OPERATOR MANUAL FOR

303 Series High Voltage

POWER SUPPLY

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1. GENERAL INFORMATION

1.1 INTRODUCTION

Lambda Americas ALE series 203 and 303 are state of the art switch mode high voltage power supplies, designed primarily for capacitor charging applications such as laser systems, modulators, and pulse forming networks. They can also be used in many continuous DC applications including beam power for magnetrons, gyrotrons, klystrons and electron beam loads.

The 203L and 303L Models are fully instrumented with front panel meters displaying output voltage and current, status LEDs, a key switch for OFF, LOCAL or REMOTE operation, HV ON/OFF push-button switches, and a counting dial for output voltage adjustment. The rear panel features external interlock, external inhibit, remote control and slave (parallel operation) control connections.

The 203S and 303S Models can only be operated by remote control and feature only front panel status LEDs. The "S" Models have been designed to operate as a slave unit to the "L" Models or in systems where local control is not a requirement. As many 203 or 303 supplies as required, can be connected in parallel to provide greater output power.

1.2 203 and 303 OVERVIEW

1.2.1 FEATURES

- 203 - 20kJ/sec capacitor charging power, 30kW in continuous DC.
- 303 - 30kJ/sec capacitor charging power, 50kW in continuous DC.
- Output voltages from 0-1kV to 0-50kV
- Rep rates from single shot to several hundred hertz.
- Local or remote operation (L Model) with comprehensive control interface.
- Parallel operation (master/slave) for high power applications.
- Water-cooling for major means of excess heat removal.
- State of the art "Heat Pipe Cooling" system.

1.2.2 BENEFITS

- Smallest package size available in this power range (50kW in 12.25” package)
- Highest power available in a single package
- Low EMI/RFI
- Low ambient heating and quiet operation
- Lightweight switchmode design
- Rack mount chassis configuration
- Low stored energy provides greater safety
- Immunity to external EMI

1.2.3 APPLICATIONS:

- Charging capacitors and capacitor banks.
- Powering pulse forming networks/modulators.

- Powering lasers: Excimer, flashlamp pumped dye, Yag, CO_2, etc.
- Line type modulators for RF generation and pulse discharge applications in research.
- Continuous power for RF tubes – magnetron, gyrotron, TWT, klystron etc.
- Electron beam applications.
- DC power source for pulsed hard-tube and solid state modulators.

1.3 CAPACITOR CHARGING TECHNOLOGY

Capacitor charging applications require a power supply designed specifically for the task. The Series 203 and 303 supplies allow capacitors to be charged in pulse forming networks and modulators in a very fast, efficient and controllable manner.

The units are compact high power constant current sources that can linearly and rapidly charge a capacitive load to high voltage. Once the load capacitor is charged to the programmed voltage, the supply will switch over to a voltage regulation mode and maintain the load voltage at the programmed level, until the load is discharged.

The flexible design of the 203 and 303 allow the units to be ordered with (L model) or without (S model) the front panel controls and meters. The front panel controls are ideal in applications where local control and readbacks are necessary, such as R&D, laboratory use and diagnostics. All front panel controls and indicator signals are available at the rear panel remote control connector regardless which front panel option (L or S) is selected. The S models feature only front panel status indicators and remote controls and are a cost effective solution for applications where local controls are unnecessary.

The unit is self-contained, requiring only AC power and water for cooling. Several units may be connected in parallel for higher power operation. There is no theoretical limit to the number of units that may be paralleled. Typically one master unit and one or more slave units may be used to obtain as much output power as necessary. **Consult the factory before connecting parallel units in continuous or DC applications.**

The 203 and 303 are also ideally suited to charge reservoir capacitors in resonant charging circuits where high rep rates (several kilohertz) are required, such as in metal vapor lasers or solid-state modulators. They can also be used as a continuous DC High Power Source for RF tubes such as klystrons, TWTs, or other DC loads such as DC-DC converters. When the 203 and 303 supplies are operated in continuous applications it is often necessary to add an external capacitor between the load and ground to improve the ripple performance of the unit. Consult the factory for details of the type and size of capacitor.

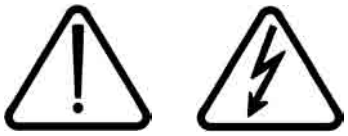
1.4 ADDITIONAL FEATURES:

- Internal contactor and fuses for AC disconnect and protection
- Standard AC power and control connectors
- Documentation Manual Including -
  - Installation
  - Check out
  - Block diagram
  - Suggested remote interfaces and control circuits

- 10 ft (3m). output cable is standard, other lengths are optional.

NOTE: *This manual contains information, instructions and diagrams which apply to standard constructions. If special features or modifications have been installed, the instructions specific to that modification are contained in Addenda and take precedence if conflicts exist. Please take care to refer to the correct information for your unit.*

1.5 SAFETY PRECAUTIONS



All 203 and 303 power supplies are designed to minimize the risk of fire or shock hazard. This instrument received comprehensive mechanical and electrical inspection prior to shipment. Nevertheless, certain safety precautions must be observed. Only TECHNICALLY QUALIFIED SERVICE PERSONNEL familiar with the principles of electrical safety should operate this supply. The power supply SHOULD NOT BE EXPOSED TO WATER (EXCEPT COOLING CONNECTIONS) OR MOISTURE OR DUSTY ENVIRONMENTS. Electrical safety must be maintained at all times.

Lethal voltages are developed within the power supply's enclosure and at the output cable. Therefore, the cover may not be removed by the user (see Warranty in preamble section for variance). Also, the large capacitors in the supply may store power even after the AC input line is removed. ALLOW AT LEAST 40 SECONDS DISCHARGE TIME between removing the AC input line and opening the cover. ALSO, ALLOW AT LEAST 40 SECONDS between switching the AC power off and switching it on again.

1. Ensure all covers are in place and securely fastened before switching ON the AC power.
2. Proper grounding from the input AC power is required to reduce the risk of electric shock. Ensure that the AC Protective Earth Ground connection has at least the same gauge wire as the supply leads shown in Table 4-1.
3. Use extreme caution when connecting AC input power, and never apply the incorrect input voltage, refer to ratings label.
4. Use extreme caution when connecting the high voltage output cable to the load.
5. Ensure all load capacitors are completely discharged prior to connection. Never handle the output cable when the power supply is operating.
6. Never attempt to operate the power supply in any manner not described in this manual.
7. Never remove DANGER and WARNING labels from the power supply. Replace lost or damaged labels immediately.
8. The power supply should only be serviced by Lambda Americas factory authorized personnel.

1.6 SCOPE OF THIS MANUAL

This manual is used for installing and operating the 203 and 303 Series Power Supply. Suggestions and requirements for connecting AC power, load cables and signal cables are given. Various operating modes and programming modes are described.

1.7 MODEL NUMBER FORMAT

The model numbering system for the 203 and 303 Series power supply includes symbols for features and options. They are separated by dashes.

Examples are: 303L-10kV-POS-400VAC and 203S-20kV-POS-DC.

The 203 and 303 are available with two basic front panel configurations, the L, and S. The choice of panel configuration is dependant upon the installation and system requirements. See section 5 for further details.

Table 1-1 shows a partial listing of the model description format for the 203/303 Power Supply family. For additional options, the customer may contact the Sales Department at Lambda Americas. Special options are typically shown as a four-digit suffix to the model number.

203/303(model) - (voltage) - (polarity) - (mode) - (input) - (options)

Model (L, or S)

Output Voltage Range kV

POS or NEG Polarity

Mode		
Standard	Capacitor Charging	Blank
DC	Continuous DC Operation	DC

AC INPUT VOLTAGE(1)		
	Input	Suffix
Standard	432-528 VAC, 50-60 Hz 3ϕ (88A Max)	Blank
400VAC Option	360-440 VAC, 50-60 Hz 3ϕ (100A Max)	400VAC
208VAC Option	180-264 VAC, 50-60 Hz 3ϕ (95A Max)	208VAC

OPTIONS	
5V Programming	5V
Low Enable	EN
Custom cable length	xxxx
Other options	xxxx

Note 1. See Input power table specification section 4.5 for more details.

Table 1-1 Model Description Format

2. SPECIFICATIONS

2.1 Output Power

AC INPUT VOLTAGE	MODE	MAXIMUM OUTPUT POWER RATING	
		MODEL 203	MODEL 303
432-528 VAC, 50-60 Hz, 3ϕ	Cap Charging	20kJ/sec av, 25kJ/sec pk	30kJ/sec av, 37.5kJ/sec pk
	Continuous DC	30kW	50kW
360-440 VAC, 50-60 Hz, 3ϕ	Cap Charging	20kJ/sec av, 25kJ/sec pk	25kJ/sec av, 32.5kJ/sec pk
	Continuous DC	30kW	40kW
180-264 VAC, 50-60 Hz, 3ϕ	Cap Charging	20kJ/sec av, 25kJ/sec pk	Not Available
	Continuous DC	20kW	Not Available

2.2 Polarity

Fixed positive or negative (specify when ordering)

2.3 H.V. Return

Ground through H.V. output cable shield to chassis, and through separate safety ground cable.

2.4 Pulse to Pulse Repeatability

± 0.5% full load range and input voltage range into minimum capacitance (value dependent on minimum voltage range).

2.5 Rep Rate

Single shot to 200 Hz. Lower regulation for 200Hz to 1 kHz rates.

2.6 Protection

Output over voltage

Output short circuit

AC input power failure

AC input power out of range

Excess voltage

Over and under temp

2.7 Input Power:

AC INPUT VOLTAGE	MAXIMUM INPUT CURRENT (1)	
	MODEL 203	MODEL 303
432-528 VAC, 50-60 Hz, 3ϕ	40A/Phase (Cap charging)	60A/Phase (Cap charging)
	60A/Phase (Continuous DC)	98A/Phase (Continuous DC)
360-440 VAC, 50-60 Hz, 3ϕ	47A/Phase (Cap charging)	71A/Phase (Cap charging)
	71A/Phase (Continuous DC)	94A/Phase (Continuous DC)
180-264 VAC, 50-60 Hz, 3ϕ	94A/Phase (Cap charging)	Not Available
	94A/Phase (Continuous DC)	Not Available

Note (1): Refer to section 2.1 for output power rating

2.8 Phase Configuration

Wye or Delta, any rotation, separate ground.

Note: neutral connection is required for 360-440VAC input configuration, Neutral current 2A or less.

2.9 Power Factor

0.9 at full load and nominal AC line

2.10 Efficiency

85% at full load and nominal AC line

2.11 AC Line Filtering

Passive power factor correction and EMI filters included

2.12 Inrush Current

Limited to below full power level

2.13 Max. Discharge

15 seconds to safe output level at output cable without external load consideration.

2.14 Physical Specifications

Size: 19" (483 mm) Rackmount standard front panel
17" (432 mm) chassis width
12.25" (311 mm) High
22" (559 mm) Deep + 5" (127 mm) for cables

2.15 Cooling Water

Maximum exit temperature for cooling water at approximately 2.0 US gpm (7.6 L/min) is 35℃ Minimum exit temperature for cooling water at approximately 2.0 US gpm (7.6 L/min) is 15℃ (Higher temperature water requires greater flow). All water paths are at ground potential and are copper or brass.

2.16 Water Fittings

1/4 inch NPT male threaded pipes

2.17 Weight

190 lbs. (86.4 kg) approx.

2.18 Shock and Vibration

Unboxed 0.5 g.
Factory packing 2.0 g

2.19 Shipping

Gross weight with packing material: 240 lbs. (109 kg) approx.
Size: 27"W X 21" H X 30"D (686 mm X 535 mm X 762 mm)

2.20 Air Temperature Range

Operating:	0℃ to 55℃ ambient air
Storage:	-55℃ to 70℃

2.21 Humidity

Operating:	0% to 90% (Non-condensing)
Storage:	0% to 90%

2.22 Altitude

Operating:	12,000 ft. (3658 m)
Storage:	30,000 ft. (9144 m) at 25℃ or less

NOTES:

3. OUT-OF-BOX-INSPECTION

3.1 VISUAL INSPECTION

Prior to shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the unit is unpacked, inspect for any damage that may have occurred in transit. Verify the following:

A. Check the operation of the front panel control (knob should rotate smoothly).

B. Confirm that there are no dents or scratches on the panel surfaces.

C. Check front panel meters and LEDs for any broken or cracked lenses.

If any damage is found, follow the instructions in Section 3.3 and in the "Returning Equipment" instructions in the preamble section of this manual.

3.2 ELECTRICAL INSPECTION

Before the power supply is installed in a system, verify that no internal damage occurred during shipping. A simple preliminary electrical test should be performed. These tests are described below. **Note:** The sequences described are for L models, for S models the corresponding signals must be applied and monitored through the remote control interface.

3.2.1 TEST 1

Purpose: Verify general logic operation and generate maximum output current and check overload protection circuits. With AC power "OFF" and disconnected, short the H.V. output by connecting the center conductor of the output cable to its return shield (braid). This dead short will allow the unit to generate full output current at zero voltage.

1. Set the output voltage control to zero. Connect the AC power to the unit. Turn "ON" the AC power front panel switch.
2. Turn the front panel keyswitch to the LOCAL position (if applicable). Press the H.V. "ON" button and turn up the H.V. control until the power supply is generating output current into the dead short. The current meter will indicate max. current. The voltage meter will read zero and the power supply will intermittently turn on and off indicating the "overload" condition. The unit should continue to cycle in this mode with a 1 sec. repetition rate indefinitely. (The power supply will go into overload when max. current is drawn for more than half a second).
3. Turn off the H.V. and A.C. power switches.

This test indicates the inverter section is generating maximum current and the logic and overload circuitry works correctly.

3.2.2 TEST 2

Purpose: Verify that the power supply generates maximum rated voltage, and the regulation and feedback circuits are functioning.

1. With AC power OFF and disconnected, connect an appropriate load capacitor to the power supply output cable.
2. Prepare to charge the capacitor. NOTE: Operating a 203 or 303 power supply into an open circuit (no load operation) will instantly damage the power supply's H.V. output diodes. Make sure the load (capacitor) is connected and the H.V. output cable is securely inserted and connected.

3. For L models turn the voltage control on the front panel turned all the way down to zero (counter clockwise), apply AC power and press the HV ON button. By turning up the H.V. control knob the capacitor will charge to the voltage indicated on the front panel voltmeter. The power supply may be turned all the way up to its max. output voltage provided the load capacitor is sufficiently rated.
4. By turning the voltage control down or depressing the H.V. OFF button, the capacitor will "bleed" down through the internal voltage divider resistors used for regulation feedback.

Test #2 indicates the H.V. section is working correctly. Tests 1 and 2 generally indicate the unit is functioning as designed. Although 100% power had not been generated, these two tests give greater than 90% confidence that the unit is not damaged.

If any inconsistency from the above test procedure is noted, do not hesitate to call Lambda Americas Customer Service for assistance.

The supply and the FC-72 filled HV assembly should not be opened unless advised by Lambda Americas personnel. The FC-72 filled HV tank has been cleaned and the hermetically sealed at the factory, opening the supply or the assembly will void the factory warranty, and may compromise performance.

3.3 CONTACTING LAMBDA AMERICAS CUSTOMER SERVICE

When contacting customer service locate the product description, part number and serial number from the label located on the rear of the unit, and have this information available.

Phone: (732) 922-9300 x 342 E-mail: toni.blas@us.tdk-lambda.com

Fax: (732) 922-1441

or online at http://www.us.tdk-lambda.com/hp/RMA_request.htm

Customer Service, or an approved Service Center, should be contacted if:

- The power supply is mechanically or electrically damaged.
- The power supply requires on-site calibration, or replacement warning decals.
- The customer has questions about a special application that is not described in this manual.

Normally, the customer may *NOT* open any chassis covers that have a warranty seal. Breaking a seal will void the warranty.

At the discretion of Lambda Americas, the customer may be granted permission to break the warranty seal and open the chassis covers. Customer Service shall confirm the permission by sending a replacement seal. Once the unit has been serviced, the customer shall close the cover and apply the replacement seal adjacent to (not on top of) the broken seal.

3.4 RETURNING DEFECTIVE UNITS

The procedure for returning defective products is given in section 3.3 of this manual.

4. INSTALLATION

4.1 19-INCH RACK MOUNTING

This power supply is intended for mounting in a conventional 19-inch rack. It's 12.25 inch height makes it a "7U" size instrument. The rack should enclose the sides, top and back to protect the operator from electrical shock and protect the supply from environmental contamination.

Never install the 203 or 303 so only the front panel screws support its weight!

The 203/303 must never be installed without support in the back or sides of the unit. The 203/303 should be mounted on heavy-duty chassis slides –such as General Devices CTS-124- or on a suitable shelf or supports inside the rack.

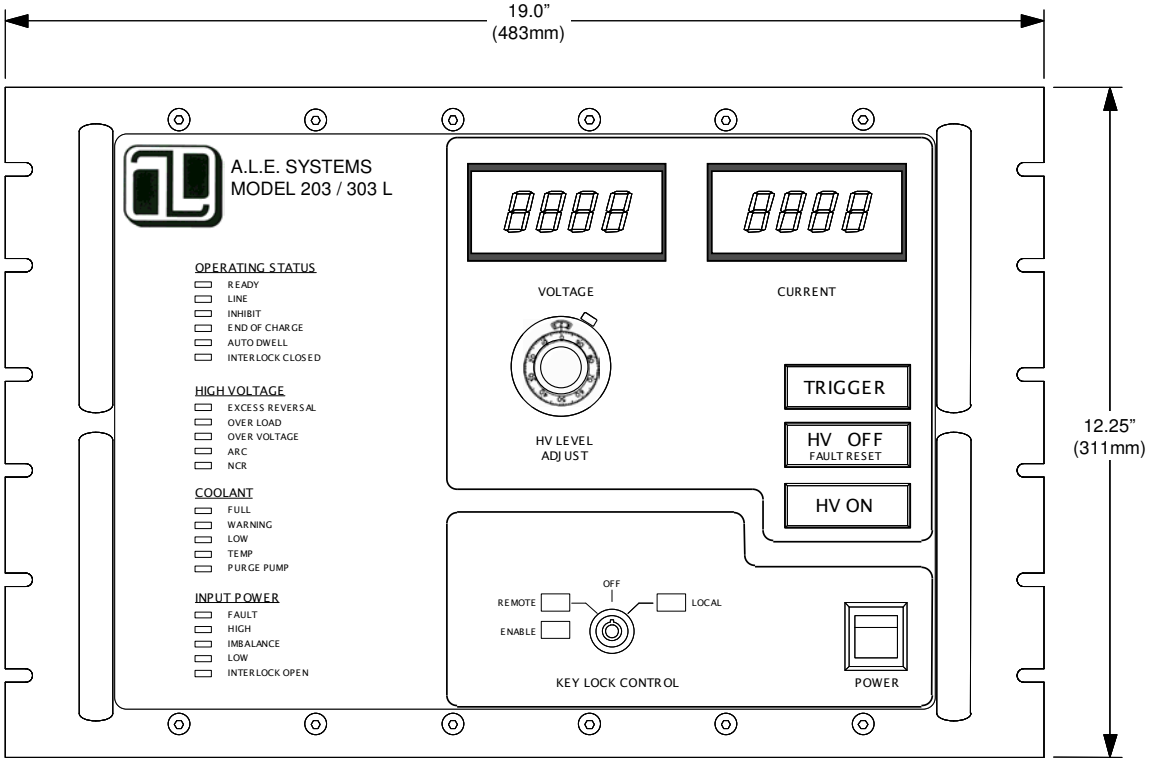


Figure 4-1 203/303L Front View

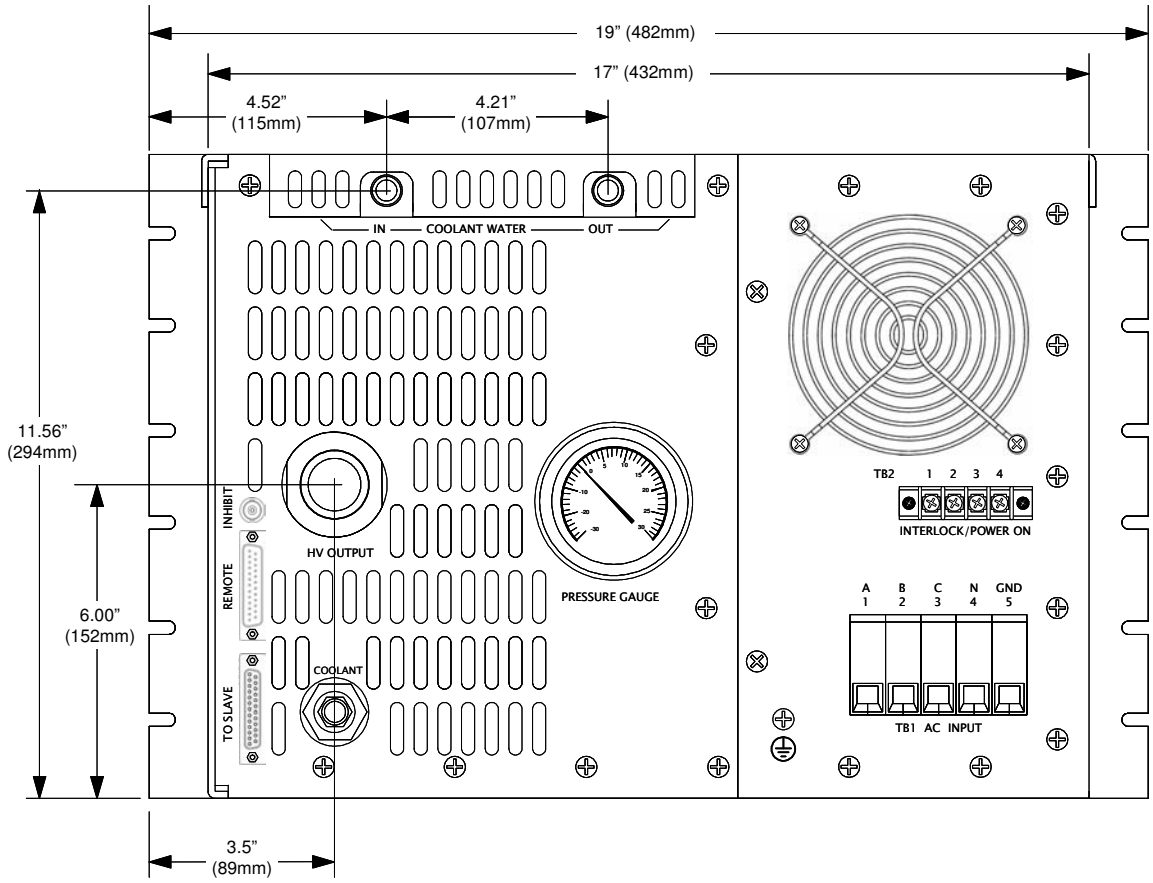


Figure 4-2 203/303 Rear View

4.2 VENTILATION REQUIREMENTS

Ensure there is at least 5 inches (12.5 cm) of clearance at the rear of the unit for airflow, cables and water lines. If the power supply is to be installed 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 55°C.

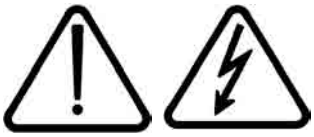
4.3 WATER COOLING REQUIREMENTS

Water with a flow rate at 2 US gallons per minute (7.6litres/min) having an exit temperature of 15 to 35°C is required to cool the instrument. This is required to maintain the allowable tank temperature range of 15 to 48°C. This temperature range may be maintained by running normal tap water through the power supply at the rate of 1 to 2 US gpm. Chilled water should not be used. (⚠ - If the supply is to be stored at temperatures below 4°C, the user should ensure all water is blown out of the coolant pipes).

4.4 ORIENTATION

The power supply must be operated in a level horizontal orientation. More than a quarter of an inch (6.25mm) difference in height in any direction could potentially cause an arcing condition and/or coolant fault in the high voltage tank and should be avoided.

4.5 AC POWER CONNECTION



The maximum voltage allowed between any two AC input terminals is 550VAC. If this voltage is exceeded, catastrophic damage will result, that is not covered by Lambda Americas standard warranty.

The customer's AC power line connects to the 203/303 via a UL/CSA approved 5 position terminal block on the rear panel of the unit (see Figure 4-3). Only use a power cable with the correct voltage and current rating (see Table 4-1). The ground wire must be equal to or larger than the recommended gauge. 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 earth wire at the input AC power terminal block. Use extreme caution when connecting input AC power and never apply the incorrect input power.

The Protective Earth Ground ⏚ must be connected before applying AC Line Power to the 203/303.

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 480 or 208V configuration. For models with the 400VAC input configuration (360-440VAC) the neutral wire must be connected to terminal marked N. The power connections are not phase rotation sensitive, so any phase can be connected to any of the AC inputs.

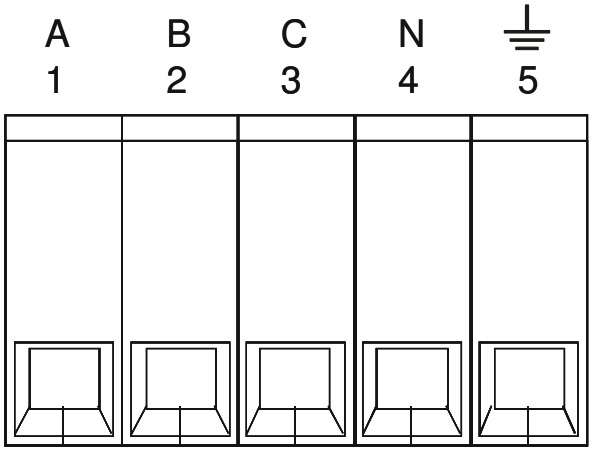


Figure 4-3. AC Input Terminal Block

If the power supply was purchased with the 400VAC input configuration, in addition to the three phases, the neutral wire must be connected to terminal marked N. Failure to connect the Neutral wire in a 400VAC unit may result in damage to the supply. Neutral current is 2A or less.

AC INPUT VOLTAGE	MODE	RECCOMENDED AC INPUT CABLE SIZE	
		MODEL 203	MODEL 303
432-528 VAC, 50-60 Hz, 3ϕ	Cap Charging	5 AWG	4 AWG
	Continuous DC	4 AWG	3 AWG
360-440 VAC, 50-60 Hz, 3ϕ	Cap Charging	5 AWG	4 AWG
	Continuous DC	4 AWG	3 AWG
180-264 VAC, 50-60 Hz, 3ϕ	Cap Charging	3 AWG	Not Available
	Continuous DC	3 AWG	Not Available

Table 4-1 Recommended AC Input Cable

The AC input rating is marked on the rear terminal of the power supply. The rating is also part of the unit's model description shown in Table 1-1.

4.6 CONNECTING THE HIGH VOLTAGE OUTPUT

Ensure that the power supply is off and disconnected from the AC input power and that all load capacitors are discharged and shorted to ground before making any connections. Never handle the HV cable while the supply is operating. Never operate the supply without a load capacitor connected.

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

When operating above 20kV and 200Hz rep rate a silicone grease (such as Dow Corning DC-4) must be applied to the HV cable before insertion into the HV connector. The grease is used to displace air in the connector and reduce long-term corona effects. A cable greasing procedure is available for download from the Lambda Americas web site.

The load ground must be connected to the chassis ground through a separate safety ground cable with a suggested minimum wire size of 6 AWG in addition to the H.V. output cable shield (see Figure 4-4).

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. Currents due to voltage reversal at high rep. rates 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 Application Note 517 (available from the factory or at www.lambda-emi.com) for more information.

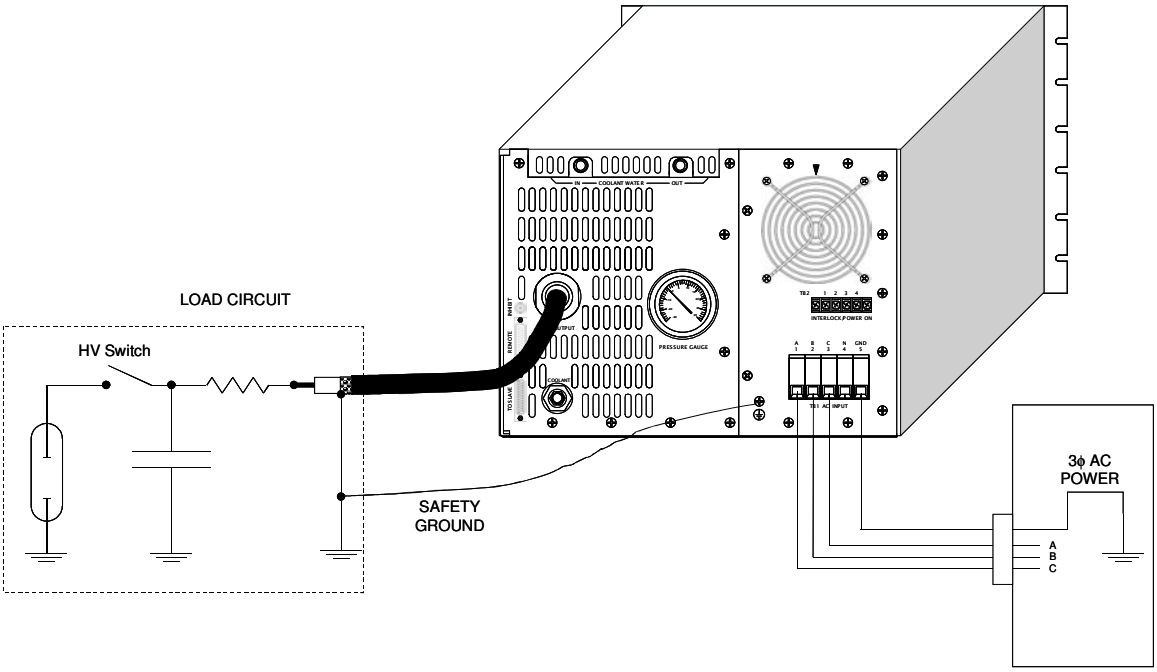


Figure 4-4 Typical Load Circuit Connection

Dress the high voltage cable creating a gentle curve making sure there are no sharp bends as this will tend to reduce the cable's insulation strength. Strain relieve the load end of the high voltage cable to prevent breaking of the center conductor. Keep the HV cables as distant as possible from the input power and the control signals.

To connect the HV cable to the load it is necessary to remove the cable jacket, shield, and any semiconducting layer that remains on the cable insulation after removing the shield.

The cable outer jacket should be removed to reveal the cable shield. At least 12” or 300mm of outer jacket should be removed for suitable voltage hold-off. The exposed shield should be trimmed to an appropriate length and terminated with a ground connection. With the shield removed, the black semiconducting layer is exposed. This layer should be very carefully removed using a sharp craft knife, and a peeling action. Once the semiconducting layer is removed the exposed EPR insulation should be cleaned with IPA or an equivalent solvent. If any of the semiconducting layer remains on the HV cable insulation it may cause the cable termination to fail.

NOTES:

5. CONTROLS, INDICATORS, CONNECTORS

5.1 FRONT PANEL LAYOUT (L Model)

The 203/303L series power supply is equipped with a fully instrumented front panel featuring output voltage control, voltage and current metering, and comprehensive status LEDs, along with local/remote mode keyswitch, and power on switch. The 203/303L can be operated locally from the front panel or remotely via the control connector located on the rear panel (see Section 6.2). Figure 5-1 below shows the front panel layout of the 203/303L power supply.

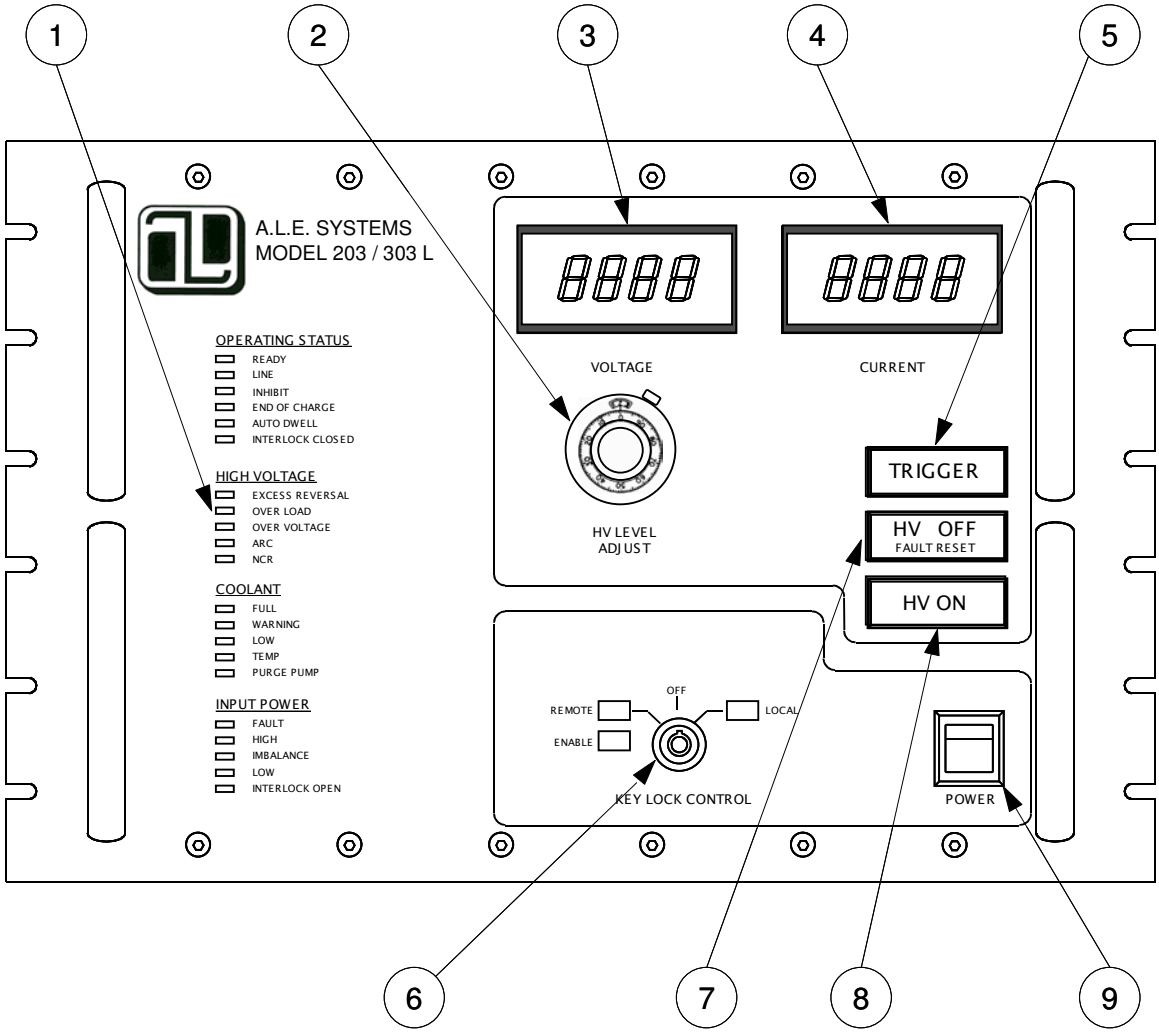


Figure 5-1. 203/303L Front Panel Controls and Indicators

The function of each numbered item is outlined in Table 5-1

REF	DESCRIPTION	NOTE	SECTION
1	Status LEDs	Indicates the status of the power supply	5.2
2	Local Voltage Set	10 turn pot for setting output voltage in local mode	5.3
3	Voltage Display	Digital display of output or set voltage	5.4
4	Current Display	Digital display of average output current	5.5
5	TRIGGER Push Button	Indicates presence of Inhibit signal, and controls supply in single shot trigger mode	5.6
6	Local/Remote Keyswitch	Switches control between remote, local, and off modes	5.7
7	HV OFF Push Button	Turns OFF HV output and resets latching faults	5.8
8	HV ON Push Button	Turns ON HV output	5.9
9	Power switch	Turns on/off power to auxiliary circuits	5.10

Table 5-1 Front Panel Controls and Indicators (L Model)

The front panel controls/indicators are described in detail in the following sections.

5.2 Power Supply Status LEDs (Ref 1)

There are four distinct sets of status LEDs on the 303L front panel. Each group indicates the status of a specific section of the power supply.

5.2.1 Operating Status LEDs

5.2.1.1 READY (Normally ON)

The READY indicator, when illuminated, indicates that the power supply is ready to generate high voltage. This indicator illuminates at the end of the automatic internal self check cycle after the POWER switch has been turned on. The READY indicator will illuminate if there are no faults and the interlock is closed. The READY state is entered regardless of the position of the KEY LOCK CONTROL. READY indicates that the HV can be generated if LOCAL or REMOTE is entered and the HV ON push-button is depressed or the remote ENABLE is present respectively.

The presence of a fault in the COOLANT or INPUT POWER LEDs including INTERLOCK OPEN will cause the unit to be NOT READY.

5.2.1.2 LINE (Normally ON)

Illuminates when AC line voltage is applied and the internal control logic is powered up.

5.2.1.3 INHIBIT (Normally ON)

The INHIBIT indicator displays the logical OR of all the internal and external signals that can prevent H.V. output, including EOC, AUTO DWELL, EXTERNAL INHIBIT, OVERLOAD, and any fault. If the INHIBIT indicator is OFF and the unit is not delivering charge current, there is an internal power supply failure that may require servicing by authorized service personnel. If an inhibit signal (HIGH) is applied at the rear panel BNC connector, the INHIBIT indicator will illuminate and output current cannot be delivered.

5.2.1.4 END OF CHARGE (Normally OFF)

The END OF CHARGE indicator will illuminate when the load capacitor is charged to the programmed output voltage. The END OF CHARGE indicator will be extinguished when the high voltage is OFF or during load charging. End Of Charge may illuminate if the output voltage is programmed to zero.

5.2.1.5 AUTO DWELL (Normally OFF)

The AUTO DWELL (also known as Autoinhibit) feature shuts OFF or inhibits the output current when the capacitive load is discharged. This feature allows the HV switch in the external load circuit to better recover after the load switching event.

The AUTO DWELL feature overcomes the need for the external inhibit signal in most cases. The AUTO DWELL circuit automatically creates an internal inhibit of approximately 1 ms after the circuit detects high dv/dt at the output. The AUTO DWELL period can be programmed via a 0-10 VDC signal applied to the AUTO DWELL input on the rear panel remote interface connector. 0V input gives an Auto Dwell period of approximately 500μs, 10V gives an Auto Dwell period of 5ms.

The AUTO DWELL circuit will only work (detect a discharge) when the discharge occurs from between 20% to 100% of the full output voltage rating of the power supply. If a discharge occurs from less than 20% of the rated voltage the circuit will not generate an internal inhibit and the power supply will continue to deliver output current.

5.2.1.6 INTERLOCK CLOSED (Normally ON)

This indicator is illuminated when the external interlock circuit is closed. The 4 position barrier strip interlock terminals located on the rear panel (see Figure 4-2) must be shorted to allow the supply to operate. These terminals may be run through any number of contacts for personnel and system safety. INTERLOCK CLOSED is the inverted signal of interlock open included in the INPUT POWER status LEDs. If the interlock circuit is not closed, the main AC power contactor cannot close, AC power cannot be applied to the HV power generating circuitry and the power supply will not operate.

The INTERLOCK circuit also runs through a safety switch located under the top cover that opens if the top cover is removed, again preventing closure of the AC contactor.

5.2.2 HV Status LEDs

5.2.2.1 EXCESS REVERSAL (Normally OFF)

This indicator will illuminate if excess voltage reversal is detected at the HV output. A large reversal would cause damage to the power supply by drawing too much current through the output diode rectifiers. While the EXCESS REVERSAL sense circuit does not directly protect the diodes, it will stop the power supply from continuing to run in the case where reversal may be building up and could cause damage if left unchecked.

This protection circuit will reset automatically after three (3) seconds and restart the power supply. Repeated operation of this circuit indicates the presence of a persistent problem that must be corrected by some form of protection, clipper circuit or small series resistor. Refer to Application Note 517 (available from the factory or at www.us.tdk-lambda.com/hp) for more information.

5.2.2.2 OVERLOAD (Normally OFF)

The OVERLOAD circuit indicates if a short circuit or an extremely large capacitor is inadvertently connected to the power supply.

The OVERLOAD indicator will illuminate and turn off the output if the power supply is continuously delivering full output current for more than 500ms, allowing for automatic recovery from a latched H.V. switch condition. In this mode, when the output current flows for more than half a second (for example if the load is shorted or a very large capacitor bank) the power supply will turn off, automatically reset itself and turn back ON. The power supply will turn ON and OFF with an approximate 80% duty cycle, allowing maximum average power to be delivered without exceeding the AC input current rating.

The OVERLOAD indicator will also illuminate and turn OFF the power supply if the unit is operated with a load charging duty cycle greater than 80% (independant of repetition rate). If the OVERLOAD circuit is activated in this mode the supply will turn OFF and automatically reset after approximately 500ms.

5.2.2.3 OVERVOLTAGE (Normally OFF)

The OVERVOLTAGE indicator illuminates when a higher level of voltage is present on the output cable than the power supply is fully rated for (full scale). The OVERVOLTAGE indicator will also illuminate if the unit is being programmed to a higher level than the unit is rated for. The power supply will turn OFF the high voltage output (inhibited) and may be reset by depressing the HV ON push-button when the overvoltage condition is no longer present.

5.2.2.4 ARC (Normally OFF)

When illuminated, the ARC indicator signals a major fault internal to the high voltage tank of the power supply. This type of fault may be reset if the POWER is cycled; however, if it recurs, the unit should not be used any further because the output may be uncontrolled if present and could cause further damage to the supply or its load. The power supply should then be serviced by qualified personnel.

5.2.2.5 NCR (Normally OFF - not used)

5.2.3 COOLANT status LEDs

In the event of any coolant faults the user should verify installation orientation is in accordance with section 3.4 prior to contacting Lambda Americas.

5.2.3.1 FULL (Normally ON)

When illuminated, this indicator signals that the high voltage tank in filled to the correct level with coolant. This indicator may be extinguished if the unit is cold.

5.2.3.2 WARNING (Normally OFF)

This indicator will FLASH if the coolant level drops below its safe operation level, indicating that the coolant may be leaking (there are no environmental or safety hazards from this coolant leaking. It will evaporate before it collects). The unit should be serviced if the coolant is low.

5.2.3.3 LOW (Normally OFF)

The LOW indicator when illuminated indicates the coolant level is below the allowable level to safely operate the power supply. The COOLANT LOW indicator will turn OFF the high voltage output and it cannot be reset until the coolant level is corrected. The unit must be serviced by authorized service personnel.

5.2.3.4 TEMP (Normally OFF)

The TEMP LED Illuminates if the HV tank temperature is outside of its operating limits. The fixed operating limits have minimum low temperature and a maximum high temperature. When illuminated, the TEMP indicator will turn OFF the high voltage output. When the internal temperature returns to a normal level, the output may be switched back on by depressing the HV ON push-button.

The FC-72 coolant has a wide operating temperature range and is controlled and stabilized by the cooling water flowing through the high voltage tank. The maximum allowable tank temperature is 45°C, and the minimum is 15°C.

This temperature range can be maintained by running normal tap water through the power supply at a rate of 2 gallons per minute (7.58 L/min). Chilled water should not be used, it can cause the lower operating temperature limit to be reached, as well as causing condensation to form which should always be avoided. Condensation in the power supply could cause damage and the warranty will be void.

5.2.3.5 PURGE PUMP (Normally OFF)

The PURGE PUMP indicator illuminates when the purge pump is operating. The pump will operate automatically, cycling on and off when necessary. The interval of operation should be only a few minutes at a time and not more than once in any continuous 24-hour operating period. The power supply will continue to run normally during the automatic purge operation. The purge pump is designed to remove excess air that may accumulate in the high voltage tank. The purge pump removes accumulated air to allow the most efficient cooling and best possible dielectric environment.

5.2.4 INPUT POWER status LEDs (External Faults)

5.2.4.1 FAULT (Normally OFF)

The FAULT LED illuminates when any one of the input power faults in this group occurs. The FAULT indicator will remain ON (latch ON) after the external fault condition detected has cleared (the indicator goes OFF). The FAULT LED will turn off the power supply's output and under certain conditions will open the main AC power contactor. The FAULT indicator may be reset by depressing the HV OFF push-button and depressing the HV ON push-button.

5.2.4.2 HIGH (Normally OFF)

The HIGH LED illuminates when the external AC input voltage is above the maximum limit (typically 10% above nominal). Damage can result if the AC input exceeds the rating and therefore the supply disconnects itself from the line by opening the contactor.

When the HIGH line condition is removed the indicator extinguishes and the power supply can be reset by operating the HV OFF and HV ON push-buttons.

5.2.4.3 IMBALANCE (Normally OFF)

The IMBALANCE LED illuminates if an internal power imbalance occurs, which could happen under abnormal power conditions. The fault will automatically reset when the condition corrects itself.

The AC contactor is opened and the FAULT indicator is illuminated which may be reset using the push-button after the IMBALANCE LED extinguishes. This does not indicate an AC line to line imbalance.

5.2.4.4 LOW (Normally OFF)

The LOW AC line LED will illuminate if the AC input voltage drops below approximately 85% of the nominal nameplate level. The power supply will continue to deliver output current unless voltage dip is too great (either low voltage or for a long time). The power supply will shut down the output until the AC line is restored. The line fault resets the power supply automatically.

5.2.4.5 INTERLOCK OPEN (Normally OFF)

INTERLOCK OPEN illuminates when the interlock circuit either on the rear panel or top cover is opened and indicates the inverse of INTERLOCK CLOSED in the Operating Status LED Group. If the interlock is opened while the supply is operating, the main AC line contactor will be opened, disconnecting AC power from the H.V. circuitry. The fault indication is reset automatically when the interlock circuit is closed (LED extinguished). Before power can be generated the fault must be reset by pushing the HV OFF followed by the HV ON push-buttons.

5.2.5 INDICATOR TROUBLESHOOTING

In order to aid in power supply troubleshooting, Table 5-2 shows a detailed status chart of all front panel LEDs and indicators.

	NORMAL INDICATION	TYPE OF INDICATION	RESET BY	ASSOCIATED INDICATORS	WILL CAUSE SYSTEM "NOT READY"
OPERATING STATUS					
☐ READY	ON	STATUS	N/A	INTERLOCK & ALL FAULTS	N/A
☐ LINE	ON	STATUS	N/A	NONE	YES
☐ INHIBIT	ON(1)	STATUS	N/A	NONE	NO
☐ END OF CHARGE	OFF(2)	STATUS	N/A	NONE	NO
☐ AUTO DWELL	OFF(2)	STATUS	N/A	NONE	NO
☐ INTERLOCK	ON	STATUS	N/A	INTERLOCK OPEN	YES
HV					
☐ EXCESS REVERSAL	OFF	EXTERNAL FAULT	AUTOMATICALLY	NONE	YES
☐ OVERLOAD	OFF	EXTERNAL FAULT	N/A	NONE	YES
☐ OVER VOLTAGE	OFF	EXTERNAL FAULT	HV OFF/ON PUSH	NONE	YES
☐ ARC	OFF	INTERNAL FAULT	POWER SWITCH	NONE	YES
☐ NCR	NOT USED				
COOLANT					
☐ FULL	ON	STATUS	N/A	WARNING, LOW	NO
☐ WARNING	OFF	STATUS	REFILLING	FULL, LOW	NO
☐ LOW	OFF	INTERNAL FAULT	REFILLING	FULL, WARNING	YES
☐ TEMP	OFF	INTERNAL FAULT	AUTOMATICALLY	NONE	YES
☐ PURGE PUMP	OFF	STATUS	N/A	NONE	NO
AC INPUT					
☐ FAULT	OFF	STATUS	HV OFF/ON PUSH	ALL BELOW	YES
☐ HIGH	OFF	EXTERNAL FAULT	AUTOMATICALLY	NONE	YES
☐ IMBALANCE	OFF	EXTERNAL FAULT	AUTOMATICALLY	NONE	YES
☐ LOW	OFF	EXTERNAL FAULT	AUTOMATICALLY	NONE	YES
☐ I NTERLOCK OPEN	OFF	EXTERNAL FAULT	HV OFF/ON	NONE	YES

(1) OFF WHILE CHARGING, ON BEFORE "HV ON" DEPRESSED

(2) ON WHILE UNIT IS OPERATING

Table 5-2 Front Panel Indicator Troubleshooting Chart

5.3 LOCAL VOLTAGE CONTROL (Ref 2)

The local voltage control potentiometer is a precision 10 turn dial indicator that adjusts the output voltage between zero and 100% of rated voltage. The output voltage can be set at the desired level by turning the dial to the required percentage before depressing the HV ON push button. It is good practice to turn the control fully counter clockwise after operating the supply. The local voltage control has no effect when the supply is operate in remote mode.

5.4 OUTPUT VOLTAGE METER (Ref 3)

The VOLT METER is a digital display that indicates the peak output voltage in kilovolts. The displayed voltage is the peak output voltage at END OF CHARGE during normal operation of charging and discharging the load. The VOLT METER displays the voltage at the output (on the output cable) even when the HV output is turned OFF, and hence shows any residual voltage that remains on the capacitive load.

5.5 OUTPUT CURRENT METER (Ref 4)

The CURRENT METER indicates the average DC (or constant) current flowing in the HV output cable.

5.6 TRIGGER push button (Ref 5)

The TRIGGER indicator/push-button will illuminate when an INHIBIT signal is applied to the power supply. The TRIGGER indicator will illuminate long enough to be seen even if the inhibit pulse is very short (microseconds).

In addition the TRIGGER push-button allows "one shot" charging and discharge of the load circuit. This is useful when charging very large capacitor banks for "one shot" applications. To use this function, depress the TRIGGER push-button when the power supply is in the OFF state (OFF push-button illuminated). The HV ON push-button will F-L-A-S-H and continue to flash indicating the power supply is armed. When the HV ON push-button is depressed, the power supply will turn ON the HV output, charge the capacitor load and turn OFF when END OF CHARGE is reached. The HV will stay OFF and not recharge or "top off" the capacitor if its voltage begins to bleed off.

5.7 KEY LOCK CONTROL (Ref 6)

DO NOT MOVE THE KEY LOCK POSITION FROM OFF TO LOCAL OR REMOTE UNLESS A SUITABLE CAPACITIVE LOAD IS CONNECTED TO THE POWER SUPPLY'S OUTPUT CABLE, AND THE LOAD IS CORRECTLY GROUNDED

The KEY LOCK CONTROL is used to set the operational mode of the power supply in one of three positions, OFF, LOCAL, or REMOTE.

5.7.1 OFF Position

With the KEY LOCK in the OFF position, the POWER switch may be turned but HV cannot be turned on. The unit may be locked in the OFF position and the key removed to protect equipment and personnel. In normal lab operation, the KEY LOCK CONTROL switch should remain in the OFF position and should be turned to LOCAL after the POWER switch is turned on and the power supply has completed its self checks. It is recommended that the unit always be locked in the OFF position and the KEY removed when not in use as a safety precaution. The key can only be removed when in the OFF position. It cannot be removed in either LOCAL or REMOTE positions.

5.7.2 LOCAL Position

With the KEY LOCK in the LOCAL position the power supply is controlled from the front panel (refer to section 6.1). The local voltage control, HV ON, HV OFF, and TRIGGER push buttons are active in LOCAL. Note that the key cannot be removed in this position.

5.7.3 REMOTE Position

With the KEY LOCK in the REMOTE position the front panel HV LEVEL ADJUST and HV ON push button are not active. These commands must be provided via the remote 25 pin D-sub connector on the rear panel. The HV OFF push button remains active with the KEY LOCK in the remote position. Note that the key cannot be removed in this position.

5.7.4 REMOTE/LOCAL/ENABLE LEDs

There are three LEDs adjacent to the keylock control, REMOTE, LOCAL, and ENABLE. The REMOTE LED indicates the keylock is in the remote position and the local controls have no function (except HV OFF which will override remote control). The LOCAL LED indicates the keylock is in the local position, and only the front panel controls can be used to operate the supply.

The ENABLE LED indicates that a remote enable command is being sent to the power supply via the remote interface. This is an important check turning the KEY LOCK CONTROL switch to the REMOTE position. The presence of an ENABLE signal when selecting REMOTE mode does not allow high voltage to be generated. The remote ENABLE signal must be recycled (ON-OFF-ON) before H.V. can be generated.

The ENABLE LED will illuminate when the power supply KEY LOCK is in the OFF or LOCAL position as a useful indication that the remote interface is connected and operational.

5.8 HV OFF/Reset (Ref 7)

The HV OFF push-button turns OFF the HV output when depressed. This push-button will illuminate and stay illuminated when depressed (HIGH VOLTAGE is OFF). The HV OFF push-button will always operate even with the KEY LOCK in the remote position.

The HV OFF push-button switch will FLASH continuously when the HV output has been turned OFF automatically by a latching fault. Latching faults include INTERLOCK OPEN, HIGH AC input, and IMBALANCE. These faults may be reset by depressing the flashing HV OFF push-button after the fault condition has been cleared, INTERLOCK closed, etc.

5.9 HV ON (Ref 8)

DO NOT DEPRESS THE HV ON PUSH-BUTTON UNLESS A SUITABLE CAPACITIVE LOAD IS CONNECTED TO THE POWER SUPPLY'S OUTPUT CABLE, AND THE LOAD IS CORRECTLY GROUNDED

The HV ON push button turns ON the high voltage output when depressed only after all interlocks are closed, self checks are completed and the unit is switched to the LOCAL mode. HIGH VOLTAGE will be generated immediately when the HV ON is depressed and the push-button switch will illuminate and remain illuminated while the HV in ON. The supply will charge the load to the voltage determined HV LEVEL ADJUST 10 turn pot. It is prudent to first reset the HV LEVEL ADJUST 10 turn pot fully counterclockwise (to zero) before depressing the HV ON push-button when first using this power supply. Later on during system usage, the HV LEVEL ADJUST control may be left set at the desired level.

If a fault is present when the HV ON push-button is depressed, the HV OFF push-button will FLASH indicating the presence of a fault condition.

5.10 AC POWER (Ref 9)

The front panel POWER switch controls the main input power to the unit. It closes the AC input contactor that applies AC power to the control logic. The POWER switch only controls a low voltage signal, and is not directly connected to the main AC line. This low voltage control signal is wired in series with two terminals on the rear panel. (4 position barrier strip) marked as INTERLOCK/POWER ON (see Figure 5-3).

The INTERLOCK/POWER ON terminals at the rear of the unit must be jumpered or wired to a remote switch or contactor. Both the remote contacts and the front panel switch must be closed for the unit to turn on.

Once the unit is turned on using the front panel POWER switch, the internal control logic begins a check sequence test all the lights by switching them all on for about one second to let the operator know that all the LED's and the associated drivers are working, and that the power is applied to the logic circuits.

Within 4 to 6 seconds after the POWER switch is closed and all tests are finished the AC contactor automatically closes (a loud ‘thunk’ will be heard) applying AC power to the main power circuits, placing the power supply in the READY state (READY LED illuminated). When READY the power supply is considered to be armed and could be generating high voltage.

5.11 FRONT PANEL LAYOUT (S Model)

The 303S series power supply is equipped with a partially instrumented front panel featuring comprehensive status LEDs, and a power on switch. The 303S can only be operated remotely via the control connector located on the rear panel (see Section 6.2).

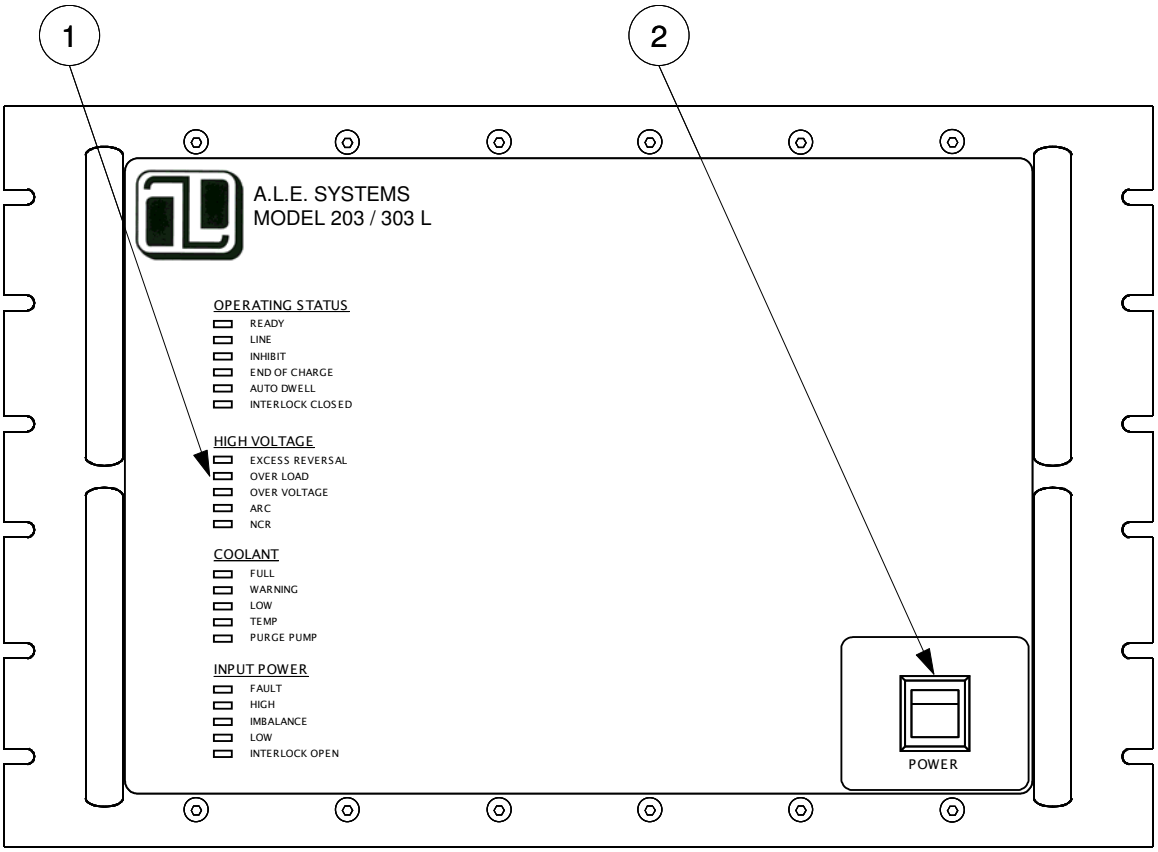


Figure 5-2 203/303S Front Panel Controls and Indicators

REF	DESCRIPTION	NOTE	SECTION
1	Status LEDs	Indicates the status of the power supply	5.2
9	Power switch	Turns on/off power to auxiliary circuits	5.10

Table 5-3 Front Panel Controls and Indicators (S Model)

A description of the function of the LEDs and the power switch are given in sections 5.2 and 5.10 respectively.

5.12 REAR PANEL LAYOUT (L Models)

All of the interconnect and service connections for the 203/303L are located on the power supply rear panel. Figure 5-3 shows the rear panel layout and location of the various connectors.

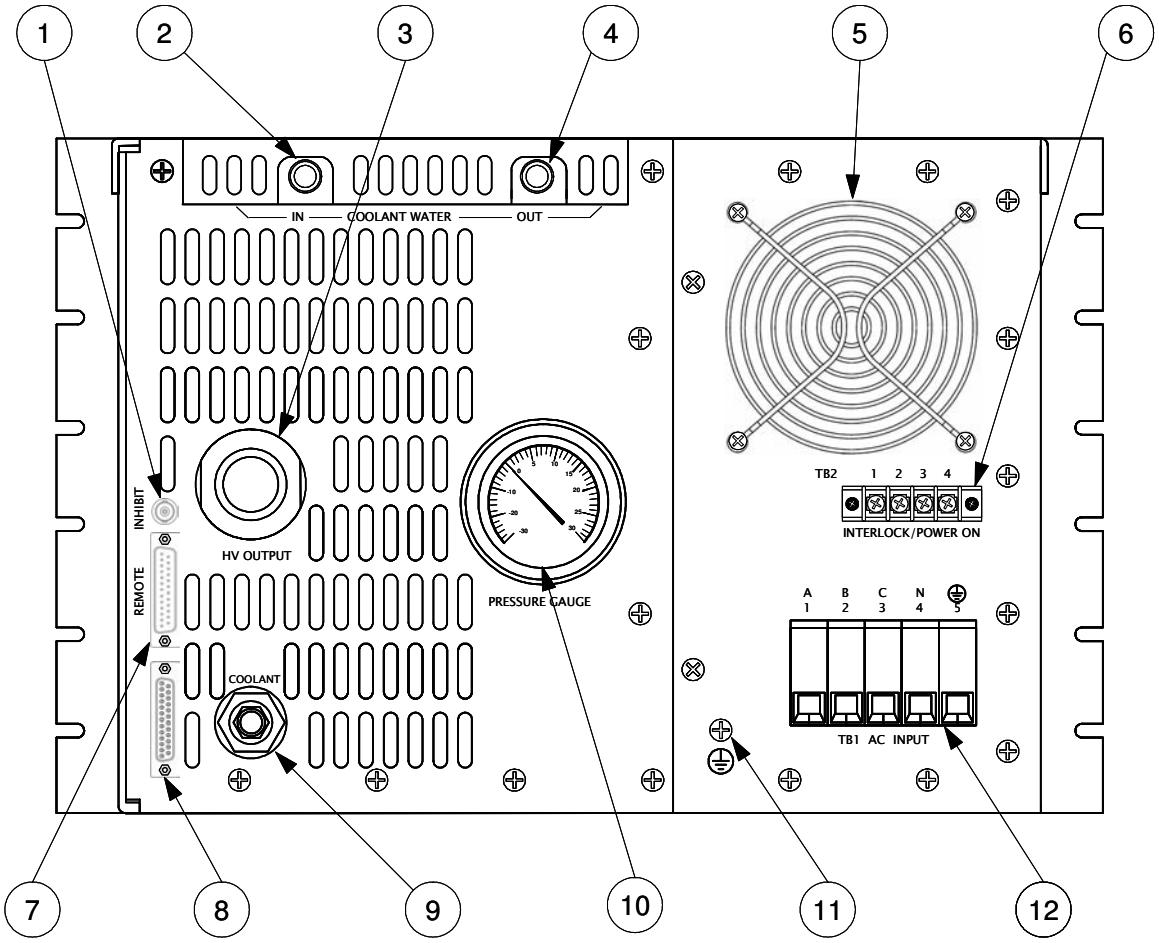


Figure 5-3 203/303L Rear Panel Connections

REF	DESCRIPTION	NOTE	SECTION
1	Inhibit BNC	BNC socket for external inhibit signal	5.12.1
2	Coolant Water Inlet	¼ NPT male threaded coolant inlet pipe	5.12.2
3	HV Output Connector	HV output connector	5.12.3
4	Coolant Water Out	¼ NPT male threaded coolant outlet pipe	5.12.2
5	Cooling Fan	Input section cooling fan	5.12.4
6	Interlock/Power On Terminal strip	External interlock and remote power on terminals	5.12.5
7	Remote connector	Remote control interface 25 pin D-sub plug	5.12.6
8	Slave connector	Slave interface 25 pin D-sub socket	5.12.7
9	Coolant service valve	Coolant valve to allow external tank fill	5.12.8
10	Tank pressure gauge	HV tank pressure gauge	5.12.9
11	Safety ground	10-32 safety ground connection	5.12.10
12	AC input terminal	AC input terminal block	5.12.11

Table 5-4 203/303L Rear panel Functions

The function of each item in Table 5-4 is described in the following sections.

5.12.1 INHIBIT BNC (Ref 1)

The inhibit BNC input is a standard BNC socket that allows an external connection to a pulse generator or control system and gives the user control of the power supply output current. A logic 1 (10-15V) input will inhibit the supply (shuts off the output current) and a logic 0 (ground or open) allows the supply to operate.

5.12.2 Coolant Water Inlet/Outlet (Ref 2/4)

¼ NPT male threaded pipe connection for external cooling water supply.

5.12.3 HV Output Connector

Connector socket for mating HV cable supplied with unit. The connector should be kept clean and free from debris at all times.

5.12.4 Cooling Fan

Although the supply is water cooled a small cooling fan is used to cool the AC input circuitry. Allow at least 5 inches of clearance and do not obstruct clear air flow around the fan.

5.12.5 Interlock/Power On Terminal strip

Provides an external connection for the customer to allow both interlock and remote power on functions to be controlled. The interlock terminals should be connected to any safety interlock circuitry in the power supply installation. The remote power on terminals are wired in series with the front panel ON switch, and can be used as a remote ON/OFF switch of the front panel switch is left in the ON position. **Note: The Interlock/remote power on terminals are chassis referenced 24VAC circuits and should never be connected to ground.**

5.12.6 Remote connector

A 25 pin D-sub male connector that allows remote operation and monitoring of all power supply functions when the unit is operated in REMOTE mode.

5.12.7 Slave connector

A 25 pin D-sub female connector that allows connection of a slave supply for increased power operation.

5.12.8 Coolant service valve

External valve to allow topping up of the HV tank with FC-72 without the need for removing the top cover. Do not undertake this procedure without contacting the factory.

5.12.9 Tank pressure gauge

The tank pressure gauge indicated the pressure inside the FC-72 filled HV assembly. With the power supply non operating at room temperature the gauge should show a vacuum between 10 and 15in Hg. With the supply operating at full power the gauge should read between 10 and 15PSI.

5.12.10 Safety ground

10-32 safety ground screw installed in chassis. Should be used for additional safety ground cable between supply and load circuit.

5.12.11 AC input terminal

Main AC input power terminal block see section 4.5 for further details.

5.13 REAR PANEL LAYOUT (S Models)

The 303S rear panel is almost identical to the 303L except these is no SLAVE or INHIBIT BNC connector. If a number of units are to be connected in parallel, a daisy chain type ribbon cable should be used to connect the supplies together. See section 6.3 for more details. Note: The numbers in Figure 5-4 refer to Table 5-4.

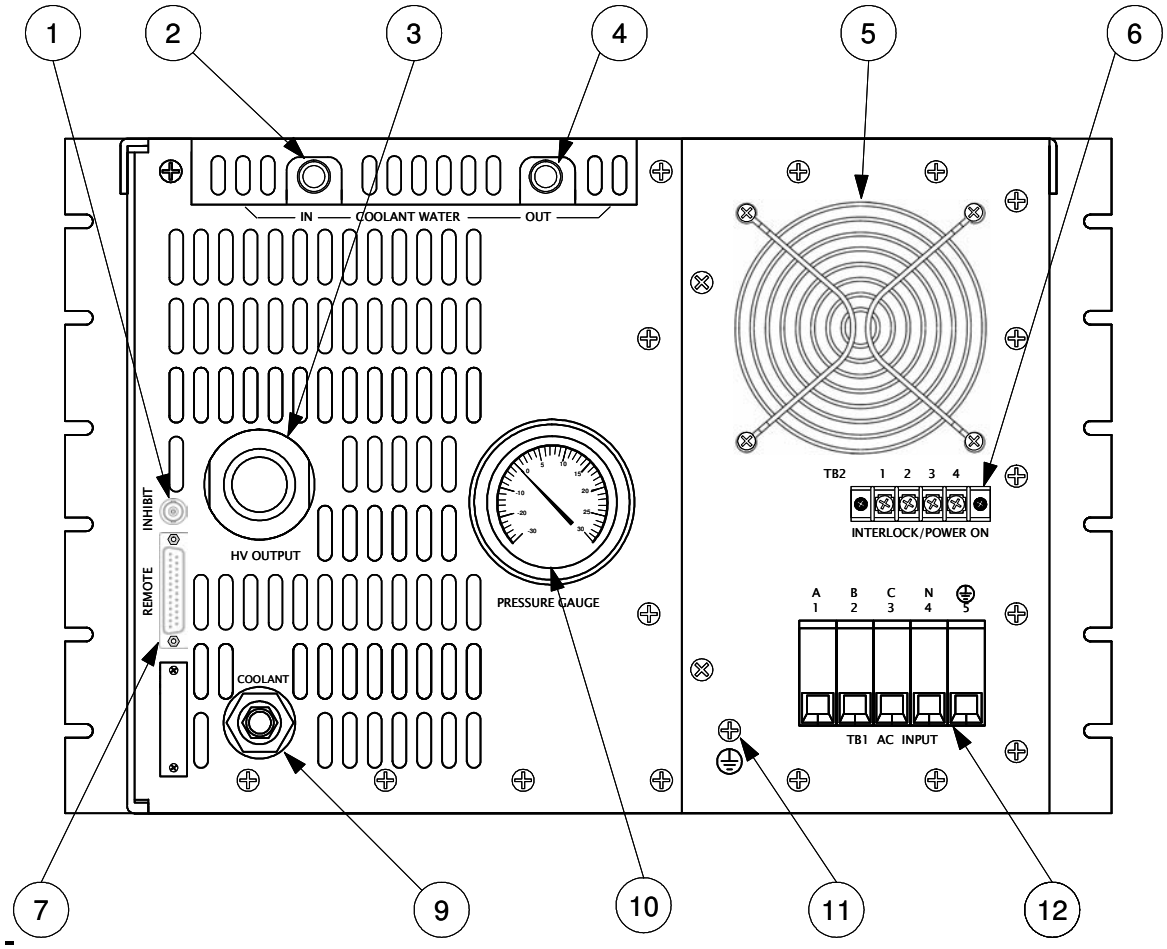


Figure 5-4 203/303S Rear Panel

NOTES:

6. OPERATING INSTRUCTIONS

The 203/303 power supply is designed for operation in two modes. The first mode is local, where the power supply is operated using the front panel controls. Local operation is only possible with the L model supply. The second mode is remote, where control signals are passed via the 25pin remote connector. Remote operation is possible with all 203/303 model power supplies (L and S).

6.1 LOCAL OPERATION (203/303L only)

The model 203/303L has full front panel instrumentation and controls for use in laboratory, prototype or OEM systems. The front panel controls include power on/off, remote/local keyswitch, HV on/off push-buttons, output voltage adjust, digital voltage and current meters, and status indicators. An internal AC contactor is included which is controlled by the front panel power switch and the interlock terminals on the rear of the unit. A BNC connector is provided on the rear panel for easily connecting a pulsed INHIBIT signal when operating from the front panel. The model 203/303L can be operated as a "master" unit in parallel with several model 203/303S or "slave" units for increased output power. Refer to Section 6.3 Parallel Operation.

After all external AC input, cooling, and load connections have been correctly made and the high voltage cable properly terminated at the load, the power supply is ready to operate.

NOTE: The 203/303 series power supplies are not designed to operate into an open circuit load. Operating the supply with no external load capacitor could result in damage to the high voltage output section and would void the warranty.

CAUTION

HIGH VOLTAGES MAY POTENTIALLY EXIST FROM THIS POINT FORWARD

To operate the supply, follow the steps below;

1. Turn counting dial "HV Level Adjust" fully CCW.
2. Ensure key switch is in the OFF position.
3. Turn on AC power, "POWER" switch.

   The fan should be running. The front panel LED's will light and reset. The LINE and INHIBIT LED's should be illuminated. The END OF CHARGE LED may or may not be on at this time. The INTERLOCK CLOSED LED should also be illuminated.
4. Turn key switch to the LOCAL position. Push the HV ON button, slowly turn the high voltage adjust level to the desired output voltage. Note that at any point in stopping the adjustment, the end of charge light will illuminate.
5. When the desired output voltage is reached, the load switch should now operate and the power supply will begin charging the load at the rated power level.

After the load has been discharged the AUTO DWELL function will inhibit the output current for a short time before the load is re-charged. Alternatively an external inhibit signal can be connected to the rear panel mounted BNC connector.

To turn OFF the power supply depress the OFF button or use the inhibit line. Opening the interlock terminals will also cause the power supply to turn off. In this case the unit can only be turned back on after the interlock has been closed and the ON button depressed followed by the OFF button to RESET the fault. Any other fault occurring in the internal protection circuitry will interrupt the power supply's operation causing it to turn OFF.

For a full explanation of each control and indicator refer to Section 5.

6.2 REMOTE OPERATION (All models)

All 203/303 models are easily controlled through the 25 pin sub D-type remote interface connector located on the rear panel. The minimum required signals for remote control operation are; HV On/Off, Vprogram and GND. The remaining signals are provided for status monitoring and fault diagnosis, or more sophisticated control methodologies. A description of each signal is shown in Table 6-1, with a schematic showing a suggested remote interface circuit shown in Figure 6-1.

Pin	Signal Name	I/O	Description
1	+15VDC	O	+15V $^{1}/_{8}$A max. May be used to power LEDs etc in a remote control circuit.
2	READY	O	Open collector. Low impedance when power supply is NOT READY.
3	INBIHIT LED	O	Open collector. Low impedance when power supply is inhibited from charging.
4	END OF CHARGE LED	O	Open collector. Low impedance when power supply reaches End of Charge.
5	EXCESS REVERSAL	O	Open collector. Low impedance when EXCESS REVERSAL is sensed.
6	COOLANT WARNING	O	Open collector. Low impedance when coolant is below the full level.
7	OVER VOLTAGE	O	Open collector. Low impedance when output OVERVOLTAGE is sensed.
8	ARC	O	Open collector. Low impedance when ARC is detected in the HV tank.
9	AUTO DWELL	I	0-10V signal programs AUTO DWELL period between 500us and 5ms in range 1 (factory preset) or 5ms to 50ms in range 2.
10	HV ON/OFF	I	15V=On, ground or open =Off. Also used to reset latching faults by cycling from On to Off. Input impedance >1M Ω
11	Vprogram	I	0-10V = 0-100% of rated output voltage. Input impedance >1MΩ.
12	CURRENT METER OUTPUT	O	Unscaled indication of output current.
13	ANALOG OUT	O	0-10V (±1%) Analog of output voltage waveform. Impedance 1kΩ
14	INTERLOCK LED	O	Open collector. Low impedance when external interlock circuit is open or power supply top cover is removed.
15	INPUT POWER FAULT LED	O	Open collector. Low impedance when input power fault occurs (high, imbalance, interlock). When signal is activated the supply will latch off.
16	AUTO DWELL LED	O	Open collector. Low impedance when AUTO DWELL is activated.
17	LOAD FAULT LED	O	Open collector. Low impedance when LOAD FAULT condition occurs. Load fault is a non-latching fault and will self reset after approximately 500ms (for models without LP option).
18	DO NOT CONNECT		

19	COOLANT FAULT	O	Open collector. Low impedance when the internal over temperature sensor is activated. The power supply shuts off and will not restart until the unit has returned to normal operating temperature. On occasion the thermal sensor may be activated by residual heat after shut down. This is normal and will reset itself within one minute after re-application of power. This signal is logical OR connected with the COOLANT WARNING LED.
20	PURGE PUMP	O	Open collector. Low impedance when PURGE PUMP is activated.
21	DIGITAL GROUND		Common ground connection for digital circuits.
22	INHIBIT INPUT	I	5-15V Inhibits unit, open or ground allows operation. Input impedance >10kΩ.
23	ANALOG GROUND		Common ground connection for analog circuits.
24	+11VDC	O	+11V regulated for use with Vprogram and AUTO DWELL program inputs.
25	VOLTAGE METER OUT	O	+10VDC indicates max rated output voltage.

Table 6-1 203/303 Remote Interface Description

To operate an L model in remote mode the front panel keyswitch must be in the REMOTE position. Before operating either a 203/303 L or S in remote mode it must first be connected to a master supply, or an appropriate control system.

6.2.1 Remote Control Signals

There are two recommended remote control signal arrangements for the 203/303 supply. The first utilizes the 203/303 in built AUTO-DWELL function, and the second utilizes a customer supplied inhibit signal. Each case is detailed in the following sections.

6.2.2 Remote Operation with AUTODWELL

The simplest remote control for the 203/303 series power supplies requireds only an external HV ON/OFF signal (Pin 10), and a Vprogram signal (Pin11), and ground (Pin 21/23). The Vprogram signal should be set to the appropriate analog level that corresponds to the desired output voltage. For any given model with standard 10V programming, the program voltage (in Volts) is given by;

$$\text{Vprogram} = \frac{\text{Vcharge} \times 10}{\text{Vrated}}$$

Note: The program voltage should never be greater than 10V.

Once the desired Vprogram signal has been set by the remote control system, the supply can be turned on. The first step is to turn on the AC power switch on the supply front panel, or close the remote power on the rear panel if it is being used.

With the supply AC power turned-on and the Vprogram set to the desired level, the HV ON signal can be asserted (Pin 10=15V). As soon as the HV ON signal is high the output of the supply is energized and the load will begin charging.

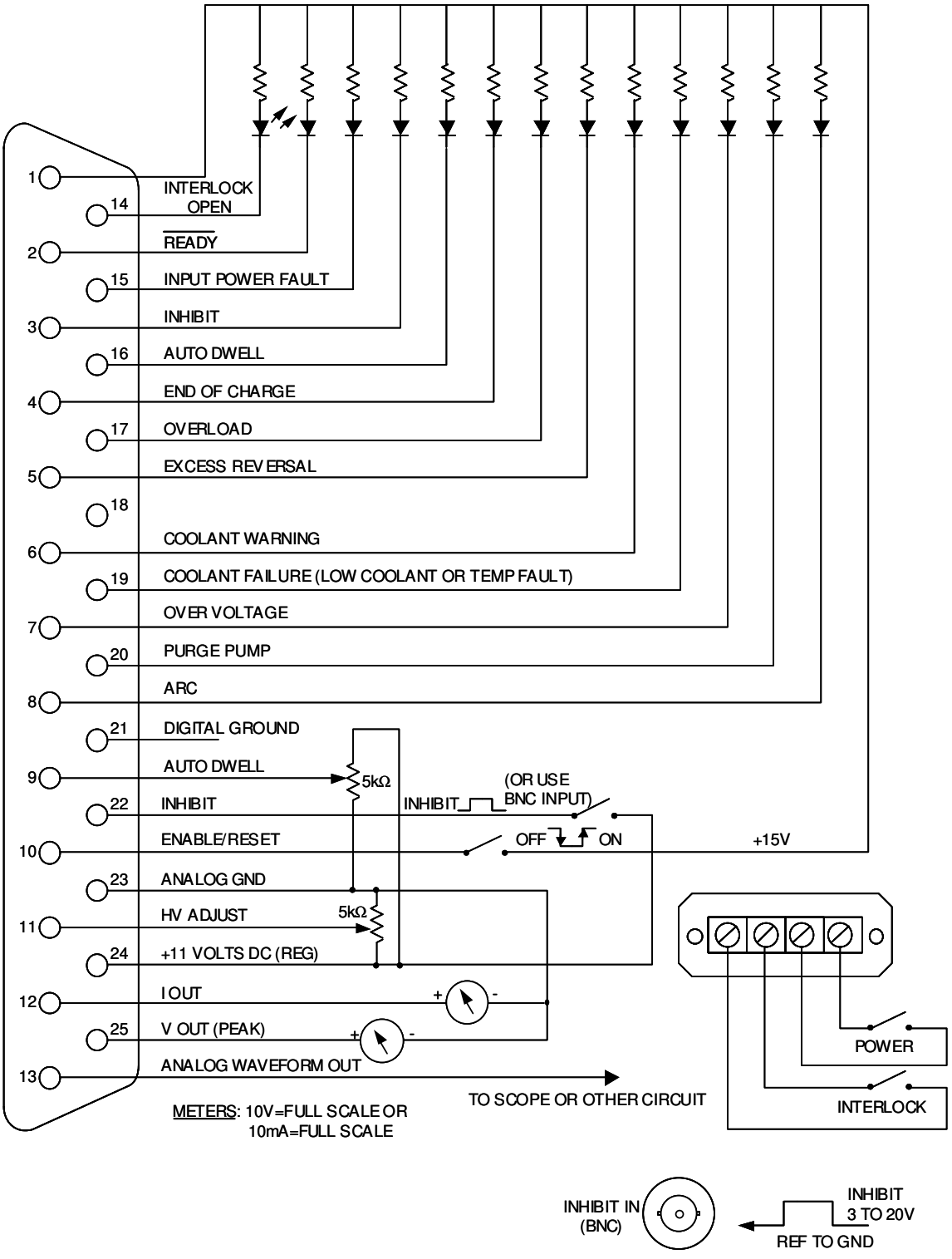


Figure 6-1. External remote interface circuit.

The load will continue to charge at full current until the supply reaches End Of Charge (EOC - output voltage=program voltage). After the supply reaches EOC the load voltage is maintained at the programmed level by short bursts of charge current. When the load is discharged the AUTODWELL circuit automatically creates an internal inhibit signal

that shuts off the output current for a short period (1ms default). Note: the AUTODWELL period is programmable between 500µs and 5ms via remote Pin 9. The AUTODWELL circuit will only detect load discharge when the output voltage falls from between 20% and 100% of rated voltage to zero. If the load is discharged at below 20% of rated voltage, the AUTODWELL circuit will not activate and the supply will continue to deliver current.

When the AUTODWELL period is over, the supply will begin to recharge the load and the cycle repeats. The supply will continue to operate in this manner until HV OFF is asserted (PIN 10=0V). See Figure 6-2 for typical remote interface waveforms.

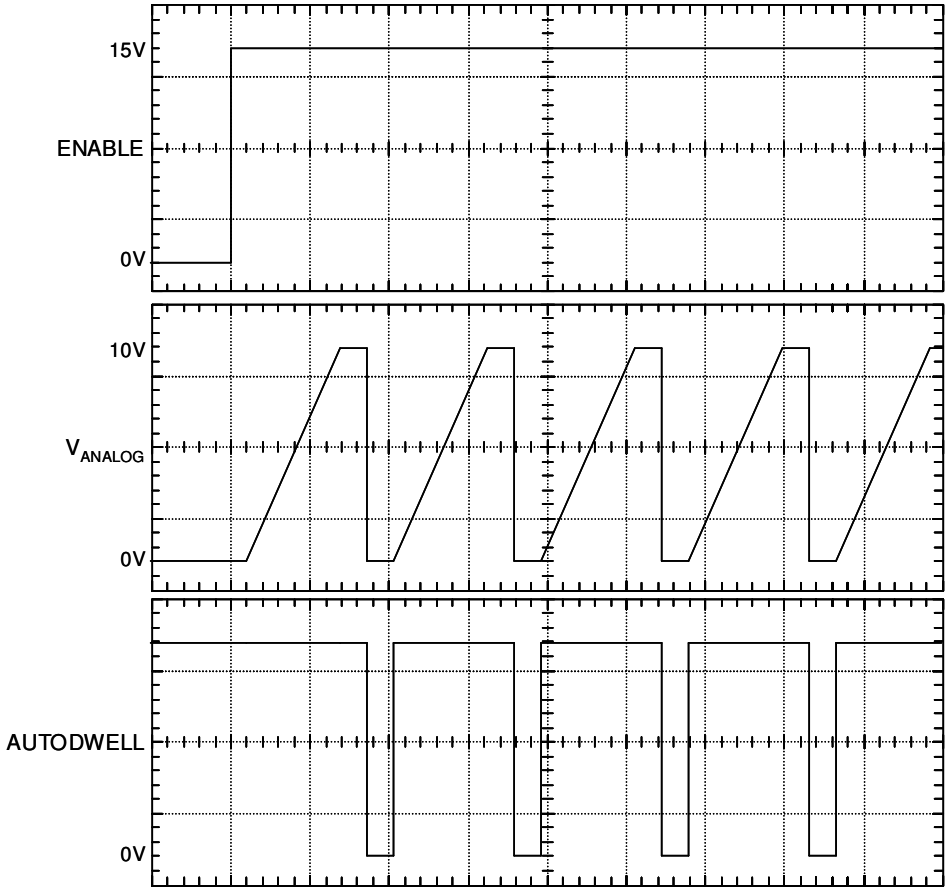


Figure 6-2 Remote Interface waveforms for 303 operated with AUTODWELL

6.2.3 Remote Operation with INHIBIT

Although the AUTODWELL signal offers the user the simplest remote programming method for the 203/303, the INHIBIT signal is commonly used to control the output current and offers greater flexibility, allowing the user to minimize the time at which the load capacitor remains at high voltage. The INHIBIT signal should be asserted (Pin 22=5-15V) prior to activating the HV ON signal. Once HV ON has been set, then INHIBIT can be removed (Pin 22=0V), and the supply will begin charging the load. A few 10s of microseconds before the load switch is triggered to close, the INHIBIT signal should be asserted to turn-off the output current, and aid in switch recovery. Once the load switch has recovered from the discharge event, INHIBIT can be removed and the load recharged. A typical set of remote control waveforms is shown in Figure 6-3.

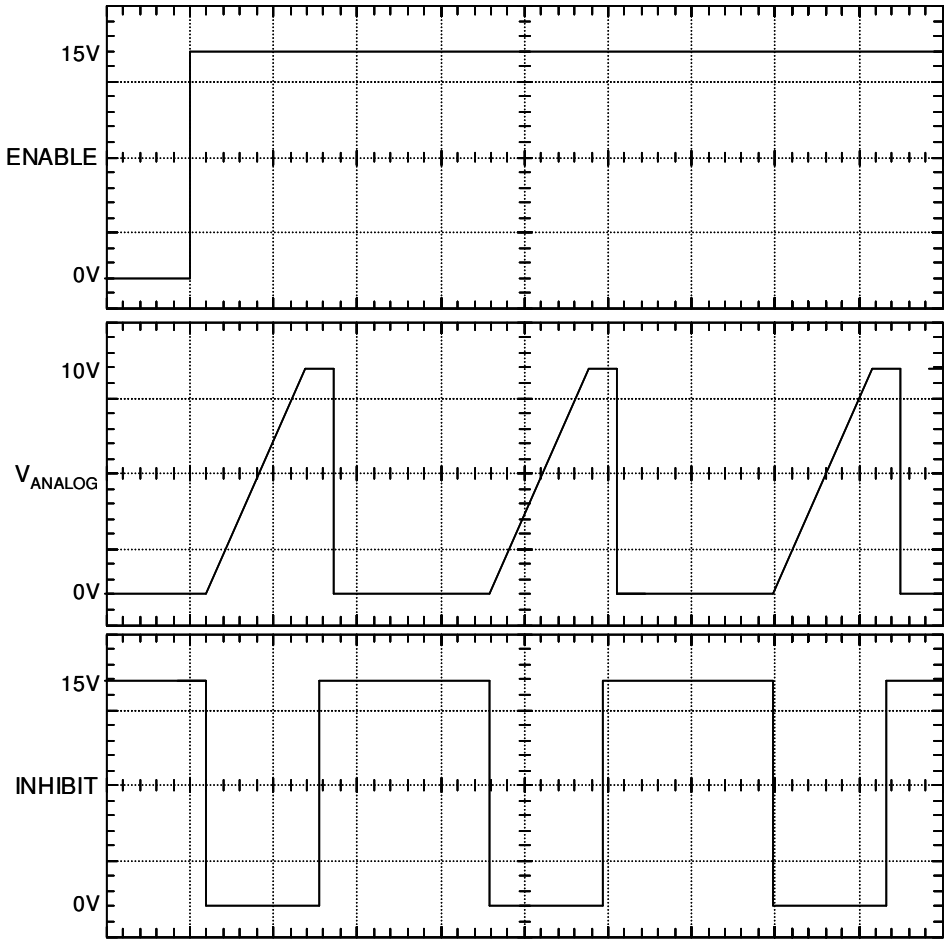


Figure 6-3 Remote Interface waveforms for 303 operated with INHIBIT

6.3 Parallel Operation

The 203/303 series capacitor charging power supplies are constant current sources, and can be connected in parallel for applications requiring increased power. To operate more than one unit in parallel all that is required is a parallel control cable, and to connect the HV output cables together at the load. Either model 203/303L or 203/303S or any combination of units can be operated in parallel. If at least one model 203/303L is connected in a parallel system then the system can be operated without an external controller by using the 203/303L as a master supply in local mode.

If status, voltage, and current displays/measurements are required individually for each supply in a parallel system then the 'daisy chain' control cable is not appropriate, and each unit must be individually connected to a remote control system.

6.3.1 Parallel system comprising 203/303L supplies

If all of the parallel units are L model supplies then one unit should be operated as the master supply in either local or remote mode. The other parallel supplies can be connected to the SLAVE 25-pin D-sub connector on the master unit rear panel (refer to Figure 6-4). The SLAVE control cable can be a pin-to-pin ribbon or other cable that is

'daisy chained' to the REMOTE connector on each of the SLAVE supplies. Note: The master 203/303L supply in a parallel system only displays the status, voltage, and current output for that unit, not for the entire system. The slave supplies will also display the voltage and current only for that specific unit.

6.3.2 Parallel system comprising both 203/303L and 203/303S supplies

For a system comprising both 203/303L and S units, a single L model should be operated as a master in either local or remote mode. The other parallel supplies can be connected to the SLAVE 25-pin D-sub connector on the master unit rear panel (refer to Figure 6-4). The SLAVE control cable can be a pin-to-pin ribbon or other cable that is 'daisy chained' to the REMOTE connector on each of the SLAVE supplies.

6.3.3 Parallel system comprising 203/303S supplies

A system comprising only model 203/203S supplies must be operated from a control system. The control system should be connected using a pin-to-pin ribbon or other cable that is 'daisy chained' to the REMOTE connector on each of the 203/303S supplies in the system.

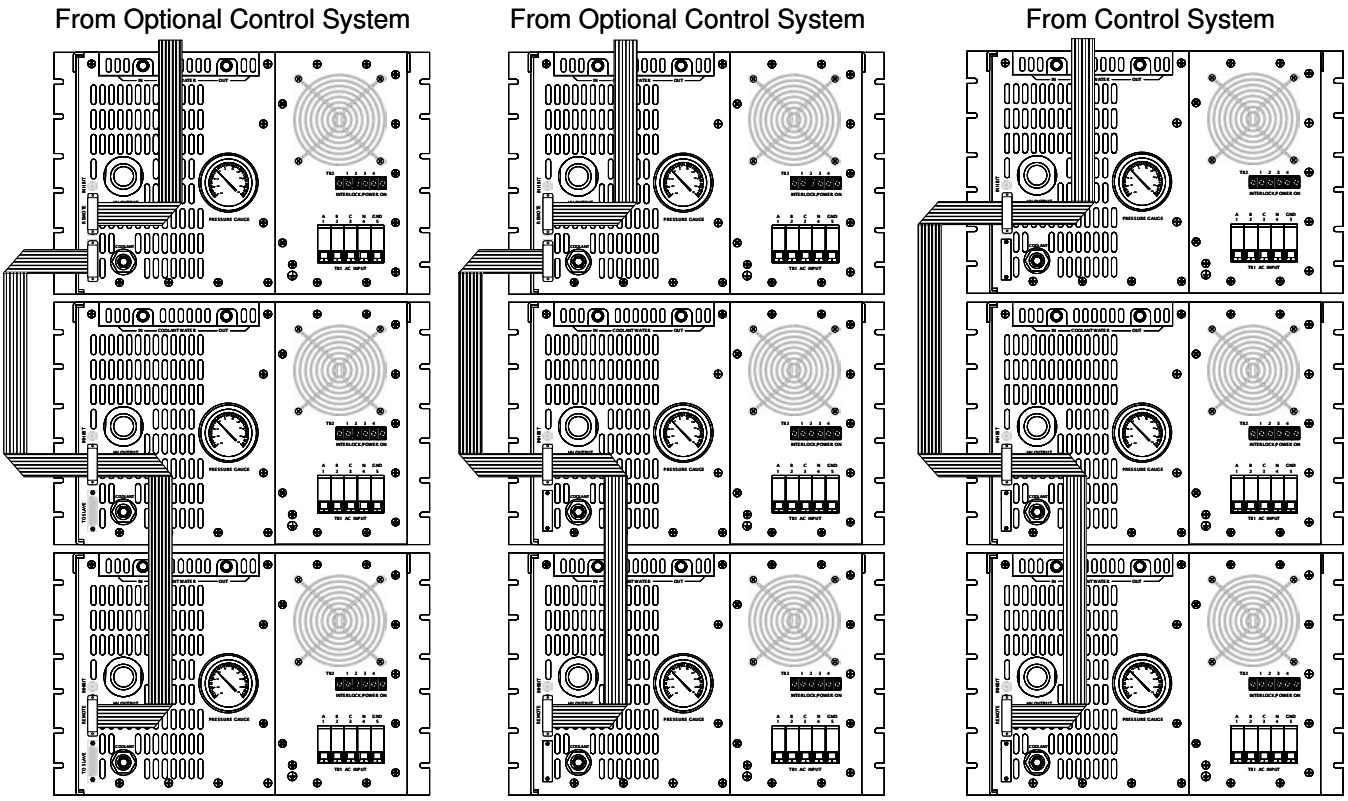


Figure 6-4 Parallel Operation Connections

7. APPLICATION NOTES

The 203/303 series power supplies are extremely powerful high voltage power sources and great care should be taken when connecting and operating these units. In order to aid installation design and number of application notes have been produced to aid the design engineer with certain load circuit component rating and selection. The latest versions of these application notes are available for download at the Lambda web site (www.us.tdk-lambda.com/hp/high_volt.htm).

The following App Notes were available at the time this manual was produced. These documents are continually being improved and expanded to always check for the latest revison on-line.

APP Note 500: Calculating Capacitor Charge Time
APP Note 502: Calculating AC Line Currents
APP Note 505: Charging units as Continuous Output DC Supplies
APP Note 507: Charging Large Load Capacitors
APP Note 509: What is Regulation and Repeatability?
APP Note 513: Power Factor Correction
APP Note 517: Protection Against Voltage Reversal

If there are any other application issues or questions that are not covered in these Application Notes, or elsewhere in this manual, please do not hesitate to contact the factory and our team of experienced HV application engineers.

Contact the Factory – We are here to help!

Tel: +1 732 922 9300

Fax: +1 732 922 9334

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LTR	E.C.O. NO.	BY	APP.	APPLICATION			LTR	E.C.O. NO.	BY	APP.
				USED ON	NEXT ASSY.	QTY.				
G	ECO# 19694 01/10/01	LWR		303	FINAL	REF	01	INITIAL RELEASE 7/20/94	SAdB	
							02	REVISED 12/01/94	SAdB	
							A	TG 3 12/19/94	SAdB	
							B	ECO #14605 7/13/95	AK	
							C	ECO #15157 2/16/96	CJS	
							D	ECO #15602 7/25/96	CJS	
							E	ECO #15850 9/26/96	CJS	
							F	ECO #16040 12/31/96	CJS	

A6 LED BD P/O A1 20-855-000 001-0089

A4 CONTROL BD P/O A1 020-0134 01-000-695

INTERFACE BD 020-0143 001-0064

A1 FRONT PANEL ASSY

ON/OFF SWITCH

INTERLOCK SWITCH SW1

A11 ASSY SENSE PCB 20-861-480 01-000-602

C1 2400uF 450V, C2 2400uF 450V, C3 2400uF 450V, C4 2400uF 450V, C5 2400uF 450V, C6 2400uF 450V

R3A 20K 11W, R3B 20K 11W

FB2 F6 100A 300V

FB3 F9 100A 300V

A9 HV TANK ASSY 26-569-XXX 001-0059

J3 TANK SIGNAL CONNECTOR
J1 VOLTAGE FEEDBACK
J2 CURRENT FEEDBACK
E2 UNRA+
E1 UNRA- UNRB+
E3 INVERTER RETURN A
E4 INVERTER RETURN B

L1 125uH 100A, L2 125uH 100A

A10 REAR PANEL ASSY

REMOTE CONN.

SLAVE CONN.

INHIBIT CONN.

POWER ON INTERLOCK LOOP

TB1

W6

A2 LV P/S BD (AUX) 20-853-000 001-0015

CR3 (-) C3 (+)

K2 10A 240VAC 124-0011 INRUSH RELAY

C7 25uF 440VAC, R1 330K 1W

C8 25uF 440VAC, R2 330K 1W

INRUSH COIL P/O W1

A1 001-0036 LINE RECTIFIER

K1 124-0008 MAIN CONTACTOR 110A 600VAC

MAIN CONTACTOR COIL

INTERLOCK SENSE

RETURN +24 CHASSIS GROUND

24VAC CT 24VAC

M1

FB1 F1 100A, F2 100A, F3 100A

J1 0187 480VAC 3Ø

VR1, VR2, VR3, VR4, VR5, VR6

T1, T2

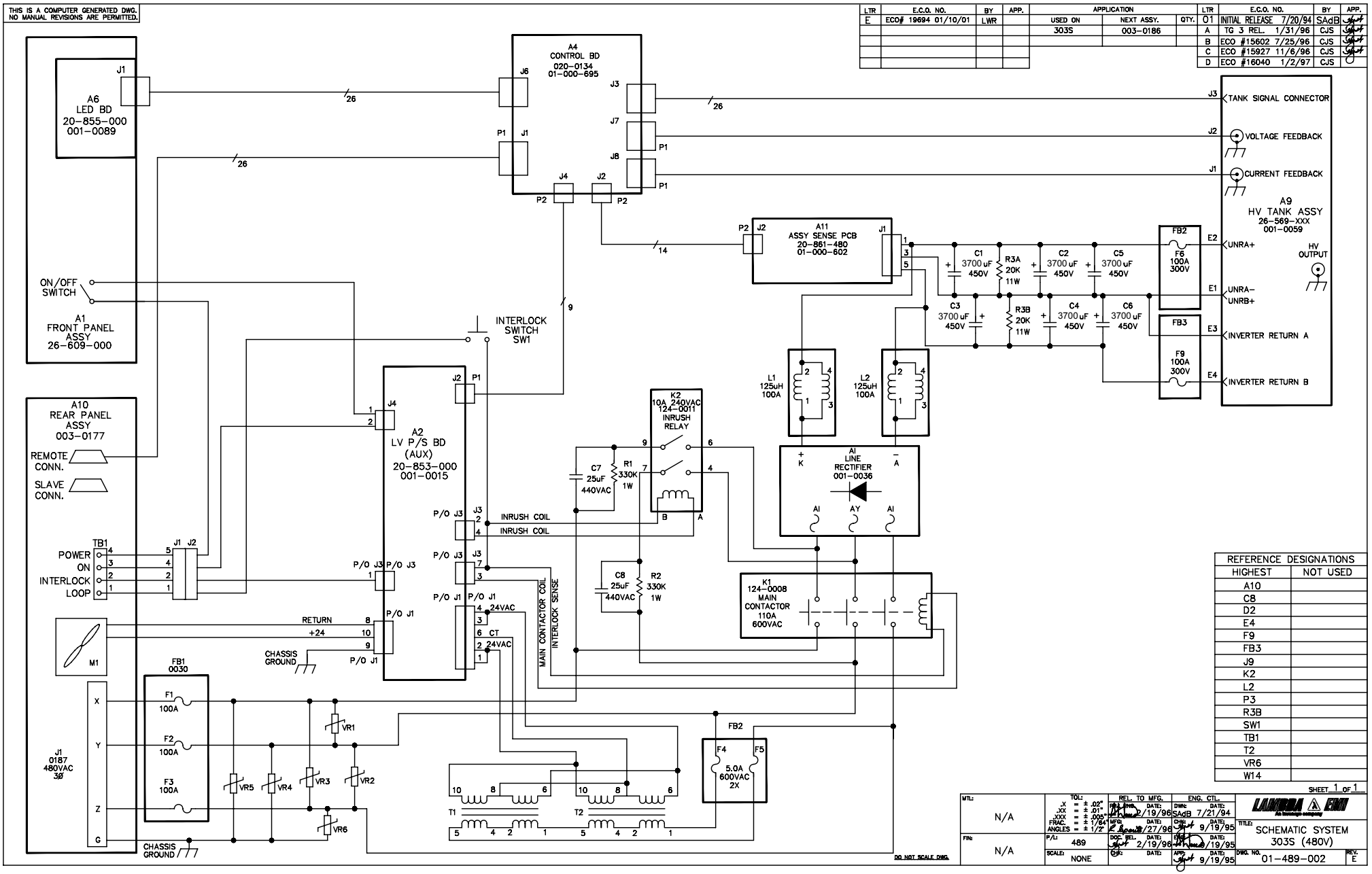
FB2 F4 F5 5.0A 600VAC 2X

CHASSIS GROUND

DO NOT SCALE DWG.

SHEET 1 OF 1

MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. APP: DATE: 8/11/95	ENG. CTL. DWN: SAdB DATE: 7/21/94	LAMBDA EMI An Ametek company	
FIN: N/A	P/L: 489	MFG: DATE: 8/11/95	CHK: DATE: 8/11/95	TITLE: SCHEMATIC SYSTEM 303 (480V)	
	SCALE: N/A	DOC. REL: DATE: 8/11/95	APP: DATE: 8/11/95	DWG. NO. 01-489-001	REV. G



LTR	E.C.O. NO.	BY	APP.	APPLICATION		QTY.
				USED ON	NEXT ASSY.	
E	ECO# 19694 01/10/01	LWR		303S	003-0186	

LTR	E.C.O. NO.	BY	APP.
01	INITIAL RELEASE 7/20/94	SAdB	
A	TG 3 REL. 1/31/96	CJS	
B	ECO #15602 7/25/96	CJS	
C	ECO #15927 11/6/96	CJS	
D	ECO #16040 1/2/97	CJS	

REFERENCE DESIGNATIONS	
HIGHEST	NOT USED
A10	
C8	
D2	
E4	
F9	
FB3	
J9	
K2	
L2	
P3	
R3B	
SW1	
TB1	
T2	
VR6	
W14	

SHEET 1 OF 1

MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. DRN. DATE: 2/19/96 MFG. DATE: 2/27/96 DOC. REL. DATE: 2/19/96 CHK. DATE:	ENG. CTL. DWN: SAdB 7/21/94 CHK: 9/19/95 ENG: DATE: 9/19/95 APP: DATE: 9/19/95	LAMBDA EMI An Ametek company
FIN: N/A	P/L: 489			TITLE: SCHEMATIC SYSTEM 303S (480V)
	SCALE: NONE			DWG. NO. 01-489-002 REV. E

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APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.				
			A	TG REL 2/20/97	CJS	
			B	ECO #17426 4/16/98	CJS	GFS
			C	ECO #19694 01/10/01	LWR	

A4
CONTROL BD
020-0134
01-000-695

A1

A6
LED BD
20-855-000
001-0089

INTERFACE
BD
020-0143
001-0064

A1
FRONT PANEL
ASSY
26-570-000

ON/OFF
SWITCH

INTERLOCK
SWITCH
SW1

A10
REAR PANEL
ASSY
26-595-000

REMOTE
CONN.

SLAVE
CONN.

INHIBIT
CONN.

POWER
ON
INTERLOCK
LOOP

TB1

A2
LV P/S BD
(AUX)
20-853-000
001-0015

CR 3
C3

K2
10A 240VAC
INRUSH
RELAY

C7
25uF
440VAC

R1
330K
1W

C8
25uF
440VAC

R2
330K
1W

A11
ASSY SENSE PCB
20-861-480
01-000-602

NC

C1-6
2400uF
450V

R3A
20K
11W

R3B
20K
11W

L1
500uH
50A

L2
500uH
50A

AI
LINE
RECTIFIER
001-0036

K1
MAIN
CONTACTOR
110A
600VAC

A9
HV TANK ASSY
26-569-XXX
001-0059

TANK SIGNAL CONNECTOR

VOLTAGE FEEDBACK

CURRENT FEEDBACK

UNRA+

HV OUT

UNRA-
UNRB+

INVERTER RETURN A

INVERTER RETURN B

FB2
F6
100A,300V

FB3
F9
100A,300V

M1

FB1
F1
NOS 100
F2
NOS 100
F3
NOS 100

J1
208VAC
3Ø

CHASSIS
GROUND

VR1
VR2
VR3
VR4
VR5
VR6

T1
T2

FB2
F4
F5
5.0A
600VAC
2X

24VAC
CT
24VAC
+24

DO NOT SCALE DWG.

SHEET 1 OF 1

MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. PRJ. ENG. DATE: 3/20/97 MFG: DATE: 3/21/97 DOC. REV. DATE: 3/10/97 QHK: DATE:	ENG. CTL. DWN: C.SEIBERT DATE: 2/20/97 CHK: DATE: 3/10/97 ENG: DATE: 3/20/97 APP: DATE: 3/10/97	LAMBDA EMI An Ametek company
FIN: N/A	P/L: 489 SCALE: NONE			TITLE: SCHEMATIC SYSTEM 203 (208V)
				DWG. NO. 01-489-004 REV. C

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153S	003-0186		A	TG 3 REL. 3/12/96	CJS	
			B	ECO #15602 7/26/96	CJS	
			C	ECO #16040 1/13/97	CJS	
			D	ECO# 19694 01/10/01	LWR	

A6
LED BD
20-855-000
001-0089

INTERFACE
BD
020-0143
001-0064

ON/OFF
SWITCH

A1
FRONT PANEL
ASSY

A10
REAR PANEL
ASSY

REMOTE
CONN.

SLAVE
CONN.

INHIBIT
CONN.

POWER
ON
INTERLOCK
LOOP

TB1

M1

J1
0187
480VAC
3Ø

A4
CONTROL BD
020-0134
01-000-695

A2
LV P/S BD
(AUX)
20-853-000
001-0015

LV P/S BD

INTERLOCK
SWITCH
SW1

CR3

(-) C3 (+)

P/O W1

INRUSH COIL
P/O W1

INRUSH COIL
P/O W1

MAIN CONTACTOR COIL

INTERLOCK SENSE

RETURN

+24

CHASSIS
GROUND

CHASSIS
GROUND

A11
ASSY SENSE PCB
20-861-480
01-000-602

K2
10A 240VAC
124-0011
INRUSH
RELAY

C7
25uF
440VAC

R1
330K
1W

C8
25uF
440VAC

R2
330K
1W

K1
124-0008
MAIN
CONTACTOR
110A
600VAC

AI
001-0036
LINE
RECTIFIER

L1
125uH
100A

L2
125uH
100A

C1 2400uF 450V
C2 2400uF 450V
C3 2400uF 450V
C4 2400uF 450V
C5 2400uF 450V
C6 2400uF 450V

R3A
20K
11W

R3B
20K
11W

FB1
F1 100A
F2 100A
F3 100A

VR1
VR2
VR3
VR4
VR5
VR6

T1
T2

FB2
F4 F5
5.0A
600VAC
2X

FB2
F6
100A
300V

FB3
F9
100A
300V

A9
HV TANK ASSY
26-569-XXX
001-0059

J3 TANK SIGNAL CONNECTOR
J1 VOLTAGE FEEDBACK
J2 CURRENT FEEDBACK
E2 UNRA+
E1 UNRA-
UNRB+
E3 INVERTER RETURN A
E4 INVERTER RETURN B

DO NOT SCALE DWG.

REFERENCE DESIGNATIONS	
HIGHEST	NOT USED
A10	
C8	
D2	
E4	
F9	
FB3	
J9	
K2	
L2	
P3	
R3B	
SW1	
TB1	
T2	
VR6	
W14	

SHEET 1 OF 1

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FIN: N/A	P/L: 489			TITLE: SCHEMATIC SYSTEM 303L 415V
	SCALE: NONE			DWG. NO. 01-489-006 REV. D

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			A	TG REL. 3/25/96	CJS	
			B	ECO #15582. 7/9/96	CJS	
			C	ECO #15553. 7/9/96	CJS	
			D	ECO #16150 2/26/97	CJS	
			E	ECO #16447 7/11/97	CJS	
			F	ECO #16492 7/16/97	CJS	
			G	ECO #22265 9/27/06	LWR	

REMOTE CONTROL
COOLANT FAILURE J1-12
COOLANT LEVEL WARNING J1-11
LINE SENSE BOARD
HIGH LINE J2-1
LOW LINE J2-8
INBALANCE J2-6
J5-5
J5-11
J5-12
J2-4
J2-7
J2-5
R131 100K
R132 100K
R133 100K
R3 10K
R4 10K
R5 10K
C35 .1
C36 .1
C37 .1
U3 4081
U8 40106
R134 100K
R135 100
R136 100
C86 .01
C85 .01
J6-25 HIGH LINE
J6-23 LOW LINE
J6-24 INBALANCE
LINE FAULT J6-4
R137 100
LINE INHIBIT SHEET 2
LINE FAULT J1-4
PUMP ON J1-14
ARC J1-15
U2 2004
U30 2004
U5 4071
U22 4013
R6*
C38 5 50V
12 POR
NOTE:
* R6,USE 200K FOR 480 VAC
R6,USE 2M FOR 208 VAC
D29 IN914
J6 ARC
J6-
C39 50V
2M R7 1M
D7 IN914
OV J1-13
INTERLOCK OPEN J1-2
FAULT J1-3
FAULT J6-3
SP2
SP3
LINE
TEMP
FREON
ARC
OV
INTERLOCK
CONNECT INTLK
U26 4078
OV-B (SHT.2)
OV-A (SHT.2)
U6 4071
ENABLE/RESET J1-19
R8 10K
R41 100K
C40 .01
D8 IN914
R9 1K
C41 .01
U22 4013
OFF (SHT.2)
SP6
ZERO START SHT.2
NCR J1-10
NCR (SHT.2)
J6-10
D12 IN914
R16 100K
J5-6 OFF/NCR
R14 1K
R15 1M
C43 .1
+15 D9 A114F DC BREAKER BD.
J5-9 +15
-5
J5-13 NEG
J5-7 GND
TP2-11 J5-10 SET
TP2-10 J5-9 RESET
R10 2.7K
R11 24K
P1 5K CW
R12 6.98K
U15 TL431
U14 324
VREF 11 VOLTS
R126 XXX
R127 XXX
C89 XXX
TO SP11 SHT.2
R144 10K
SP7
U18 339
R125 10K
R143 11K
C84 XXX
+24V
TP2-9 J5-4 LEM CURRENT
TP2-8 J5-3 LEM CURRENT
TP2-7 J5-2 LEM CURRENT
TP2-6 J5-1 LEM CURRENT
SP5
J5-14 CONN. INTLK
R13 10K
C42 .1
COOLANT FULL J6-2
COOLANT WARNING J6-11
ADD COOLANT J6-12
TEMP FAULT J6-20
PUMP ON J6-14
R23 10K
R22 1M
C45 1.0
R21 10K
R42 1.5M
C82 4.7
C79 4.7
P11
R44 1M
R43 10K
R17 1M
C44 OPEN
R146 10K
R33 10K
R32 51
P12
SP1
S2 PUMP MANUAL
U12 339
U13 339
U14 324
U10 40106
U7 4071
R24 1K
R25 10K
R26 10K
R27 10K
R28 10K
R29 10K
R121 1K
R122 1K
R30 30.9K
R31 30.9K
P8 1K
C46 .1
C47 .1
C48 .1
C49 .1
C50 .1
C51 .1
C80 4.7
C81 4.7
TANK CONN. J3-9 REF
J3-8 TOP
J3-7 MID
J3-6 BOTTOM
J3-3 GND
J3-2 GND
J3-12 UPPER TEMP
J3-11 LOWER TEMP
1 J9
2 AUX PUMP CONTROL
3
5
6
LVPS RELAY DRIVE BOARD
J4-6 PUMP CONTROL
J4-5 INRUSH CONTROL
J4-4 MAIN CONTACTOR CONTROL
R34 20K
D11 IN4006
4N25
R138 1K
J4-3 INTLK SENSE
J4-10 INTLK SENSE
J4-7 RETURN
J4-1 +24 VDC
J4-2 +15 VDC
J4-8 -5 VDC
+15
J6-1
J6-16
ALL MTG HOLES
N.C.
J3-20 CLAMP
R39 10
J3-10
C55 .1
R35 330K
U16
C52 .1
ARC BYPASS
R40 1M
R36 10K
J3-13 ARC
C53 .001
U23C 4013
U9 40106

MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. ENG: DATE: 3/28/96 MFG: DATE: 3/28/96 DOC. REL. DATE: 3/28/96 CHK: DATE:	ENG. CTL. DWN: C.SEIBERT DATE: 3/25/96 CHK: DATE: 3/25/96 ENG: DATE: 3/28/96 APP: DATE: 3/25/96	LAMBDA EMI
FIN: N/A	P/L: 489			TITLE: SCHEMATIC, 303 CONTROL CARD
DO NOT SCALE DWG.	SCALE: NONE			DWG. NO. 01-000-695 REV. G

SHEET 1 OF 3

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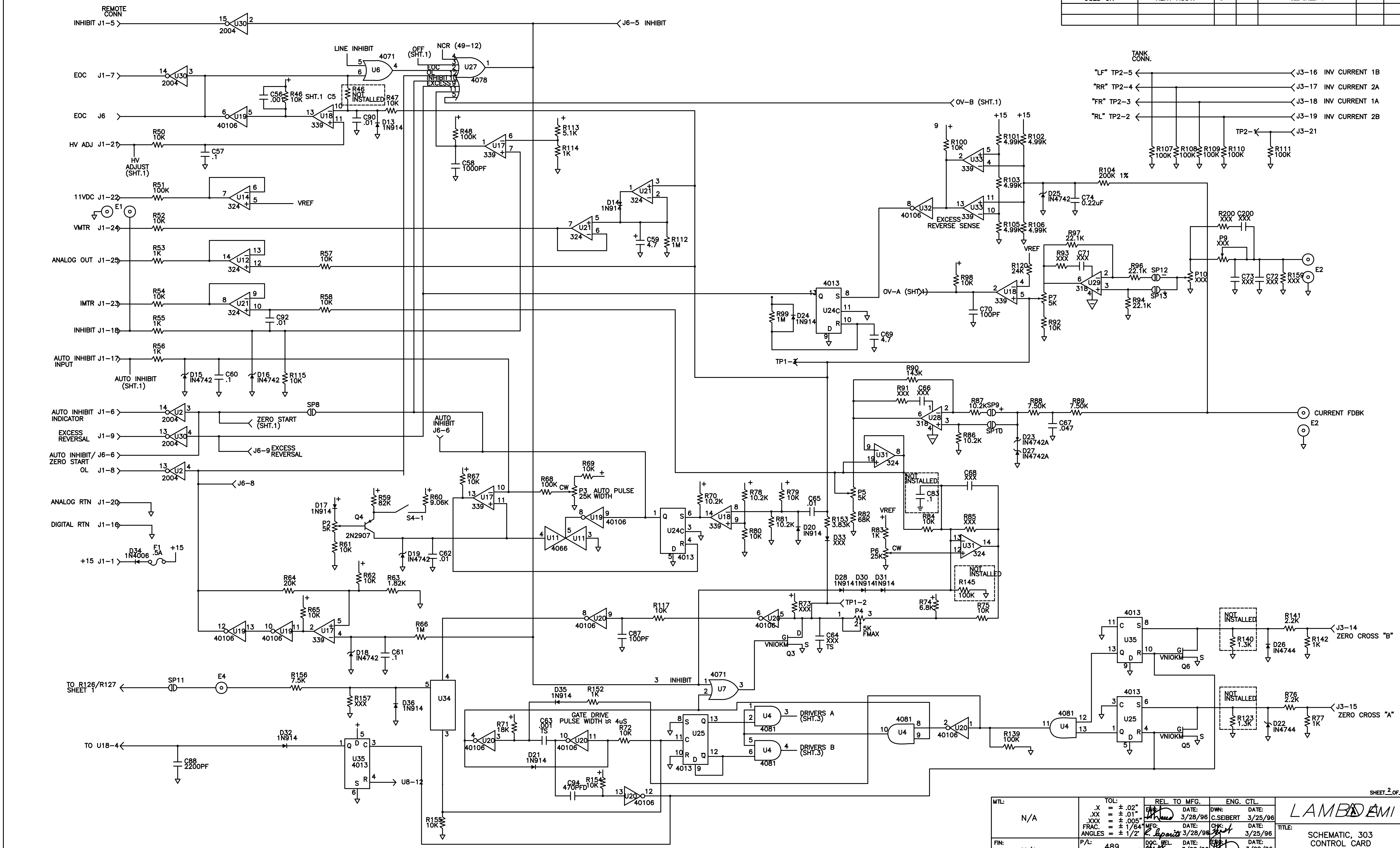
APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.		SEE SHEET 1		

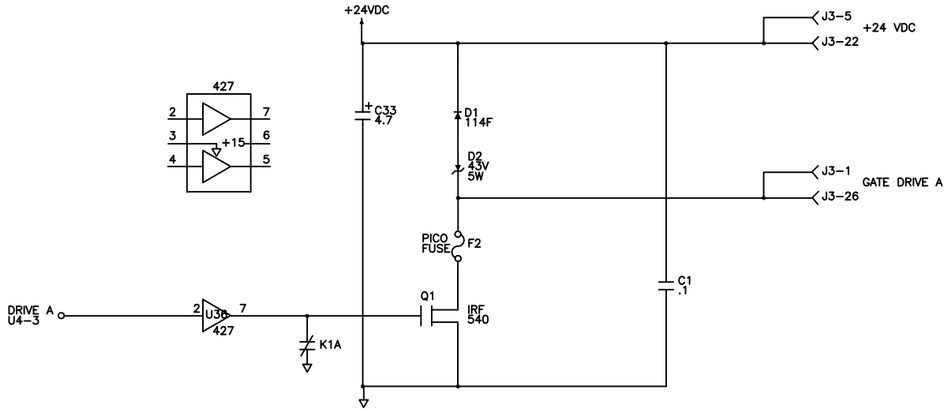


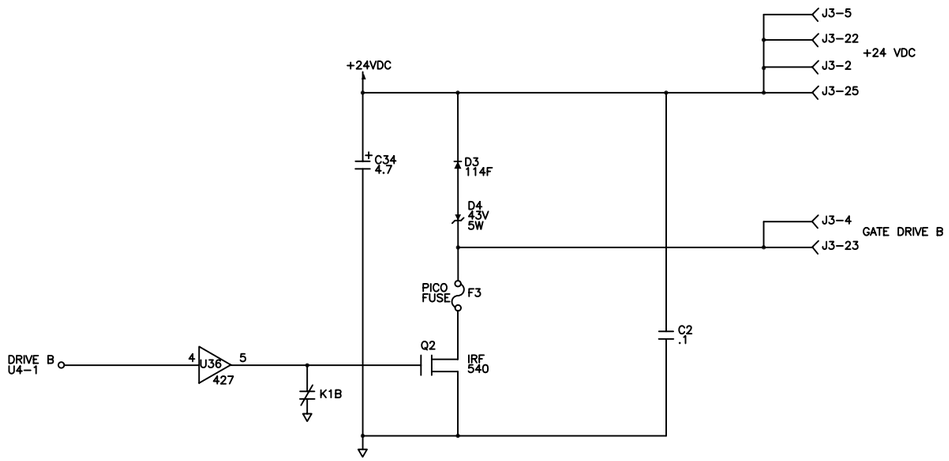
SHEET 2 OF 3

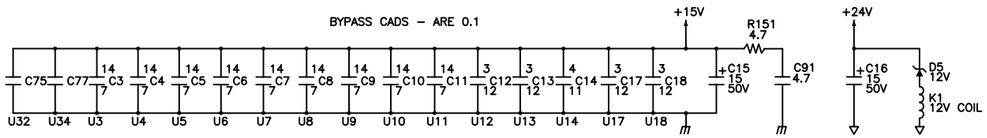
MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. DATE: 3/28/96	ENG. CTL. DWN: C.SEIBERT DATE: 3/25/96	LAMBDA EMI
		MFG: DATE: 3/28/96	CHK: DATE: 3/25/96	TITLE: SCHEMATIC, 303 CONTROL CARD
FIN: N/A	P/L: 489	DOC. REL. DATE: 3/28/96	ENG: DATE: 3/28/96	
DO NOT SCALE DWG.	SCALE: NONE	CHK: DATE:	APP: DATE: 3/25/96	DWG. NO. 01-000-695 REV. G

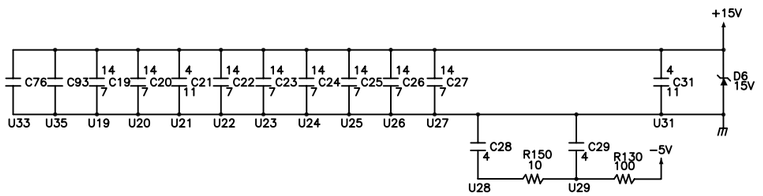
THIS IS A COMPUTER GENERATED DWG.
NO MANUAL REVISIONS ARE PERMITTED.

APPLICATION		LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.				
				SEE SHEET 1		









NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS.
   CAPACITOR VALUES ARE IN MICROFARADS.

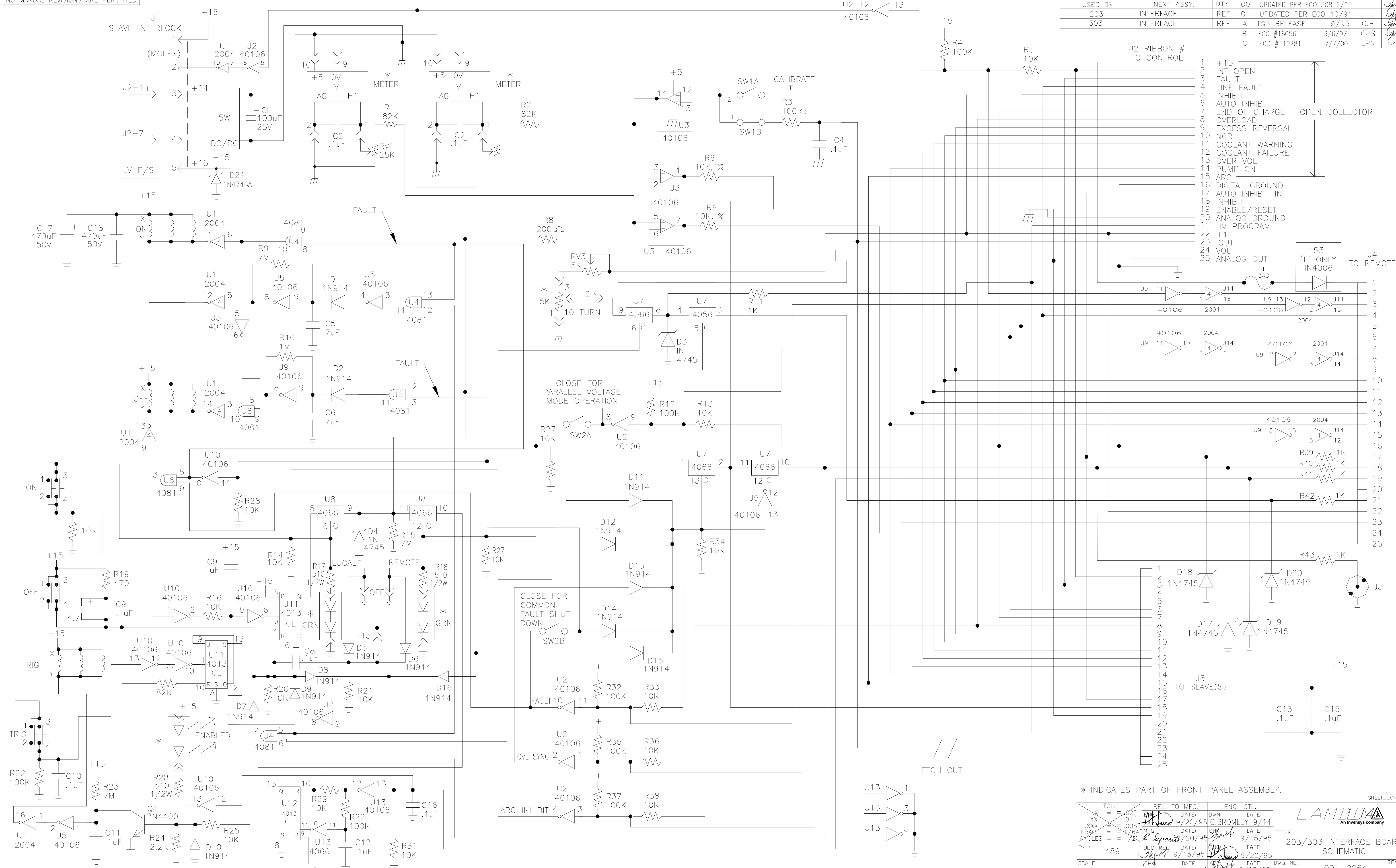
SHEET 3 OF 3

MTL: N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. ENG: DATE: 3/28/96 MFG: DATE: 3/28/96 DOC. REL. DATE: 3/28/96 CHK: DATE:	ENG. CTL. DWN: DATE: C.SEIBERT 3/25/96 CHK: DATE: 3/25/96 ENG: DATE: 3/28/96 APP: DATE: 3/25/96	LAMBDA EMI
FIN: N/A	P/L: 489			TITLE: SCHEMATIC, 303 CONTROL CARD
DO NOT SCALE DWG.	SCALE: NONE			DWG. NO. 01-000-695 REV. G

THIS IS A COMPUTER GENERATED DWG.
NO MANUAL REVISIONS ARE PERMITTED.

APPLICATION		
USED ON	NEXT ASSY.	QTY.
203	INTERFACE	REF
303	INTERFACE	REF

LTR	DESCRIPTION		BY	APP.
00	UPDATED PER ECO 308	2/91		
01	UPDATED PER ECO	10/91		
A	TG3 RELEASE	9/95	C.B.	
B	ECO #16056	3/6/97	CJS	
C	ECO # 19281	7/7/00	LPN	



J1 SLAVE INTERLOCK
(MOLEX)
J2-1+
J2-7-
LV P/S
DC/DC
D21 1N4746A
METER
C1 100uF 25V
R1 82K
RV1 25K
R2 82K
SW1A CALIBRATE
SW1B
R3 100 Ω
C4 .1uF
R4 100K
R5 10K
J2 RIBBON # TO CONTROL
1 +15
2 INT OPEN
3 FAULT
4 LINE FAULT
5 INHIBIT
6 AUTO INHIBIT
7 END OF CHARGE
8 OVERLOAD
9 EXCESS REVERSAL
10 NCR
11 COOLANT WARNING
12 COOLANT FAILURE
13 OVER VOLT
14 PUMP ON
15 ARC
16 DIGITAL GROUND
17 AUTO INHIBIT IN
18 INHIBIT
19 ENABLE/RESET
20 ANALOG GROUND
21 HV PROGRAM
22 +11
23 IOUT
24 VOUT
25 ANALOG OUT
OPEN COLLECTOR
R6 10K,1%
C17 470uF 50V
C18 470uF 50V
FAULT
R8 200 Ω
R9 7M
R10 1M
C5 7uF
C6 7uF
RV3 5K
10 TURN
D3 IN 4745
R11 1K
153 'L' ONLY IN4006
J4 TO REMOTE
F1 3AG
CLOSE FOR PARALLEL VOLTAGE MODE OPERATION
SW2A
R12 100K
R13 10K
R27 10K
R28 10K
ON
OFF
TRIG
R14 10K
R15 7M
D4 1N 4745
LOCAL
REMOTE
R17 510 1/2W
R18 510 1/2W
GRN
R19 470
R16 10K
C9 .1uF
C8 .1uF
D5 1N914
D6 1N914
D8 1N914
D9 1N914
D16 1N914
D7 1N914
R20 10K
R21 10K
82K
ENABLED
R28 510 1/2W
R22 100K
C10 .1uF
R23 7M
Q1 2N4400
R24 2.2K
D10 1N914
R25 10K
C11 .1uF
U12 4013 CL
R29 10K
R22 100K
C12 .1uF
R31 10K
C16 .1uF
D11 1N914
D12 1N914
D13 1N914
D14 1N914
D15 1N914
CLOSE FOR COMMON FAULT SHUT DOWN
SW2B
R34 10K
FAULT
R32 100K
R33 10K
OVL SYNC
R35 100K
R36 10K
ARC INHIBIT
R37 100K
R38 10K
J3 TO SLAVE(S)
ETCH CUT
R39 1K
R40 1K
R41 1K
R42 1K
R43 1K
D17 1N4745
D18 1N4745
D19 1N4745
D20 1N4745
J5
C13 .1uF
C15 .1uF

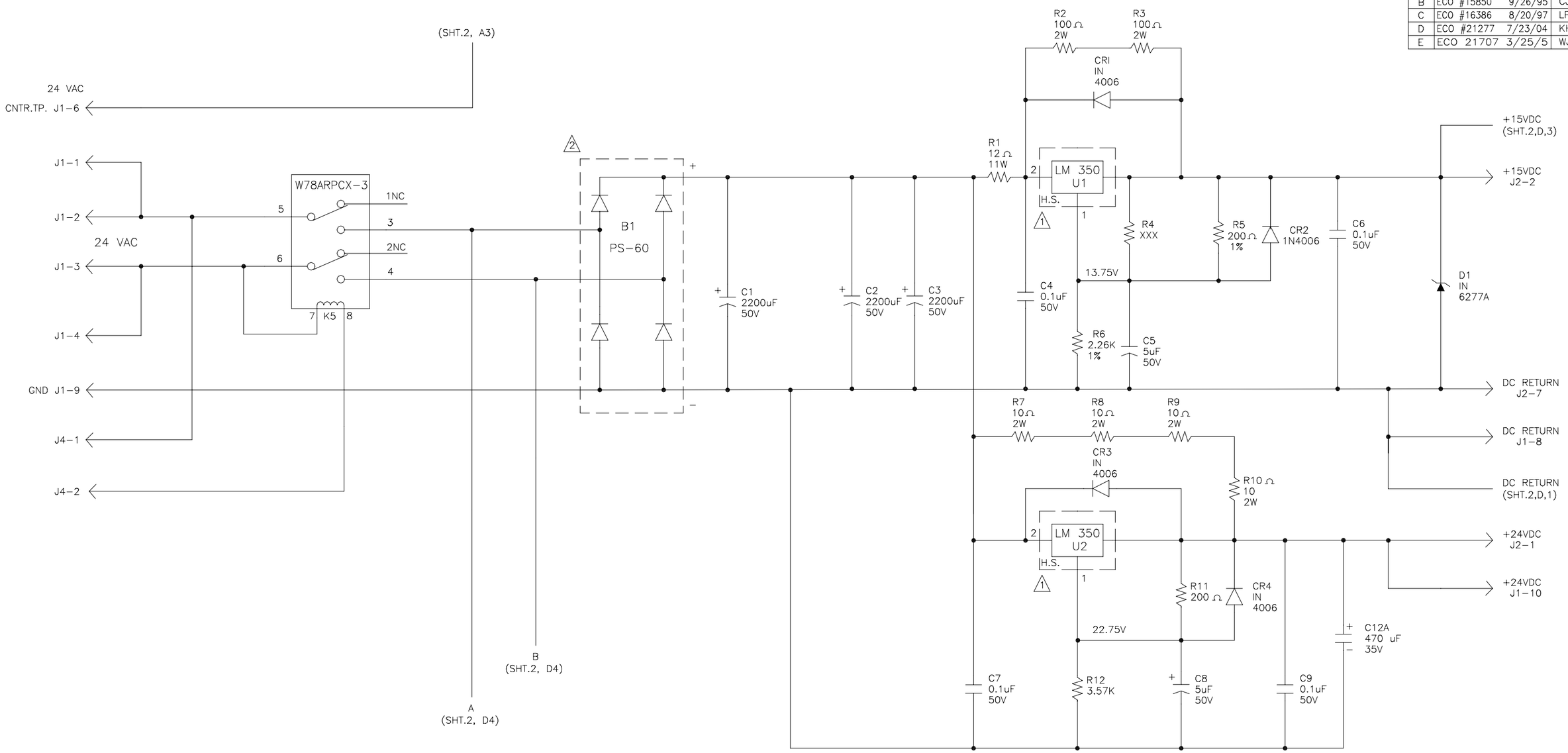
* INDICATES PART OF FRONT PANEL ASSEMBLY.

SHEET 1 OF 1

TOL:	REL. TO MFG.	ENG. CTL.	
.X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	DATE: 9/20/95	DWN: C.BROMLEY DATE: 9/14	LAMBDA EMI — An Invensys company
	MFG: DATE: 9/20/95	CHK: DATE: 9/15/95	TITLE: 203/303 INTERFACE BOARD SCHEMATIC
P/L: 489	DOC. REL: DATE: 9/15/95	ENG: DATE: 9/20/95	
SCALE:	CHK: DATE:	APP: DATE: 9/15/95	DWG. NO. 001-0064 REV. C

THIS IS A COMPUTER GENERATED DWG.
NO MANUAL REVISIONS ARE PERMITTED.

LTR	E.C.O. NO.	BY	APP.
01E	CHANGE NOTE 1 6/89	JT	
00	REVISE PER ECO 308 2/91	JT	
01	REVISE PER ECO 382 5/91	JT	
A	TG3 RELEASED 8/95	CB	
B	ECO #15850 9/26/95	CJS	
C	ECO #16386 8/20/97	LPN	
D	ECO #21277 7/23/04	KHL	TIA
E	ECO 21707 3/25/5	WJH	



NOTES:

1. U1 & U2 ARE BOTH MOUNTED ON THE SAME HEATSINK WITH THERMAL PAD INSULATION.
2. B1 HAS HEATSINK ATTACHED.
3. POWER MODULE (M1) PIN NUMBERS 1-5 HAVE BEEN ASSIGNED BY ALE AND DO NOT NECESSARILY MATCH THE PIN NUMBERS ASSIGNED BY THE VENDER.

REF. DWGS:
PCB A\W ALE 020-0136
PCB A\W ALE 20-853-000

SHEET 1 OF 2

MTL:	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. ENG: DATE: 9/20/95	ENG. CTL. DWN: C.B. DATE: 8/95	LAMBDA EMI
FIN:	P/L: 489	MFG: DATE: 9/26/95	CHK: DATE: 9/27/95	TITLE: LOW VOLTAGE POWER SUPPLY SCHEMATIC
	SCALE:	DOC. REL. DATE: 9/8/95	APP: DATE: 9/20/95	DWG. NO. 001-0015 REV. E
		DO NOT SCALE DWG.	APP: DATE: 9/8/95	

AUTOCAD DRAWING.
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY DRAWING
AND MAY NOT BE FILLED IN.

THIS IS A COMPUTER GENERATED DWG.
NO MANUAL REVISIONS ARE PERMITTED.

LTR	E.C.O. NO.	BY	APP.
—	SEE SHT. 1 FOR CHGS.	—	—

A (SHT.1, B4)

B (SHT.1, B4)

CR8 IN 4006

CR9 IN 4006

CR10 IN 4006

+15 VDC (SHT.1, D2)

CR11 IN 4006

CR12 IN 4006

J4-10

J3-1

MAIN CONTRACTOR POWER

R13 100Ω

C10 .33uF

K1 PK-56-12

CR5 IN 4006

J3-3

CR6 IN 4006

SOLENOID

K1 PK-56-12

J3-2

INRUSH RELAY POWER

R14 100Ω

C11 .47uF

1 14 2

7 8 6

K1 PRMA1A12B

J3-4

J2-4 MAIN CONTRACTOR CONTROL

J2-5 INRUSH RELAY CONTROL

CR7 IN 4006

K1 PK-56-12

R15 1K 1/2W

J2-6 DC PUMP & SOLENOID CONTROL

J3-7

INTERLOCK SENSE

J2-3 INTERLOCK SENSE

24VAC CNTR. TP (SHT.1, D4)

DC PUMP 5002DV

M1 NML0505S

GND Vin DV +V

1 2 3 4

J2-2 +15VDC

R16 220 1/4W

C14 0.1uF 50V

C13 22uF 25V

J2-8 -15V

DC RETURN (SHT.1, C1)

AUTOCAD DRAWING.
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY DRAWING
AND MAY NOT BE FILLED IN.

MTL:

FIN:

TOL:
.X = ± .02"
.XX = ± .01"
.XXX = ± .005"
FRAC. = ± 1/64"
ANGLES = ± 1/2"

P/L: 489

SCALE:

REL. TO MFG.
PRJ. ENG. DATE:
MFG: DATE:
DOC. REL. DATE:
DO NOT SCALE DWG.

ENG. CTL.
DWN: DATE: SEE SHT 1
CHK: DATE:
ENG: DATE:
APP: DATE:

LAMBDA EMI

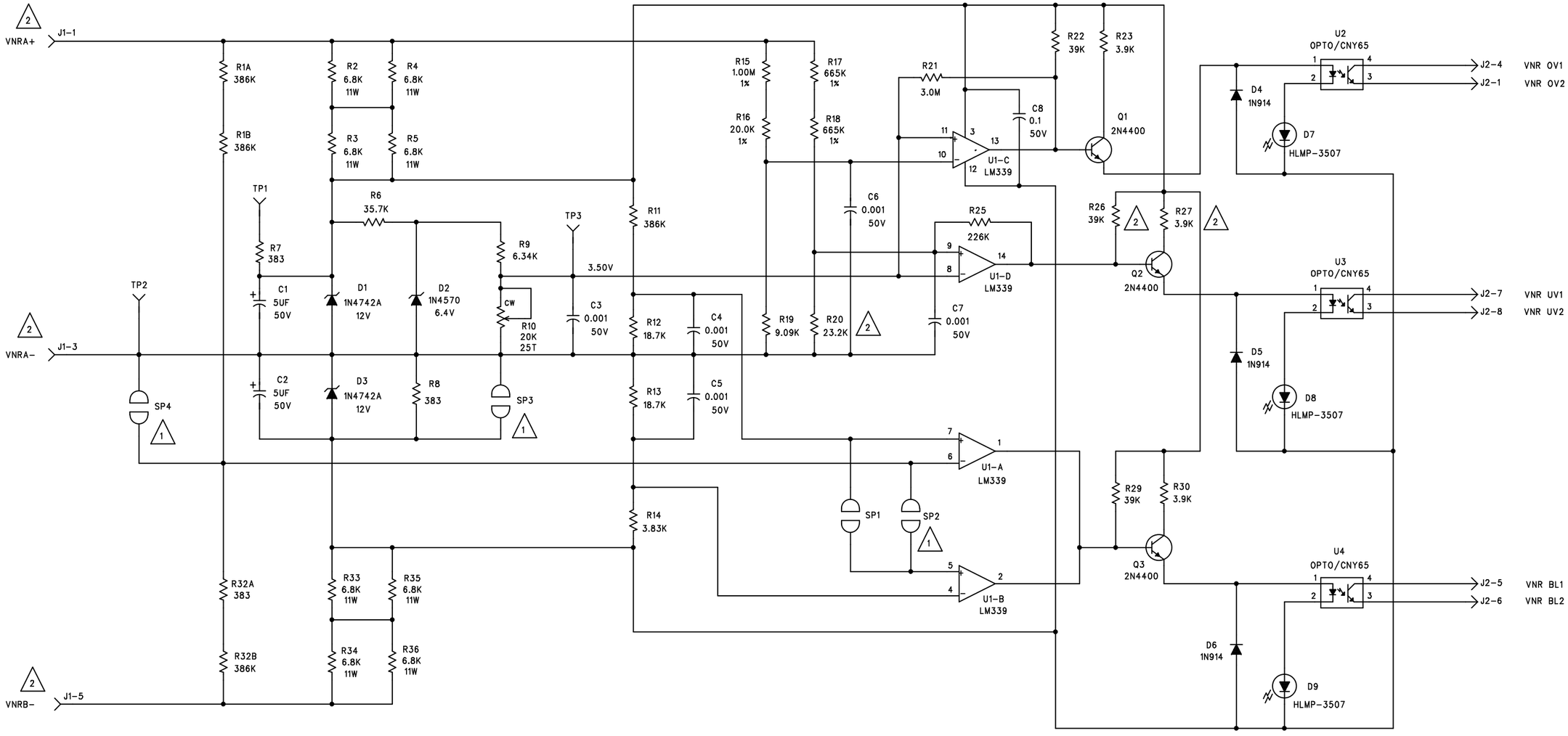
TITLE: LOW VOLTAGE POWER SUPPLY SCHEMATIC

DWG. NO. 001-0015

REV. E

APPLICATIONS		
USED ON	NEXT ASSY	QTY
203	SENSE BD	REF
303	SENSE BD	REF

REVISIONS			
LTR	DESCRIPTION	BY/DATE	APP/DATE
00	RELEASED PER ECO # 477	11/91	WJW
A	TG3 RELEASED	12/19/94	WJW
B	REDRAWN-NO CHANGES	LPN 6/19/97	WJW



1 DENOTES SP2 CLOSED; SP1, SP3, SP4 OPEN.

2 DENOTES PINS 2, 4 AND 7 OF J1 ARE REMOVED FROM THE CONNECTOR.

NOTES:

1. UNLESS SPECIFIED, ALL RESISTORS ARE IN OHMS.
   ALL CAPACITORS ARE IN MICROFARADS.
   K = 1,000 AND M = 1,000,000.

TOLERANCES: .X = +/- .02, .XX = +/- .01, .XXX = +/- .005, FRAC = +/- 1/64, ANGLES = +/- 1/2	RELEASE TO MFG	ENG CONTROL	ELECTRONIC MEASUREMENTS INC.
	PRJ.MGR: DATE:	DWN: D.S. DATE: 3/29/88	TITLE: SCHEMATIC, SENSE BOARD
	MFG: DATE:	CHK: D.S. DATE: 11/91	WAS 001-014
P/L: 489	DOC.REL: WJW DATE: 6/19/97	ENG: S.AHMED DATE: 11/16/95	SHEET/FILE NAME: SHEET 1 OF 1
SCALE:	CHK: DATE:	APP: WJW DATE: 11/10/95	DRAWING NO: 01-000-602 REV: B