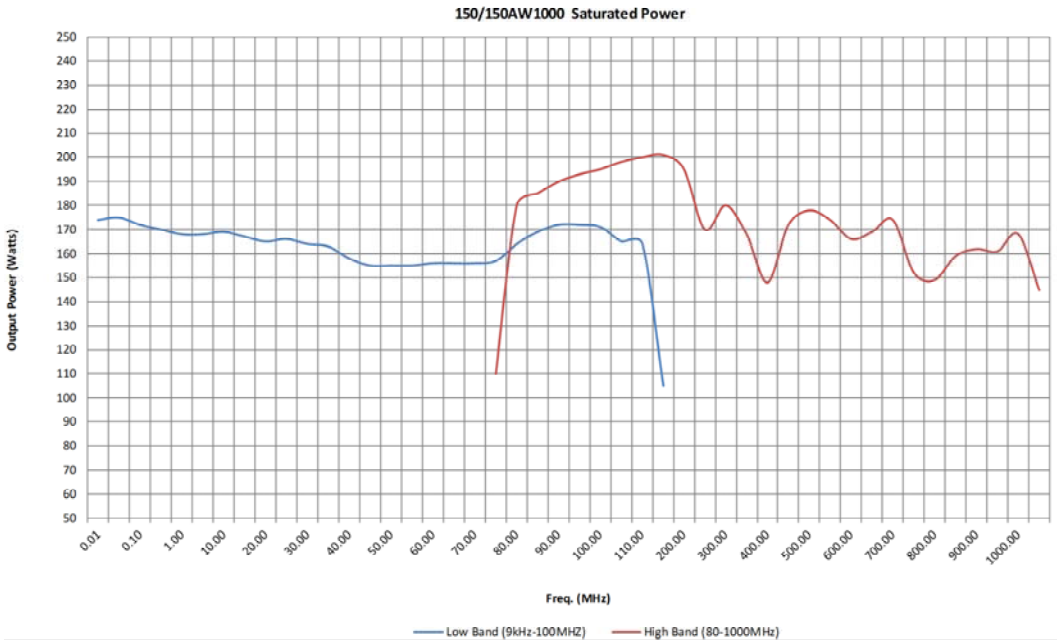
Features

The Model 150/150AW1000 is a portable, self-contained, air-cooled, dual-band, broadband, completely solid-state amplifier designed for applications where instantaneous bandwidth, high gain and linearity are required.

This model is equipped with a Digital Control Panel (DCP) which provides both local and remote control of the amplifier. The digital display on the front panel indicates control status and reports of internal amplifier status. All amplifier control functions and status indications are available remotely in GPIB/IEEE-488 format, RS-232 hardwire and fiber optic, USB, and Ethernet.

This model is designed to have low spurious signals, exhibit very good linearity, and is extremely load tolerant which enables it to be used in many RF applications such as: RF susceptibility testing, antenna/component testing, and communication technology testing. It can be used as a test instrument covering multiple frequency bands and are suitable for a variety of communication technologies such as CDMA, W-CDMA, TDMA, GSM, UWB, WiMAX etc.

The export classification for this equipment is EAR99.



AR RF/Microwave Instrumentation
160 School House Rd
Souderton, PA 18964
215-723-8181

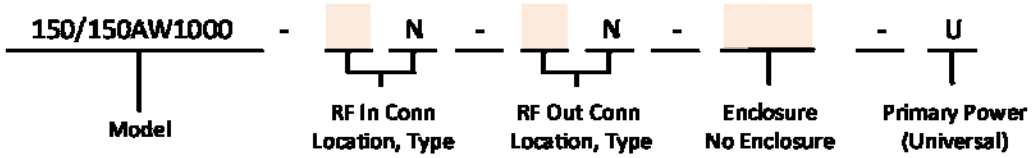
For an applications engineer call:800.933.8181

www.arworld.us

150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz

Model Configurations



CONNECTOR LOCATION	
Front	F
Rear	R

ENCLOSURE	
Enclosure	E
No Enclosure	NE

Specifications, General

INPUT FOR RATED OUTPUT: 1.0 milliwatt maximum, 0 dBm

INPUT IMPEDANCE: 50 ohms, VSWR 2.0:1 maximum

OUTPUT IMPEDANCE: 50 ohms, nominal

MISMATCH TOLERANCE: 100% of rated power without foldback. Will operate without damage or oscillation with any magnitude and phase of source and load impedance. See Application Note #27.

MODULATION CAPABILITY: Will faithfully reproduce AM, FM, or pulse modulation appearing on the input signal.

SPURIOUS: Minus 73 dBc typical

CONNECTORS:
RF Input: N female
RF Output: N female

REMOTE INTERFACES:
IEEE-488: 24 pin female
RS-232: 9 pin subminiature D (female)
RS-232 (Fiber-optic): Type ST
USB 2.0: Type B
Ethernet: RJ-45

SAFETY INTERLOCK: 15 pin subminiature D

COOLING: Forced air (internal self-contained liquid)

SIZE (W x H x D):
With cabinet: 50.3 x 20.5 x 74.9 cm (19.8 x 8.1 x 29.5 in)
Without Cabinet: 48.3 x 17.7 x 74.9 cm (19 x 7.0 x 29.5 in)

WEIGHT:
With Cabinet 42.6 kg (94 lbs)
Without Cabinet 31.3 kg (69 lbs)

EXPORT CLASSIFICATION: EAR99

ENVIRONMENTAL:
Operating Temperature: 5°C / +40°C
Operating Altitude: Up to 2000M
Shock and vibration: Normal Truck Transport

REGULATORY COMPLIANCE:
EMC EN 61326-1
Safety UL 61010-1
CAN/CSA C22.2 #61010-1
CENELEC EN 61010-1
RoHS DIRECTIVE 2011/65/EU

150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz

Model 150/150AW1000, 0.01–100MHz Band Selected

RATED POWER OUTPUT: 150 watts minimum

POWER OUTPUT @ 3dB COMPRESSSION: Nominal 165 watts; Minimum 140 watts

POWER OUTPUT @ 1dB COMPRESSION: Nominal 135 watts; Minimum 110 watts

GAIN FLATNESS: ±1.0 dB typical; ±1.5 dB maximum

FREQUENCY RESPONSE: 10kHz–100MHz instantaneously

GAIN (at maximum setting): 51.8 dB minimum

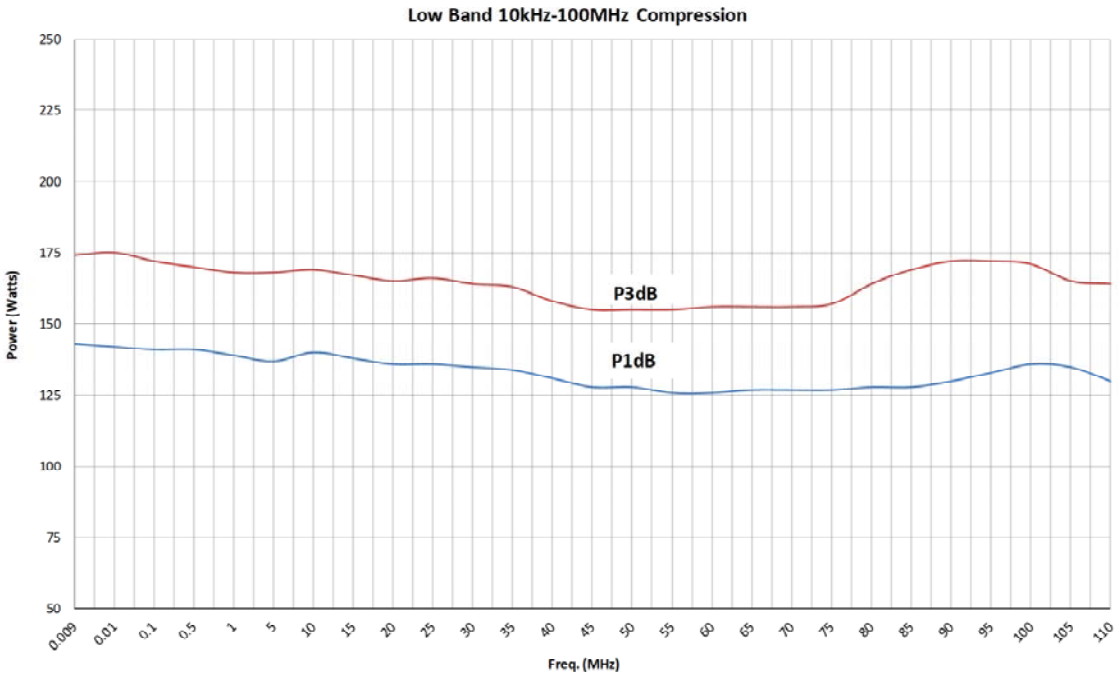
GAIN ADJUSTMENT (Continuous Range): 20 dB minimum

THIRD ORDER INTERCEPT: 55 dBm typical

NOISE FIGURE: 8 dB typical

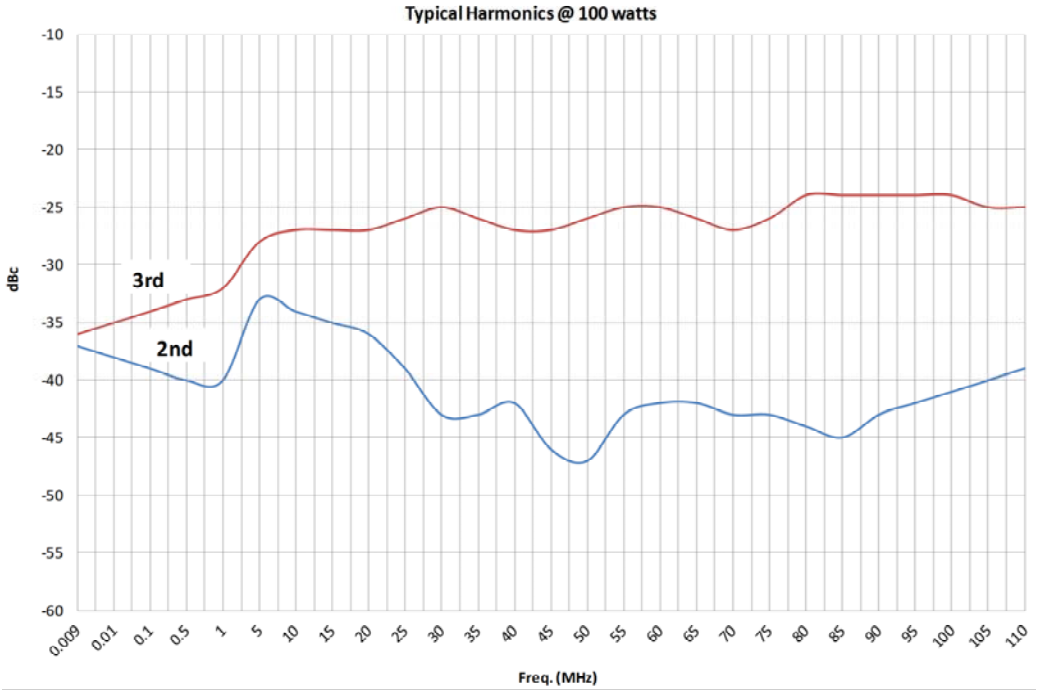
HARMONIC DISTORTION: Minus 20 dBc maximum at 100 watts, -30 dBc typical at 70 watts

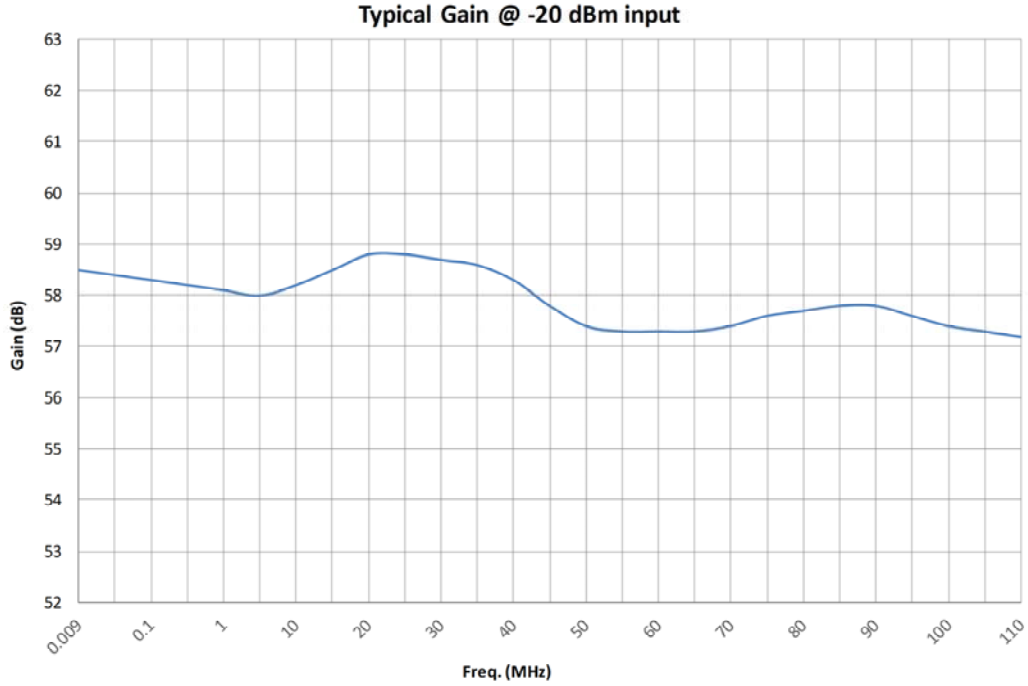
PRIMARY POWER (Universal, Selected Automatically): 100-240 VAC, 50/60 Hz, 500 watts



150/150AW1000

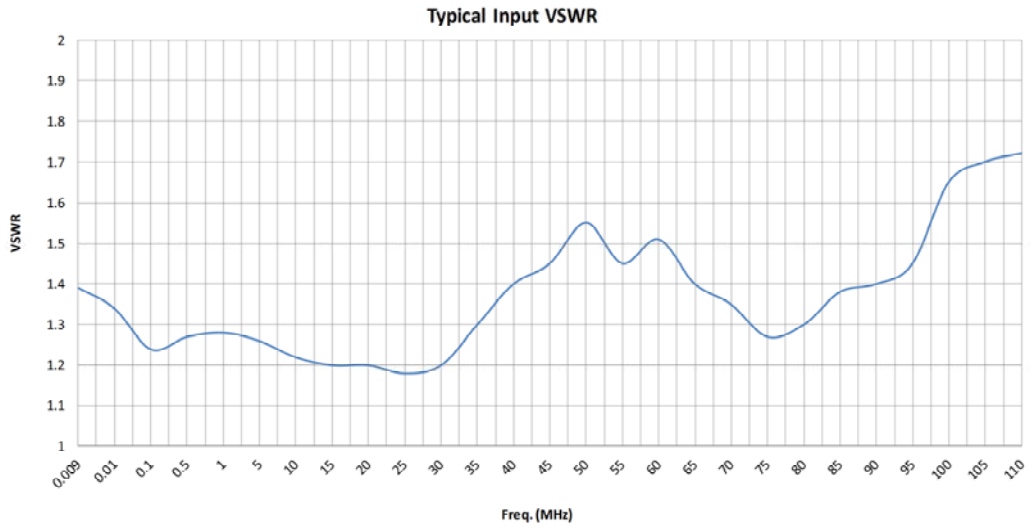
- 150 Watts CW
- 10kHz–1000MHz

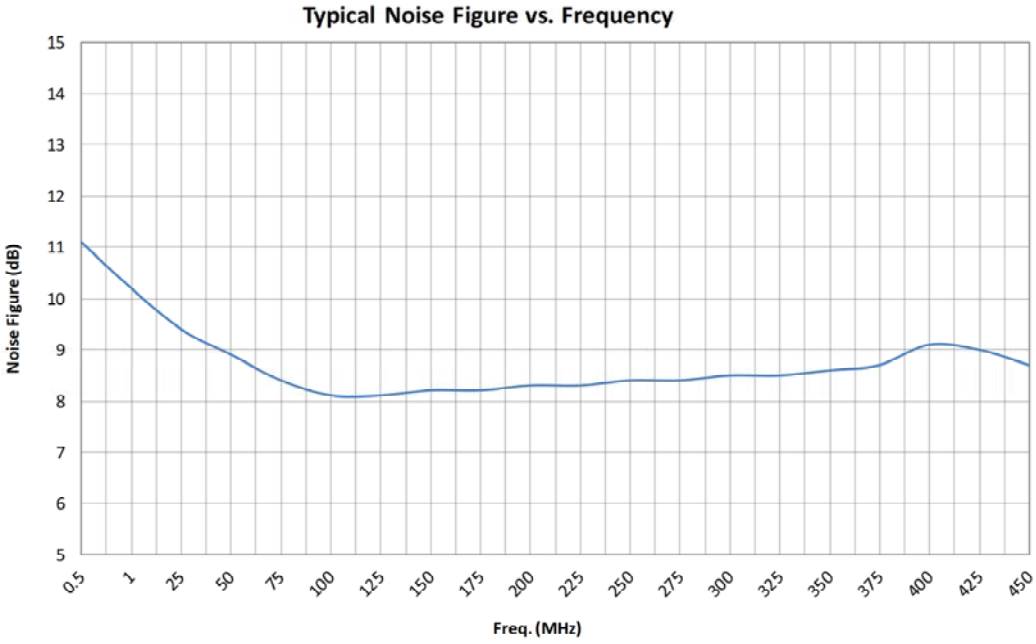




150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz





150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz

Model 150/150AW1000, 80–1000MHz Band Selected

RATED POWER OUTPUT: 130 watts minimum

POWER OUTPUT @ 3dB COMPRESSSION:
Nominal 150 watts; Minimum 125 watts

POWER OUTPUT @ 1dB COMPRESSION:
Nominal 125 watts; Minimum 100 watts

GAIN FLATNESS:
±1.5 dB typical; ±2.0 dB maximum

FREQUENCY RESPONSE:

80–1000 MHz instantaneously

GAIN (at maximum setting): 52 dB minimum

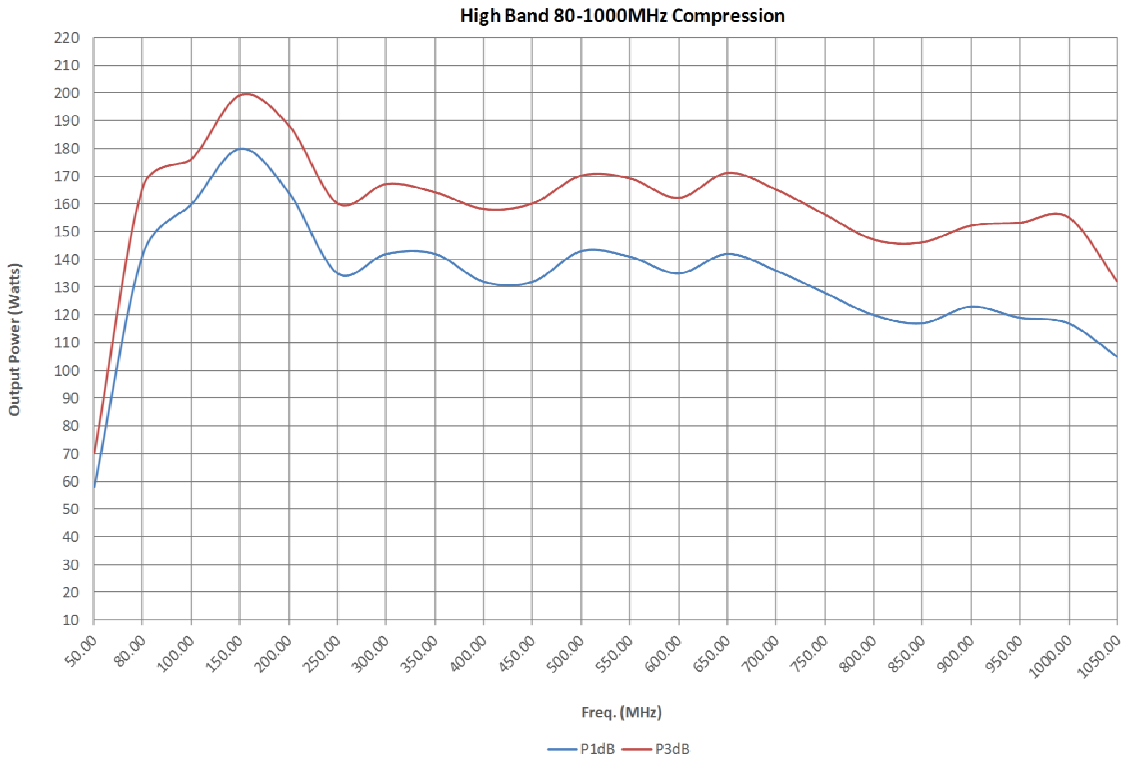
GAIN ADJUSTMENT (Continuous Range):
20 dB minimum

THIRD ORDER INTERCEPT: 58 dBm typical

NOISE FIGURE: 8 dB max; 6 dB typical

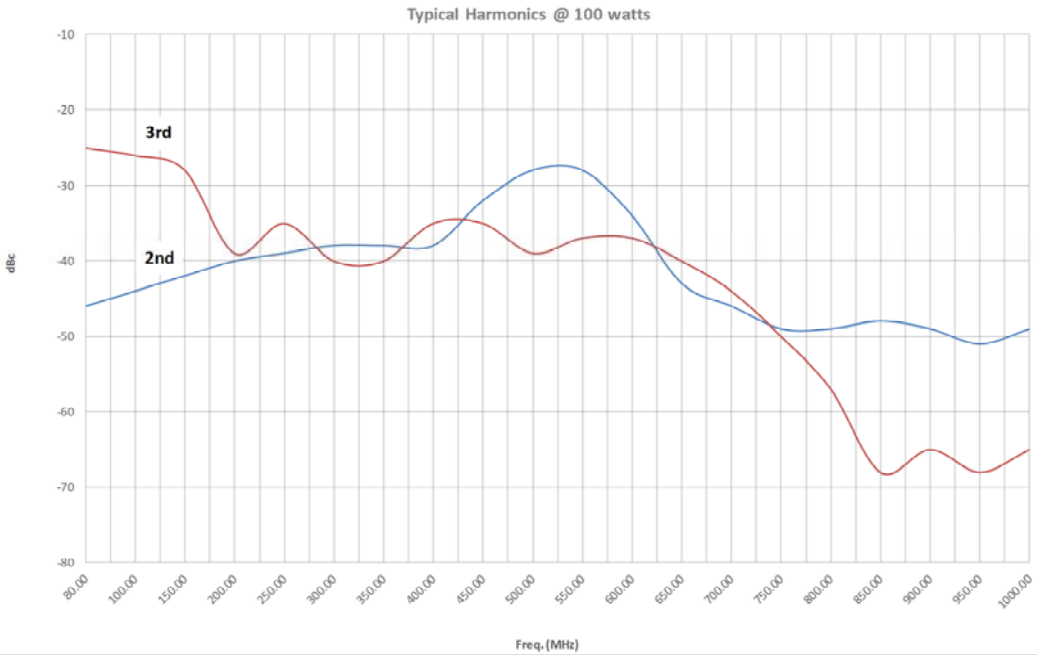
HARMONIC DISTORTION: Minus 20 dBc maximum at 100 watts; minus 30 dBc typical at 100 watts

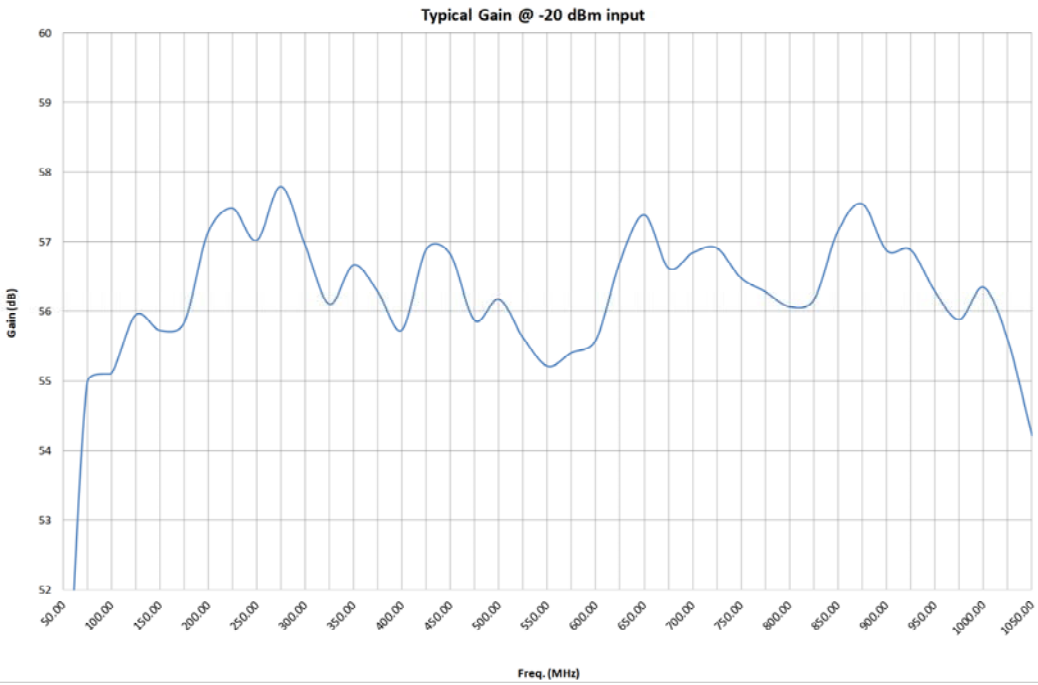
PRIMARY POWER (Universal; Selected Automatically): 100-240 VAC, 50/60 Hz, 650 watts



150/150AW1000

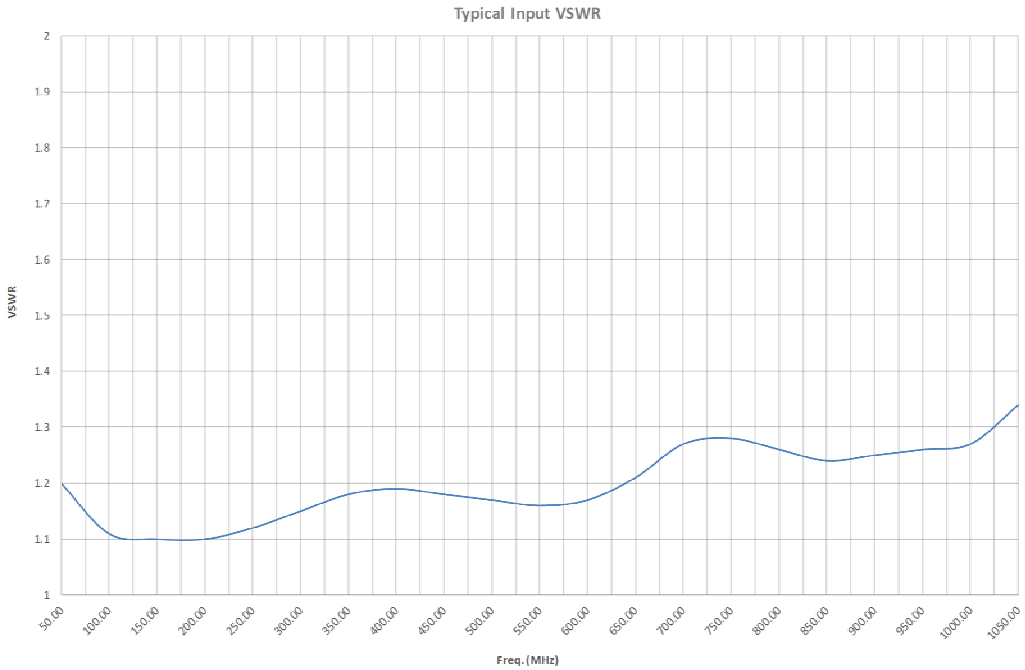
- 150 Watts CW
- 10kHz–1000MHz

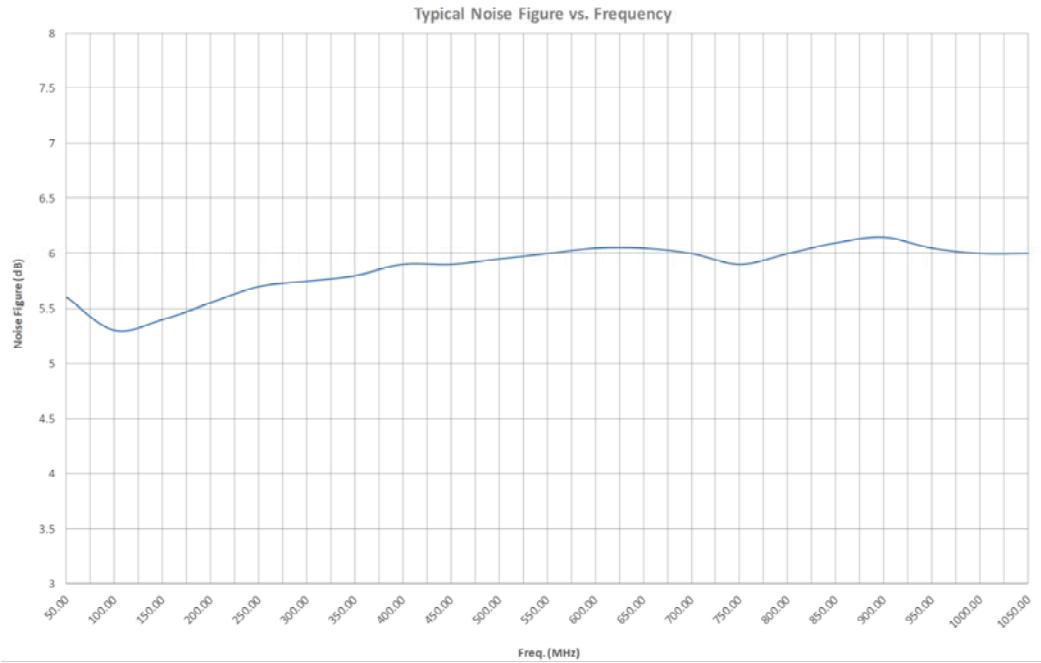




150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz

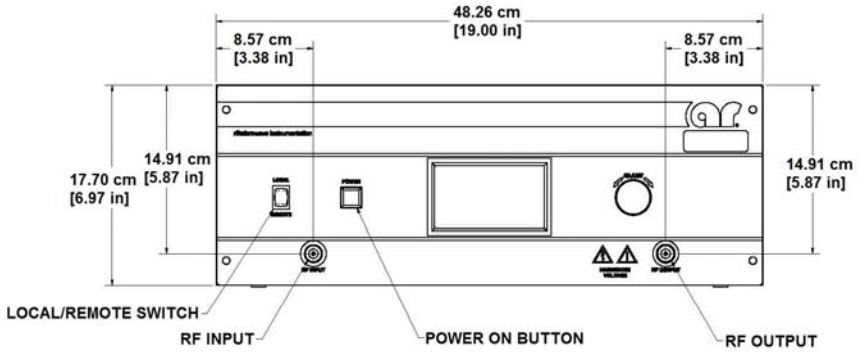


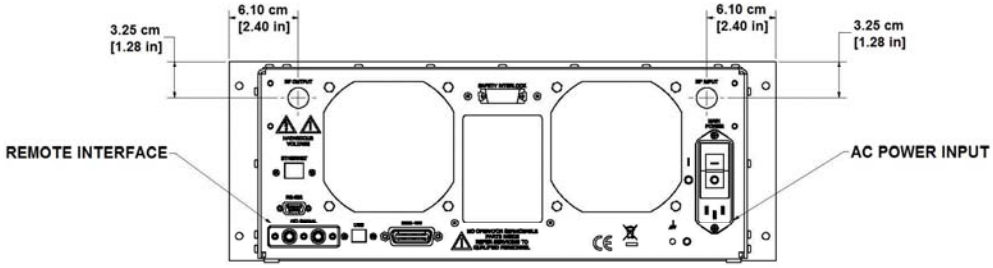


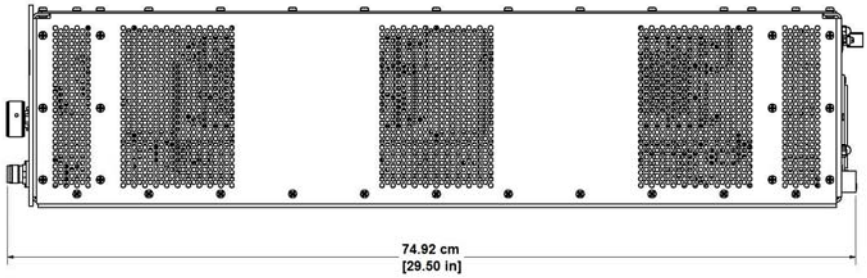
Envelope Drawing

150/150AW1000

- 150 Watts CW
- 10kHz–1000MHz







2. OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the Model 150/150AW1000 broadband amplifier is quite simple. The amplifier's input signal, whether swept or fixed in frequency, is fed into the jack marked **RF INPUT,** and the amplifier's output signal is taken from the jack labeled **RF OUTPUT**. The unit is turned on by activating the front panel **POWER** switch. In the event of a major malfunction, protection is provided by a circuit breaker located on the unit's rear panel.

CAUTION:

The Model 150/150AW1000 Amplifier will provide 100% of rated power without foldback into a mismatched load. The amplifier will operate without damage or oscillation with any magnitude and phase of source and load impedance. However, placing the amplifier in the operate mode without a load connected to the output connector is not recommended. It has also been designed to withstand, without damage, RF input power levels up to twenty (20) times its rated input of 1mW. However, signal levels higher than 20mW or transients with high peak voltages can damage the amplifier. Also, accidental connection of the Model 150/150AW1000's output to its input (either through direct connection or parasitic feedback paths) will cause oscillations that may permanently damage the unit's input transistors.

The 150/150AW1000 RF power transistors are protected from over temperature by sensing the chassis temperature near the RF output transistors. In the event of a cooling fan failure or an airflow blockage, the DC voltage will be removed from the RF stages, when the chassis temperature reaches approximately 70°C.

Normal operation can be resumed after the chassis temperature drops below 70° C.

2.2 AMPLIFIER FRONT AND REAR PANELS

Figure 2-1 shows the front panel of the Model 150/150AW1000 Broadband Microwave Amplifier. Figure 2-2 shows the rear panel of the Model 150/150AW1000 Broadband Microwave Amplifier.

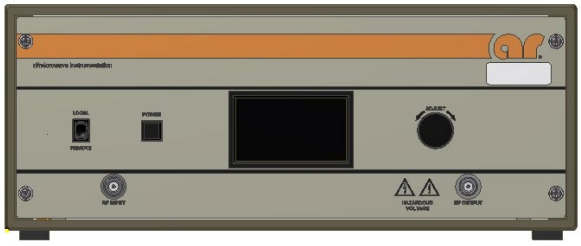


Figure 2-1. Model 150/150AW1000 Front Panel

Figure 2-2. Model 150/150AW1000 Rear Panel

2.2.1 Local Control Interface

This section describes local operation of the 150/150AW1000 using the human interface items found on the control panel.

2.2.1.1. Toggle Switch

The Toggle Switch is provided for protection from unexpected remote control of the 150/150AW1000. The 150/150AW1000 can only be turned on locally when the Toggle Switch is in the LOCAL position. Likewise, the unit can only be turned on or controlled remotely when the Toggle Switch is in the REMOTE position. All remote queries are processed and responded to in either of the two Toggle Switch positions.

2.2.1.2 Power Button

The momentary POWER button turns the main power to the 150/150AW1000 on and off. The status of the green light-emitting diode (LED) in the switch indicates whether the 150/150AW1000 power is on or off. The main power supply fans are active when power is on. The LCD touch display is active as long as the main circuit breaker for the 150/150AW1000 power entry module is on.

2.2.1.3 Adjust Knob

The ADJUST knob is used to set the RF Gain of the amplifier. The range of RF Gain is 0 to 100 percent. The ADJUST knob can be rotated both clockwise and counterclockwise 360 degrees.

2.2.1.4 Touch Screen

The Touch screen is a color LCD that can accept single touch events from soft blunt objects such as a human finger. The mechanism that registers touch events is resistive based and relies on pressure not capacitance. Menu options presented on the touch screen are typically gray in color with a black text label in the center. When a valid touch event is registered, a thin black box appears around the valid touch location and an optional audible beep will occur.

2.2.1.5 Menu Map

Figure 2-3 shows the menu map for the 150/150AW1000. The screens depicted are only example screens. The actual values and settings will be different on the actual amplifier depending on user settings and operating conditions.

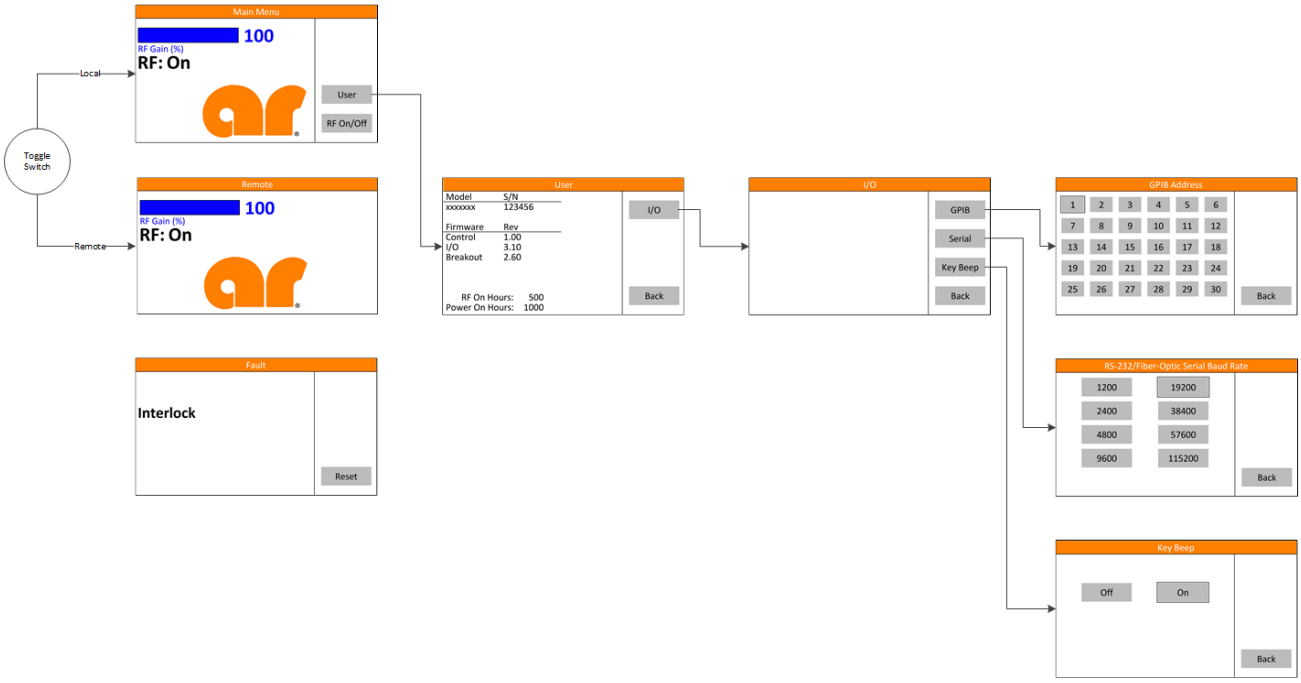


Figure 2-3. Menu Map

2.3 LOCAL OPERATION

2.3.1 Power-up Sequence

1. Connect the input signal to the unit's RF INPUT connector. The input signal level should be 0dBm maximum.
2. Connect the load to the unit's RF OUTPUT connector.
3. Set the REMOTE/LOCAL switch to LOCAL.
4. Check to see that the MAIN POWER switch on the unit's rear panel is set to the (on) position.
5. Select either Low Band or High Band option from the front display.
6. Press the POWER switch.
7. Place the unit in the Operate mode by pressing the RF ON/OFF touch screen button.
8. Adjust the amplifier's gain by pressing the Select button on the Main Menu, then the RF Gain button in the subsequent menu. Adjust the value using the Adjust knob rotating the ADJUST knob.
9. In the event of a fault, press the RESET touch screen button; if the fault does not clear, refer to section 4.3 **Troubleshooting** of this manual.

2.4 REMOTE COMMUNICATIONS

This section describes remote operation of this product using the installed communications ports connected to a remote device such as a personal computer. All ports are active at all times, however only one port may be used at a time. Communicating through two or more ports at one time will cause data collisions and lost commands or queries.

The **REMOTE**/**LOCAL** switch on the front panel allows for the amplifier to be controlled using the remote communications ports or the front panel controls depending on its position. All remote queries will work in either switch position. All remote commands will only work when the switch is set to **REMOTE**. When the switch is set to **REMOTE** all front panel controls are disabled.

NOTE: Some of the following ports may not be installed on your amplifier.

2.4.1 IEEE-488 (GPIB) Communications

For IEEE-488 operation, the device address is set using the dip switches on the rear panel of the amplifier. It is set to address 1 at the factory. If another device on the IEEE-488 bus is already using address 1, reset the switch to a vacant address. (Resetting the address requires re-booting the unit).

Specific IEEE-488 bus commands depend on which software package you are using. To send commands be sure that the amplifier's address is set properly and that the controller has correctly identified the unit as a "listening" device.

When sending commands to the unit via the GPIB interface, terminate the command with a **<LF>**, an **EOI**, or both. The system ignores characters following the termination.

2.4.1.1 Setting the IEEE-488 (GPIB) Address

The GPIB device address can be set to any number between 1 and 30. This selection is made by navigating to the GPIB address selection screen (Section 3.3.1.5.4). To get there from the Main Menu, touch the User menu button followed by the I/O menu button and finally the GPIB menu button. Touching any of the buttons labeled 1 to 30 immediately sets the GPIB address to the corresponding value. A thin black outline indicates the present GPIB address selection. When the back button is pushed the address selection is stored to non-volatile memory. Therefore, if power is lost prior to hitting the back button any address selection changes will be lost. The default GPIB address is 1.

2.4.2 RS-232 Communications

The RS-232 port is a serial communications bus. All commands and queries through this port must be terminated with a **<LF>.** When a valid query is received, it is processed and the result is immediately transmitted back over the RS-232 interface. This port is designed to time-out if there is no activity on the bus for more than 5 seconds. At this time the internal buffer is cleared and a **TIMEOUT_ERROR<LF>** message is sent out from this port.

The RS-232 port is setup as a **DCE** port. When connecting to a PC a straight one-to-one cable should be used. A null modem is **NOT** needed. The settings and pinout diagram for this port can been found below.

Table 2-1. RS-232 Port Settings

Word Length	8 bits
Stop Bits:	1
Baud Rate:	19.2 kbps
Parity:	None
HW Handshake:	None

Table 2-2. RS-232 (DCE) Port Pinout Diagram DB-9 Female

Pin 1	DCD
Pin 2	TD
Pin 3	RD
Pin 4	DTR
Pin 5	GND
Pin 6	DCR
Pin 7	CTS
Pin 8	RTS
Pin 9	Unused

2.4.3 Fiber-Optic Communications

The Fiber-Optic port is a serial communications bus. All commands and queries through this port must be terminated with a <LF>. When a valid query is received, it is processed and the result is immediately transmitted back over the Fiber-Optic interface. This port is designed to time-out if there is no activity on the bus for more than 5 seconds. At this time the internal buffer is cleared and a TIMEOUT_ERROR<LF> message is sent out from this port.

The Fiber-Optic port provides the user with the ability to optically isolate the controlling PC from the amplifier. This can be useful where the amplifier is placed in an environment where RF/Microwave energy could be coupled onto a connection to one of the "wired" communications ports and fed back to the controlling PC.

Both optical connections (Tx and Rx) are optimized to work with light at a wavelength of 820nm. For more detailed specifications on this port, consult the Avago HFBR series datasheet found at www.avagotech.com.

A glass, multi-mode, fiber-optic cable of 200um is recommended, however fiber-optic cable as small as 50um can be used. The connector type for this port is ST.

This port can be used with either an AR IF7000 RS-232 to Fiber-Optic Interface or an AR IF7001 USB to Fiber-Optic Interface. Note that these devices use SMA connectors so a fiber-optic cable is needed with ST connectors on one end and SMA connectors on the other. This cable can be obtained from a fiber-optic cable distributor such as FIS. Their web-site can be found at www.fiberinstrumentsales.com. An example cable that will work for this connection is FIS Part Number D615M7FIS. The 7 in the part number refers to the length of the cable. In this case the length is 7 meters.

Table 2-3. Fiber-Optic Port Settings

Word Length	8 bits
Stop Bits:	1
Baud Rate:	19.2 kbps
Parity:	None
HW Handshake:	None

2.4.4 USB Communications

The USB port on this product is a USB 2.0 port. It also complies with the USB Test and Measurement Class Standard. Communications with this port requires the host computer to have a USBTMC driver available. All commands and queries through this port must be terminated with a **<LF>.**

The cable required to make this connection is a USB 2.0 A-B peripheral device cable. The cable can be no longer than 5 meters. If a longer distance is required a USB hub must be used. A cable carrying the official USB logo is recommended.

When connected to a PC running Windows 2000 or XP a window will pop-up labeled Hardware Wizard. If this PC has National Instruments LabView installed it will have a USBTMC driver that will work with this port. This driver will allow the device to be easily controlled using National Instruments Measurement and Automation Explorer or LabView. If a user wishes to write code in a different programming language, a custom driver can be requested from AR. It should be noted that the USBTMC driver provided by National Instruments is a VISA driver which can be used with other programming languages besides LabView. For more information on this please consult the National Instruments Website found at www.ni.com.

NOTE: All firmware updates are done through the USB port.

2.4.5 Ethernet Communications

The Ethernet port on this product allows it to be remotely controlled through a TCP data channel. All commands and queries through this port must be terminated with a **<LF>.**

By default this port is setup to work on a network with a DHCP server. Upon connection, an IP address is assigned to the device based on its hardware address. The hardware address is printed on a label located near the Ethernet port.

If the connected network does not have DHCP enabled then the device can be assigned an IP address by the user. To do this, download the utility called DeviceInstaller™ from www.Lantronix.com. For assistance using this utility please consult the embedded help file for this utility.

The DeviceInstaller™ utility will scan the network and find all connected Lantronix Ethernet devices. This list of found devices will include any connected AR Ethernet devices. By selecting one of the connected devices from the list, its IP address and subnet mask can be changed along with a number of other settings. One should use caution in adjusting any settings he/she is unfamiliar with as doing so may cause the port to become unresponsive. By default the port for the TCP data channel is 10001.

* DHCP (Dynamic Host Configuration Protocol) is a protocol used to assign a dynamic IP address to the unit. The network server software assigns an available IP address to the unit when the instrument is turned on. A different IP address may be assigned at different times.

2.4.6 Remote Commands

- If a command or query is unrecognized it is echoed back out the port it came in on.
- All commands and queries are terminated with a Line Feed character.
- A Line Feed character is indicated by <LF> in subsequent command and query definitions.
- All queries can be sent when the Toggle switch is in the LOCAL or REMOTE position.
- All commands can only be sent when the Toggle switch is in the REMOTE position.
- All spaces in command and query definitions are indicated by <space>.
- If a query is recognized, its associated response is echoed out the port it came in on.

A COMMUNICATIONS_ERROR<LF> can occur if the time between commands or queries is too short, or the internal RS-485 link between the IO Board assembly and the Multipurpose Board (MPB) assembly is broken.

The development of application programs requires an understanding of the operation of the multi-band amplifier as well as the intended application.

An application program on the computer/controller should issue only one character string (command or query) at a time. After each functional command is issued, the multi-band amplifier's status should be checked to ensure that the command has been properly executed. The application program should allow sufficient time for the function to be completed before checking the status.

The application program should facilitate the checking of the status just prior to issuing a command, since the status could have been changed by a fault condition or by operator actions.

Variables represented by wild card characters i.e., x, y, z etc. do not indicate or delimit the number of characters actually specified.

Table 2-4. Relationship between Amplifier Controls and Remote Communication

AC Power and Circuit Breaker		Power		Toggle Switch		Remote Communication	
On	**Off**	**On**	**Off**	**LOCAL**	**REMOTE**	**Command**	**Query**
	√					X	X
√			√		√	√	√
√		√			√	√	√
√		√		√		X	√
√			√	√		X	√

X = No,
√ = Yes

2.4.6.1 Power On/Off

This command controls the power on/off state of the amplifier.

Syntax: **POWER:x**

Parameters: State(x):

OFF = power off

ON = power on

Response Format: None (No query for this command)

Example: To turn the power on, send the following command:

POWER:ON<LF>

To turn the power off, send the following command:

POWER:OFF<LF>

2.4.6.2 RF On/Off

This command controls the RF on/off state of the amplifier.

Syntax: **RF:x**

Parameters: State(x):

OFF = power off

ON = power on

Response Format: None (No query for this command)

Example: To turn the RF on, send the following command:

RF:ON<LF>

To turn the RF off, send the following command:

RF:OFF<LF>

2.4.6.3 Reset Faults

This will clear all faults, if possible.

Syntax: **RESET**

Parameters: None

Response Format: None (No query for this command)

Example: To clear any faults, send the following command:

RESET<LF>

2.4.6.4 Level Adjust

This command sets the RF gain of the amplifier.

Syntax: **LEVEL:xy**

Parameters: Parameter(x):

GAIN = RF Gain

Value(y):

For RF Gain:

0 = Minimum

100 = Maximum

Response Format: None (No query for this command)

Example: To set the RF Gain to minimum, send the following command:

LEVEL:GAIN0<LF>

To set the RF Gain to 50%, send the following command:

LEVEL:GAIN50<LF>

2.4.6.5 Identity

Query to identify the amplifier.

Syntax: ***IDN?**

Parameters: None

Query only (always requires a ? character)

Response Format: **f,m,n,<LF>**

Where:

f = manufacturer

m = model designation

n = firmware revision

Example: To get the identity of the amplifier, send the following command:

***IDN?<LF>**

Response: **AR-RF/MICROWAVE-INST,XXXXXXXX,1.0<LF>**

2.4.6.6 IO Board Firmware Revision

Query to get the firmware revision of the I/O Board.

Syntax: ***IOB?**

Parameters: None

Query only (always requires a ? character)

Response Format: **INTERFACE_BOARD_SW_REVx<LF>**

Where:

x = firmware revision

Example: To get the firmware rev. of the I/O Board, send the following command:

***IOB?<LF>**

Response: **INTERFACE_BOARD_SW_REV3.10<LF>**

2.4.6.7 State

Query to find the state of the amplifier.

Syntax: **STATE?**

Parameters: None

Response Format: **STATE=<space>xyza<LF>**

Where: **x, y, z**, and **a** are each an ASCII character representing a hexadecimal character. They can be 0 to 9 or A to F.

Each hexadecimal character represents a 4-bit binary number. This 4-bit number is a bit pattern which contains information about the state of the amplifier. The definitions of these bit positions can be found in the table below.

NOTE: Bits labeled NOT USED may be read as a bit state of 1 or 0

Table 5. States

	BIT POSITION	BIT DESCRIPTION	BIT STATE 0	BIT STATE 1	NOTES:
x	0	(NOT USED)			
	1	(NOT USED)			
	2	(NOT USED)			
	3	REMOTE CONTROL	DISABLED	ENABLED	Response to Toggle Switch position
y	0	POWER STATUS	OFF	POWER ON	
	1	STANDBY STATUS	OFF	STANDBY	Also known as RF OFF
	2	OPERATE STATUS	OFF	OPERATE	Also known as RF ON
	3	FAULT STATUS	OFF	FAULT EXISTS	
z	0	(NOT USED)			
	1	POWER SAVE	OFF	ON	
	2	BAND SELECTION	HIGH	LOW	
	3	(NOT USED)			
a	0	(NOT USED)			
	1	(NOT USED)			
	2	(NOT USED)			
	3	(NOT USED)			

Example: To read the state, send the following query.

STATE?<LF>

Response: **STATE=<space>8300<LF>** *(Remote Mode, Power On, RF OFF, Power Save OFF, HIGH Band)*

2.4.6.8 RF Gain

Query to get the RF gain.

Syntax: **RFG?**

Parameters: None

Response Format: **RFG=<space>x<LF>**

Where:
x = 0000 to 0100

Example: To find out the RF gain of the amplifier, send the following query:

RFG?<LF>

Response: **RFG=<space>0075<LF>** *(75% Gain)*

2.4.6.9 Operating Hours (RF On)

Query to get the RF On operating hours.

Syntax: **OH?**

Parameters: None

Response Format: **OH=x<LF>**

Where:

x = **0** to **100000**

Units are Hours. Values can be up to six digits in length. Leading zeros are read as spaces.

Example: To find out the RF On operating hours, send the following query.

OH?<LF>

Response: **OH=<space><space><space><space>37<LF>** *(The system has spent 37 Hours in an RF On state)*

2.4.6.10 Operating Hours (Power On)

Query to get the Power On operating hours.

Syntax: **OHP?**

Parameters: None

Response Format: **OHP=x<LF>**

Where:

x = **0** to **100000**

Units are Hours. Values can be up to six digits in length. Leading zeros are read as spaces.

Example: To find out the Power On operating hours, send the following query.

OHP?<LF>

Response: **OHP=<space><space><space>428<LF>**

(The system has spent 428 Hours in a Power On state)

2.4.6.11 SBB (Piggyback) Firmware Revision

Query to get the firmware revision of the piggyback SBB assembly.

Syntax: ***SBB?**

Parameters: None

Query only (always requires a ? character)

Response Format: **SBB_SW_REVx<LF>**

Where:

x = firmware revision

Example: To get the firmware rev. of the piggyback SBB assembly, send the following command:

***SBB?<LF>**

Response: **SBB_SW_REV2.60<LF>**

2.4.6.12 System Serial Number

Query to get the serial number of the system.

Syntax: **SN?**

Parameters: None

Query only (always requires a ? character)

Response Format: **x<LF>**

Where:

x = serial number (6 to 8 characters)

Example: To get the serial number, send the following command:

SN?<LF>

Response: **1234567<LF>**

2.4.6.13 Band Selection

Allows the user to select the band of the amplifier

Syntax: **BANDy**

Parameters: Band(y):

L = low band

H = high band

Example: To select the low band, send the following command:

BANDL<LF>

2.4.6.14 AC Power-On Defaults

Default settings that are applied at AC mains power-on can be changed by adding the following prefix to select commands.

Syntax: **DEFAULT:**

Compatible commands:

Level Adjust

LEVEL:GAIN	
LEVEL:DET	**(Not available on all models)**
LEVEL:THR	**(Not available on all models)**
LEVEL:RESP	**(Not available on all models)**

Mode Select

MODE:MANUAL	**(Not available on all models)**
MODE:PULSE	**(Not available on all models)**
MODE:ALC<space>INT	**(Not available on all models)**
MODE:ALC<space>EXT	**(Not available on all models)**

NOTES:

1. *Use the command **DEFAULT:FACTORY** to reset all applicable settings back to their factory defaults.*
2. *All applicable defaults can be queried, except **DEFAULT:FACTORY**, by adding a ? character in place of the setting parameter.*
3. *If the ALC Lockout Feature (not available on all models) is engaged, the default ALC values set with this command will not be used.*

Example 1: To set the default RF Gain to 75%, send the following command:

DEFAULT:LEVEL:GAIN75<LF>

Example 2: To query the default RF Gain setting, send the following command:

DEFAULT:LEVEL:GAIN?<LF>

Response: **DEFAULT:LEVEL:GAIN75<LF>**

Example 3: To set the default mode to manual, send the following command:

DEFAULT:MODE:MANUAL<LF>

2.4.6.15 Faults

Query to find the faults that have occurred with the amplifier.

Syntax: **FSTA?**

Parameters: None

Response Format: **FSTA=<space>00xx**

Where:

xx = **00** to **17 (Hexadecimal)**

xx	Dec	Description
00	00	No Fault
02	02	Interlock
03	03	PS1
04	04	PS2
05	05	PS3
06	06	Thermal A2
07	07	Thermal A7
08	08	Thermal A6
09	09	Thermal A4
0A	10	PS2 Thermal
0B	11	PS3 Thermal
14	20	Amp A2
15	21	Amp A7
16	22	Amp A6
17	23	Amp A4

Example: To find out what faults have occurred, send the following query.

FSTA?<LF>

Response: **FSTA= 0002<LF>** *(Interlock Fault)*

3. THEORY OF OPERATION

3.1 INTRODUCTION

The Model 150/150AW1000 RF amplifier consists of a 0.01–100 MHz RF amplifier assembly and a 80 to 1000 MHz amplifier assembly.

The power supply section consists of an AC input filter, a switch, three switching power supplies, and a regulator circuit.

The control system consists of a Control/Fault Board, an Interface Board and remote interfaces for IEEE-488, RS-232, USB, and Ethernet.

3.2 RF AMPLIFIER OPERATION - 0.01-100 MHZ (Schematic 10046147)

The RF amplifier assembly consists of a Pre-Amplifier (Pre-Amp), and a 150 Watt, 100 MHz module.

3.2.1 A1 2W Pre-Amplifier Assembly (Schematic 10041189, 10041352, 10041055)

The 2W Pre-Amplifier Assembly consists of 3 sub-assemblies: the A1 Pre-Amplifier Assembly, the A2 Switch Assembly, and the A3 2W Amplifier Assembly.

3.2.1.1 A1 Pre-Amplifier Assembly (Schematic 10041189)

The Pre-Amplifier PWB Assembly consists of a variable attenuator circuit (Q1-Q4), a gain stage (U4), a resistive splitter (R13, R14, R16), an RF power detector (U6), and associated control circuitry. The overall gain of the pre-amplifier assembly is approximately 6-8 dB at minimum attenuation. The power detector (U6) is used to sense the input RF power and it increases the attenuation of the variable attenuator circuit if an input overdrive condition is detected.

3.2.1.2 A2 Switch Assembly (Schematic 10041352)

The Switch Assembly is made up of a variable attenuator circuit (Q1-Q4) and associated control circuitry. The switch can either be in an on or off state depending on the Inhibit input signal (E4). In the off state, when E4 is pulled low, the switch will reduce the amplifier gain by approximately 40 dB.

3.2.1.3 A3 2W Amplifier Assembly (Schematic 10041055)

The 2W Amplifier Assembly has two gain stages (U1 and Q1) that have a combined gain of approximately 30 dB. The output RF power is greater than 2W at the 1 dB compression point.

3.2.2 A2 150W 100MHz Module Assembly (Schematic 10039874)

The 150W 100MHz Module Assembly consists of RF matching circuits, an RF transistor (Q1), a bias control circuit, and a fault detection circuit.

The RF input is fed to a 4:1 balun transformer composed of T1 and T2. The output signal of the 4:1 transformer is connected to the gates of Q1. The drains of Q1 are connected to a 4:1 balun transformer composed of T3 and T4. Q1 has approximately +34 VDC applied to both drains at a total current of 8.5A. The RF stage has approximately 21 dB of gain and an output compression point of 110W or greater.

The current through Q1 is monitored by U1. The output of U1 is fed to an op amp (U3) which has a reference voltage on the non-inverting input. U3 compares the output of U1 to the reference voltage and generates an error signal. This error signal varies the gate voltages of Q1 which in turn controls Q1's current draw.

U5 is a comparator that monitors the output of U1 and generates a fault signal if the drain current varies outside normal operating conditions. It also monitors the module temperature via a thermistor (R31) and generates a fault signal if the module heatsink exceeds approximately 80^{o}C.

3.3 RF AMPLIFIER OPERATION- 80-1000 MHZ (SCHEMATIC 10046147)

The RF amplifier assembly consists of a Pre-Amplifier (Pre-Amp), a Driver Amplifier (Driver Amp), and a 20-watt amplifier.

3.3.1 A1 Variable Gain Amplifier (Schematic 10033908, 10031972, 10032111)

The A1 variable gain amplifier consists of 3 subassemblies: the A1 Pre-Amplifier PWB Assembly, the A2 High Isolation Switch Assembly, and the A3 Two-Watt Amplifier Assembly.

3.3.1.1 A1 Pre-Amplifier PWB Assembly (Schematic 10033908)

The Pre-Amplifier PWB Assembly consists of a stage of gain (U1), a variable attenuator (U2), a resistive splitter (R3, R5, R4), another stage of gain (U3) an RF power detector (U9) and control circuitry. The overall gain of the pre-amplifier assembly is approximately 17 dB at minimum attenuation. The power detector (U9) is used to sense the input RF power and it increases the attenuation of U2 if an input overdrive condition is detected.

3.3.1.2 A2 High Isolation Switch (Schematic 10031969)

The High Isolation switch is normally in the thru mode. The switch can reduce the amplifier gain by more than 40 dB when the pulse input (E4) is pulled low.

3.3.1.3 A3 Two-Watt Amplifier

The Two-Watt Amplifier has a gain of approximately 16 to 18 dB. The Two-Watt Amplifier increases the overall variable gain amplifier to approximately 31 to 32 dB of gain. The output RF power is approximately 30 dBm at the 1 dB compression point.

3.4 A4 DRIVER AMP

The A2 Driver amp consists of RF matching circuits, an RF transistor a DC current control circuit, a DC switching circuit and a fault detection circuit. The RF input is fed to a 4:1 transformer composed of T1, T2, and T3. The push-pull output signal of the 4:1 transformer is connected to the gates of push-pull connected Q1. The drains of Q1 are connected to a 4:1 transformer composed of T4, T4 and T6. The RF transistor, Q1, has approximately 24.1 VDC applied to the drains at 2.4 amps current for the driver and 4.8 amps total current draw. The RF stage has approximately 14dB of gain.

Voltage comparator U1 senses the presence of the –8 VDC. The output of U1 is high if the –8V supply is –5.5 or less. The output of U1 pulls low when the –8 volts is present turning on Mosfet Q2 which supplies the DC voltages to the drain of Q1.

The current through Q1 is monitored by U2. The output of U2 is fed to an op amp (U5) which has a reference voltage on the non-inverting input and it compares the output of U2 to the reference voltage and generates an error signal to vary the gate voltage of the RF transistor Q1 which controls the drain current.

U3 is a positive 5V regulator. It supplies DC to the current sense circuit, U2, the op amp, U5, and the fault detection circuit, U6. SW1 is a thermal switch. It closes at a heat sink temperature of approximately 70° to protect the module in the event of an over-temperature condition.

3.4.1 A5 Two-Way Splitter

The Two-Way splitter splits the input signal into two equal-amplitude, equal-phase signals. The amplitude of each signal is 3–3.5 dB below the input signal when both outputs are terminated into 50Ω loads.

3.3.3 A6, A7 W-Final Module

A6 and A7 W-Final Amps consists of RF matching circuits, an RF transistor a DC current control circuit, a DC switching circuit and a fault detection circuit.

The RF input is fed to a 4:1 transformer composed of T1, T2, and T3. The push-pull output signal of the 4:1 transformer is connected to the gates of push-pull connected Q1. The drains of Q1 are connected to a 4:1 transformer composed of T4, T4 and T6. The RF transistor Q1, has approximately 22.5 VDC applied to the drains at 4 amps current for the driver and 7 amps current for the finals. The RF stage has approximately 18 dB of gain for the finals and an output compression point of 50 watts or greater from final amplifiers A6 and A7.

Voltage comparator U1 senses the presence of the –8 VDC. The output of U1 is high if the –8V supply is –5.5 or less. The output of U1 pulls low when the –8 volts is present turning on Mosfet Q2 which suppliesthe DC voltages to the drain of Q1.

The current through Q1 is monitored by U2. The output of U2 is fed to an op amp (U5) which has a reference voltage on the non-inverting input and it compares the output of U2 to the reference voltage and generates an error signal to vary the gate voltage of the RF transistor Q1 which controls the drain current.

U3 is a positive 5V regulator. It supplies DC to the current sense circuit, U2, the op amp, U5, and the fault detection circuit, U6. SW1 is a thermal switch. It closes at a heat sink temperature of approximately 70° to protect the module in the event of an over-temperature condition.

3.3.4 Two-Way Combiner

The Two-Way combiner combines the output signals from the two W-Final modules into equal-amplitude, equal-phase signals. The amplitude of each signal is 3–3.5 dB below the input signal when both outputs are terminated into 50Ω loads.

3.4 POWER SUPPLY

Power supply PS1 supplies a +5VDC housekeeping supply for the control system assemblies A12 Control/Fault Board and A14 Interface Board. PS1 also supplies +5VDC to the A9 Regulator assembly.

PS1 also supplies +15 VDC at 2.5 amps to module A2. PS1 also supplies -15 VDC at 2.5 amps to module A1 through A4 and A6 and A7. PS1 supplies +24 VDC to fans B1 through B3. PS1 is a switching supply that automatically sets the AC input circuits to the correct connections for the line voltage 90-264 VAC input ranges 47-440 Hz.

Power Supply PS2 is a single output supply which provides +32 VDC to the A2 150 Watt module and to the A9 regulator board. Primary AC circuit protection is provided by the circuit breaker in the Power Entry Module.

Power Supply PS3 is a single output supply which provides +24 VDC to modules A4, A6 and A7. Primary AC circuit protection is provided by the circuit breaker in the Power Entry Module.

3.5 A9 REGULATOR BOARD (SCHEMATIC 10044666)

The A9 regulator board filters the +32 VDC and has one regulator for RF amplifier stage A1.

U2 is an adjustable, three-terminal, positive-voltage regulator capable of supplying +24 VDC at 5A.

3.6 CONTROL SYSTEM

3.6.1 A12 Control/Fault Board (Schematic 10042218)

The A12 Control/Fault board consists of one 16-bit microcontrollers and several other ICs that monitor and indicate the status of the amplifier. Power is supplied using only a single 5-volt power supply. The board offers the following:

Feature	Quantity
Open drain outputs	4
Digital outputs	6
Digital inputs (5-volt tolerant)	24
Analog outputs	2
2-channel encoder input	1
Inputs for a keypad	6
Display connectors	1
Serial communication jacks	2

3.6.2 A14 Interface Board (Schematic 10020073)

4. MAINTENANCE

4.1 GENERAL MAINTENANCE INFORMATION

The Model 150/150AW1000 requires very little maintenance since it is a relatively simple instrument. It is built with etched circuit wiring and solid state devices that will ensure long, trouble free life. However, should trouble occur special care must be taken in servicing to avoid damage to the devices or the etched circuit board.

Since the components are soldered in place, substitution of components should not be resorted to unless there is some indication that they are faulty. In addition, take care when troubleshooting, not to short voltages across the amplifier. Small bias changes may ruin the amplifier due to excessive dissipation or transients.

Components in AR instruments are conservatively operated to provide maximum instrument reliability. In spite of this, parts within an instrument may fail. Usually, the instrument must be immediately repaired with a minimum of down time. A systematic approach can greatly simplify and, thereby, speed up the repair.

However, due to the importance of the amplifier's alignment, it is recommended that when failure is caused by breakdown of any of the components in the signal circuits, the amplifier be returned to the factory for part replacement and amplifier realignment. Shipping instructions are as follows.

To return an item, contact AR Customer Service for an RMA number and shipping instructions. Returns from outside the United States are not permitted without prior authorization. If shipping from outside of the United States, closely follow all directions on the RMA form for return shipping and marking. See warranty statement at rear of manual.

4.2 DISASSEMBLY PROCEDURE

CAUTION:

Extreme caution should be exercised when troubleshooting this unit, particularly when measuring voltages in the power supply section of the unit. Hazardous voltages do exist in the unit that could cause serious injury to any personnel performing the measurements.

The amplifier can be removed from the housing by removing four screws from the front panel and four screws from the rear securing brackets. The amplifier can then be slid from the housing. The top and side covers can be removed to gain access to the RF assemblies. The power supply and remote interfaces are accessible by removing the bottom cover.

4.3 TROUBLESHOOTING

CAUTION:

The microwave transistors used in the Model 150/150AW1000 amplifier are GaN/GaAs FETs. These devices are very reliable when installed in a suitable circuit, but they can be easily damaged by improper troubleshooting or handling techniques.

The gate junctions of the GaN/GaAs FETs have a high input impedance and are susceptible to static damage or damage due to the use of an ungrounded soldering iron. Do not try to check the GaAs FETs with an ohmmeter.

Use caution when troubleshooting the GaN/GaAs FETs; do not short the gate to the ground or to the drain.

CAUTION:

Use care when unpacking new GaN/GaAs FETs. The GaN/GaAs FET packaging should only be opened at Electrostatic Discharge (ESD)-approved workstations, by individuals who are familiar with the handling of microwave GaN/GaAs FETs and other ESD-sensitive devices.

Troubleshooting the Model 150/150AW1000 in a logical manner can speed the solution to a problem. The settings of potentiometers (pots), capacitors (caps), or other variables should not be disturbed until other problems have been eliminated. Comparing the measured DC voltages to those shown on the schematics can solve many problems. Before measuring circuit voltages, first verify that the voltages to the circuits are correct.

Model 150/150AW1000 troubleshooting symptoms and remedies are described in the sections that follow

- 4.3.1 General Fault Reading
- 4.3.2 The Unit Cannot be Operated Remotely
- 4.3.3 Thermal Fault Lo Band
- 4.3.4 Thermal Fault Hi Band
- 4.3.5 Interlock Fault
- 4.3.6 PS1 Fault
- 4.3.7 PS2 Fault
- 4.3.8 PS3 Fault
- 4.3.9 Lo Band Amplifier Fault
- 4.3.10 Hi Band Amplifier Fault
- 4.3.11 Lo Band Low or No Power Output (DC Tests)
- 4.3.12 Hi Band Low or No Power Output (DC Tests)
- 4.3.13 Lo Band Low or No Power Output (RF Test)
- 4.3.14 Hi Band Low or No Power Output (RF Test)

4.3.1 General - Reading Faults

The Model 150/150AW1000 incorporates relatively simple fault detection circuitry, which makes use of the digital display panel to alert the user or technician which component(s) need service. Use of these indications can usually expedite troubleshooting of the amplifier. Most faults can be immediately determined down to the assembly level. If a reset is still indicated, turn off the RF power signal to the input of the amplifier, read and record the fault indication displayed on the digital control panel for later reference. Then, use the RESET function to see if the fault clears. If the fault clears, slowly bring the amplifier's drive level back up and ensure that recommended RF power levels are not exceeded. If the fault indication is no longer visible, the fault may have been brought about by a temporary transient condition, component thermal condition or excessive RF drive to the amplifier's input. If the fault does not clear with the RF drive off, some other problem exists in the amplifier.

4.3.2 The Unit Cannot Be Operated Remotely

1. Verify that the front panel LOCAL/REMOTE switch is set to the REMOTE position.
2. Verify that the unit operates locally by resetting the LOCAL/REMOTE switch to the LOCAL position; if the unit does not operate locally, see 4.3.1 of this manual.
3. Check the position of the ADDRESS via the control software on the front panel touch screen as shown in Figure 2-3 herein. Check to see that these switches are properly set for either RS-232 or IEEE-488 operation, as desired. (See Section 2 of this manual for the proper ADDRESS settings.)

4.3.3 Thermal Fault-Lo Band (Schematic 10046147, 10039874)

1. During a Thermal Fault, the front panel touch screen interface should read Ax THERMAL FAULT.
2. Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fans (B1 thru B3) are operating normally and that the air inlet on the bottom of the unit and the air outlets on the rear of the unit are not blocked.
3. If the unit does not reset and the cooling fans are operating normally, check the voltage at the A12A3 Control/Fault Board, J5, Pins 23 thru 26 should be ≤0.1V.
4. If the voltage on A12A3 J5, pin 23 thru 26 is high, check the connection through S1 to ground.

4.3.4 Thermal Fault Hi Band (Schematic 10046147, 10045396)

1. During a Thermal Fault, the front panel touch screen interface should read Ax THERMAL FAULT.
2. Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fans B1 thru B3 are operating normally and that the air inlet on the bottom of the unit and the air outlets on the rear of the unit are not blocked.
3. If the unit does not reset and the cooling fans are operating normally, check the voltage at the A12A3 Control/Fault Board, J11, Pin 3; it should be ≤0.1V.
4. If the voltage on A12A3 J5, Pin 3 is high, check the connection through S1 to ground.

4.3.5 Interlock Fault (Schematic 10046147)

The Model 150/150AW1000 is equipped with an interlock connector, which is located on the rear panel. The interlock circuit can be used to sense the openings of doors to screen rooms, test chambers, and so forth, and to turn off RF energy when these doors are opened.

NOTE: The Model 150/150AW1000 is shipped with a mating connector, which has a jumper between Pins 1 and 8, installed in the rear panel interlock connector. The unit will not operate unless the interlock circuit is closed.

1. In the event of an Interlock Fault, the front panel touch screen should read INTERLOCK FAULT**.**
2. Check to see if it is safe to be power up the unit—are there personnel present in the screen room, or are doors to the screen room open?
3. After checking for safety, try to clear the Interlock Fault from the front panel by using the RESET switch.
4. If the Interlock Fault will not clear, check for continuity in the External Interlock Circuit (Pin 1 to Pin 8 in the connector, which mate with P1 in the rear panel).
5. Check the voltage on A12A3 J5, pin 30; it should be $\leq$ 0.1V.
6. If the voltage on A12A3 J5, pin 30 is high, check the interlock line to ground.

4.3.6 PS1 Fault (Schematic 10046147)

The PS1 power supply has DC Fault output which is normally low ($\leq$ 0.1V) to the A12A3 J5, pin 29. If any of the PS1 outputs fail, this output will go high ($\geq$ 4.0V) and will report a fault.

4.3.7 PS2 Fault (Schematic 10046147)

The PS2 power supply has DC Fault output which is normally low ($\leq$ 0.1V) to the A12A3 J5, pin 28. If any of the PS2 outputs fail, this output will go high ($\geq$ 4.0V) and inhibit the A1 Pre-Amplifier.

PS2 also has a Thermal Fault output which is normally low ($\leq$ 0.1V) to the A12A3 J5, pin 22. If the temperature of PS2 rises above 70°C, a Thermal Fault will be reported

4.3.8 PS3 Fault (Schematic 10046147)

The PS3 power supply has DC Fault output which is normally low ($\leq$ 0.1V) to the A12A3 J5, pin 27. If any of the PS3 outputs fail, this output will go high ($\geq$ 4.0V) and inhibit the A2 Driver Amplifier.

PS3 also has a Thermal Fault output which is normally low ($\leq$ 0.1V) to the A12A3 J5, pin 21. If the temperature of PS3 rises above 70°C, a Thermal Fault will be reported

4.3.9 Lo Band Amplifier Fault (Schematic 10046147, 10039874)

1. The fault output of the A2 module is sensed on A3A12, J5, pin 26.
2. Verify the correct voltages to the modules. Troubleshoot any incorrect voltages.

   FL1 = +32 ± 0.2V
   FL4 = +15 ± 0.2V
   FL5 = -15 ± 0.2V

4.3.10 Hi Band Amplifier Fault (Schematic 10046147, 10045396)

1. The fault output of the A4, A6 and A7 modules is sensed on A12A3, J5, pins 23 thru 25.
2. Verify the correct voltages to the modules. Troubleshoot any incorrect voltages.

C50	+24.0 V	±0.3 V
C51	–15.0 V	±0.3 V

4.3.11 Lo Band Low or No Power Output (DC Tests) (Schematic 10046147)

All indicators on the Model 150/150AW1000 are normal, the front panel touch screen reads **Power On**, and the cooling fans (B1, B2 and B3) are operating.

1. Check the position of the RF Gain control—is it set to maximum gain?
2. Check the RF input to the unit—is it the correct amplitude and frequency?
3. Check the RF output connection from the unit—is it correctly connected to the load? Is the coaxial cable okay?
4. Check the following voltages on the Power Supply. If any of the voltages are out of tolerance, correct them before further troubleshooting.

   PS1 J1 Pin 1 +15 V ±0.2 V
   PS1 J1 Pin 13 -15 V ±0.2 V

5. Check the voltage on the feed thru caps of the A2 Module. Troubleshoot any incorrect voltage.

FL1	+32 V	±0.2 V
FL4	+15 V	±0.2 V
FL5	-15 V	±0.2 V

6. Check the voltage on the feed thru caps of the A1 Pre-Amp, with the RF gain control at maximum gain. Troubleshoot any incorrect voltages.

FL2	+24 V	±0.5 V
FL3	-15 V	±0.5 V
FL4	+4.7 V	±0.5 V

4.3.12 Hi Band Low or No Power Output (DC Tests) (Schematic 10046147)

All indicators on the Model 150/150AW1000 are normal, the front panel touch screen reads **Power On**, and the cooling fans B1, B2 and B3 are operating.

1. Check the position of the RF Gain control—is it set to maximum gain?

2. Check the RF input to the unit—is it the correct amplitude and frequency?

3. Check the RF output connection from the unit—is it correctly connected to the load? Is the coaxial cable okay?

4. Check the following voltages on the Power Supply. If any of the voltages are out of tolerance, correct them before further troubleshooting.

PS1 J1 Pin 13	-15 V	±0.5 V
PS3 Out	-24 V	±0.5 V

5. Check the voltage on the feed thru caps of the A1 Pre-Amp, with the RF gain control at maximum gain. Troubleshoot any incorrect voltages.

C1	+24.0 V	±0.5 V
C2	–15.0 V	±0.5 V
C3	+4.7 V	±0.5 V

6. Check the voltages on the feed-thru caps of A2, A6 and A7.

C50	+24.0 V	±0.3 V
C51	–15.0 V	±0.3 V

4.3.13 Lo Band Low or No Power Output (RF Test) (Schematic 10046147)

NOTE: The DC Tests specified in Section 4.3.10 should be completed before conducting the RF tests specified in the following sections.

1. The Lo Band (.01-100 MHz) typical gain response at 0 dBm input and -20 dBm input is shown in Figure 4-1. The actual gain may vary considerably from that shown in Figures 4-1 and 4.2 but should be ≥ 51.7 dB at 0dBm input and ≥ 56 dB at –20 dBm input.

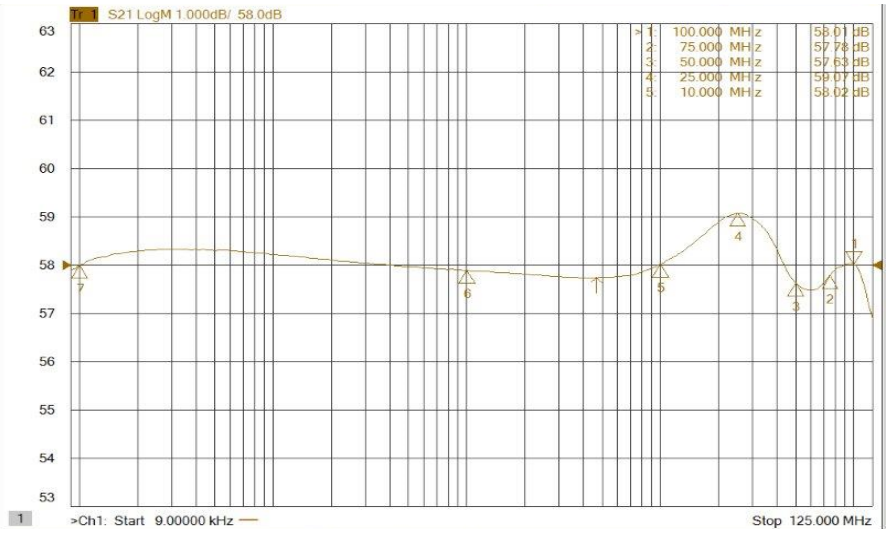


Figure 4-1. Typical Response at –20dBm Input

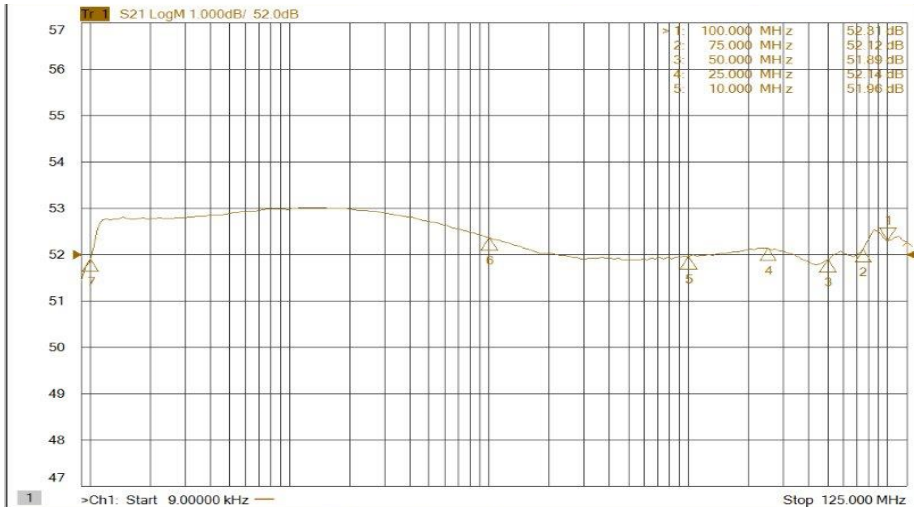


Figure 4-2. Typical Response at 0dBm Input

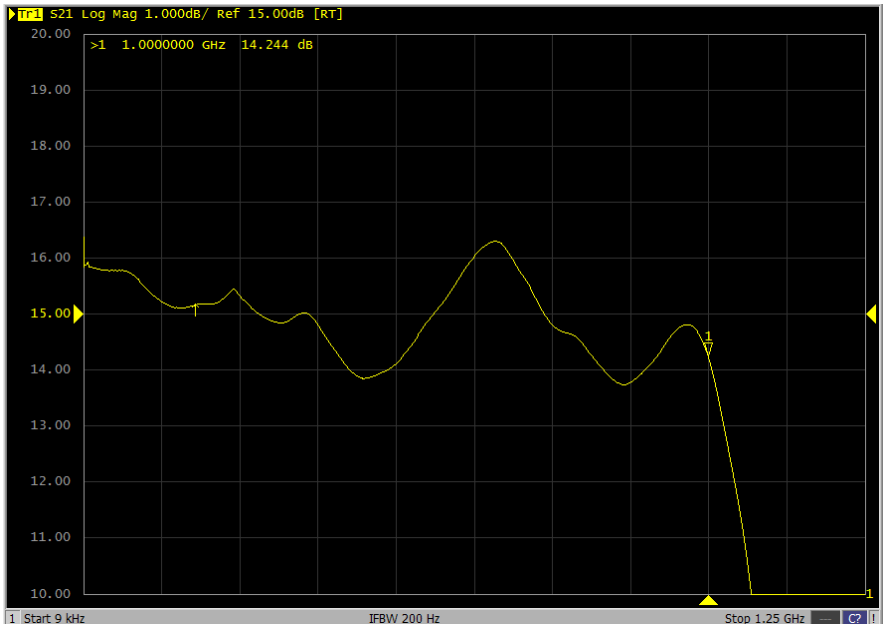


Figure 4-3. Typical Gain Response of 100W Module

2. The typical response for the A1 Pre-Amplifier (at maximum gain setting) is shown in Figure 4-4.

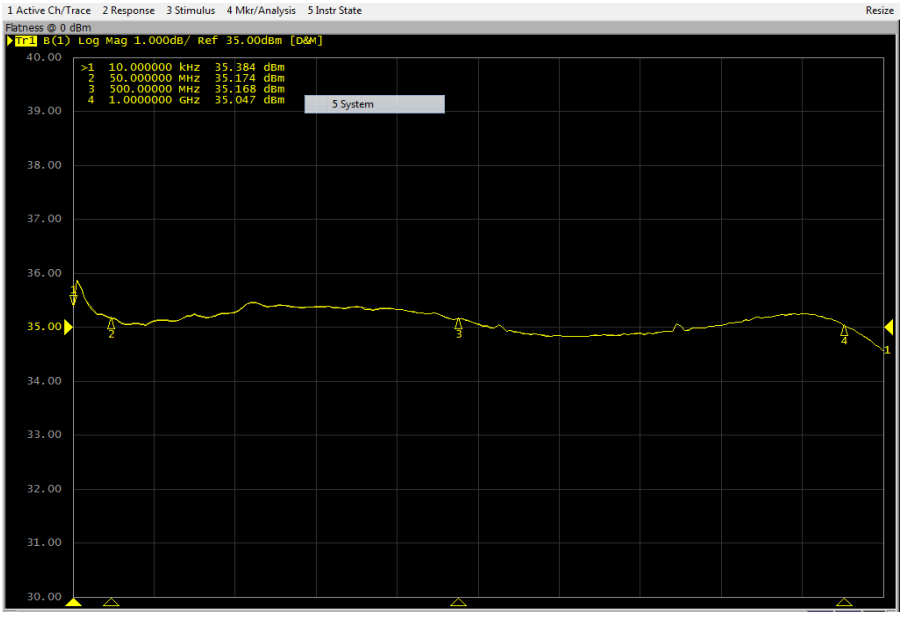


Figure 4-4. Typical A1 Pre-Amplifier Response

4.3.14 Hi Band Low or No Power Output (RF Test) (Schematic 10046147)

1. The Hi Band (80 to 1000 MHz) typical gain response at 0dBm input and –20dBm input is shown in Figure 4-5 And 4-6. The actual gain may vary considerably from that shown in Figures 4-5 and 4-6, but should be > 51.7 dB at 0 dBm input and > 57 dB at -20 dBm input.

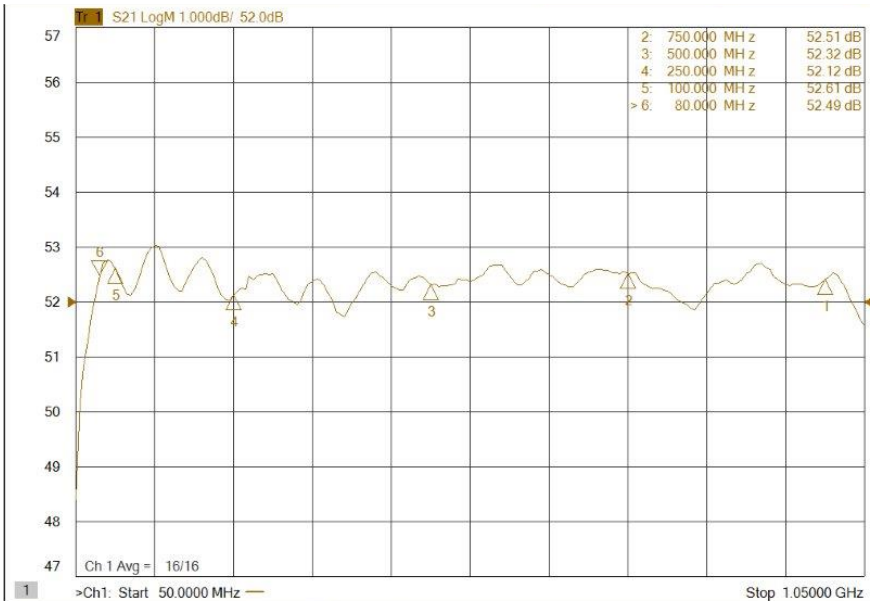


Figure 4-5. Hi Band Typical Gain Response at 0 dBm input.

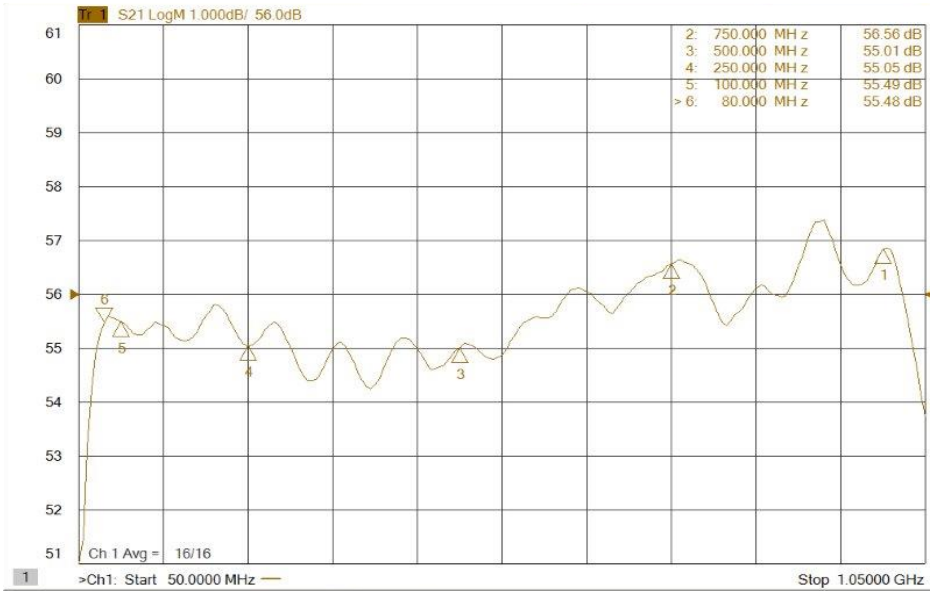


Figure 4-6. Hi Band Typical Gain Response at -20 dBm input.

Phase matching must be maintained from the input of the A5 Two-Way Splitter to the inputs of the A8 Two-Way Combiner; if coaxial cables are removed, they must be reinstalled in the same locations from which they were removed. Replacement coaxial cable assemblies must the same lengths as the original ones.

*NOTE: If the original gain is low, the amplifier chain can be separated at the input to the A5 Two-Way Splitter and the gain checked from the input to the A5 Two-Way Splitter to the **RF OUTPUT** connector on the unit's front panel.*

2. Remove the coaxial cable from the output of the A2 Driver Amplifier to the input of the A5 Two-Way Splitter. The typical response from the input of the A5 Two-Way Splitter to the RF OUTPUT connector on the unit's front panel is shown in Figure 4-7.

   If the response is normal, see Step 5. If the response is abnormal, perform the following tests.

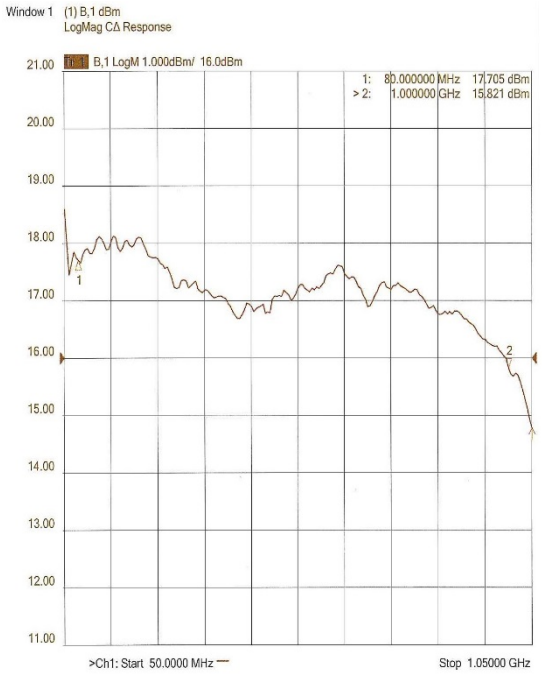


Figure 4-7. Typical Response: Input A5–Front Panel RF Output

3. If the gain is slightly low (i.e., several dB below typical), try disconnecting the inputs from the A6 and A7 Final Module one at a time, then reconnect them. Note the difference in response when disconnecting the module; if any module causes less of a change in gain than the others, check the module and the coaxial cable associated with that module. Typical module response is shown in Figure 4-8.

Figure 4-8. Typical Module Response

4. If the typical gain response to each module (A6 and A7) is normal check the 2-way splitter (A3) and the 2-way combiner (A8) for proper performance.

5. The typical response for the A4 Driver Module Amplifiers is shown in Figure 4-9.

Figure 4-9. Typical A4 Driver Module Response

NOTE: The A3 Pre-Amplifier's response may differ considerably—particularly in flatness—from the typical responses shown in the Figure 4-11.

6. The typical response for the A3 Pre-Amplifier (at maximum gain setting) is shown in Figure 4-10.

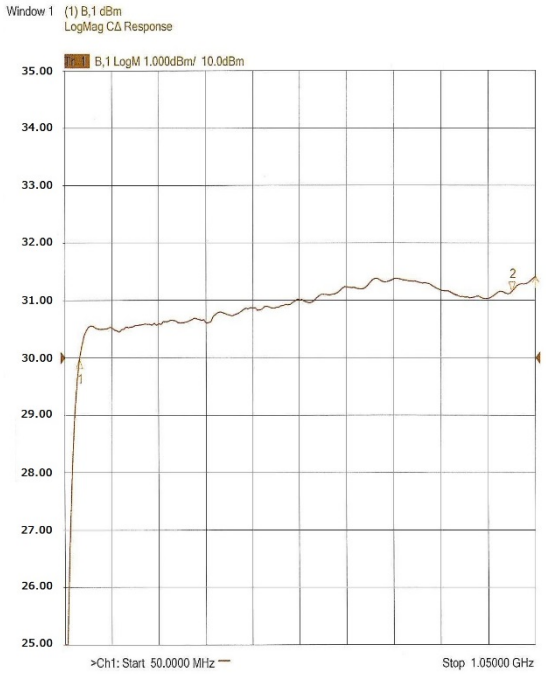


Figure 4-10. Typical A1 Pre-Amplifier Response

WARRANTIES: LIMITATION OF LIABILITY

Seller warrants (i) that seller has title to the goods sold and (ii) that Amplifiers (all parts excluding traveling wave and vacuum tubes), Antennas, field monitors, field probes, field analyzers, field analyzer processor units, system controllers, system interlock, power meters, leak detectors, RF conducted probes, RF conducted clamps, Multi-tone, EMI receiver systems, RF down converters, RF conducted immunity systems, conducted immunity accessories, radiated immunity test systems, safety meters, safety sensor heads, tripods, directional couplers, waveguide adapters, termination loads, load attenuators, impedance stabilization networks, and coaxial cables will be free from defects in material and workmanship for a period of three (3) years from date of shipment shown on AR RF/Microwave Instrumentation invoice.

All modules, used in the amplifiers for the 1-6 GHz, 4-18 GHz, 6-18 GHz, all HPM products, and other applications, are hermetically-sealed. This sealing process protects the internal hybrid circuitry from humidity that could compromise the long term reliability of the product. These modules are not field-repairable and should *never* be opened outside of AR's Microelectronics Lab. The modules in these product lines have a security label on two sides of the modules between the housing and lid/cover. If the security label is removed and or cut, the warranty of the module will be voided.

Vacuum tubes in the 'L' series amplifiers, traveling-wave tubes in TWT amplifiers, and power heads will be free from defects in material and workmanship for a period of one (1) year.

Contact AR RF/Microwave Instrumentation for warranty information regarding items not listed.

Seller's sole responsibility in fulfilling these warranties shall be to repair or replace any goods which do not conform to the foregoing warranties or, at seller's option, to give buyer credit for defective goods. The warranty is valid only when used in the country specified at time of order. Warranty service must be obtained from the repair facility designated at that time. If warranty service is not available in the country where the equipment is to be used, it must be returned to AR RF/Microwave Instrumentation. Warranty service will be provided only for defective goods which are returned within the warranty period, freight costs prepaid to AR RF/Microwave Instrumentation or its designated repair facility.

There are no other warranties, express or implied, including any warranty of merchantability or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.

No person other than an officer of Amplifier Research Corporation, has any authority to bind seller to any affirmation, representation or warranty except as specifically included in the preceding terms and conditions.

Rev 1216