rf/microwave instrumentation

Operating and Service Manual

681

Model

10029616

Part Number

Serial Number

EXPORT CONTROLLED DATA.
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rf/microwave instrumentation

Declaration of Conformity

Issue Date: July 28, 2009
Model #/s: 681
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 2004/108/EC
Reference standards:

EN 61326:2006 Electrical equipment for measurement, control and laboratory use–EMC requirements

CISPR 11 Edition 4:2003	Conducted Emissions, Group 1, Class B
CISPR 11 Edition 4:2003	Radiated Emissions, Group 1, Class B
IEC 61000-3-2:2000	Harmonics
IEC 61000-3-3:2002	Flicker

EN 61326:2006 Electrical equipment for measurement, control and laboratory use–Immunity requirements

IEC 61000-4-2:2001	Electrostatic Discharge
IEC 61000-4-3:2002	Radiated Immunity
IEC 61000-4-4:2004	EFT/Burst, Power Leads
IEC 61000-4-5:2001	Surge Immunity
IEC 61000-4-6:2003	Conducted Immunity, Power Leads
IEC 61000-4-11:2004	Voltage Dips and Interrupts

LVD Directive 2006/96/EC
Reference standards:

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use.

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:

Donald R. Shepherd
President

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 89/336/EEC. The equipment must therefor be operated in a shielded area which provides a sufficient level of attenuation to meet the radiated emissions and immunity specifications. All AC, DC and Control lines connected to the equipment and entering or exiting the shielded area must have sufficient isolation to meet the conducted 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	Minimum line isolation
100 watts	50 dB	50 dB
101 - 1000 watts	60 dB	60 dB
1001 - 10,000 watts	70 dB	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 89/336/EEC notwendig ist. Das Gerät muß deshalb in einem geschirmten Raum betrieben werden, welcher eine ausreichenden Schirmung bietet, um die Emissions- und Störfestigkeitsspezifkation einzuhalten. Alle Wechsel- und Gleichspannungsleitungen sowie Steuerleitungen, die mit dem Gerät verbunden sind und in den geschirmten Raum von außen hereingeführt werden, müssen ausreichend gefiltert sein, um die Emissionsspezifkation einzuhalten. Es werden folgenden Minimalwerte der Schirmdämpfung und Filterung in den unterschiedlichen Leistungsklassen empfohlen.

Hochfrequenzleistung	min. Schirmdämpfung	min Filterdämpfung
100 Watt	50 dB	50 dB
101-1000 Watt	60 dB	60 dB
1001-10.000 Watt	70 dB	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 89/336/EEC 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. Toutes les alimentations alternatives, continues ainsi que les liaisons de contrôle connectées à cet équipement, qui entrent ou sortent de cette enceinte doivent avoir une isolation suffisante pour satisfaire aux spécifications concernant les émissions conduites et d'immunité. 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	Isolation minium de la ligne
100 Watts	50 dB	50 dB
101 à 1.000 Watts	60 dB	60 dB
1.001 à 10.000 Watts	70 dB	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

BEFORE APPLYING POWER

Review this manual and become familiar with all safety markings and instructions.

Verify that the equipment line voltage selection is compatible with the main power source.

Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications. It is designed to be used in the process of generating, controlling, and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore, the output of the amplifier must be connected to an appropriate load such as an antenna or field-generating device. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. 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.

SAFETY GROUND

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

PHYSICAL DAMAGE

The RF amplifier should not be operated if there is physical damage, missing hardware, or missing panels.

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.

SAFETY SYMBOLS

This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information.

Dangerous voltages are present. Use extreme care.

CAUTION: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.

Indicates protective earth terminal.

RANGE OF ENVIRONMENTAL CONDITIONS

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.

COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

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1. GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Model 681 is a self-contained, broadband microwave 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 681, used with a frequency-swept signal source, will provide rated power output from 0.7–4.2 gigahertz (GHz) (See Specification Sheet at the end of this section for more details). 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 681 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 681 include the following:

- **A Digital Control Panel (DCP)** 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.
- **RF output level protection.**
- **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 681 contains two switching power supplies. The input voltage range to the power supplies is 90–264 VAC, 50-60Hz, selected automatically. The AC input power, combined for these two supplies is approximately 900 watts.

PS1 has a +5 volt, standby supply for the A22A1 Control/Fault board and the A23A1 Interface board used for the remote interfaces. The +5 volt supply is also for operation of the A21 ALC board.

PS1 is a multiple output supply. The main +26.8V, 10A supplies voltage to the RF low level and the first driver quad amp. The +24V, 7A is for operating the cooling fans and the –24 volts DC is supplied to the (A20) Regulator board and the A1 preamplifier.

PS2 is a single output supply. The main +26.8V, 27A supplies voltage to the RF final stages. Primary AC circuit protection is provided by the circuit breaker in the Power Entry Module.

1.4 PROTECTION CIRCUITS

Features incorporated into this unit include RF output level protection circuits, thermal protection circuits, and internal DC level sensing and monitoring circuits that sense the voltage on each of the final and driver amplifier modules. There is protection for the AC main circuit. Both switching supplies are short circuit protected. Reaching a threshold of either of the RF forward (incident) or reverse (reflected) power limit adjustments, which are adjusted to approximately 225 watts and 200 watts respectively, will initiate limiting, or smooth drive level fold-back, in a low-level stage of the amplifier chain. If the limiting circuits cannot keep the amplifier's levels below the limit threshold, the protection circuits will invoke a shutdown of the main power supplies and low-level driver in the amplifier. Power amplifier modules are monitored for both over-current and under-current. A **RESET** function is provided to permit re-powering of the amplifier in case of transient or temporary activation of the amplifier's protection circuitry. The low-level driver and output amplifier subassemblies are thermally monitored.

The digital control panel monitors all fault signals, stores and displays any that are invoked and asserts the required action.

1.5 INSTALLATION

Before proceeding, thoroughly inspect the amplifier for signs of physical damage that may have been incurred during shipment and completely read the following installation and operating instructions, paying special attention to all **CAUTION** notes.

1.5.1 Location

Select an operating location that will permit air to circulate freely around the amplifier's cabinet. The Model 681 utilizes air cooling and should be located where the normal flow of air into or exiting from the unit will not be restricted, diverted, or re-circulated through the unit itself; in particular, the flow of warm air exiting the rear of the amplifier should not be impeded.

Do not position the unit next to a wall or other equipment that would restrict the flow of air into the bottom of the unit or out of the rear of the unit.

1.5.2 Power

The Model 681 is designed to operate using AC primary power of 90–264 Volts Alternating Current (VAC), 47–63 Hz single phase, 900 watts maximum.

CAUTION:

Dangerous voltages are present in the Model 681 whenever the unit is plugged into an AC outlet. Always disconnect the unit from the main power line when servicing it. Please note that neither the Keylock Switch nor the POWER switch will completely shut off the unit's AC power.

rf/microwave instrumentation

Model 681, M1
180-200 Watts CW
0.7GHz–4.2GHz

The Model 681 is a portable, self-contained, air-cooled, broadband, completely solid-state amplifier designed for applications where instantaneous bandwidth, high gain and linearity are required. Push-pull circuitry is utilized in all high power stages in the interest of lowering distortion and improving stability. The Model 681, when used with a sweep generator, will provide 180-200 watts minimum over frequency range.

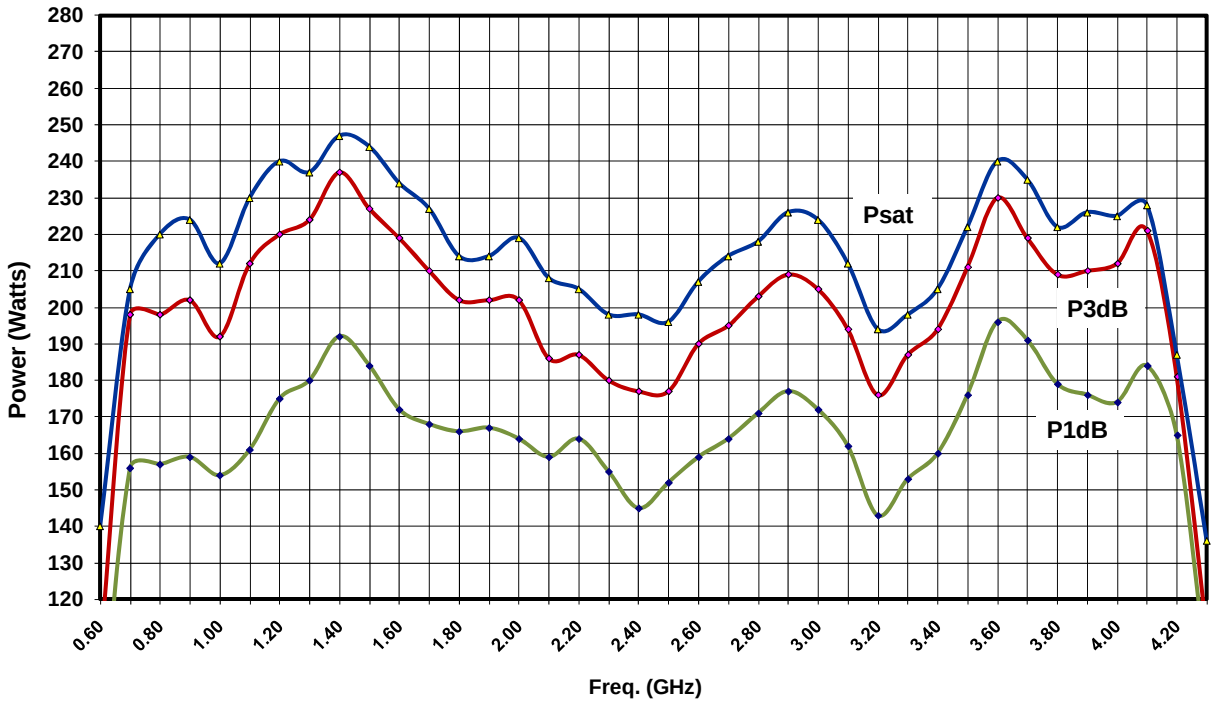
The Model 681 is equipped with a Digital Control Panel (DCP) which provides both local and remote control of the amplifier. The DCP uses a digital display, menu assigned softkeys, a single rotary knob, and four dedicated switches (POWER, STANDBY, OPERATE and FAULT/RESET) to offer extensive control and status reporting capability. The display provides operational presentation of Forward Power and Reflected Power plus control status and reports of internal amplifier status. Special features include a gain control and RF output level protection.

All amplifier control functions and status indications are available remotely in GPIB/IEEE-488 format, RS232 hardwire and fiber optic, USB and Ethernet. The buss interface connector is located on the back panel and positive control of local or remote operation is assured by a keylock on the front panel of the amplifier.

The low level of spurious signals and linearity of the Model 681 make it ideal for use as a driver amplifier in testing wireless and communication components and subsystems. It can be used as a test instrument covering multiple frequency bands and is suitable for a variety of communication technologies such as CDMA, W-CDMA, TDMA, GSM etc. It is also suitable for EMC Test applications where undistorted modulation envelopes are desired.

The export classification for this equipment is 3A001. These commodities, technology or software are controlled for export in accordance with the U.S. Export Administration Regulations. Diversion contrary to U.S. law is prohibited.

MODEL 681 TYPICAL POWER OUTPUT



SPECIFICATIONS, 681

RATED POWER OUTPUT ..... 200 watts typical
190 watts minimum, 0.7-3.0 GHz; 180 watts minimum, 3.0-4.2 GHz
200 watts minimum, 728–960 MHz
1475–1559 MHz
1805–1990 MHz
2010–2170 MHz
2570–2690 MHz

INPUT FOR RATED OUTPUT ..... 1.0 milliwatt maximum

POWER OUTPUT @ 3dB COMPRESSSION
- Nominal ..... 190 watts
- Minimum ..... 160 watts minimum

POWER OUTPUT @ 1dB COMPRESSION
- Nominal ..... 165 watts
- Minimum ..... 125 watts minimum

FLATNESS ..... ±1.5 dB typical
±2.0 dB maximum

FREQUENCY RESPONSE ..... 0.7–4.2 GHz instantaneously

GAIN (at maximum setting) ..... 52.6 dB minimum

GAIN ADJUSTMENT ..... (Continuous Range), 15 dB minimum, (4096 steps remote)

INPUT IMPEDANCE ..... 50 ohms, VSWR 2.0:1 maximum

RF POWER DISPLAY ..... 0–250 Watts

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

THIRD ORDER INTERCEPT ..... 60 dBm typical

HARMONIC DISTORTION ..... Minus 20 dBc, maximum at 175 watts

SPURIOUS ..... Minus 73 dBc typical.

PRIMARY POWER (Selected Automatically) ..... 90-132, 180-264 VAC, 50/60 Hz, single phase, 1050 watts maximum

CONNECTORS
- RF Input ..... N female, See Model Configurations
- RF Output ..... N female, See Model Configurations
- REMOTE INTERFACES
  - IEEE-488 ..... 24 pin
  - RS-232 ..... 9 pin Subminiature D
  - RS-232 (fiber optic) ..... Type ST
  - USB 2.0 ..... Type B
  - Ethernet RJ-45

SAFETY INTERLOCK ..... 15 pin Subminiature D

COOLING ..... Forced air (self contained fans)
- Maximum Operating Temperature ..... 32°C

WEIGHT ..... 34.5 kg (76 lbs)

SIZE (W x H x D) ..... 48.3 x 26.7 x 61cm (19.0 x 10.5 x 24in)

EXPORT CLASSIFICATION 3A001

MODEL CONFIGURATIONS

Model	RF Input Connector	RF Output Connector
681	Front Panel	Front Panel
681M1	Rear Panel	Rear Panel

2. OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the Model 681 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 681 Amplifier is *typically* not critical in regard to source and load Voltage Standing Wave Ratio (VSWR) and will remain unconditionally stable with any magnitude and phase of source and load VSWR. *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 681'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 681 Amplifier is protected from input overdrive by an automatic level control circuit which will limit the maximum RF level to the first gain stage (U2) of the RF Amplifier to approximately 0 dBm. The 681 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 CONTROL AND INDICATOR FUNCTIONS

The Model 681's front panel is shown in Figure 2-1; the unit's rear panel features are detailed in Figure 2-2.

2.2.1 Keylock Switch

The Keylock Switch is provided for protection from unauthorized use or unexpected remote control of the amplifier. The amplifier can only be turned on locally when the Keylock Switch is in the **LOCAL** position. Likewise, the unit can only be turned on or controlled remotely when the Keylock Switch is in the **REMOTE** position. Placing the Keylock Switch in the **INHIBIT** position places the amplifier in the off mode and prohibits any control of the amplifier.

2.2.2 POWER Switch

The momentary **POWER** switch turns the main power to the amplifier on and off. The status of the green light-emitting diode (LED) in the switch indicates whether the amplifier's power is on or off. The main power supply fans are active when power is on. The graphic display is active as long as the main power circuit breaker of the amplifier power entry module is on.

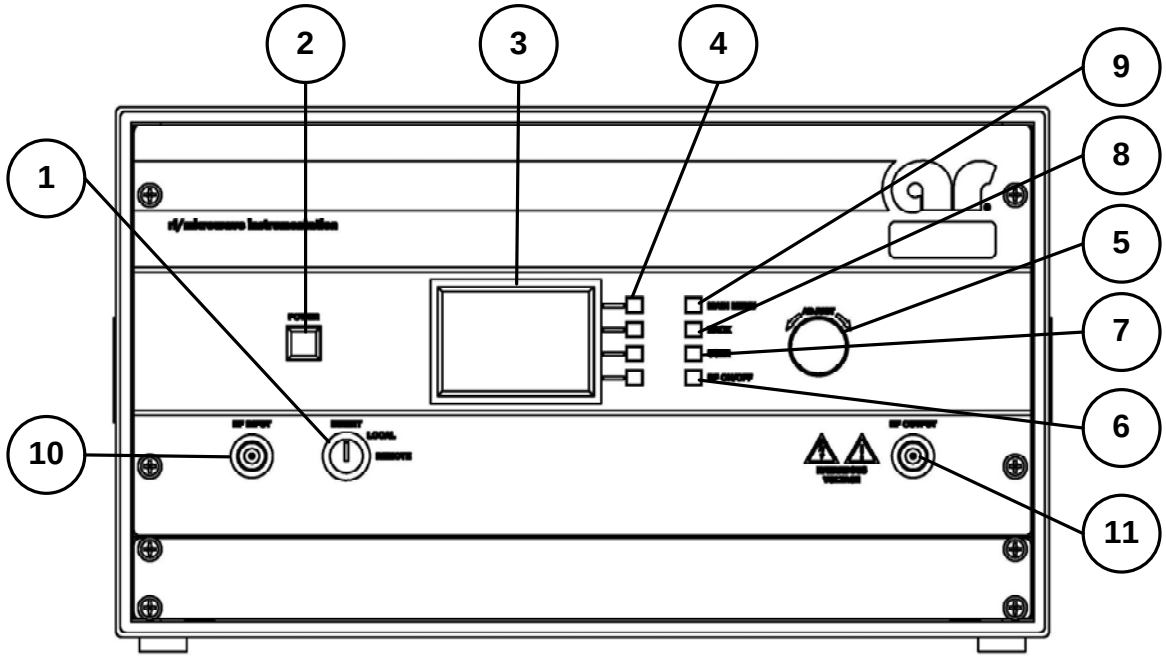


Figure 2-1 Digital Control Panel (DCP) Features

Item	Title	Function
1	INHIBIT, LOCAL, REMOTE	Keylock Switch, 3-position; key removal in INHIBIT position only
2	POWER	POWER control with indicator LED
3	DISPLAY	Numerous parameter values and fault messages
4	SOFT-KEYS	Soft-keys 1–4 (#1 top, #4 bottom) (Function varies with menu)
5	ADJUST	Adjust knob to change selected variables
6	RF ON/OFF	RF Control button
7	USER	Access User screen
8	BACK	Returns user to previous menu
9	MAIN MENU	Returns user to the main menu
10	RF INPUT	Type N female connector
11	RF OUTPUT	Type N female connector

2.2.3 Main Power

The Main Power circuit breaker is located on the rear panel of the amplifier.

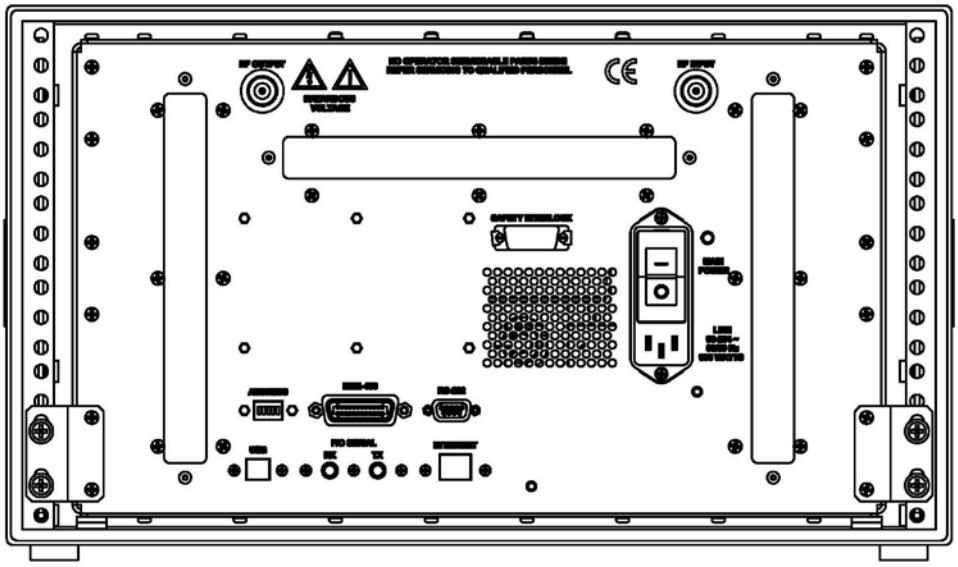


Figure 2-2. Rear Panel Features

2.2.4 RF ON/OFF

The RF ON/OFF button toggles the amplifier from a Standby to an Operate mode. The status of the function is indicated on the display as RF ON or RF OFF. In the RF ON state, RF output is enabled according to control settings and amplifier RF input. Main cooling fans will operate. In the RF OFF state, there will be no RF output.

2.2.5 RESET Function (Soft Key)

The RESET function is a soft key menu selection that will cause the amplifier to attempt to reset. Selecting Reset may clear the fault, depending upon the type of fault that has occurred. If the amplifier is in an over-driven condition, lowering the amplifier's gain or RF input level should enable the function to reset the amplifier.

2.3 DIGITAL CONTROL PANEL (DCP) OPERATIONS

The operations described in this section assume that the user is performing these operations from the amplifier's front panel with the Keylock Switch in the LOCAL position. Computer access to command and status functions is also available when the Keylock Switch is set to REMOTE. Refer to section 2.5.5 for information on remote operation.

Amplifier functions are visually monitored on the front panel display. POWER is controlled by a dedicated push-button switch to the left of the display. The safety Keylock Switch is located to the lower left of the display.

To the immediate right of the display are eight buttons in two columns. The four buttons in the right column are dedicated functions. The MAIN MENU sets the panel display and the associated circuitry to control the most basic functions of the amplifier, as identified on the display. The BACK button is for navigation within the various menus presented on the display, changing the display to the previously shown menu. The USER button initiates a set of menus used to set up various control functions. The RF ON/OFF button causes the power amplifier sections to produce RF output power from the rear output connector, based on the various settings and the input level to the amplifier. The main amplifier fans will be heard when this function is active. The four buttons in the left column are soft keys whose function changes according to the menu choices on the display to their immediate left.

To the far right is an ADJUST knob. This knob is used to adjust most of the variables shown on the display. Many variables can also be fine-adjusted by soft keys when corresponding up/down arrows appear on the display.

The display is active and illuminated whenever A.C. power is supplied to the unit and the main circuit breaker is on.

Each menu display is arranged according to a similar pattern. To the right of the display a label is shown which is used to designate both the name of the adjacent soft-key and the variable that is being adjusted. Most displays include the Forward and Reflected power levels on the two bottom-most lines of the display. These indications are developed using a dual-directional coupler located within the amplifier near the RF output port, and should be used as uncalibrated indicators of approximate power level.

General Display Navigation is shown in Figure 2-3, **LCD Soft Key Screens**.

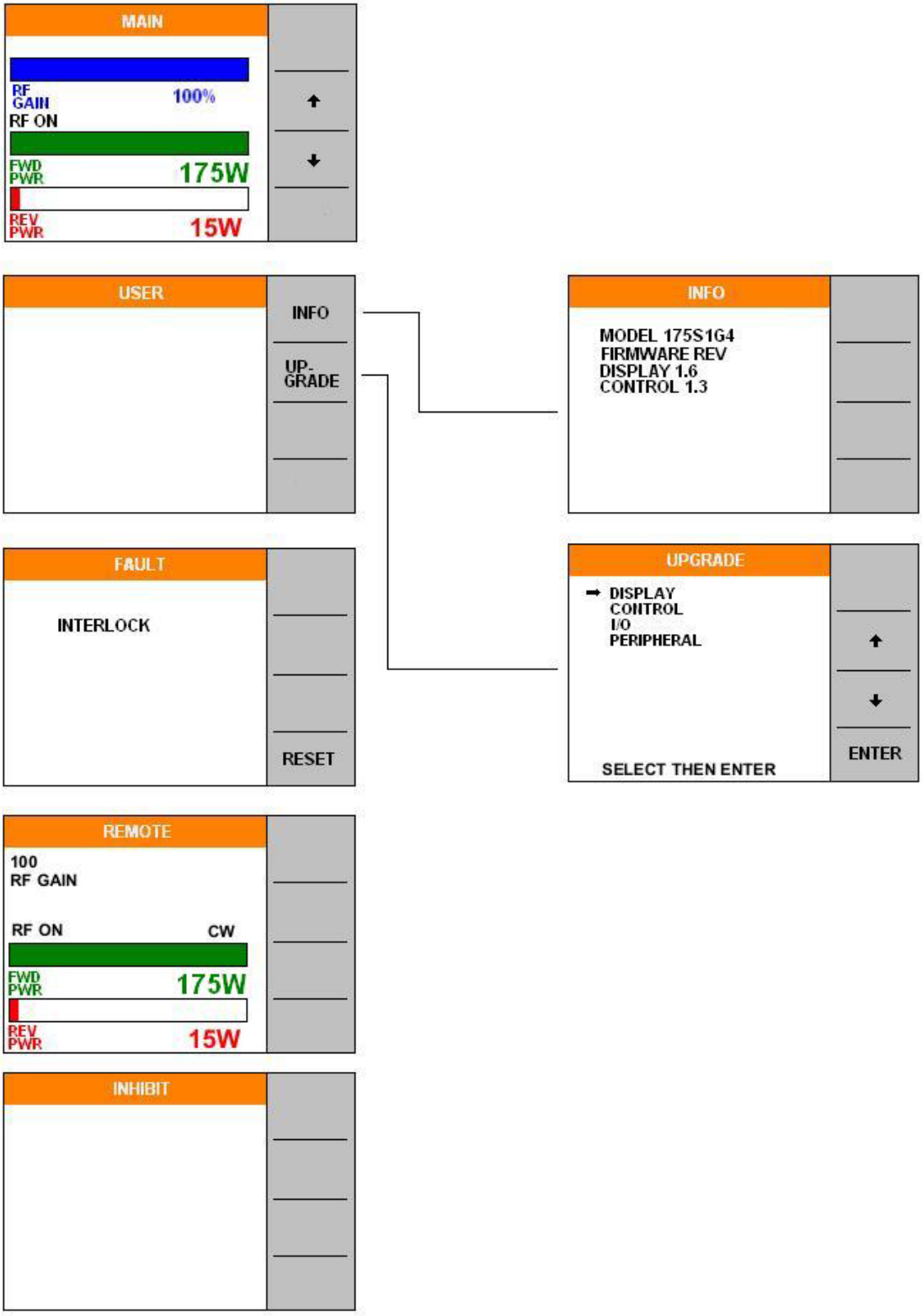


Figure 2-3. LCD Soft-Key Screens

2.3.1 RF GAIN Control

The RF GAIN control, which has a minimum of 15dB of range, is used to adjust the input attenuator of the preamplifier-leveler module. This control simply adjusts the output power level for a fixed input power level.

To adjust the RF Gain, press the RF GAIN soft-key. Adjust the value using the adjust knob or the UP/DOWN scroll keys. Please note that the display panel is limited in resolution compared to the control signals, which are generated and sent to the leveler electronics module. A quick press of the UP or DOWN keys that may not show any change on the display may, in fact, cause very small, precise changes in the amplifier's RF output.

2.4 INPUTS AND OUTPUTS

The input and output connectors described in the following sections are located on the unit's front or rear panels; refer to the Front and Rear Panel Features drawings (Figure 2-1, Figure 2-2).

2.4.1 RF Input

This Type N connector is the RF input to the amplifier. It should be connected to a RF signal generator or sweep generator.

2.4.2 RF Output

This Type N connector is the RF output of the amplifier.

CAUTION:

Do not connect or disconnect any loads or cables from the amplifier's RF Output when the amplifier is in the Operate mode. Dangerous voltages that could cause serious injury to the user exist at the RF Output when the amplifier is under power.

2.4.3 IEEE-488, USB, and RS-232 Interfaces

The Model 681's remote interfaces allow remote control, via a computer, of all amplifier functions (except for the Keylock Switch position) that can be controlled from the front panel. When the amplifier is in the Remote mode (as determined by the position of the Keylock Switch), a special Remote display is shown (see Figure 2-3). Front panel controls are deactivated, except for the Keylock Switch, which can be rotated to LOCAL or INHIBIT in order to prevent remote control commands from being executed.

Refer to section 2.6 for information on remote operation of the amplifier.

2.4.4 Safety Interlock Connector

The safety interlock connector interface provides for external safety switch interlocks that will prevent the amplifier from entering or being placed in the Operate mode unless an external connection is made. A connection between Pins 1 and 8 must be completed to operate the amplifier.

2.5 AMPLIFIER OPERATION

2.5.1 Local Operation

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 1 (on) position.
5. Press the POWER switch.
6. Place the unit in the Operate mode by pressing the RF ON/OFF button.
7. Adjust the amplifier's gain by rotating the GAIN knob.
8. In the event of a fault, press the FAULT/RESET switch; if the fault does not clear, refer to section 4.3 **Troubleshooting** of this manual.

2.6 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 / INHIBIT** Keylock switch on the front panel allows for the amplifier to be controlled using the remote communications ports, the front panel controls, or neither depending on its position. All remote queries will work in any 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.

2.6.1 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.

2.6.1.1 Setting the IEEE-488 (GPIB) Address

The IEEE-488 device address can be set to any number between 1 and 30. This selection is made by setting Switches 1 to 5 of the rear panel DIP switch to the binary equivalent of the number. Table 2-1 illustrates this switch selection. Please note that although addresses 0 and 31 can be entered, neither address is valid for this device, and therefore should be avoided.

Table 2-1. IEEE-488 Address Selection

Device Address	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
0	DO NOT USE - (RESERVED FOR CONTOLLER)				
1	on (1)	off (0)	off (0)	off (0)	off (0)
2	off (0)	on (1)	off (0)	off (0)	off (0)
3	on (1)	on (1)	off (0)	off (0)	off (0)
4	off (0)	off (0)	on (1)	off (0)	off (0)
5	on (1)	off (0)	on (1)	off (0)	off (0)
:					
30	off (0)	on (1)	on (1)	on (1)	on (1)
31	DO NOT USE				

2.6.2 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 2-2. RS-232 Port Settings

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

Table 2-3. 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	DSR
Pin 7	CTS
Pin 8	RTS
Pin 9	Unused

2.6.3 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 2-4. Fiber-Optic Port Settings

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

2.6.4 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.

2.6.5 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 this utilities embedded help file.

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.

2.6.6 Remote Commands

All commands are available to the user for remote operation of the amplifier.

- If a command is unrecognized it is echoed back out the port it came in on.
- All commands and queries are terminated with a **<LF>**.
- All queries can be sent in Remote or Local mode
- All commands can only be sent in Remote mode
- All spaces in commands and queries are indicated by **<space>**

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 and the Control Board is broken.

The development of application programs requires an understanding of the operation of the 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 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 amplifier's status.

The application program should facilitate the checking of the amplifier's 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 2-5. Relationship between Amplifier Controls and Responses

X=NO, √=YES

AC POWER AND CIRCUIT BREAKER		POWER		KEYLOCK SWITCH			REMOTE COMMUNICATION	
ON	OFF	ON	OFF	INHIBIT	LOCAL	REMOTE	COMMAND	QUERY
	√						X	X
√			√			√	√	√
√		√				√	√	√
√		√			√		X	√
√		√		√			X	√
√			√		√		X	√
√			√	√			X	√

2.6.6.1 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>**

2.6.6.2 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>**

2.6.6.3 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>**

2.6.6.4 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 amplifier to minimum RF Gain, send the following command: **LEVEL:GAIN0<LF>**

To set the amplifier to 50% RF Gain, send the following command: **LEVEL:GAIN50<LF>**

2.6.6.5 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,681,1.2<LF>**

2.6.6.6 IO Board Firmware Revision

Query to get the firmware revision of the IO 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 IO Board, send the following command: ***IOB?<LF>**

Response: **INTERFACE_BOARD_SW_REV2.01<LF>**

2.6.6.7 State

Query to find the state of the amplifier.

Syntax: **STATE?**

Parameters: None

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

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

	BIT POSITION	BIT DESCRIPTION	BIT STATE 0	BIT STATE 1	NOTES:
x	0	PULSE STATUS	OFF	PULSE	
	1	BLANK SELECTION STATUS REPORT	OFF	INHIBITED	From PROGRAM or CONFIG.STRING
	2	BLANK	DISABLED	ENABLED	
	3	REMOTE CONTROL (read only)	DISABLED	ENABLED	Response to key-switch position
y	0	POWER STATUS	OFF	POWER ON	
	1	STANDBY STATUS	OFF	STANDBY	
	2	OPERATE STATUS	OFF	OPERATE	Also known as RF ON/OFF
	3	FAULT STATUS	OFF	FAULT EXISTS	
z	0	KEYLOCK INHIBIT	OFF	INHIBITED	Response to key-switch position
	1	(NOT USED)			
	2	(NOT USED)			
	3	(NOT USED)			
a	0	MODE CW	DISABLED	ENABLED	Also known as MANUAL MODE
	1	(NOT USED)			
	2	(NOT USED)			
	3	(NOT USED)			

Example: To read the state of the amplifier, send the following query. **STATE?<LF>**

Response: **STATE= 8100<LF>** *(Remote Mode and Power On)*

2.6.6.8 Forward Power

Query to get the forward power.

Syntax: **FPOW?**

Parameters: None

Response Format: **FPOW=x**

Where:
x = **0** to **99999**

Values are corrected and linearized. They can be up to five digits in length. Leading zeros are read as spaces. Units are Watts.

Example: To find out the forward power, send the following query. **FPOW?<LF>**

Response: **FPOW= 54<LF>** *(54 Watts of forward power)*

2.6.6.9 Reverse Power

Query to get the reverse power.

Syntax: **RPOW?**

Parameters: None

Response Format: **RPOW=x**

Where:

x = **0** to **99999**

Values are corrected and linearized. They can be up to five digits in length. Leading zeros are read as spaces. Units are Watts.

Example: To find out the reverse power, send the following query. **RPOW?<LF>**

Response: **RPOW= 9<LF>** *(9 Watts of reverse power)*

2.6.6.10 RF Gain

Query to get the RF gain.

Syntax: **RFG?**

Parameters: None

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

Where:

x = **0000** to **0100**

Example: To find out the RF gain of the amplifier, send the following query: **RFG?<LF>**

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

2.6.6.11 Faults (681)

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

Syntax: **FSTA?**

Parameters: None

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

Where:

xx = **00** to **14 (Hexadecimal)**

xx	Description
00	No Fault
01	(unused)
02	Interlock
03	Thermal Driver
04	RS-485 Error
05	DC OK
06	ALC
07	Amp A3
08	Amp A5
09	Amp A6
0A	Amp A9
0B	Amp A10
0C	Amp A11
0D	Amp A12
0E	Amp A13
0F	Amp A14
10	Amp A15
11	Amp A16
12	Thermal Final Left
13	Thermal Final Right
14	Power Supply 2

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 681 RF amplifier consists of a 0.8–4.2 GHz RF amplifier assembly. The RF amplifier assembly consists of a Pre-Amplifier (Pre-Amp), a Driver Amplifier (Driver Amp), a Quadrature-Coupled Amplifier (Quad Amp) used as a driver, a two-way splitter, (2) quad amplifiers used as drivers, (2) four-way splitters, (8) quad amplifiers and an 8-way combiner.

The power supply section consists of an AC input filter with fuses and a switch, a switching power supply, 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

3.2.1 A1 Pre-Amp (Schematic No. 10025084)

The RF input signal is fed to the A1 Pre-Amp, RF attenuators U1 and U2. U1 and U2 are Gallium Arsenide (GaAs) Field-Effect Transistor (FET) Attenuators. DC signals between approximately -0.5 V to -2.5 V are used to control the shunt and series legs of the RF Attenuators. These Attenuators are used for manual gain control using the front panel gain control and to attenuate RF input signals above 0 dBm by utilizing internal voltages.

Inductor-Capacitor (LC) networks C1, L1, C2 and L2 form high-pass filters that are used to attenuate low-frequency signals.

U2 is a broadband GaAs Monolithic Microwave Integrated Circuit (MMIC) and is the first stage of gain in the amplifier. The output of U2 is fed to the input of the Wilkinson Two-Way Splitter.

The Wilkinson Two-Way Splitter splits the signal into two paths. One output is fed to the input of the A2 Driver Amp and the other output is fed to a detector. The detector output is used to protect the unit in the event of input overdrive.

Integrated circuit (IC) U6B provides a DC signal to the series element of the U1 and U2 attenuators. The U1 and U2 attenuators have minimum attenuation when the control signal is at approximately -2.7V, with maximum attenuation (minimum gain) occurring with -1.9V on the control input.

IC U7B amplifies the signal from the CR1 detector diode. IC U7A is a comparator; its normal output is approximately -9.7V. When the RF input signal to the A1 Preamplifier is increased above approximately 1mW (0 dBm), the voltage output from U7A will become less negative. This voltage is fed to the input of U6A. The amplifier has maximum gain at approximately -2.7V control input; minimum gain occurs at -1.9V. The attenuation of U1 and U2 will increase as the output of U7A varies from -9.7V toward 0V. This will help protect the unit in the event of input overdrive.

3.2.2 A2 Driver Amp (Schematic 10025421)

The Driver Amp is assembled on a Teflon®/glass printed wiring board (PWB). It has three (3) GaAs FET gain stages. Each stage is input and output DC isolated by coupling capacitors. Resistive feedback is used from the drain to the gate of the GaAs FET to decrease the low-frequency gain. Shunt capacitive stubs are used to tune the amplifier. The drain of Q4 is matched to the output. The GaAs FET transistors are operated in a depletion mode. They will conduct the maximum DC current with 0 VDC bias on their gates and are normally operated with between approximately -0.5 to -4.0 VAC on their gates.

IC U1 is a voltage regulator set to 13.5V output with a current limit of approximately 1.2 amps. Q4 turns off the voltage regulator when the -5V supply falls below approximately -3.5V. PNP transistors Q5, A6 and Q7 regulate the DC current through Q1, Q2 and Q3.

3.2.3 A3, A5, A6, A9 through A16 Quadrature-Coupled Amplifiers (Schematic 10027753)

IC U1 is a voltage comparator used to monitor the -8V supply. Q1 turns off the +26.8VDC when the -8V supply voltage falls below approximately -3.5V. PNP transistors Q2 and Q5 regulate the DC current through Q3 and Q4, respectively, by sensing the voltage drop across 2.0Ω resistors R5 and R16 and varying the negative voltage on the gates of Q3 and Q4, thereby maintaining the drain current at approximately 1.25 amps. The DC operation of Q3 and Q4 can be checked on Test Point 1 (TP1) and Test Point 2 (TP2) without removing the unit's lid. The normal voltage on TP1 and TP2 without RF drive is 24.0 ±0.4V.

U2 and U3 are 90° quadrature couplers: U2 splits the input signal into two signals with a phase difference of 90°; U3 combines the RF outputs from Q3 and Q4 and is connected to the output connector J2. 50Ω termination resistors R17 and R18 absorb any difference signals and help to improve the input and output VSWR of the module. The module has a gain of 9dB or greater and delivers approximately 15 watts of RF power.

IC U4 is a quad comparator that senses if the drain voltage of Q3 or Q4 varies above or below the normal operating range. If the drain voltage of either Q3 or Q4 should fall below +23.8VDC, or if it should rise above +25.0VDC, the output of U4 will drop low and the Amplifier Fault LED (DS1) will light.

3.2.4 A4 Two-Way Splitter

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

3.2.5 A7, A8 Four-Way Splitter

The Four-Way splitter is a multi-section, broadband, Wilkinson splitter. The input signal is split into four equal-amplitude, equal-phase signals. The amplitude of each signal is 6–6.5dB below the input signal when both outputs are terminated into 50Ω loads.

3.2.6 A17 Eight-Way Combiner

A17 is an Eight-Way radial combiner with impedance-matching. When the outputs of the eight quad amplifiers are fed to the eight-way combiner, the combined output will be approximately 9dB above the output of a single quad amplifier.

3.2.7 A18 Dual Directional Coupler

A18 is a 50 dB dual directional coupler which is connected to the output of the A17 eight-way combiner. The coupler monitors the forward and reflected power.

3.2.8 A19 Detector Assembly

A19 contains two detectors which are connected to the forward and reflected coupled ports of A18. The DC outputs are fed to the A21 ALC board which uses these signals to protect the amplifier, display forward and reverse power, and to provide leveled RFoutput.

3.3 POWER SUPPLIES (PS1 AND PS2)

Power supply PS1 supplies a +5VDC housekeeping supply for the control system assemblies A22A1 Control/Fault Board, A23A1 Interface Board, and A21 ALC board.

PS1 also supplies +26.8 VDC at 18.75 amps, +24 VDC at 7 amps, -24 VDC at 2 amps. 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.

The +24 VDC at 10.0 amp power supply is fed to the A2 Driver and the A3 Driver to supply the FET drain voltage for these amplifiers, and is also regulated to +12 V in the preamplifier. The +24 VDC at 7 amps is for fans B1 through B5.

The –24 V at 2 amps power supply is regulated to –12 V and –5 V through the A13 regulator board and is also regulated to -12V in the A1 pre-amplifier.

PS2 supplies +26.8 VDC at 27 amps. PS2 is a switching power supply that automatically sets the AC input circuits to the correct connections for the line voltage 90-264 VAC, 50-60 Hz.

PS2 supplies +26.8 VDC to quad amplifiers A5, A6 and A9 through A16 to provide the drain voltage for these amplifiers.

3.3.1 A20 Regulator Board (Schematic #10027610)

The A20 regulator board filters the –24 VDC and has two (3) regulators for the RF amplifier stages.

U1 is a negative regulator (-12 VDC). This regulator supplies the input voltage for the U2 and U3 regulators.

U2 is a negative regulator (-8 VDC). This regulator supplies voltage for the gate voltages of the Quad Amps (A3, A5, A6, A9–A16).

U3 is a negative regulator (-5 VDC). This regulator supplies voltage for the gate voltages of the A2 Driver Amplifier.

3.4 CONTROL SYSTEM

3.4.1 A11 Control/Fault Board (Schematic #10021920)

The A11 Control/Fault board consists of two 16-bit microcontrollers and about nine 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	2
Digital outputs	12
Digital inputs (5-volt tolerant)	24
Analog outputs	2
Mixed signal inputs	4
2-channel encoder input	1
Inputs for a keypad	8
Display connectors	2
Serial communication jacks	2

3.4.2 A14 Interface Board (Schematic #10020073)

3.4.3 A21 ALC Board (Schematic #10023927)

This section describes the operation of the level control board. The level control board performs the following functions:

- Provides automatic level control of the amplifier's output when the amplifier is placed in the ALC mode.
- Limits RF input level to the amplifier and turns on the audio alarm when forward or reflected power levels exceed specified levels.
- Drives forward and reflected indicators on the front panel display.

4. MAINTENANCE

4.1 GENERAL MAINTENANCE INFORMATION

The Model 681 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.

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 eight screws from the front panel and four screws from the rear securing brackets. The amplifier can then be slid from the housing. The top cover can be removed to gain access to the low level RF assemblies. The power supplies, power combiner and remote interfaces are accessible by removing the bottom cover.

The RF final quad amplifiers are accessible by removing the side covers.

4.3 TROUBLESHOOTING

CAUTION:

The microwave transistors used in the Model 681 amplifier are GaN HEMT transistor. 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 HEMTs 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 GaN HEMTs with an ohmmeter.

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

CAUTION:

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

Troubleshooting the Model 681 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 681 troubleshooting symptoms and remedies are described in the sections that follow

- 4.3.1—General: Reading Faults
- 4.3.2—The Unit Cannot be Operated Remotely
- 4.3.3—Thermal Fault
- 4.3.4—Interlock Fault
- 4.3.5—Power Supply Faults
- 4.3.6—Amplifier Faults
- 4.3.7—ALC Fault
- 4.3.8—Low or No Power Output (DC Tests)
- 4.3.9—Low or No Power Output (RF Test)

4.3.1 General - Reading Faults

The Model 681 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.

The digital control panel of the 681 indicates the output power from the 681 and the power reflected back to it. If the reflected power is very high, with respect to the forward power, this could indicate that the output coax cable is defective or that the load being driven has a high VSWR.

4.3.2 The Unit Cannot Be Operated Remotely

1. Verify that the front panel keyswitch is set to the REMOTE position.

2. Verify that the unit operates locally by setting the keyswitch 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 switch assembly; this assembly can be accessed through the unit's rear panel. Check to see that these switches are properly set for either RS-232 or IEEE-488 operation, as desired. (See subsection 2.2.2 of this manual for the proper ADDRESS switch settings.)

   NOTE: Address switches are only read at unit power-up; remove and re-apply AC power (i.e., reset the circuit breaker) after changes are made.

4.3.3 Thermal Fault (Schematic Diagram No 10028672)

During a Thermal Fault, the front panel display should read THERMAL FAULT.

1. Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fans 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.
2. If the unit does not reset and the cooling fans are operating normally, check the voltage at the A1 Control/Fault Board, J13, Pins 26, 27 and 28.
3. If the voltage on A1 J13, Pins 26, 27 and 28 are high, check the connection through the proper thermal sensor line to ground.

4.3.4 Interlock Fault (Schematic Diagram No. 10028672)

The Model 681 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 681 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 display 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 P32 in the rear panel).
5. Check the voltage on A1 J13, pin 30; it should be $\leq$ 0.1V.
6. If the voltage on A1 J13, pin 30 is high, check the interlock line to ground.

4.3.5 Power Supply Faults (Schematic Diagram No. 10028672)

4.3.5.1 PS1 Fault (DC OK)

The PS1 power supply has a DC OK output which is normally high (≤4.0V) to the A1J13, pin 29. If any of the PS1 outputs fail, this output will go low (≤0.1V) and inhibit the A2 Driver Module.

4.3.5.2 PS2 Fault (POWER FAIL)

The PS2 power supply has POWER FAIL output which is normally low (≤0.1V) to the A1 J13, pin 24. If the PS2 output fails, this output will go high (≥ 4.0V) and inhibit the A2 Driver Amplifier.

4.3.6 Amplifier Faults (Schematic Diagram Nos. 10028672 and 10027753)

1. The individual fault outputs for the eleven Quadrature-Coupled Amplifiers (Quad Amps) (A3, A5, A6 and A9 through A16) are sensed on the A1 Control/Fault Board, J13, pins 10 through 20.
2. The amplifier's top cover can be removed to allow access to Quad Amp A3. The side covers can be removed to allow access to A5, A6, and A9 through A16. Modules.
3. The Amplifier Fault LED (DS1) should be lit, indicating which Quad Amp(s) has failed.
4. Verify the correct voltages to the Quad Amps. Troubleshoot any incorrect voltages.

C1 = +26.8 ± 0.2V	TP1 = +24.0V ± 0.3V
C4 = -8.0 ± 0.2V	TP2 = +24.0V ± 0.3V

4.3.7 ALC Fault

Indication – **ALC**

As stated previously, the power limit controls could not limit either the forward or reverse power to the preset threshold. This can be a transient type of problem, if the fault can be cleared. If the fault cannot be cleared with no RF input drive power, then there is a malfunction in the ALC board or associated circuit.

4.3.8 Low or No Power Output (DC Tests) (Schematic Diagram No. 10028672)

All indicators on the Model 681 are normal, the front panel display reads **RF On**, and the cooling fans 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 C Module	+26.8 V	±0.5 V
PS1 DB Module Channel 1	+24 V	±0.5 V
PS1 DB Module Channel 2	-24 V	±0.5 V
PS2	+24 V	±0.5 V

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

C1	+26.8 V	±0.5 V
C2	-5 V	±0.5 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.

C10	+26.8 V	±0.5 V
C9	-24 V	±0.5 V
C11	+5 V	±0.5 V

7. Check the voltages on TP1 (C21) and TP2 (C22) on the A3, A5, A6, and A9 through A16 Quad Amps; the voltage should be 24.0 ±0.3V. If any of the voltages on TP1 and TP2 are low, check the voltages on C1 and C4 of that amplifier.

TP1, TP2	+24.0 V	±0.3 V
C1	+26.8 V	±0.3 V
C4	–8.0 V	±0.3 V

4.3.9 Low or No Power Output (RF Test) (Schematic Diagram No. 10028672)

NOTE: The DC Tests specified in Section 4.3.8 should be completed before conducting the RF tests specified in the following sections.

1. The Model 681's typical gain response at 0 dBm input and -20 dBm input is shown in Figures 4-1 and 4-2. The actual gain may vary considerably from that shown in Figure 4-1 but should be≥ 52.5 dBm. Figure 4-2 should be ≥ 54 dBm. *NOTE: If the overall gain is low, the amplifier chain can be separated at the input of A4 Two-Way Splitter.*

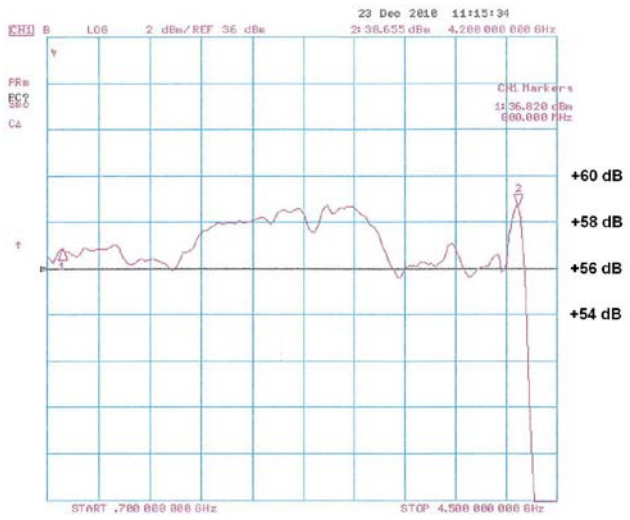


Figure 4-1. Typical Response at 0 dBm Input

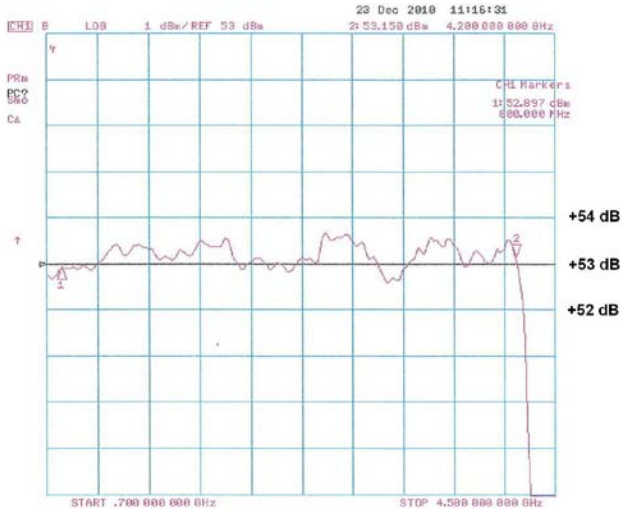


Figure 4-2. Typical Response at –20 dBm Input

Phase matching must be maintained from the input of the A4 Two-Way Splitter to the inputs of the A17 Eight-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 A4 Two-Way Splitter and the gain checked from the input to the A4 Two-Way Splitter to the **RF OUTPUT** connector on the unit's front panel.*

2. Remove the coaxial cable from the output of the A3 Quad Amp to the input of the A4 Two-Way Splitter. The typical response from the input of the A4 Two-Way Splitter to the RF Output connector on the unit's front panel is shown in Figure 4-3.

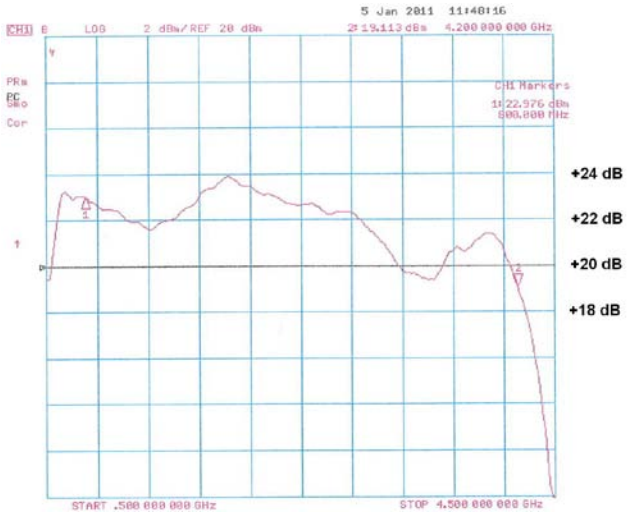


Figure 4-3. Typical Response: Input A4 Front Panel RF Output

If the response is normal, see Step 8. If the response is abnormal, perform the following tests.

3. If the gain is slightly low (i.e., several dB below typical), try disconnecting the inputs from the A9 through A16 Quad Amps one at a time, then reconnect them. Note the difference in response when disconnecting the Quad Amps; if any Quad Amp causes less of a change in gain than the others, check the Quad Amp, coaxial cable, and so forth associated with that Quad Amp. Typical Quad Amp Response is shown in Figure 4-4**.**

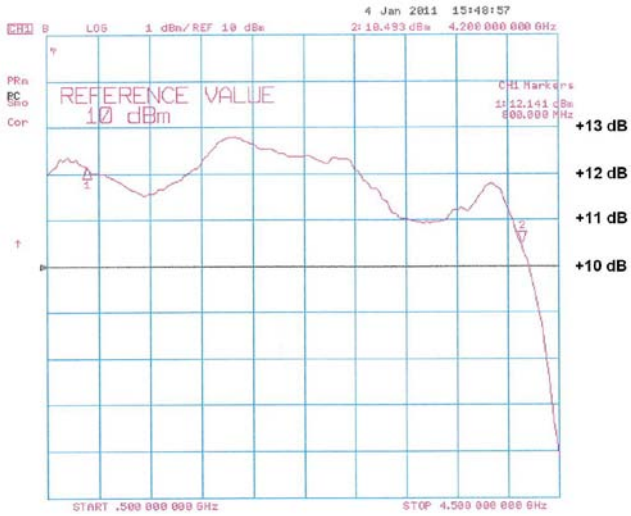


Figure 4-4. Typical Quad Amp Response

4. If the gain is 5dB or more below the typical response, do the following:

   - Disconnect the coaxial cable from the input of the A5 Quad Amp, and note the results.

   - Reconnect the coaxial cable from the input of A5 and disconnect the coaxial cable from the input of the A6 Quad Amp; the results should be similar. If not, check the side that made the least difference. Check the Two-Way Splitter, the Four-Way Splitter, the Quad Amp, and so forth.

5. A typical Two-Way Splitter Insertion Loss is shown in Figure 4-5. The unused port must be terminated when checking the insertion loss.

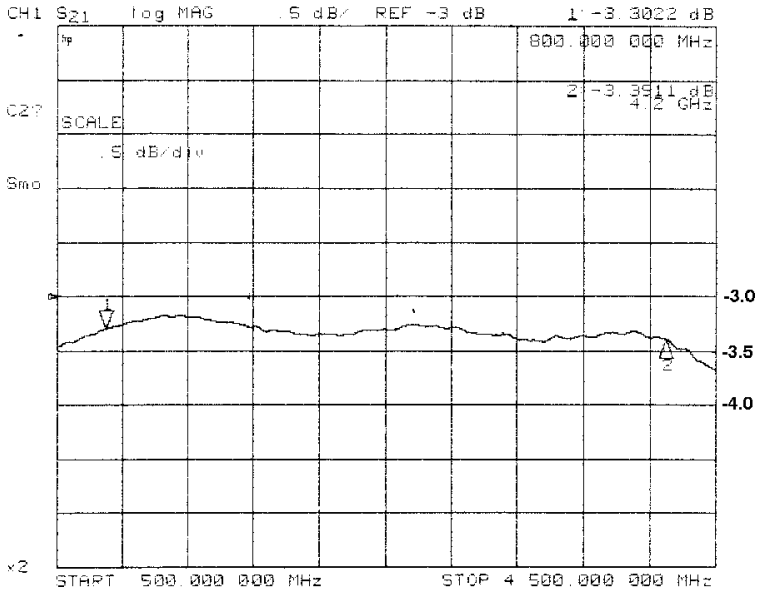


Figure 4-5. Typical Two-Way Splitter Insertion Loss

6. A typical Four-Way Splitter Insertion Loss is shown in Figure 4-6**.** The unused port must be terminated when checking the insertion loss.

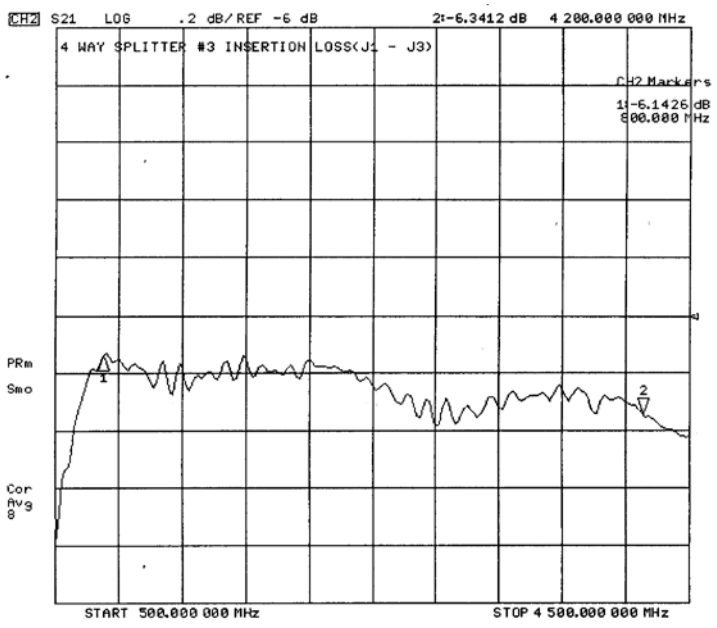


Figure 4-6. Typical Four-Way Splitter Insertion Loss

7. A typical Eight-Way Combiner Insertion Loss and Combined Port Return Loss is shown in Figure 4-7. The unused port must be terminated when checking the Insertion Loss.

   NOTE: The Return Loss of the Eight-Way Combiner's combined output port is typically better than 17dB (see Figure 4-8). The Return Loss of the Eight-Way Combiner's eight input ports is approximately 2dB when one port is driven.

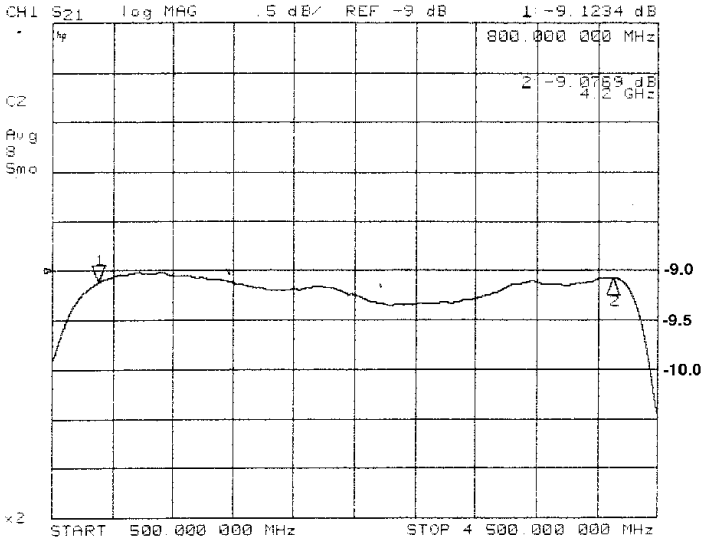


Figure 4-7. Typical Eight-Way Combiner Insertion Loss

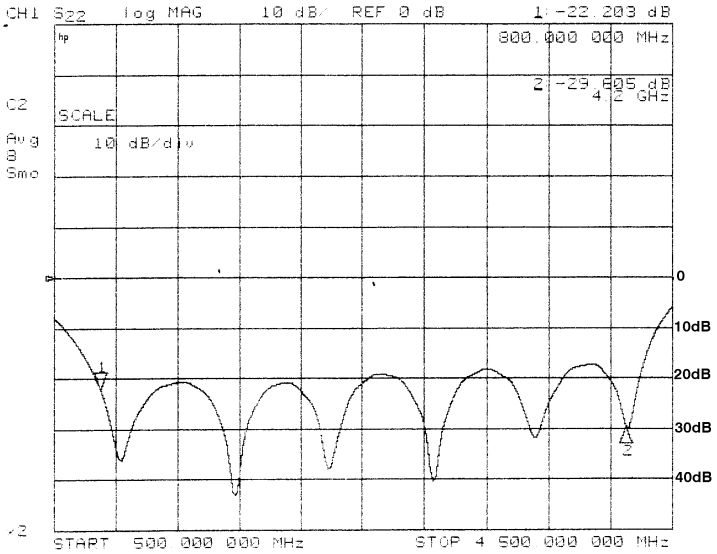


Figure 4-8. Typical Eight-Way Combiner Return Loss: Combined Output Port

8. If the response of the output stages (i.e., A4 Two-Way Splitter input to front panel RF output) is normal, check the response of the A3 Quad Amp (see Figure 4-9).

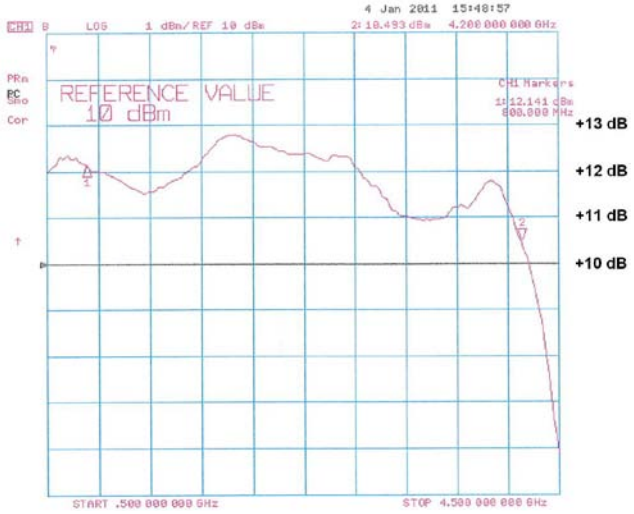


Figure 4-9. Typical Quad Amp Response

NOTE: The A2 Driver amplifier, and the A1 Preamplifier's response may differ considerably, particularly in flatness, from the typical response shown in Figure 4-10, Figure 4-11 and Figure 4-12.

9. The typical response for the A2 Driver amplifier is shown in Figure 4-10.

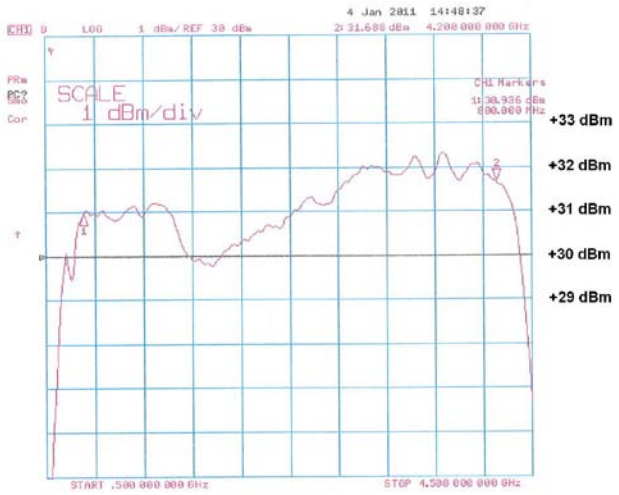


Figure 4-10. Typical A2 Driver Amplifier Response

10. The typical response for the A1 Preamplifier (at maximum gain setting) is shown in Figure 4-11.

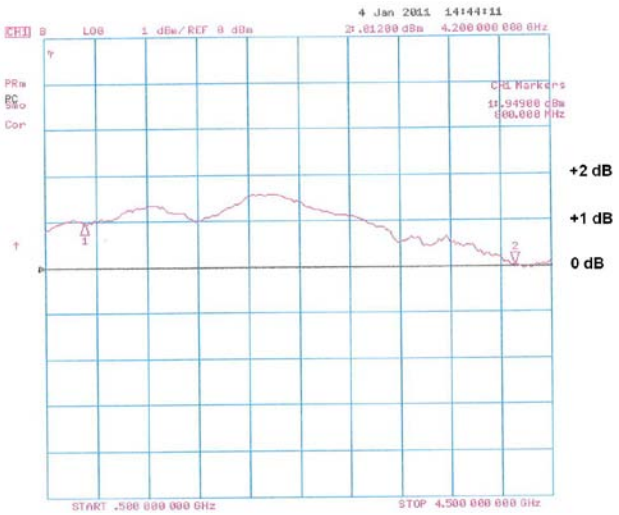


Figure 4-11. Typical A1 Preamplifier Response

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