

THE ADVANCED ENERGY[®] MDX 1K MAGNETRON DRIVE

User Manual

PN: 5700045-D

THE
ADVANCED ENERGY®
MDX 1K MAGNETRON DRIVE

User Manual

ADVANCED ENERGY
INDUSTRIES, INC

1600 Prospect Parkway
Fort Collins, Colorado 80525
(303) 221-4670
Telex #45-0938

PN: 5700045-D

To ensure years of dependable service, Advanced Energy® products are thoroughly tested and designed to be among the most reliable and highest quality systems available worldwide. All parts and labor carry our standard 1-year warranty.

For **Customer Service**, call:

AE, Colorado office	(303) 221-0108 (24-hour line) Fax: (303) 221-5583
AE, California office	(408) 263-8784 (8 a.m. to 5 p.m. Pacific Standard Time — California only) Fax: (408) 263-8992
AE, Japanese office	81 (03) 3222-1311 Fax: 81 (03) 3222-1315
AE, German office	49 (0711) 777-87-18 Fax: 49 (0711) 777-87-00
all others	contact your local service center—see the list on the next page

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In the interest of providing even better equipment, Advanced Energy Industries, Inc., reserves the right to make product changes without notification or obligation.

For more information, write Advanced Energy Industries, Inc., 1600 Prospect Parkway, Fort Collins, CO 80525.

AE Service Centers

<u>Company Name</u>	<u>Phone/Fax Numbers</u>
Vacutec AB Sweden	46 (0) 40-437270 Fax: 46 (0) 40-435538
Gambetti Kenologia snc Italy	39 (02) 9055660 Fax: 39 (02) 9052778
Segen Technologies, Ltd. Israel	972 (03) 9363106 Fax: 972 (03) 9362030
Zeus Co., Ltd. Korea	82 (02) 577-3181 Fax: 82 (02) 576-3199
Schmidt Scientific Taiwan	886 (02) 5013468 Fax: 886 (02) 25029692

Returning Units for Repair

Before returning any product for repair and/or adjustment, call AE Customer Service and discuss the problem with them. Be prepared to give them the serial number of the unit and the reason for the proposed return. This consultation call will allow Customer Service to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

If you return a unit without first getting authorization from Customer Service, and that unit is found to be functional, you will have to pay a retest and calibration fee, and all shipping charges.

Upgrading Units

AE will upgrade older units for a fee (a percentage of the current list price, based on the age of the unit. Such an upgraded unit will carry a 6-month warranty (which will be added to any time remaining on the original warranty).

DESIGNED FOR MAGNETRONS

The new MDX series of Magnetron Drives are designed for hard use in a vacuum environment. Advanced circuit and semiconductor technology makes these amazing units over 90% smaller and lighter than comparable equipment.

Performance is also remarkably improved through high frequency switching techniques that reduce output energy storage. This decreases splatter and enables faster response to stabilize magnetron loads.

FULL POWER

The new MDX Magnetron Drives come equipped with standard features like a power regulator, interlock string, remote interface, full digital meters and an integrator.

The drive is fully protected from arcs and open/short circuits. Arc-Out™, a recent Advanced Energy Industries, Inc. development, senses an abnormal load and quenches the arc before damage occurs.

FULL I/O

All displayed signals are available continuously at the rear I/O connector. In addition:

- Analog control of ramp and output
- Logic or contact control of ON/OFF
- Fully buffered and ground referenced 0-5 volt signals for voltage, current and power
- Logic outputs for interlock, output and setpoint status information.

SERVICEABILITY — MODULAR

Advanced Energy Industries, Inc. standard modules are used throughout the MDX, enabling replacements to be made in minutes without special tools, soldering or adjustments.

CONFIDENCE

The MDX family is designed to be among the most reliable and quality-oriented systems available. All parts and labor carry our standard 1-year warranty, and for a small premium we will extend to a full 5 years.

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******* WARNING *******

PROPER USE AND SAFE OPERATING PROCEDUES OF THE EQUIPMENT ARE THE RESPONSIBILITY OF THE USER OF THIS SYSTEM.

Advanced Energy Industries, Inc. provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices. Take appropriate action to protect personnel and property from hardware failure.

ALL PERSONNEL WHO WORK WITH OR ARE EXPOSED TO THIS EQUIPMENT MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS AND/OR FATAL BODILY INJURY.

DO NOT BE CARELESS AROUND THIS EQUIPMENT.

1.0

SAFETY

The high voltage nature of the output of these power supplies dictates the use of caution when near the output power connection.

Precautions:

- 1) Make certain that the chassis is properly grounded —THE GROUND CONNECTION PROVIDED SHOULD NOT BE DEFEATED!
- 2) THE PROTECTIVE COVERS SHOULD NOT BE REMOVED FROM THE SUPPORT DURING OPERATION.

2.

GENERAL DESCRIPTION

The MDX series of Magnetron Drives are designed as power sources for DC magnetron applications.

The unit will reliably deliver full power to a magnetron cathode at 1000V.

This power is controlled within any of three regulation modes; power, current or voltage. The control can be made from the front panel or a user port.

Full instrumentation is included as is a programmable ramp, a full interlock string, and front panel setpoint lock.

A high frequency conversion technique coupled with a proprietary Arc-Out™ circuit enables extremely low stored energy, reducing energy discharged into an arc by several order of magnitude. This greatly decreases splatter and thermal shock on sensitive targets.

3.0

SPECIFICATIONS

- Input voltage - 115 VAC \pm 10%
50/60 Hz
- Input current - 12A nominal @ 1KW (full power)
0.92 power factor
15A circuit breaker
- Output power - 0-1000W
- Output voltage - 0-1000V. 1500V open circuit voltage
- Output current - 0-1.0A
- Output ripple - 5% RMS MAX., ripple frequency=50KHz
- Cooling - 0 to 45°C ambient. Three inches of clearance to
the rear and one side of unit is required.
- Humidity - 0-92% non-condensing

4.0 UNPACKING

DO NOT APPLY POWER TO THE UNIT BEFORE FOLLOWING THIS PROCEDURE:

Unpack and inspect your power supply carefully. Check for any sticking switches on the front panel and any obvious physical damage.

Remove the top cover (6 phillips screws). Inspect the plexiglass for signs of physical damage and if none are observed, proceed to the next section.

5.0 POWER CONNECTIONS

The standard power is 115V \pm 10% at 50/60 Hz. A three prong, grounded U.S. standard connector is provided with the unit. DO NOT OPERATE ON AN UNGROUNDED OUTLET. DO NOT CUT OFF GROUND TAB.

WARNING

MAKE CERTAIN USER MAIN CIRCUIT BREAKER IS OFF DURING HOOK UP.

6.0 OUTPUT CONNECTOR

Connector - Amphenol 83-822

Use RG-8U cable for the output connection. The correct connection has been supplied.

Note: The shield is connected to the chassis ground and will be positive or negative referenced to the center connector as ordered.

7.0 USER INTERFACE CONNECTOR

Connector - Subminiature "D" (25 pin)

<u>PIN#</u>	<u>NAME</u>	<u>DESCRIPTION</u>	<u>REFERENCE</u>
1	A.IOUT	Analog signal representing output current	7.2.1
2	A.POUT	Analog signal representing output power	7.2.2
3	A.VOUT	Analog signal representing output voltage	7.2.3
4	D.XWATER	User water interlock	7.2.4
5	D.XVAC	User vacuum interlock	7.2.4
6	D.AUX	User auxiliary interlock	7.2.4
7	D.XOFF	Remote system off command	7.2.5
8	D.XON	Remote system on command	7.2.6
9	INTLKCOM	Interlock common	7.2.7
10	A.XREF	External reference voltage (5.0V)	7.2.8
11	A.RAMPOUT	Analog signal representing ramp program	7.2.9
12	A.LEVELOUT	Analog signal representing level program	7.2.10
13	D.SETPOINT	Digital indication representing output at setpoint	7.2.11
14	A.VAUX	External voltage (+15V)	7.2.12
15	_____	_____	
16	_____	_____	
17	_____	_____	
18	_____	_____	
19	_____	_____	
20	M.COM	Meter common	7.2.13

<u>PIN#</u>	<u>NAME</u>	<u>DESCRIPTION</u>	<u>REFERENCE</u>
21	OUTCOM	Indicator common	7.2.14
22	D.OUTPUT	Digital indication representing output present	7.2.15
23	A.XLEVEL	Remote system level adjust	7.2.16
24	A.XRAMP	Remote system ramp adjust	7.2.17
25	INCOM	External program common	7.2.18

Note: All levels that are referred to as high are +15V logic unless otherwise stated.

7.2.1 A.IOUT

The A.IOUT connection provides a fully buffered 0 to 5 volt output signal representing output current. 5V equals 1.0A for an MDX-1K. See Diagram 5. A.IOUT is referenced to M.COM. Source impedance is 100 ohms.

7.2.2 A.POUT

The A.POUT connection provides a fully buffered 0 to 5 volt output signal representing output power. 5V equals 1000 watts for an MDX-1K. See Diagram 5. A.POUT is referenced to M.COM. Source impedance is 100 ohms.

7.2.3 A.VOUT

The A.VOUT connection provides a fully buffered 0 to 5 volt output signal representing output voltage. 5V equals 1000VDC. See Diagram 5. A.VOUT is referenced to M.COM. Source impedance is 100 ohms.

7.2.4 D.XAUX, D.XVAC, D.XWATER

These allow the user to gain access to the interlock string. With the string not satisfied, the main contactor will not close, or if the contactor is closed, breaking the string will cause the main contactor to open. After activation, the interlock status indicator will extinguish. To turn on the Magnetron Drive again, the failed interlock must be corrected. After this, D.XON or OUTPUT will turn on the Magnetron Drive. Connect the appropriate interlock through a closed switch on INTLKCOM to indicate a good interlock. See Diagram 2.

7.2.5 D.XOFF

The D.XOFF command duplicates the OUTPUT OFF of the front panel. This function overrides all other commands and forces the Magnetron Drive to turn off by opening the main contactor.

7.2.6 D.XON

D.XON command allows remote turn on of the Magnetron Drive. To use this command, the REMOTE ON must be selected on the rear panel. See Figure 1. This transfers the OUTPUT ON command to D.XON. A momentary contact closure of D.XON to INTLKCOM 9 will cause the Magnetron Drive to turn on if D.XOFF is connected through a contact closure to INTLKCOM. See Diagram 3. A two-wire command is possible with D.XON and D.XOFF connected together. If this is done, both must be connected to INTLKCOM continuously to turn on the Magnetron Drive. See Diagram 4.

7.2.7 INTLKCOM

All interlock connections are referred to INTLKCOM, a dedicated ground that returns to the internal system ground, the chassis ground, and finally safety ground.

7.2.8 A.XREF

The A.XREF connection provides the user with an accurate 5V reference ($5V \pm 10mV$). Reference A.XREF to INCOM.

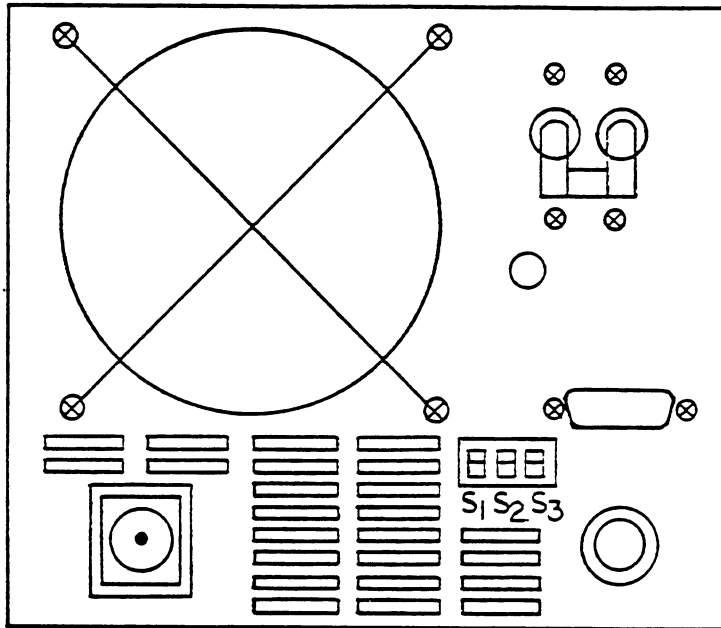
Note: Do not load the A.XREF to more than 5mA. Source impedance is 100 ohms.

7.2.9 A.RAMPOUT

The A.RAMPOUT connection provides a fully buffered 0-5V output signal representing the amount of time for the output ramp. 5V equals 10.0 seconds or minutes, whichever is selected. See Figure 1. Source impedance is 100 ohms.

7.2.10 A.LEVELOUT

The A.LEVELOUT connection provides a fully buffered 0-5V output signal representing the presently programmed setpoint of the Magnetron Drive. 5V equals max setpoint. Reference A.LEVELOUT to M.COM. Source impedance is 100 ohms.



Switch S1-RAMP.

This switch changes the ramp from 1-10.0 seconds (switch in upper position) to 1-10.0 minutes (switch in lower position).

Switch S2-REMOTE PROG.

This switch changes the program control from the front panel control (switch in the upper position) to user connector control (switch in the lower position). The user connector is used for both level programming (A.XLEVEL) and for Ramp programming (A.XRAMP).

Switch S3-REMOTE ON.

This switch changes the OUTPUT ON control from the front panel (switch in the upper position) to the user connector (switch in the lower position).

FIGURE 1. MDX-1K REAR CHASSIS SWITCH LOCATION

7.2.11 **D.SETPOINT**

D.SETPOINT is an output signal that duplicates the SETPOINT light indication on the front panel. D.SETPOINT goes low when the output setpoint has been reached. D.SETPOINT should be referenced to OUTCOM. D.SETPOINT will flash at a rate of approximately 3.5Hz. When the output is not at setpoint, it will flash at approximately 15Hz when the output is ramping.

7.2.12 **A.VAUX**

The A.VAUX connection is a user available + 15V referenced to OUTCOM. This output is internally limited at 100mA.

7.2.13 **M.COM**

All meter connections are referenced to M.COM, a dedicated ground that returns to internal system ground, then chassis ground, and finally safety ground.

7.2.14 **OUTCOM**

Ground return used as a reference for MDX drive that parallels front panel status indicators. A dedicated ground that returns to the internal system ground, then chassis ground, and finally safety ground.

7.2.15 **D.OUTPUT**

D.OUTPUT is an output signal that duplicates the OUTPUT light indication on the front panel. The OUTPUT light on the front panel will illuminate when the OUTPUT is enabled. D.OUTPUT goes high when the OUTPUT is enabled. Reference D.OUTPUT to OUTCOM. Source impedance is 100 ohms.

7.2.16 **A.XLEVEL**

The A.XLEVEL connection allows the user to program output level from an external source. See Diagram 6. The signal should be 0 to 5V, with 5V being maximum output. To enable this function, REMOTE PROGRAM must be selected. See Figure 1. Reference A.XLEVEL to INCOM. Source impedance is 100 ohms.

7.2.17 A.XRAMP

The A.XRAMP connection allows the user to program ramp time from an external source. See Diagram 6. The signal should be 0 to 5V, with 5V being max ramp time (10.0 minutes or seconds). To enable this function, REMOTE PROGRAM must be selected on rear panel. See Figure 1. Reference A.XRAMP to INCOM. Source impedance is 100 ohms.

7.2.18 INCOM

All analog input control connections are referenced to INCOM, a dedicated ground that returns to the internal system ground, then chassis ground, and finally safety ground.

User Plug

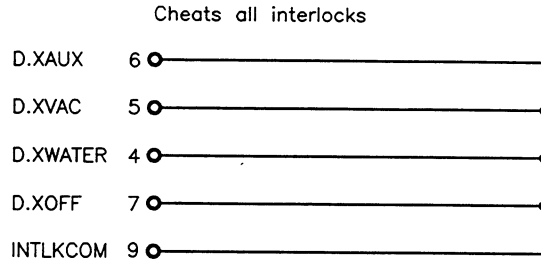


Diagram 1. Cheater Plug

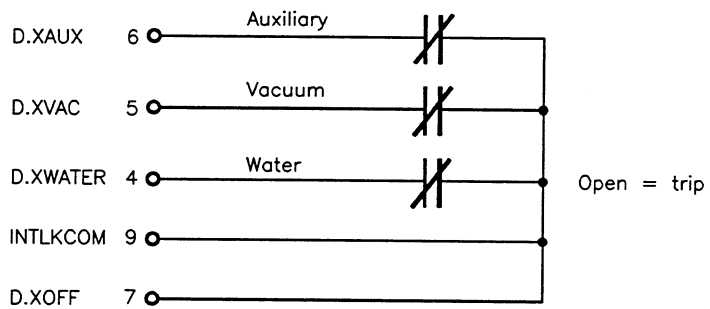


Diagram 2. Normal Interlock Connection

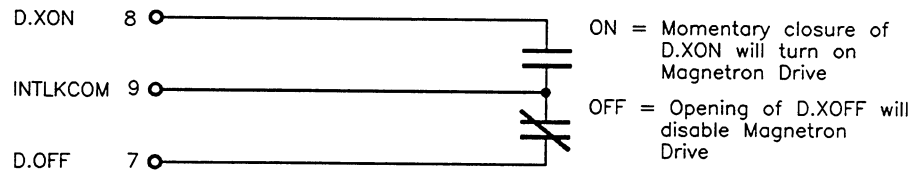


Diagram 3. Three-wire Control Connection

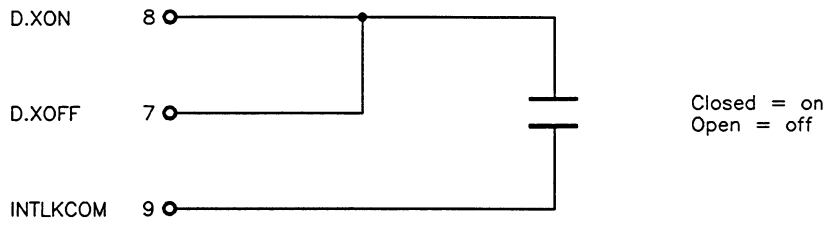


Diagram 4. Two-wire Control Connection

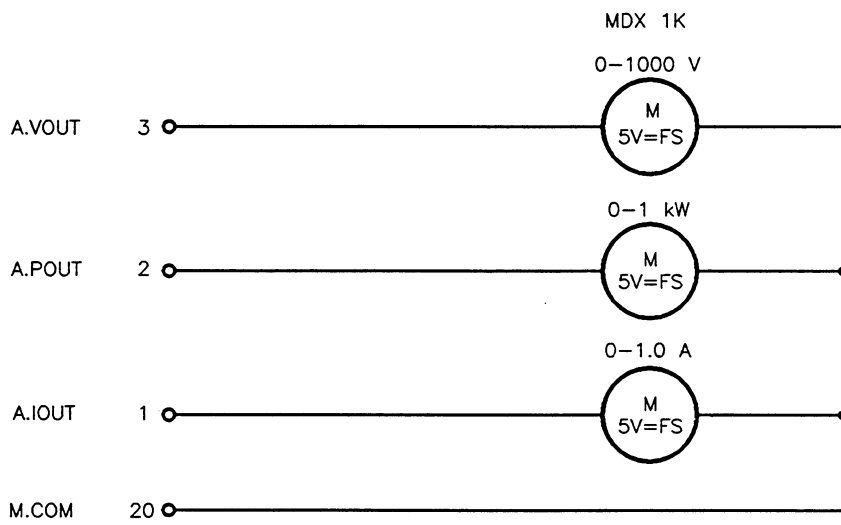


Diagram 5. External Metering

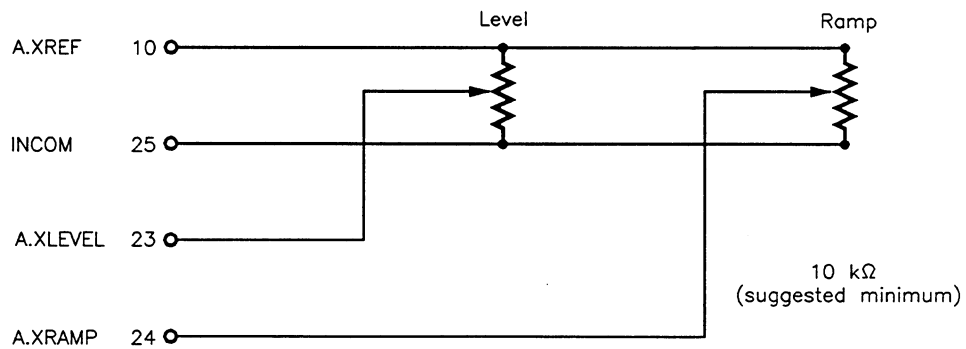


Diagram 6. External Programs

8.0 FRONT PANEL CONTROLS

8.3.1 POWER

The power button turns on the internal power of the power supply.

8.3.2 OUTPUT OFF

The OUTPUT OFF button will turn off the Magnetron Drive.

8.3.3 OUTPUT ON

The OUTPUT ON button turns on the Magnetron Drive if the front panel mode is selected, a regulation mode has been selected and all interlocks are satisfied. If a setpoint value has previously been programmed, the MDX will go to that value when turned on.

8.3.4 REGULATION; POWER, CURRENT, VOLTAGE

The MDX Magnetron Drive allows three modes of regulation; POWER, CURRENT or VOLTAGE. The current mode is selected by pressing CURRENT, the power mode by pressing POWER, and the voltage mode by pressing both POWER and CURRENT simultaneously. The user can change modes only when the output has been turned off.

8.3.5 LEFT DISPLAY

The LEFT DISPLAY allows continuous monitoring of the Regulation Mode. When the Regulation Mode is changed, the parameter that is monitored changes to the new mode.

8.3.6 STATUS INDICATORS

8.3.6.1 ARC

The ARC LED flashes when an arc is sensed or if the ARC-OUTTM circuit is activated.

8.3.6.2 SETPOINT

The SETPOINT LED turns on when the output reaches the pre-selected setpoint. It will flash if current, voltage or power exceed their maximum limits or if the output cannot reach the programmed level.

8.3.6.3 RAMP

The RAMP LED will rapidly flash when the output is ramping toward the pre-selected setpoint. If the output is out of regulation it will flash at a slower rate. Once the final setpoint is reached, the LED will turn off.

8.3.6.4 PLASMA

The PLASMA LED turns on when a minimum current threshold is being delivered to the load.

8.3.6.5 OUTPUT

The OUTPUT LED turns on when the Magnetron Drive has been enabled and the main contactor closes.

8.3.6.6 OVERTEMP

The OVERTEMP LED senses internal overtemperature

8.3.6.7 INTLK

This LED is a user interlock indicator. The LED is on when the interlock is satisfied. A failed interlock will cause its LED to extinguish. When an interlock fails, the Magnetron Drive is turned off and cannot be restarted until the interlock failure is corrected and the LED is on again.

8.3.7 SETPOINT

The SETPOINT button allows the user to preprogram the output level. Press this button (the regulation mode LED and the SETPOINT LED will turn on) while watching the right display program for the desired output level. Pressing the SETPOINT button again will allow the user to program the ramp time.

8.3.8 LEVEL

The LEVEL knob is used to program the output level. Drive setpoints can be programmed in either the ON or OFF mode. If the level is changed during a ramp, the output changes for the ramp to finish at its preprogrammed time. Once the output is at the preprogrammed level, the LEVEL knob has full control of the output level.

8.3.9 RAMP

The RAMP knob allows the user to preprogram the amount of ramp time (time from 0 output to preprogrammed level). This can be programmed for either 1-10.0 seconds or 1-10.0 minutes. See Figure 1.

8.3.10 RIGHT DISPLAY

The RIGHT DISPLAY allows continuous monitoring of the following parameters in conjunction with the 'ACTUAL' or 'SETPT' switches.

8.3.10.1 KW

When the KW LED is on, the DISPLAY is monitoring either output kilowatts if the ACTUAL LED is on or is monitoring the power setpoint if the SETPOINT LED is on and the supply is in the POWER REGULATE MODE. Press SETPT or press ACTUAL switch.

8.3.10.2 VOLTS

When the VOLTS LED is on, the RIGHT DISPLAY is monitoring output voltage if the ACTUAL LED is on or is monitoring the VOLTAGE REGULATION SETPOINT if the SETPOINT LED is on and the supply is in the VOLTAGE REGULATE MODE. Press SETPT or ACTUAL switch.

8.3.10.3 AMPS

When the AMPS LED is on, the RIGHT DISPLAY is monitoring output current if the ACTUAL LED is on or is monitoring the CURRENT REGULATION setpoint if the SETPOINT LED is on and the supply is in the CURRENT REGULATE MODE. Press SETPT or ACTUAL switch.

8.3.10.4 MINUTES OR SECONDS

When the MINUTES or SECONDS and SETPOINT LEDS are on, the RIGHT DISPLAY shows the ramp setpoint.

8.3.11 SETPT

The SETPT switch allows the user to check programmed setpoints. If the RIGHT DISPLAY indicates MINUTES or SECONDS, pressing the SETPT switch allows the user to see the programmed REGULATION mode setpoint. If the RIGHT DISPLAY indicates KW, VOLT or AMP, pressing the SETPT switch allows the user to check the programmed regulation MODE setpoint.

8.3.12 ACTUAL

The ACTUAL switch allows the user to select the desired mode of monitoring on the RIGHT DISPLAY.

9.0 OPERATION

Connect output connector.

Turn on breaker on rear of Magnetron.

Press the POWER SWITCH in until it latches.

All displays will read zero. The OUTPUT OFF light will be on. Other lights that will be on include both DISPLAYS, a regulation mode (if it has been selected), and the ACTUAL LED.

Select a regulation mode, CURRENT, POWER or VOLTAGE by pressing the appropriate switch. That regulation LED will illuminate.

To set ramp rate, press SETPOINT twice and adjust RAMP. Watch the right display for desired value. Refer to 8.3.7.

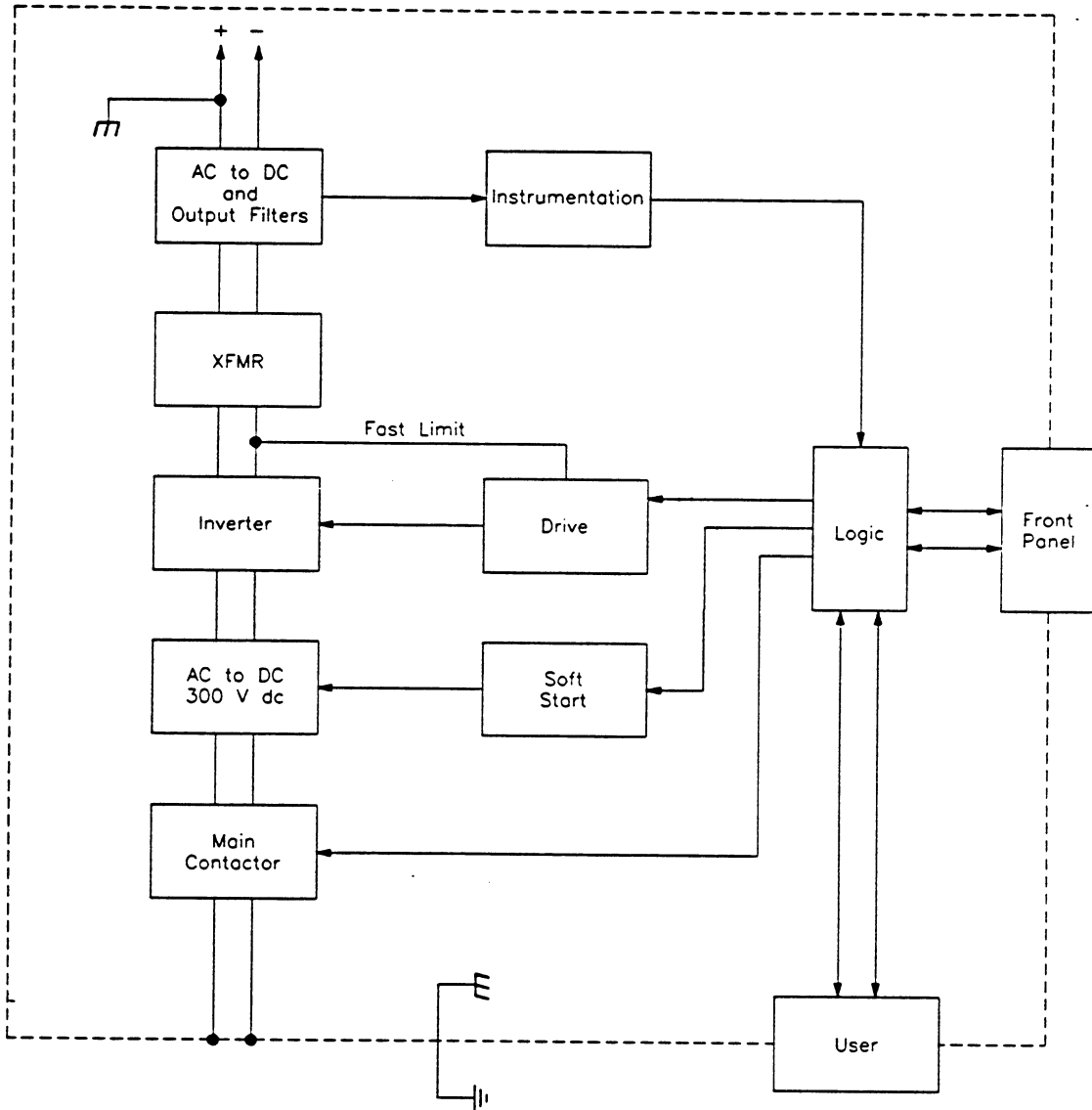
To set output level, press SETPOINT and adjust LEVEL. Watch right display for desired value. Refer to 8.3.8

To enable output, press ON. Contactor will close, the ARC LED will momentarily light, the Output, Ramp and Plasma LEDs will come on. Refer to 8.3.3.

The output will ramp to selected output level at which time the RAMP LED will go out and the SETPOINT LED will come on.

PRINCIPLES OF OPERATOR

Block Diagram:



Warranty Claims

Advanced Energy® products are warranted to be free from failures due to defects in material and workmanship for 12 months after they are shipped from the factory (please see warranty statement, below, for details).

In order to claim shipping or handling damage, you must inspect the delivered goods and report such damage to AE within 30 days of your receipt of the goods. Please note that failing to report any damage within this period is the same as acknowledging that the goods were received undamaged.

For a warranty claim to be valid, it must:

- be made within the applicable warranty period
- include the product serial number and a full description of the circumstances giving rise to the claim
- have been assigned a return authorization number (see below) by AE Customer Service

All warranty work will be performed at an authorized AE service center (see list of contacts at the front of the manual). You are responsible for obtaining authorization (see details below) to return any defective units, prepaying the freight costs, and ensuring that the units are returned to an authorized AE service center. AE will return the repaired unit (freight prepaid) to you by second-day air shipment (or ground carrier for local returns); repair parts and labor will be provided free of charge. Whoever ships the unit (either you or AE) is responsible for properly packaging and adequately insuring the unit.

Authorized Returns

Before returning any product for repair and/or adjustment, call AE Customer Service and discuss the problem with them. Be prepared to give them the serial number of the unit and the reason for the proposed return. This consultation call will allow Customer Service to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

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Upgrading Units

AE's products are continually changing as ways to improve them are discovered. AE is happy to upgrade older units so that they reflect recent improvements. The fee for upgrading a unit will be a percentage of the current list price, based on the age of the unit. Such an upgraded unit will carry a 6-month warranty (which will be added to any time remaining on the original warranty). Contact Customer Service for specifics on getting an older unit upgraded to the current revision level.

Warranty

The seller makes no express or implied warranty that the goods are merchantable or fit for any particular purpose except as specifically stated in printed AE specifications. The sole responsibility of the Seller shall be that it will manufacture the goods in accordance with its published specifications and that the goods will be free from defects in material and workmanship. The seller's liability for breach of an expressed warranty shall exist only if the goods are installed, started in operation, and tested in conformity with the seller's published instructions. The seller expressly excludes any warranty whatsoever concerning goods that have been subject to misuse, negligence, or accident, or that have been altered or repaired by anyone other than the seller or the seller's duly authorized agent. This warranty is expressly made in lieu of any and all other warranties, express or implied, unless otherwise agreed to in writing. The warranty period is 12 months after the date the goods are shipped from AE. In all cases, the seller has sole responsibility for determining the cause and nature of the failure, and the seller's determination with regard thereto shall be final.

AE, World Headquarters
1625 Sharp Point Drive
Fort Collins, CO 80525 USA
Phone: 970.221.0108 or 970.221.0156
Fax: 970.221.5583
Email: technical.support@aei.com

