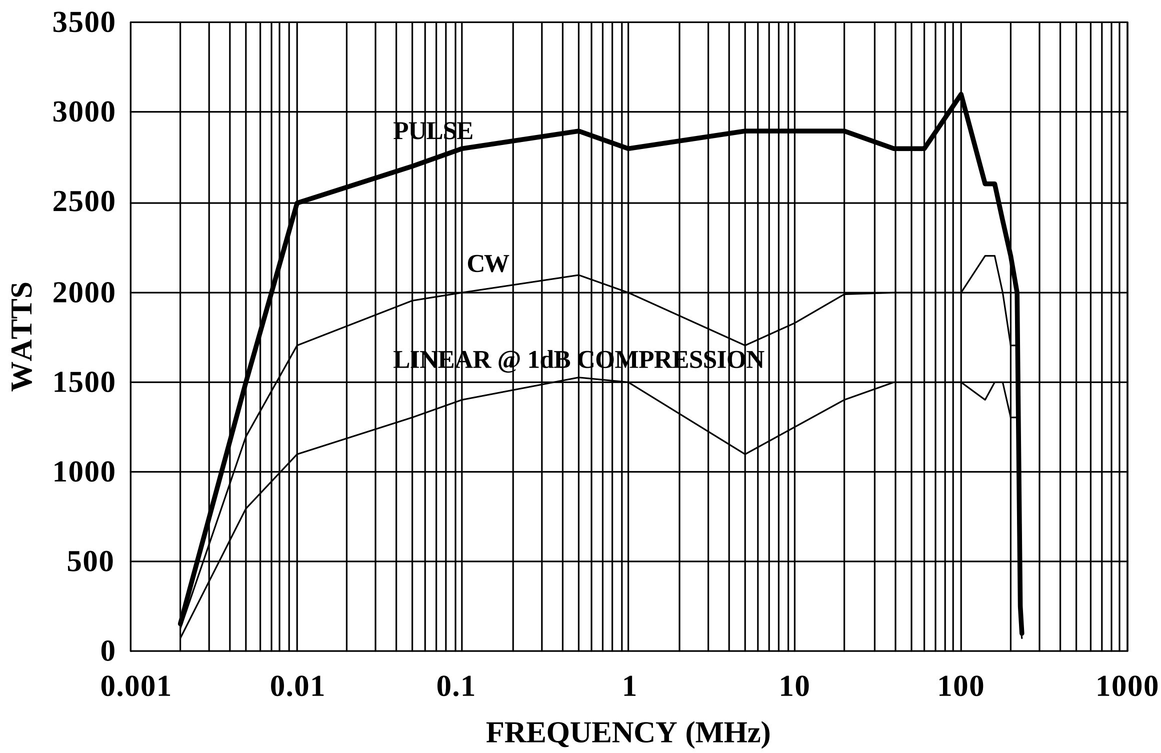
MODEL 1000L 1200 WATTS CW 2500 WATTS PULSE 10kHz-220 MHz

The Model 1000L is an economical, self-contained, air-cooled broadband amplifier designed for laboratory applications that require instantaneous bandwidth, high gain and high power output. Housed in a stylish contemporary enclosure, the Model 1000L is smaller than competitive units with similar power levels. All operating controls are functionally grouped on the front panel for simplicity of operation. These include modern, lighted push-button switches for the command functions, POWER, STANDBY, OPERATE and PULSE, a control for setting the output level of the amplifier, and a meter for monitoring critical operating voltages and currents. Remote control is provided through a rear panel mounted connector. Isolated TTL level remote control can be accomplished using our CP2001 interface. Isolated IEEE-488 compatible control can be provided with our CP3000. A highly versatile unit, the Model 1000L features rugged circuitry and a quick-acting, solid state crowbar circuit to protect the final amplifier tubes from damage due to internal arcing. An electronic circuit is provided to enable rapid gating or blanking of the amplifier.

1000L TYPICAL POWER OUTPUT



REV060396

SPECIFICATIONS
Model 1000L

POWER OUTPUT	
High Range	
Pulse	
Minimum	***2500 watts to 150MHz*** ***1750 watts to 220MHz***
Duty Cycle	***15%***
Pulse Width	***8 milliseconds***
CW	
Minimum	***1200 watts***
Low Range	***100 watts nominal***
FLATNESS, high range	***± 1.5 dB***
FREQUENCY RESPONSE	***10 kHz - 220 MHz instantaneously***
INPUT FOR RATED OUTPUT	***1.0 milliwatt maximum***
GAIN (at maximum setting)	
High Range	***61 dB minimum***
Low Range	***47 dB minimum***
GAIN ADJUSTMENT (continuous range)	***18 dB minimum***
INPUT IMPEDANCE	***50 ohms, VSWR 1.5:1 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.***
MODULATION CAPABILITY	***Linear amplitude and phase response to over 80 MHz allows faithful reproduction of AM, FM, Pulse, or phase modulation appearing on the input signal***
HARMONIC DISTORTION AT 750 WATTS	
Above 120 MHz	***Minus 30 dBc maximum***
Below 120 MHz	***Minus 15 dBc maximum*** ***Minus 18 dBc nominal***
THIRD ORDER INTERCEPT POINT	***66dBm Typical***
GATING CHARACTERISTICS	
Pulse Mode Pedestal/CW Mode Blanking	
Signal (into 180 ohms)	***Plus or minus 2.5 to 6.0 VDC***
Rise time	***20 microseconds maximum***
Fall time	***4 microseconds maximum***
RF Rise/Fall Time	***10 nanoseconds maximum***
RF Pulse Droop	***1.0% maximum at 8 milliseconds***
PRIMARY POWER (specify one)	***200/208 ± 5% VAC, 3 phase, 50/60 Hz*** ***380/415 ± 5% VAC, 3 phase, 50/60 Hz*** ***400/415 ±5% VAC, 3 phase, 50/60Hz*** ***15.2 kVA nominal***
CONNECTORS	
RF Input	***Type BNC female***
RF Output, high range	***Type C female***
RF Output, low range	***Type N female***
Gating/Blanking	***Type BNC female***
Remote Control	***25 pin female subminiature D***
COOLING	***Forced air (self contained fans)***
WEIGHT	***239 kg (525 lb)***
SIZE (WxHxD)	***56.1 x 149.9 x 58.4 cm*** ***22.1 x 59.0 x 23.0 in***

****** See Application Note #27***

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SECTION V: REPLACEABLE PARTS ***(CONTINUED)***

SECTION VI: RECOMMENDED SPARE PARTS

LIST OF FIGURES

LIST OF TABLES

SECTION I

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Amplifier Research (AR) Model 10WD1000 is a self-contained, broadband Radio Frequency (RF) amplifier designed for laboratory applications where instantaneous bandwidth, high gain, and moderate power output are required. Solid state technology is used exclusively to offer significant advantages in reliability and cost. When used with a frequency-swept signal source, the AR Model 10WD1000 will provide 10 watts of swept power output from DC–1000 megahertz (MHz). Typical applications include antenna and component testing, wattmeter calibration, electromagnetic interference (EMI) susceptibility testing, use as a driver for frequency multipliers and higher power amplifiers, and use as an RF energy source for Magnetic Resonance Imaging (MRI) studies. The Model 10WD1000 can be operated locally by using the unit's front panel controls, or remotely by using its built-in IEEE-488 or RS-232 interfaces.

1.2 POWER SUPPLIES

The Model 10WD1000 contains two switching power supplies. The input voltage range to these power supplies is 90–132 Volts Alternating Current (VAC) and 180–264 VAC, 50/60Hz, universal or automatically selected. The user does not have to switch or change anything on the Model 10WD1000 when changing the unit's AC input voltage. The unit's AC power consumption is 350 watts nominal. A built-in circuit breaker provides primary AC circuit protection.

1.3 SPECIFICATIONS

Refer to the "Amplifier Research Data Sheet" on the following pages for detailed specifications. All voltage measurements referenced in this manual are Direct Current (DC) unless stated otherwise.

SECTION II

OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the Model 10WD1000 broadband RF amplifier is simple. The amplifier's input signal, whether swept or fixed in frequency, is fed into the jack labeled **INPUT,** and the amplifier's output signal is taken from the jack labeled **RF OUTPUT.** The unit is turned on by activating the **POWER** switch. A circuit breaker in the AC power line provides protection in the event of a unit malfunction. A polarized, three-wire AC power cord is also included with the unit to provide cabinet and chassis grounding to the power mains.

CAUTION:

OPERATION OF THE MODEL 10WD1000 BROADBAND RF AMPLIFIER IS NOT CRITICAL IN REGARD TO SOURCE AND LOAD VOLTAGE STANDING-WAVE RATIO (VSWR), AND IT WILL REMAIN UNCONDITIONALLY STABLE UNDER ANY MAGNITUDE AND PHASE CONDITIONS OF SOURCE AND LOAD. IT HAS ALSO BEEN DESIGNED TO WITHSTAND INPUT POWER LEVELS UP TO TWENTY (20) TIMES ITS RATED INPUT OF 1MW WITHOUT SUSTAINING DAMAGE. HOWEVER, SIGNAL LEVELS >20MW OR TRANSIENTS WITH HIGH PEAK VOLTAGES CAN DAMAGE THE AMPLIFIER. ALSO, ACCIDENTAL CONNECTION OF THE AMPLIFIER'S OUTPUT TO ITS INPUT CAN CAUSE OSCILLATIONS THAT WILL PERMANENTLY DAMAGE ITS INPUT CIRCUITRY.

NOTE:

ALTHOUGH THE MODEL 10WD1000 HAS BEEN DESIGNED FOR THE OVERDRIVE AND LOAD TOLERANCE CONDITIONS DESCRIBED ABOVE, SUBJECTING THE AMPLIFIER TO THESE CONDITIONS SIMULTANEOUSLY CAN CAUSE FAILURE OF THE UNIT'S OUTPUT TRANSISTORS. REPEATED FAILURES OF THIS NATURE WILL NOT BE COVERED UNDER THE UNIT'S WARRANTY.

The Model 10WD1000 DC to 0.5 MHz Amplifier is protected from input overdrive by a diode limiter on the RF input.

The 0.5 to 1000 MHz Amplifier is protected from input overdrive by limiting diodes across the RF input and an Automatic Level Control (ALC) circuit that will limit the maximum RF level to the first gain stage (U1) of the RF amplifier to approximately 0dBm.

The Model 10WD1000 power transistors are protected from over-temperature by a sensor that senses the heat sink temperature near the RF output transistors. In the event of a cooling fan failure or an air flow blockage, the DC voltage will be removed from the RF stages; if and when the heat sink temperature reaches approximately 70°C, the unit's front panel vacuum fluorescent display (VFD) will read **THERMAL FAULT**. Normal operation can be resumed by resetting the Model 10WD1000 after the heat sink temperature drops below 70°C.

2.2 AMPLIFIER OPERATION

Figure 2-1 shows the front panel of the Model 10WD1000 broadband RF amplifier.

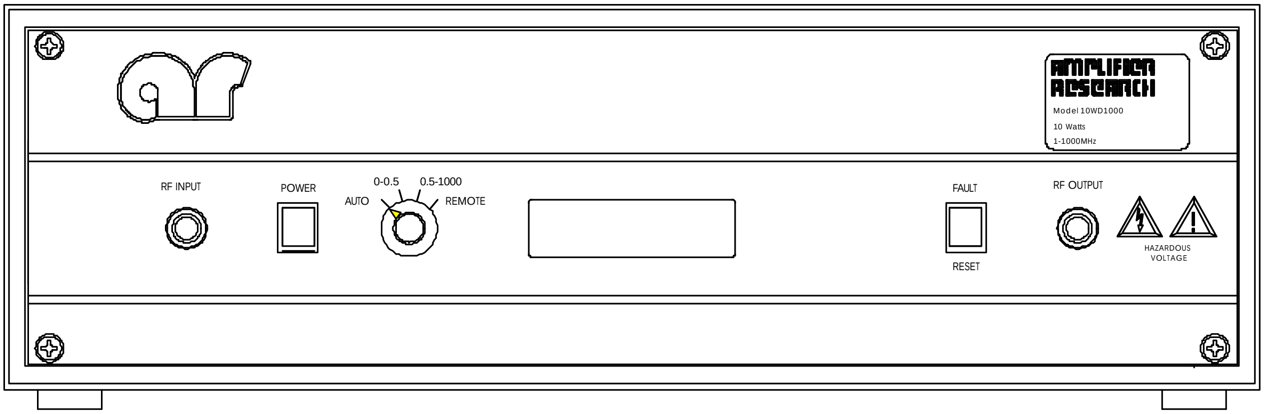

Figure 2-1
Model 10WD1000 Front Panel

Figure 2-2 shows the rear panel of the Model 10WD1000 broadband RF amplifier.

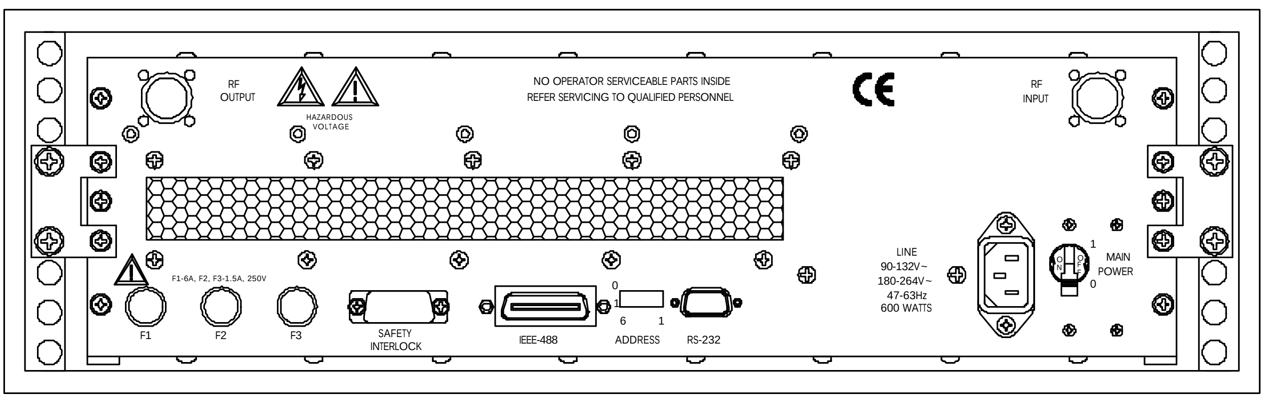

Figure 2-2
Model 10WD1000 Rear Panel

2.2 AMPLIFIER OPERATION *(CONTINUED)*

2.2.1 Local Operation

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 Function Switch to the applicable position.

4. Check to see that the **MAIN POWER** switch (circuit breaker) on the unit's rear panel is set to the **1** ("on") position.

5. Press the **POWER** switch: the front panel vacuum fluorescent display (VFD) should read **POWER ON, STATUS OK** when power is applied.

   (NOTE: The amplifier changes state each time the POWER switch is depressed—if the unit is on when the POWER switch is depressed, it will turn off; if the unit is off when the POWER switch is depressed, it will turn on.)

6. In the event of a fault, press the **FAULT/RESET** switch; if the fault does not clear, refer to subsection **4.3** ("Troubleshooting") of this manual.

NOTE: For applications with very short RF pulses or signals which contain many frequency components it may be necessary to select the correct frequency range either on the front panel or remotely.

2.2.2 Remote Operation

2.2.2.1 Introduction

This subsection describes remote operation of the Model 10WD1000 amplifier by utilizing either the IEEE-488 parallel interface or the RS-232 serial interface and a controlling device, such as a bus controller or a personal computer (PC).

2.2.2.2 Selecting Remote Operation

The Model 10WD1000 can be placed in the remote operation mode at any time by switching the FUNCTION **switch on the front panel to the** REMOTE **position. In this mode, control is transferred to the selected remote interface and all front panel controls are inoperative with the exception of the** FUNCTION **switch. The amplifier's initial state will be** Power Off**. The front panel VFD will indicate** REMOTE **until the unit is returned to the local operation mode.**

2.2.2.3 Interface Selection

The Model 10WD1000 can be controlled via either the IEEE-488 or RS-232 interface; which interface is active is determined by the position of Switch 6 of the rear panel Dual In-Line Package (DIP) switch located between the two interface connectors. If Switch 6 is in the "on" (**1**) position, the RS-232 interface will be active; if Switch 6 is in the "off" (**0**) position, the IEEE-488 interface will be active.

2.2.2.4 Interface Set-up

Switches 1–5 of the rear panel DIP switch are used to select either the RS-232 communication (BAUD) rate or the IEEE-488 device address, depending upon which interface is active. (**Note:** These switches are only read at device power-up. In order for changes made in these switch settings to take place, AC power must be removed and then re-applied to the Model 10WD1000.)

2.2.2.4.1 RS-232 BAUD rate selection

The serial communication (BAUD) rate can be set to five different levels. Selections are made by the positions of Switches 1–5 of the rear panel DIP switch. The following is a list of the available BAUD rates and the corresponding DIP switch positions:

BAUD Rate	**Switch On (1)**
1200	1 only
2400	2 only
9600	3 only
19,600	4 only
76,800	5 only

(**Note:** Any other combination of switch settings will result in a BAUD rate equal to 1200.)

2.2.2.4.2 IEEE-488 device address selection

The IEEE-488 device address can be set to any number between 1 and 30. This selection is made by setting Switches 1–5 of the rear panel DIP switch to the binary equivalent of the number. **Table 2-1** illustrates this switch selection.

2.2.2 Remote Operation *(continued)*

2.2.2.4.2 IEEE-488 device address selection *(continued)*

Table 2-1
IEEE-488 Device Address Selection

Device Address	Switch 5	Switch 4	Switch 3	Switch 2	Switch 1
1	off (0)	off (0)	off (0)	off (0)	on (1)
2	off (0)	off (0)	off (0)	on (1)	off (0)
3	off (0)	off (0)	off (0)	on (1)	on (1)
4	off (0)	off (0)	on (1)	off (0)	off (0)
5	off (0)	off (0)	on (1)	off (0)	on (1)
:					
:					
30	on (1)	on (1)	on (1)	on (1)	off (0)

2.2.2.5 Command Set Format

Each command is composed of one alpha character, up to four numeric parameters, and a command termination character. The command termination character is the “line feed” command, which is denoted and entered as <LF>. Commands are case-sensitive and must be entered in upper case only in order to be recognized.

2.2.2.6 IEEE-488 Communications

For IEEE-488 communications, the “End or Identify” (EOI) control line may also be used for command termination. When sending commands to the Model 10WD1000 via the IEEE-488 bus, terminate each command with a <LF>, an EOI, or both. No characters are permitted after the <LF> or EOI; the 10WD1000interprets characters following the <LF> or EOI as the start of the next command. When an error condition is present at the Model 10WD1000, the “Service Request” (SRQ) line is asserted; the operator can then perform a serial poll operation. The Model 10WD1000 error code (in binary) is contained in the returned serial poll status byte (STB). These error codes are defined in **Table 2-2**.

2.2.2 Remote Operation *(continued)*

2.2.2.6 IEEE-488 Communications *(continued)*

Table 2-2
Remote Error Codes/Messages

IEEE-488 Serial Poll Response (STB) (binary/decimal)	Model 25W1000B Error Condition	RS-232 Error Message
(01000001) 65	INTERLOCK FAULT	E1
(01000010) 66	THERMAL FAULT	E2
(01000011) 67	POSITIVE 20 VOLT FAULT	E3
(01000100) 68	POSITIVE 60 VOLT FAULT	E4
(01000101) 69	NEGATIVE 60 VOLT FAULT	E5

2.2.2.7 RS-232 Communications

If the RS-232 interface is active, the Model 10WD1000 will test for a properly connected RS-232 interface when it is switched into the remote operation mode. In order for the Model 10WD1000 to recognize an RS-232 connection, the “Data Carrier Detect” (DCD) line must be asserted. This line is sampled continuously to determine if the RS-232 connection is broken; therefore, it must remain asserted in order for the RS-232 interface to function. The “Clear To Send” (CTS) line is also used to gate information from the Model 10WD1000. This line must be asserted in order to receive information from the Model 10WD1000. The CTS line can be used as a “handshake” line to inform the Model 10WD1000 when it is permissible to send information. If the CTS line is de-asserted in the middle of a transmission, the character in the process of being transmitted will be completed and further transmission will halt until the CTS line is re-asserted. The Model 10WD1000 itself asserts two lines: “Data Terminal Ready” (DTR) and “Request To Send” (RTS). The DTR line is continuously asserted, while the RTS line is used to gate information into the Model 10WD1000. Connector pin-out information is given in **Table 2-3**.

2.2.2 Remote Operation *(continued)*

2.2.2.7 RS-232 Communications *(continued)*

Table 2-3
RS-232 Connector Pin-Outs

Pin No.	Signal	Data Direction*	Description
1	DCD	<	Device Carrier Detect
2	RD	<	Receive Data
3	TD	>	Transmit Data
4	DTR	>	Data Terminal Ready
5	GND	N/A	Ground
6	NC	N/A	No Connection
7	RTS	>	Ready To Send
8	CTS	<	Clear To Send
9	NC	N/A	No Connection

***Note:**
> = Output from Model 10WD1000
< = Input to Model 10WD1000

Special Note: A null modem cable or adapter is required in order to properly interface the Model 25W1000B to a standard serial port on a computer.

Once the RS-232 interface is established, commands are processed in the same manner as that of the IEEE-488 interface. The command structure is identical, except that there is no EOI line. Therefore, all commands are terminated with a line feed (<LF>). Since this is a full-duplex asynchronous interface, if the Model 10WD1000 detects an error, the error message is immediately transmitted to the host controller. These error messages are defined in **Table 2-2.**

2.2.2.7.1 RS-232 port settings

The RS-232 port settings used for communication with the Model 25W1000B are as follows.

Word Length: 8 bits

Stop Bits: 1

Baud Rate: 1200–76,800 (switch-selectable)

Parity: None

2.2.2.8 Remote Commands

The following commands are available to the user for remote communication and operation of the Model 10WD1000. In the descriptions of these commands, a lower-case “x” is used to signify a numeric value or parameter.

2.2.2 Remote Operation *(continued)*

2.2.2.8 Remote Commands *(continued)*

2.2.2.8.1 Power On/Off

Controls the power on/off state of the Model 10WD1000.

Syntax: Px

Parameters: 0 = power off

1 = power on

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

P1<LF>

2.2.2.8.2 Function

Selects frequency band or remote operation.

Syntax:Bx

Parameters: BA = Auto

BL = Lo Band

BH = Hi Band

:

:

Example: To set the Model 10WD1000 to Auto, send the following command:

GBA<LF>

2.2.2.8.3 Reset

Resets the Model 10W1000, clearing all faults, if possible.

Syntax: R

Parameters: None

Example: To clear a fault, send the following command:

R<LF>

3.1 INTRODUCTION

The Model 10WD1000 Amplifier consists of a DC to 0.5MHz and a 0.5MHz to 1000MHz Amplifier and a frequency discriminator on the heatsink, two power supplies and a operate/control circuit are located on the bottom side of the unit.

The RF input signal is connected from the front panel of the 10WD1000 to the input of the Frequency Discriminator. The correct frequency band can be selected automatically by the Frequency Discriminator or selected manually from the front panel or remotely. The Frequency Discriminator also controls relay K3 on the RF output to select either the DC-0.5MHz or the 0.5-1000MHz band.

The DC-1MHz amplifier consists of low level opamps, complimentary drivers, the output stages, the input signal limiter and an output protection circuit. The overall gain is typically 40dB.

The 1-1000MHz amplifier consists of four stages of low level gain, and a two stage output amplifier The overall amplifier gain is typically 40dB.

The Frequency Discriminator consists of one active low pass filter and amplifier, a high pass filter and amplifier, detectors and a comparator. The output is used to control RF relays on the input and the output of the 10WD1000.

The Power supply consists of a ±12V. +5V supply (PS1) a ±60 volt supply, at 1.5 amps and 20V at 10 amps (PS1) and associated relays, fuses and line filters. The operate/control board is also in the Power supply.

3.2 FREQUENCY DISCRIMINATOR

The RF input connector on the front panel of the 10WD1000 is connected to J1 of the Frequency Discriminator. A sample of the RF input is fed to a low pass filter and a high pass filter. The low pass filter has a 3dB point of approximately 1MHz. Integrated circuit U1A, C4, C5, R3, R4 and R5 form an active low pass filter. I.C. U1B amplifies the signal from U1A and drives a detector CR1 and a phase inverter U2A which drives detector diode CR2. The outputs from the low band detector diodes are sensed across R20 on the inverting input of comparator U3A.

Capacitors C10, C11 and inductor L1 form a high pass filter with a 3dB point of approximately 1MHz. I.C. U4 is a monolithic RF amplifier with approximately 25dB gain to over 1000MHz.

The output from detector diode CR3 is sensed across R22 at the non-inverting input of comparator U3A. Diodes CR4, CR5 CR7 and CR8 along with the resistors in series with them help to lower the maximum voltage developed across the input of the comparator during large signal conditions, for improved comparator operation.

The output of the comparator U3A drives Q5 which drives Relay K1, on the frequency discriminator to select either the Low band or the High band amplifier. Q5 also drives K3 to connect either the high or low band amplifier to the RF output connector of the front panel.

I.C. U5A and U5B are one shot multi-vibrators which turn off the RF for approximately 20msec. during the time the RF relays are switching, by switching the monolithic switch U6 to the terminated (off) position.

Voltage regulators U7 and U8 supply regulated ±15 VDC to the frequency discriminator board.

3.3 DC to 0.5MHz AMPLIFIER OPERATION

The DC to 0.5MHz module is a direct coupled amplifier capable of 10 watts saturated power. The amplifier operated class B with a quiescent current of approximately 150ma. Current feedback is used to provide wide amplifier bandwidth. Positive and negative 60 volt power supplies allow for direct coupling throughout the amplifier. The power supplies are current limited to approximately 1.7 amps to protect the amplifier from input overdrive and short circuits on the amplifier output.

The input signal is fed to a Diode Bridge type of limiter. This circuit begins to limit at an input signal of approximately 0dBm, to protect the amplifier from input overdrive. The signal is then fed to the first stage U1. This stage is a preamplifier with a voltage gain of approximately 15dB. The amplified signal is then fed to the second stage (U2, Q1 and Q2). This stage provides the level shifting to the high voltage levels required. Q1 and Q2 supply the drive to the third stage (Q3 and Q4) which supplies a majority of the voltage gain and sets up the quiescent current thru diodes CR1, CR2 and CR3. Transistor Q5 with Q9 and Q6 with Q10 are compound source followers, which supply the power gain of the circuit. Zener diodes VR5 and VR6 protect the gates of the MOSFET output transistors against overvoltage. Transistors Q7 and Q8 with their associated circuitry provide fast overcurrent protection by limiting the drive signal to the output stages.

3.4 0.5-1000MHz RF AMPLIFIER OPERATION

The RF Low Level stage is schematic number 1010543.

The RF input signal is fed to the first gain stage U1 thru the input attenuator, diodes CR1, CR2 and CR3. Diodes CR4 and CR5 are the RF input limiter diodes. The output of U1 is fed to gain stage U2 and the detector diode CR6 thru a fixed RF attenuator R27, R28 and R40. Diode CR6 detects the RF output level of U1.

The detected signal is fed to U3A which amplifies the detected signal. The output of U3A is fed to U3B which is used as a voltage comparator. The output of the voltage comparator is fed to the variable RF input attenuator. When the RF input level to U1 reaches approximately 0dBm the current thru the series diodes CR2 and CR3 decreases maintaining the RF level to U1 at approximately 0dBm. This helps to protect the RF stage from damage which could result from RF overdrive on the input.

Integrated circuit U2 further amplifiers the RF signal from U1 and provides RF input to Q4 which amplifies the RF signal and provides RF input to Q3. The output of Q3 is fed to gain equalizer (C10, R22, R23, L9, R24) which helps to reduce the low frequency gain. The output of the gain equalizer is fed to the first driver stage. Transistor Q1 and Q2 are used to maintain the collector current thru RF stages Q4 and Q3 at a constant value.

3.4 0.5-1000MHz RF AMPLIFIER OPERATION (Continued)

The output stage, Schematic Number 1006556, consists of push-pull RF stages Q3 and Q4. T4 is a phase splitter which provides signals of the correct phase to the base of Q3. T1 is a matching transformer between the output of Q3 and the input of Q4. Resistor/capacitor network C14, R14 and R15, C29, R25 and R26 help to reduce the excess low frequency gain of the amplifier. Transformer T2 and T3 match the collector of Q4 to 50 ohms. Transistors Q1, Q2, Q5 and Q6 sense the collector current of Q3 and Q4 and help to maintain constant collector currents. Q3 is set to 0.9 amps per side, Q4 is set to 1.5 amps per side. The output of Q4 is fed to RF relay K3 which is connected to the RF output connectors on the front panel.

The RF amplifier stages A4, A5, A6 and A7, Schematic Number 1006773 are push-pull gain stages .Transformer T1 is a phase splitter providing signals of the correct phase to the inputs of Q2. Transformer T2 and T3 match the collectors of Q2 to 50 ohms. Transistors Q1 and Q3 sense and regulate the collector currents of Q2 at 1.5 amps per side.

3.5 POWER SUPPLY ASSEMBLY (SCHEMATIC DIAGRAM NO. 1009777)

The Power Supply Assembly consists of two switching power supplies: PS1 and PS2. PS1 is a 25-watt, triple-output power supply with three regulated outputs: +5V, +12V, and -12V. PS1 has a universal input range of 85–264VAC, 50/60Hz. PS1 supplies +12V to supply power to the Operate/Control Board and to operate relay K1, which switches the AC input power to PS2 for both local and remote operation. PS1 also supplies +5V and -12V to power the Operate/Control Board. PS2 is a 20V, 10A, ±60V, 1A supply with a Power Factor Corrected front end; it will operate over an input voltage range of 85–264VAC, 50/60Hz. PS2 supplies +20V, which is fused through fuse F1 and ±60V which are fused through F2 and F3. The outputs of these fuses supply DC power to all of the RF Amplifier gain stages. PS2 also supplies +20V to operate Blower B1, which supplies air flow to cool the heat sink and the power supplies.

3.6 A4 Operate/Control Board (Schematic Diagram No. 1008597)

The A4 Operate/Control Board is a microcontroller-based printed wiring board (PWB) assembly that allows sensing and control of internal signals as well as remote personal computer (PC) control via on-board RS-232 and IEEE-488 data communications ports. The A4 Operate/Control Board utilizes a state-of-the-art, Reduced Instruction Set Computing (RISC) microcontroller that can quickly and reliably perform all front panel control and monitoring tasks, thereby allowing real-time control of the Model 25W1000B via either remote bus. Besides being reported remotely, all amplifier faults are continuously monitored and indicated via the unit’s front panel VFD.

3.7 Interface Board (Schematic Diagram No. 1009951)

The A5 Interface Board is composed of resistive networks and an I.C. switch.

The resistive networks condition the various voltage levels for use by the operate/control board. The I.C. switch U1 decodes the outputs of the operate/control board to provide the band switching signals.

SECTION IV

MAINTENANCE

4.1 General Maintenance Information

The Model 10WD1000 is a relatively simple instrument that should require very little maintenance. It is built with printed wiring boards (PWBs) and solid state components in order to ensure long, trouble-free life. However, should a malfunction occur, special care must be taken when servicing the unit in order to avoid damaging the solid state components or the PWBs.

Since the unit's solid state components are soldered in place, substitution of components should not be resorted to unless there is some indication that they are faulty. In addition, care must be taken when troubleshooting to avoid shorting amplifier voltages. Small bias changes may cause excessive dissipation or transients that could ruin the amplifier.

All components utilized in Amplifier Research instruments are conservatively operated to ensure maximum instrument reliability. Despite this, parts within an instrument may fail. In most cases, the instrument may be repaired immediately with a minimum of "down time." A systematic approach to troubleshooting can greatly simplify and thereby speed up the required repairs.

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

Please ship the unit **PREPAID** via United Parcel Service (UPS) to:

Amplifier Research Corporation

160 School House Road

Souderton, PA 18964-9990 USA

4.2 Disassembly Procedures

⚠ **CAUTION:**

EXTREME CAUTION SHOULD BE UTILIZED WHEN TROUBLESHOOTING THIS UNIT, PARTICULARLY WHEN MEASURING VOLTAGES IN THE POWER SUPPLY SECTION, SINCE HAZARDOUS VOLTAGES EXIST IN THE UNIT THAT COULD CAUSE SERIOUS INJURY TO ANY PERSONNEL PERFORMING THE MEASUREMENTS.

The amplifier can be removed from its housing by removing four (4) screws from the front panel and four (4) screws from the back panel. The amplifier can then be slid from its housing. The top cover can be removed to gain access to the RF assemblies; the bottom cover can be removed to gain access to the power supplies.

4.3 Troubleshooting

Troubleshooting the Model 10WD1000 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 10WD1000 Troubleshooting Categories:

Subsection 4.3.1—Front Panel Vacuum Fluorescent Display (VFD) Doesn’t Indicate **“Power On”** when the **POWER** Switch is Depressed

Subsection 4.3.2—The Unit Cannot be Operated Remotely

Subsection 4.3.3—Thermal Fault

Subsection 4.3.4—Interlock Fault

Subsection 4.3.5—Voltage Faults

Subsection 4.3.6—Low or No Power Output (DC Tests)

Subsection 4.3.7—Low or No Power Output (RF Tests)

4.3.1 Front Panel Vacuum Fluorescent Display (VFD) Doesn’t Indicate “Power On” when the POWER Switch is Depressed (Schematic Diagram No. 1009777)

4.3.1.1 If the Model 10WD1000 is operating in an otherwise normal fashion, the unit’s front panel vacuum fluorescent display (VFD) or the wiring to it could be defective.

4.3.1.2 Check the **FUNCTION** switch on the unit’s front panel; it must be set to the **LOCAL** position in order to operate the front panel **POWER** switch. Check the circuit breaker on the unit’s rear panel; it must be set to the “**1**” (“ON”) position.

4.3.1.3 If the **“Power On”** indication is not displayed and the cooling fan (Blower B1) is not running, check to see that the unit is plugged into a live outlet and that the AC line cord is plugged securely into the unit.

4.3.1.4 Check the output voltages from PS1; these voltages should be as follows:

PS1 J2, Pin 1	+12.0 ± 0.3VDC
PS1 J2, Pin 2	+ 5.0 ± 0.2VDC
PS1 J2, Pin 6	-12.0 ± 0.3VDC

If output voltages are not present on PS1, check the AC input to PS1.

4.3.1.5 Check the voltages to the A4 Operate/Control Board on connector A4 J2; the voltages should be as follows:

A4 J1, Pin 16	-12.0 ± 0.3VDC
A4 J1, Pin 29	+ 5.0 ± 0.2VDC
A4 J1, Pin 31	+12.0 ± 0.3VDC

4.3 Troubleshooting *(continued)*

4.3.1 Front Panel Vacuum Fluorescent Display (VFD) Doesn't Indicate "Power On" when the POWER Switch is Depressed (Schematic Diagram No. 1009777) *(continued)*

4.3.1.6 Check the voltage on A4 J1, Pin 6; it should be ≥4V when the **POWER** switch (S3) is in the normal position and <0.1V when S3 is depressed. S3 is normally open; it is closed only when it is depressed. The amplifier should change state every time the **POWER** switch is depressed.

4.3.1.7 If all voltages are correct and the unit still does not operate, contact Amplifier Research to arrange for repair or replacement of the A4 Operate/Control Board.

4.3.2 The Unit Cannot be Operated Remotely

4.3.2.1 Verify that the front panel **FUNCTION** switch is set to the **REMOTE** position.

4.3.2.2 Verify that the unit operates locally by resetting the **FUNCTION** switch to the **LOCAL** position; if the unit does not operate locally, see subsection **4.3.1** of this manual.

4.3.2.3 Check the position of the **"ADDRESS"** switch assembly (SW1) on the A4 Operate/Control Board; 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 1009777)

During a Thermal Fault, the front panel VFD should read **"THERMAL FAULT."**

4.3.3.1 Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fan (B1) is 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.

4.3.3.2 If the unit does not reset and the cooling fan is operating normally, check the voltage at the A4 Operate/Control Board, J1, Pin 43; it should be ≤0.1V.

4.3.3.3 If the voltage on A4 J1, Pin 43 is high, check the thermal daisy chain through S2 and S1 to ground.

4.3.4 Interlock Fault (Schematic Diagram No. 1009777)

The Model 10WD1000 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.

4.3 Troubleshooting *(continued)*

4.3.4 Interlock Fault (Schematic Diagram No. 1009777) *(continued)*

Note: The Model 10WD1000 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.

4.3.4.1 In the event of an Interlock Fault, the unit's front panel VFD should indicate **"INTERLOCK FAULT."**

4.3.4.2 Check to see if it is safe to power up the unit—are there personnel present in the screen room, or are doors to the screen room open?

4.3.4.3 After checking for safety, try to clear the Interlock Fault from the front panel by using the **RESET** switch.

4.3.4.4 If the Interlock Fault will not clear, check for continuity in the External Interlock Circuit (Pin 1 to Pin 8 in the connector, which mates with J2 in the rear panel).

4.3.4.5 Check the voltage on A5 J1, Pin 11; it should be ≥4.0V.

4.3.4.6 Check the voltage on A4 J1, Pin 44; it should be ≥4.0V.

4.3.4.7 If all of the above voltages are correct and the unit still will not reset, check for defective wiring and/or PWB connections, then try the **RESET** switch again. If the unit still will not reset, the A4 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A4 Operate/Control Board.

4.3.5 Voltage/Amplifier Faults (Schematic Diagram Nos. 1009777)

The Model 10WD1000 fault circuits sense a +20V fused fault and ±60 fused faults. The fuse fault circuits are located on the A5 Interface Board.

Fuse faults: Fuse faults are sensed by voltage dividers located on the A5 Interface Board; the outputs of the voltage dividers are then fed to the A4 Operate/Control Board via the following pins on A4J1:

Pin 40—Fuse F1

Pin 41—Fuse F2

Pin 42—Fuse F3

The output voltage should normally be **+5.0VDC**.

4.3 Troubleshooting *(continued)*

4.3.5 Voltage/Amplifier Faults (Schematic Diagram Nos. 1009777) *(continued)*

4.3.5.5 If a fused amplifier stage continues to blow fuses after they are replaced, refer to the correct RF stage schematic diagram to perform troubleshooting:

Fuse F1—RF Stages A1 and A2 (Schematic Diagram Nos. **1010543 and 1006556**)

Fuse F2 & F3—RF Stage A3 (Schematic Diagram No. **1007021**)

4.3.5.6 If a fuse fault is indicated on the front panel VFD but the fuse indicated is not blown, check to see that the high (+5V) signal to the A4 Operate/Control Board is present. If the high signal to the A4 Operate/Control Board is not present, check the wiring from the A4 Operate/Control Board to the A5 Interface Board. If the high signal to the A4 Operate/Control Board is present but the fault cannot be cleared, and the amplifier cannot be reset, then the A4 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A4 Operate/Control Board.

4.3.6 Low or No Power Output (DC Tests) (Schematic Diagram No. 1009777)

All indicators on the Model 10WD1000 VFD are normal, the VFD indicates **"POWER ON"** and **"STATUS OK,"** and the cooling fan (Blower B1) is operating.

4.3.6.1 Check the position of the function switch is it correct for the frequency being applied?

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

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

4.3.6.4 Check the voltages at the following locations. Troubleshoot any incorrect voltages.

Feed-through Cap.	Normal Voltage	Remarks
A1 C4	20V	Low-Level Stages
A2 C5	20V	Pre-Driver
A2 C6	20V	Driver Stage
A3 J1-1	60V	A3 DC – 0.5 MHz Module
A3 J1-3	-60V	A3 DC – 0.5 MHz Module

Note: The locations of the feed-through capacitors can be found on the RF Assembly Drawing (Schematic Diagram No. **1009682**).

4.3.7 Low or No Power Output (RF Test) (Schematic Diagram No. 1009777)

4.3.7 Low or No Power Output (RF Test) (Schematic Diagram No. 1009379) *(continued)*

If the RF gain is appreciably lower than it should be, remove the covers from A1A1 and A2A2. Inspect the amplifier stages for defective solder joints and burned or broken parts. Compare the voltages measured to the voltages shown on Schematic Diagram Nos. **1010543** and **1006556**.

<u>Note</u>: To troubleshoot amplifier stages with active bias, do the following:

1. Measure the DC input voltage.
2. Measure the DC voltage drop across the low-value resistor from VCC to the emitter of the active-bias transistor; is the voltage drop measured similar to the voltage drop shown on the schematic diagram? If the voltage drop is correct, the DC parameters of the amplifier stage are probably correct.
3. Measure the base voltage of the active-bias transistor; is the base voltage measured similar to the base voltage shown on the schematic diagram?
4. Measure the collector voltage of the RF transistor; is the collector voltage measured similar to the collector voltage shown on the schematic diagram?
5. Measure the base voltage of the RF transistor and compare it to the base voltage shown on the schematic diagram:
   - Higher than Normal (with low emitter voltage)—Indicates an open base emitter junction.
   - Lower than Normal—Indicates a short to ground or a shorted base emitter junction.

<u>Note</u>: To replace the stud mount transistors (Q3 or Q4), do the following:

1. Remove the unit's bottom panel.
2. Remove PS1 from the Power Supply Assembly to get to the access holes.
3. The nuts for Q3 or Q4 can be removed through the access holes.

4.4 LOW OR NO RF OUTPUT POWER

4.4.1 Check the operation of the Frequency Discriminator board. Is the RF relay (K1) switching to the correct output ? The RF insertion loss from J1 to J2 or J3 should be approximately 3dB. Try switching the bands manually with the front panel Band Select switch, does it function properly ?

4.4.2 After checking the Frequency Discriminator operation, check the output from the DC to 0.5MHz or the 0.5-1000MHz amplifiers at the connectors to the RF relay K3, which is connected to the output of the amplifiers. If there is output before the relay but none at the front panel connector, check the control wiring to K3, relay K3 and the coax connection from K3 to the front panel. If there is not an output from the amplifier check the appropriate amplifier.

4.5 FREQUENCY DISCRIMINATOR TROUBLESHOOTING

4.5.1 Refer to Schematic 1007024.
Check the outputs from U7 and U8 voltage regulators. U7 should be +15 VDC, U8 should be -15 VDC.

4.5.2 If the insertion loss of the RF path J1 to J2 or J1 to J3 is greater than 3dB, check the following. The voltage on pin 4 of U6 should be -5V, the voltage on pin 5 should be zero. These voltages should change to the opposite state for approximately 20msec. when the amplifier is changing bands. If the voltages are correct, check the operation of relay K1. If the voltages on U6 are incorrect check the differential amplifier Q6 and Q7 and the outputs from the 20msec one shot multi-vibrators U5A and U5B.

4.5.3 If the Manual Band select works but the Auto Band select does not work, the comparator U3A and relay driver Q5 are probably okay. Return the Band. Select switch to the Auto position, remove any input to the RF input. Check the differential voltage at the input of U3A pins 2 and 3. the voltage difference should be approximately ±15mv.

4.5.4 Check the voltage at the junction of CR5 and CR7 it should be approximately 7.5 VDC. Check the voltages from the junction of CR5 and CR7 to pins 2 and 3 of U3A, the voltages should be 0.2V less at pins 2 and 3. If the voltages are not correct, check the bias regulator U3B and Q3, transistors Q1 and Q2, detector diodes CR1, CR2 and CR3.

4.5.5 Connect a 250kHz, -10dBm, input signal to J1 of the Frequency Discriminator. Pin 2 of U3A should be approximately 0.9V more negative than pin 3.

4.5.6 Change the input signal to 1MHz at -10dBm at J1. Pin 3 should beapproximately 0.9V more negative than Pin 2.

4.6 DC-0.5MHz TROUBLESHOOTING

Refer to Schematic 1007021.

CAUTION:

High voltages are present in this Module.

This module circuitry is similar to that of an audio amplifier.

The first step in troubleshooting should be a visual inspection. Because of the voltage and currents involved when a failure does occur, it often results in indications such as discolored or burned resistors. A burned resistor is usually an indication that the transistor associated with it has failed. This can usually be verified with an ohmmeter, Failures in the low level stages are often secondary to failure of the output devices, therefore all transistors on the side that shows damage should be checked.

If there is no visible damage, apply power without an input signal. Check the ±60 VDC input power, if either voltage is absent, check fuses F2 and F3. If either supply is low the power supply may be in limit due to excessive current being drawn by the circuitry, the side that is low indicates the side which is drawing excessive current. Excessive current is usually an indication of a defective output transistor. If the ±60 VDC are normal, check the DC level on the output. The output DC level should be 0 volts. A large positive or negative voltage usually indicates a defective output transistor.

NOTE:

Failure of the output transistors can usually be verified as a low resistance reading between the gate and source or gate and drain.

Voltage readings on the DC-1MHz module should also be compared to those shown on the Schematics.