

INSTRUCTION MANUAL FOR

XR802 SERIES

POWER SUPPLY

83-488-100 Revision B

MODEL _____

SERIAL NUMBER _____

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1 GENERAL

1.1 INTRODUCTION

The high regulation XR802 Series high voltage power supplies are designed for charging capacitors in laser systems and other pulsed power applications. The model XR802DC is a compact high efficiency high voltage DC power supply with the addition of an externally mounted output filter capacitor. Depending upon the application, the stored energy requirement of this capacitor can be quite low making the XR802DC an ideal power supply for applications such as compact high power RF amplifiers for HDTV applications.

The XR802 Series is available in three different configurations; the XR802L, XR802S and XR802 OEM. These three different configurations allow the user to choose the method of controlling the power supply best suited to the overall system requirements. All three have the same mechanical dimensions, are air cooled and can be mounted in a standard 19" rack occupying only 8.75" of rack height. The XR802 Series provides up to 6,000 Watts of average power and can be paralleled for higher total system power.

The XR802 Series power supply incorporates a high-frequency IGBT Series-resonant inverter for efficient generation of the output power. A high-performance control module precisely regulates the output voltage, automatically compensating for line, load, temperature, rep rate, and program voltage variations. Normal external fault conditions such as line dropout, open or short circuit load, HV arc and overtemperature will not damage the unit.

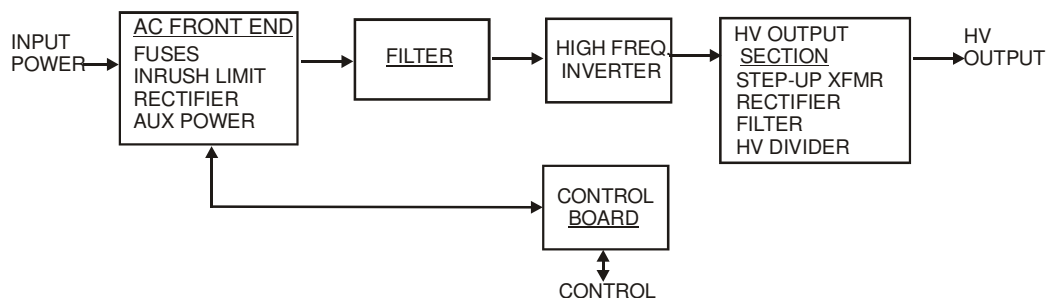


Figure 1: XR802 Series Block Diagram

The output voltage of the XR802 power supply is fully adjustable over each range.

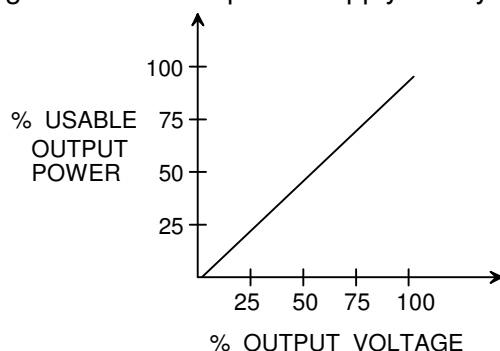


Figure 2: Output Power

1.2 SPECIFICATIONS

OUTPUT VOLTAGE/CURRENT

The output voltage is fully adjustable over each range. Recommended control range for full regulation is 10% to 100% of Full Scale. The output current from 100% to 10% of rated voltage is constant. This provides the full 6000 Watts of average output power at 100% of rated voltage.

Voltage Range	Max Current Cap-Charging	Max Current DC
0-1 kV	14.0 A	8.0 A
0-2 kV	7.0 A	4.0 A
0-4 kV	3.5 A	2.0 A
0-5 kV	2.8 A	1.6 A
0-10 kV	1.4 A	800 mA
0-20 kV	700 mA	400 mA
0-30 kV	467 mA	260 mA
0-40 kV	350 mA	200 mA
0-50 kV	280 mA	160 mA

CHARGE RATE:

6000 J/sec average

DC POWER OUTPUT:

8,000 watt

REGULATION:

±0.1% to 250 Hz Standard

±0.3% to 1 kHz Standard ±0.1% to 1 kHz Available

Total pulse-to-pulse variation with no series terminating resistance/inductance.

STABILITY

<0.2% per hour after 1 hour warm up.

PROGRAMMING LINEARITY

+/-1.0% of full-scale @10% to 100% of rated output.

PROGRAMMING ACCURACY

+/-1.0% of full-scale @10% to 100% of rated output.

INTERNAL STORED ENERGY

0.5 Joules Max.

EFFICIENCY:

85% minimum at full load and nominal line.

A.C. POWER INPUT CONNECTIONS

5 positions VDE/IEC Approved Terminal Block

Ø1, Ø2, Ø3, N,  for 400 VAC input voltage

Ø1, Ø2, Ø3,  for 209 VAC input voltage

INPUT VOLTAGE/CURRENT

208V Configuration: 180-264 V, 3 Phase, 50/60 Hz, 45 A max

400V Configuration: 360-440 V, 3 Phase, 50/60 Hz, 25 A max

POWER FACTOR:

Passive PFC. 85% minimum at full power and nominal line input

INRUSH CURRENT

Limited to below full power current.

PROTECTION FEATURES

- Output short circuit and HV arc-to-ground any time during operation.
- Open circuit at turn-on, will not damage power supply.
- Remote HV Safety Interlock loop
- AC input power contactor (Standard on 'L', 'S'; Optional for 'OEM')
- Shutdown on over-temperature, overvoltage, and open interlock.
- Highly buffered I/O for noise immunity in severe electrical environments.

COOLING

Forced air with internal fan, -20°C to 40°C inlet temperature,

ENVIRONMENTAL CONDITIONS

The power supply is safe under the following conditions:

- Altitude up to 3000m (9900 ft) operating, nonoperating 12121m (40000 ft)
- Temperature 5°C to 40°C
- Storage temperature - 40°C to 85°C.
- Maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C.
- Fluctuations not to exceed the stated input voltage range.
- Transient overvoltages according to Installation Categories (Overvoltage Categories) I, II and III in accordance with IEC 1010, current revision.
- Operation only in horizontal position for w/Oil Insulated HV Output.

HV OUTPUT CONNECTOR AND CABLE

Output Voltage	Connector	Cable
<= 6.0 kV	Amphenol 'HN'	RG-8/U
> 6.0 kV	Proprietary	Dielectric Sciences 2214 80kV

10' coaxial hv cable with grounded shield standard. Other lengths available.

METERING ACCURACY

All ±2%

FRONT PANEL

"L" Model

- 3 ½ digit voltage & current meters.
- 10 segment voltage and current trend bar graphs.
- Multi-turn HV output level control.
- HV ON, HV OFF, and push to view push button.
- 3 position key switch removable in Off position.

"L & S" MODELS

- HV ON Indicators
- HV OFF Indicators
- INHIBIT Indicators
- END OF CHARGE Indicators
- LOAD FAULT Indicators
- OVER TEMPERATURE Indicators

SHOCK

25 Gpk, half Sine wave 11mSec, x, y, z axis (3 total)

VIBRATION

MIL-STD-810E Method 514.4 basic transportation

Common carrier 10-500Hz, 0.015 g²/Hz

Duration 1 Hour

SIZE

Standard 19" rack mount. 8.75" high, 17" deep. Refer to Figure 1 for details.

WEIGHT

80 Lbs., 36 kg w/Oil Insulated HV Output

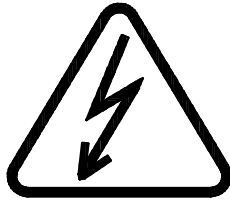
60 Lbs., 27 kg w/Air Insulated HV Output (≤6kV) options:

ALL MODELS:

- Custom output voltages
- 0 - 5 VDC Programming
- ±0.1% regulation to 1kHz.
- Remote output voltage sensing
- Rack mount slides
- EMI filter

2 INSTALLATION

2.1 SAFETY PRECAUTIONS



The user should be aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

All model XR802 power supplies contain hazardous voltage and energy. The power supply must only be operated by qualified personnel who have read this operator's manual and are familiar with the operation, hazards and application of the power supply. Proper care and judgment must always be observed. Ensure all covers are in place and securely fastened and the required grounding and cooling is supplied before connecting input AC power. Proper grounding from the input AC power is required to reduce the risk of electric shock. Use extreme caution when connecting input AC power and never apply the incorrect input power. Use extreme caution when connecting the high voltage output cable. Ensure all load capacitors are completely discharged prior to connection and never handle the output cable when the power supply is operating. Always replace fuses with the same type and Volt/Amp ratings. Never attempt to operate the power supply in any manner not described in this manual. Never remove DANGER or WARNING labels from the power supply, and replace lost or damaged labels immediately. The power supply should only be serviced by EMI factory qualified personnel.

2.2 INITIAL INSPECTION

The shipping container should contain the following items: power supply, HV output cable, male 25-pin "D" remote control connector, test data sheet and operator's manual. Examine the items immediately for damage. Locate the serial number label on the side of the power supply and verify the model number, the input voltage rating and the output voltage rating and polarity. In the event of any damage promptly notify the transportation company and EMI customer service.

2.3 MOUNTING AND COOLING REQUIREMENTS

The power supply should be mounted in a standard 19" EIA enclosure or equivalent. Chassis support brackets or rails must be added to the bottom of the power supply for proper weight distribution. In all cases adequate clearances must be provided for proper air flow and cable bends. Generally, at least 4" of clearance should be allowed at the rear of the power supply and 1" at the sides.

When operating in an enclosed system, care must be taken to ensure the ambient inlet air to the power supply does not exceed the maximum operating temperature of 40°C. this often requires addition of a system heat exchanger.

2.4 ORIENTATION

Power supplies with air H.V. sections (output voltage $\leq 6\text{kV}$ can be operated in any orientation/position. Oil Insulated power supplies must be operated in a

level position. More than a quarter of an inch (5.1mm) difference in height in any direction could cause an arcing condition in the high voltage tank.

2.5 GROUNDING AND INPUT AC POWER CONNECTION

Proper grounding from the input AC power is required to reduce the risk of electric shock. The metal chassis of the power supply is grounded through the green/yellow earthing wire at the input AC power terminal block. Use extreme caution when connecting input AC power and never apply the incorrect input power. Connect the three lines of the input power to the L1, L2, L3 terminals and the earth ground to the terminal marked with the ground symbol. No neutral connection is required for the 200V (180-264VAC) configuration. If the power supply was purchased with the 400V (340-460VAC) configuration, connect the neutral wire to terminal marked N. The power supply cannot be operated from a single phase line. Refer to Section 4 "Applications", to calculate line currents for various operating conditions such as reduced power or charging very large capacitor banks.

For input power connection use wire with min 8 AWG [0.129" (3.264 mm) diameter] and 600V insulation. External switch or circuit breaker (rating 40A/phase for 208VAC, 30A/phase for 400VAC) has to be provided. Circuit breaker must be all pole mains disconnect. The location of the circuit breaker or switch must be as close to the supply as practically possible (within reach of the operator).

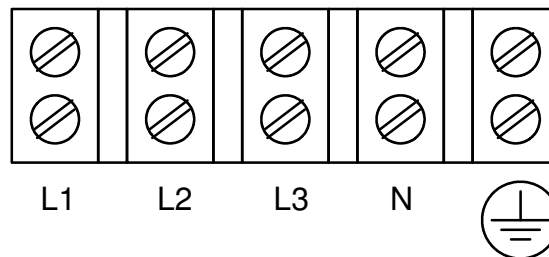


Figure 4: Input AC Power Connections



2.6 INTERNAL FUSES

All internal fuses must be replaced by a fuse of proper rating and type. All the fuses are listed in the following table.

Reference Designation	Location	
F1, F2, F3 F4, F5 F6, F7	VNR Board	60A, FAST, 300V for 208VAC, Class T 30A, FAST, 600V for 400VAC, Class T 2.5A, SLOW, 250V (5mm x 20mm) 3.15A, SLOW, 250V (5mm x 20mm)
F1	Aux Board	PTC Fuse, 2.5A, 50V
F1	Control Board	250mA, SLOW, 250V, 5mm x 20mm

2.7 CONNECTING HIGH VOLTAGE OUTPUT

Ensure that the power supply is off and disconnected from the input power and that all load capacitors are discharged and shorted to ground before making any connections. Never handle the HV cable during operation.

Always use the HV connector and cable provided with the power supply or an equivalent substitute provided by ALE Systems. **Fully insert the connector end of the HV cable and tighten the locking nut only "hand tight".**

When operating above 20kV and 200 Hz rep rate it is recommended that a silicone grease (such as Dow Corning DC-4) be used on the HV cable before insertion into the HV connector. This displaces the air in the connector and reduces long term corona effects.

The HV cable shield is connected to the power supply chassis and should be used as the HV return. An additional grounding stud is provided adjacent to the HV connector and should also be connected to the HV return. The standard shielded HV cable can contact earth ground without consequence. The optional unshielded silicone HV cable can also contact ground, but isolating it will minimize the effects of corona in the system.

Keep the minimum HV cable bend radius greater than 4" to minimize stress on the insulation. Keep the HV cable as distant as possible from the input power and the input control signals.

Some peak current will flow out of the power supply during discharge and return through the HV return and system chassis. This current comes from voltage reversal in underdamped systems and from normal discharge of filter and cable capacitance. The path for this current should not parallel control signal returns since the resulting voltages could interfere with normal system operation. When due to voltage reversal at high rep rates, this current could damage the power supply. Generally a resistor in series with the HV output can be added to limit this current to an acceptable level. Refer to Section 4 "Applications" for more information.

2.8 EXTERNAL FILTERING

An external line filter is required to insure compliance with EN55011 emission standards. A line filter is available from Electronic Measurements, Inc. for the customer's integration into his system.

This filter must be installed in the customer's cabinet in such a manner as to minimize RF coupling from the HV DC output onto the AC mains. Due to the variations in the final application, it is the customer's responsibility to insure the completed system complies with any applicable EMC standards.

2.9 CLEANING

Generally, no cleaning is required. If excessive dust is collected it can be wiped off with a damp rag. All voltage to the supply must be disconnected and the output discharged before attempting to clean the unit.

3 OPERATION

3.1 'L', 'S', & 'OEM' MODEL

MODEL XR802

This model has full front panel instrumentation for use in laboratory, prototype or OEM systems. The XR802L can be operated either from the front panel or from the rear panel remote control connector. The front panel includes power on/off, remote/local and HV on/off switches, output voltage adjust, view set switch, digital voltage and current meters, quick reference bar graphs and status indicators. An internal AC contactor is included which is controlled by the front panel power switch. A BNC connector is provided on the rear panel for easily connecting a pulsed INHIBIT signal. The model XR802L can be operated as a "master" unit in parallel with several model XR802S "slave" units for increased output power. Refer to Section 4 "Paralleling Units".

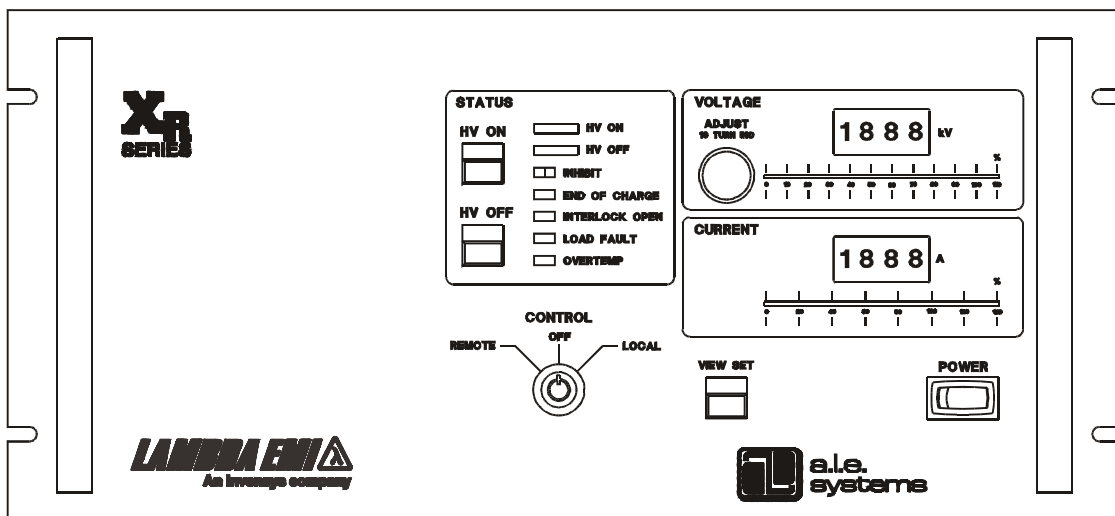


Figure 5: Model XR802L

MODEL XR802S

This model has only a power switch and status indicators on the front panel. It must be operated through its remote control connector and can function as a standalone unit or in parallel with other units. Several model XR802S units can be paralleled as "slaves" controlled by either a "master" XR802L or a single remote control circuit. An internal AC contactor is included which is controlled by the front panel power switch.

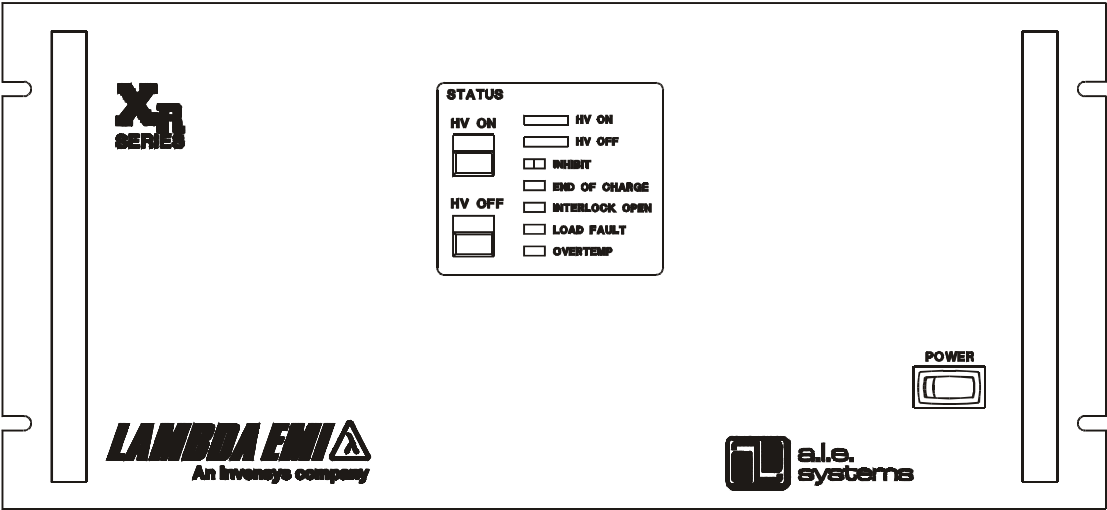


Figure 6: Model XR802S

MODEL XR802 OEM

This model has a blank front panel and is operated the same as an XR802S, from the remote control connector only. It can function as a standalone unit or in parallel for increased output power. The basic model XR802 OEM is supplied by externally controlled AC power. It can also be configured with either an internal AC contactor or front panel circuit breaker option.



Figure 7: Model XR802 OEM

3.2 REAR PANEL

Figure 8 shows the rear panel of the model XR802L. The DB-25 Female REMOTE connector is used to control the power supply when the CONTROL KEY SWITCH on the front panel is in the REMOTE position.

The INTERLOCK terminal block (at 24 VAC) can be connected to system interlocks to disable the power supply when opened. Jumpering the two terminals together allows the power supply to operate. The external interlock switch contacts must have a minimum of current rating of 250 mA. No other electrical connections should be made to these terminals. The interlock terminals should not be connected to ground. Ground connection will disable power supply.

The INHIBIT connector allows for easily connecting a pulsed INHIBIT signal when operating from the front panel. The INHIBIT signal in the REMOTE connector can be used when operating in remote control mode.

The SLAVE connector is used to control model XR802S/XR802 OEM power supplies operating in parallel with an XR802L "master" unit. The model XR802S and model XR802 OEM do not have the INHIBIT and SLAVE connectors.

Rear Panel Connectors			
Connector	Type	Function	Notes
HV Output	Proprietary >6kV Amphenol 'HN' <6kV	Coaxial HV output	Ground referred
REMOTE	DB-25 FEMALE	Power supply control input from user	'L', 'S', & 'OEM'
SLAVE	DB-25 MALE	Power supply control output from master	'L' version ONLY
INHIBIT	BNC Female	High speed HV inhibit	0-40uS Response
SENSE	BNC Female	Remote Sense Input	'RS' Option Only
INTERLOCK	2 Position Terminal Block	Safety Interlock Opens AC contactor	Requires isolated switch. 500mA AC

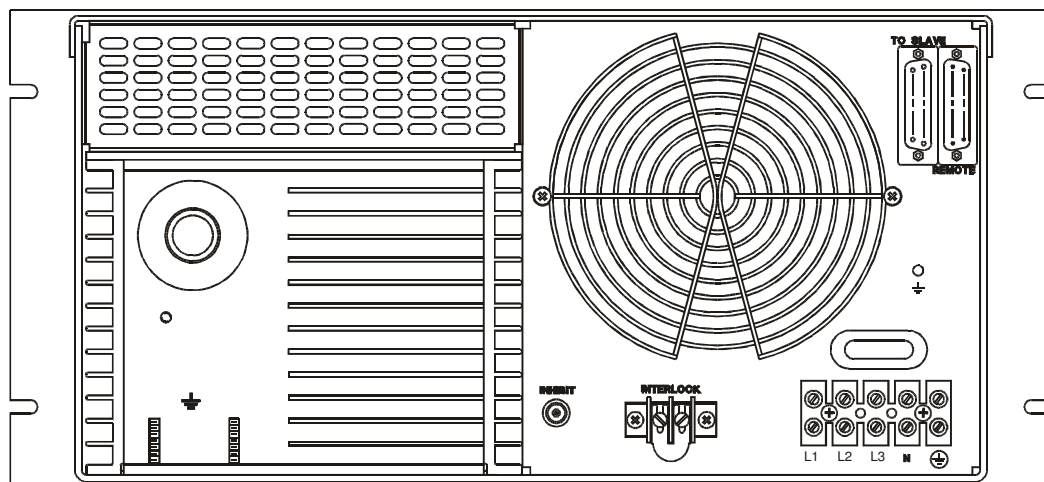


Figure 8: Rear Panel

3.3 FRONT PANEL CONTROL ('L' model only)

POWER SWITCH:

Connects AC input power to the control circuitry and closes the internal AC contactor if the interlock is closed.

CONTROL SWITCH:

Directs the power supply to take on/off and voltage program commands from either the front panel (LOCAL position) or the remote control connector (REMOTE position). The OFF position disables the power supply regardless of other commands.

HV ON SWITCH:

Turns on the high voltage output to the level set by the HV adjust knob. Also used with HV OFF to reset latched fault conditions: overvoltage, open circuit, over-temp, AC under-voltage, and interlock open. Resets latched faults.

HV OFF SWITCH:

Turns off the high voltage output. HV OFF is used to reset the latching fault conditions.

VOLTAGE ADJUST:

Clockwise increases the output from zero to maximum, 10 turns full scale.

VIEW SET:

Previews the voltage and current adjust set point before HV ON.

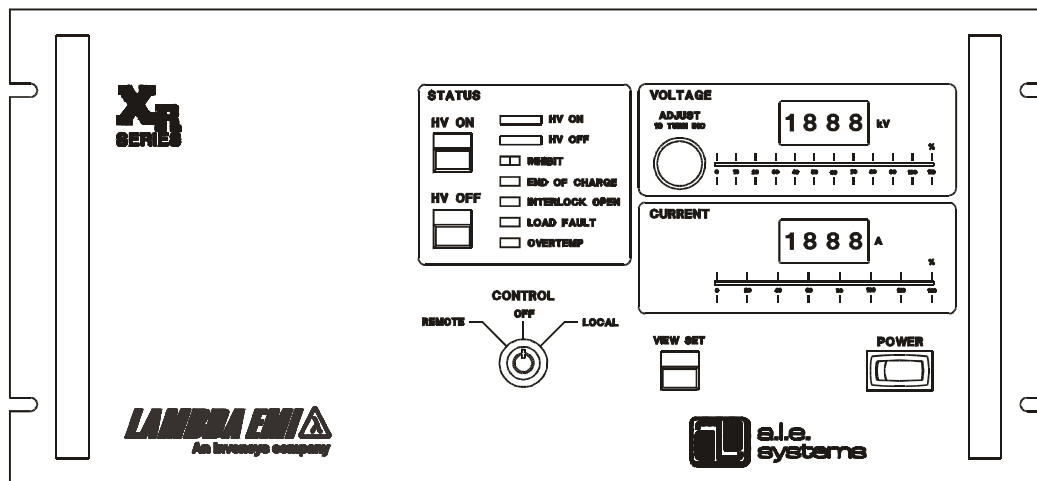


Figure 9: Model XR802L Front Panel

3.4 FRONT PANEL INDICATORS ('L' model only)

VOLTAGE METER

Displays the PEAK output voltage in kV. When 'VIEW SET' is depressed the display will indicate the set point voltage.

VOLTAGE BAR-GRAPH

Displays the REAL-TIME output voltage as a percent of rating. When 'VIEW SET' is depressed the display will indicate the set point voltage.

CURRENT METER

Displays the REAL-TIME output current in Amperes. When 'VIEW SET' is depressed the display will indicate the maximum current.

CURRENT BAR-GRAPH

Displays the REAL-TIME output current as a percent of rating. When 'VIEW SET' is depressed the display will indicate the set point voltage.

3.5 FRONT PANEL INDICATORS ('L' & 'S' models only)

HV ON

Lights to indicate that the high voltage output is enabled. If a fault condition occurs the light will extinguish regardless of the state of the HV ENABLE.

HV OFF

Lights to indicate that the high voltage output is not enabled. If a fault condition occurs the light will blink at about a 1/2 Second rate.

INHIBIT

Lights to indicate the active state of the externally applied or internally generated inhibit signals. In capacitor charging applications this light will blink during each discharge cycle.

END OF CHARGE

Lights to indicate that the measured output voltage is equal to the programmed set point voltage.

INTERLOCK OPEN

Lights to indicate an open interlock loop.

LOAD FAULT

Lights to indicate any failure with the high voltage output. Among the failures are overvoltage, output overload, inverter overload, etc.. Some possible causes are: HV diodes shorted, O/P shorted to gnd, etc. Load fault may be activated if a very large cap is being charged.

OVERTEMP

Lights to indicate that the inverter heatsink is running too hot. The major causes for this would be exceeding the rated average power, a high ambient temperature, or locked fan.

3.6 REMOTE CONTROL ('L', 'S', & 'OEM' models)

All three models are easily controlled through their remote connector on the rear of the unit. Only the HV ENABLE (Pin 8), V PROGRAM (Pin 22) and GND (Pins 12 & 24) signals are required for operation. The remaining signals are provided for status monitoring and fault diagnosis. A schematic diagram showing the suggested interface circuit appears after the following description of control signals.

DB-25 Pin No	Cable Wire No	Direction	Type	Description
1	1	OUTPUT	ANALOG	REAL-TIME OUTPUT VOLTAGE
2	3	INPUT	ANALOG	CURRENT PROGRAMMING
3	5	OUTPUT	OPEN-COL	INHIBIT INDICATOR
4	7	OUTPUT	OPEN-COL	VOLTAGE REGULATION MODE
5	9	OUTPUT	OPEN-COL	END OF CHARGE
6	11	BI-DIREC	DIGITAL	OVERLOAD SYNCHRONIZATION
7	13	INPUT	DIGITAL	INHIBIT INPUT - ACTIVE HIGH
8	15	INPUT	DIGITAL	HV ENABLE
9	17	OUTPUT	ANALOG	PEAK OUTPUT VOLTAGE
10	19	OUTPUT	OPEN-COL	HV ON INDICATOR
11	21	BI-DIREC	ANALOG	CURRENT SHARING
12	23		GROUND	ANALOG COMMON
13	25	OUTPUT	ANALOG	REAL-TIME OUTPUT CURRENT
14	2	OUTPUT	POWER	+15VDC 250mA (Fused)
15	4	OUTPUT	OPEN-COL	CURRENT REGULATION MODE
16	6	OUTPUT	OPEN-COL	OVER-TEMPERATURE FAULT
17	8	OUTPUT	OPEN-COL	INTERLOCK FAULT
18	10	OUTPUT	OPEN-COL	OVERLOAD FAULT
19	12	OUTPUT	OPEN-COL	LOAD FAULT
20	14	INPUT	DIGITAL	/INHIBIT INPUT - ACTIVE LOW
21	16	BI-DIREC	DIGITAL	OSCILLATOR SYNCHRONIZATION
22	18	INPUT	ANALOG	VOLTAGE PROGRAMMING
23	20	OUTPUT	OPEN-COL	HV OFF INDICATOR
24	22		GROUND	DIGITAL & POWER RETURN
25	24	OUTPUT	POWER	+12V 100mA (Unfused)

REMOTE Connector Pin-Out

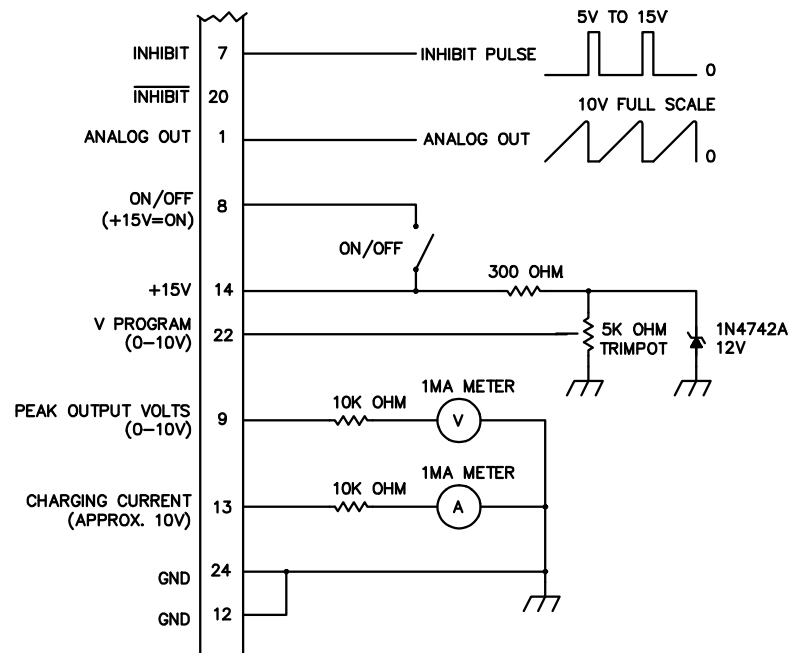
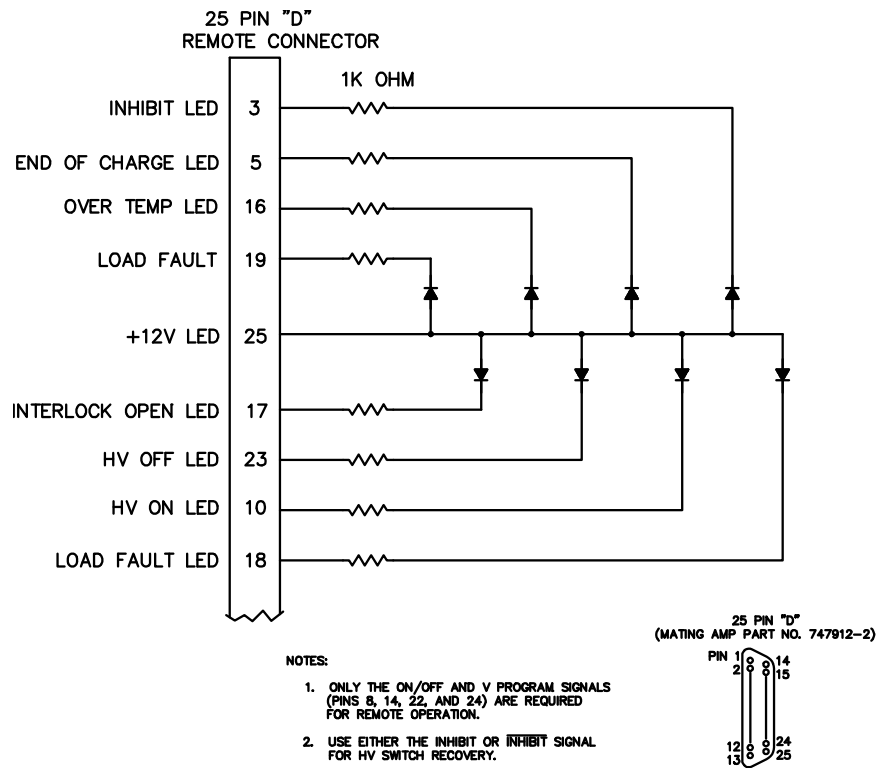


Figure 10: Remote Control Example

3.7 INITIAL CHECK-OUT PROCEDURE

The power supply should have no visible damage or defects and the cover should be securely fastened. Properly connect the input power, control connector and HV output. If there is no load connected, the power supply will sense an open circuit and immediately shut down indicating a LOAD FAULT. If there is a short circuit or overload condition on the output, the power supply will operate in a 50% duty cycle protection mode and indicate a LOAD FAULT. An overload condition can occur if the INHIBIT signal is missing and the discharge rep rate is too high to allow the capacitor to fully charge to V PROGRAM. Double check all connections and ensure that all personnel are protected from the HV output. With the HV adjust at zero volts, turn the power supply on in the following sequence:

XR802L FRONT PANEL CONTROL:

- Turn HV ADJUST knob fully counterclockwise.
- Turn POWER switch to ON.
- Turn CONTROL key switch to LOCAL.
- Push HV ON switch.
- Verify the HV output is at approx. zero volts.
- Increase HV output slowly and verify adjustability.

XR802L REMOTE CONTROL:

- V PROGRAM signal (pin 22) at zero volts.
- ON/OFF signal (pin 8) at zero volts.
- Turn POWER switch to ON.
- Turn CONTROL key switch to REMOTE position.
- Assert ON/OFF signal to 15V.
- Verify HV output is at approx. zero volts.
- Increase HV output slowly and verify adjustability.

XR802S REMOTE CONTROL:

- V PROGRAM signal (pin 22) at zero volts.
- ON/OFF signal (pin 8) at zero volts.
- Turn POWER switch to ON.
- Assert ON/OFF signal to 15V.
- Verify HV output is at approx. zero volts.
- Increase HV output slowly and verify adjustability.

XR802 OEM REMOTE CONTROL:

- V PROGRAM signal (pin 22) at zero volts.
- ON/OFF signal (pin 8) at zero volts.
- Assert ON/OFF signal to 15V.
- Verify HV output is at approx. zero volts.
- Increase HV output slowly and verify adjustability.