

INSTRUCTION MANUAL FOR
500A/102A/152A/202A
POWER SUPPLY

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ONE YEAR WARRANTY

TDK-Lambda Americas, Inc. (405 Essex Road, Neptune, N.J. 07753), warrants that the unit is free from defects in material or workmanship for a period of ONE YEAR from the date of initial shipment. TDK-Lambda Americas Inc. will service and, at its option, repair or replace parts which prove to be defective. This will be done free of charge during the stated warranty period. This warranty excludes defects resulting from misuse, unauthorized modification, operation outside the environmental or safety specifications of the power supply, or improper site preparation or maintenance. The customer shall contact TDK-Lambda Americas Inc., for warranty service or repair as described in the RETURNING EQUIPMENT section. The customer shall prepay shipping charges. If the unit is covered under the foregoing warranty, then TDK-Lambda Americas Inc. shall pay the return shipping charges.

The "WARRANTY", "CLAIM FOR DAMAGE IN SHIPMENT", and "RETURNING EQUIPMENT" information applies to equipment purchased directly from TDK-Lambda Americas Inc. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

THIS LIMITED WARRANTY IS IN LIEU OF, AND TDK-LAMBDA AMERICAS INC. DISCLAIMS AND EXCLUDES, ALL OTHER WARRANTIES, STATUTORY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OF CONFORMITY TO MODELS OR SAMPLES.

CERTIFICATION

All test and measuring equipment used by TDK-Lambda Americas Inc. for Final Acceptance Testing are traceable to primary standards certified by the National Institute of Standards and Technology.



LETHAL VOLTAGES PRESENT!



All 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.

1. Before connecting input AC power, ensure all covers are in place and securely fastened. Ensure the required safety ground to chassis is installed and sufficient cooling is supplied.
2. Proper grounding from the input AC power is required to reduce the risk of electric shock, and to comply with safety agency and code requirements.
3. Use extreme caution when connecting input AC power. Only apply the input voltage specified on the rating label.
4. Use extreme caution when connecting any high voltage cables. Never handle any output cables when the power supply is operating.
5. After a power supply is switched OFF, its output section will retain a charge which may be lethal. Allow sufficient time for self-discharge before handling anything connected to the output. The discharge time specified in the Safety Notes does *NOT* include extra time required to discharge the energy stored in the user's load.
6. When user serviceable fuses are present, always replace fuses with the same type and Volt/Amp rating.
7. Never attempt to operate the power supply in any manner not described in this manual.
8. Never remove DANGER or WARNING labels from the power supply. Replace lost or damaged labels immediately. Contact TDK-Lambda Americas Customer Service for replacement labels.
9. The power supply may be serviced only by TDK-Lambda Americas Inc. factory qualified service personnel. Breaking the warranty seal will void the warranty. Prior to opening the power supply, contact TDK-Lambda Americas Inc. Customer Service for a written Service Waiver and a replacement warranty seal.

TDK-Lambda

MANUFACTURER'S PRODUCT DECLARATION

INTENDED PURPOSE (USE)

The Power Supplies described by this manual are defined by TDK-Lambda Americas Inc. as a component for use in the composition of an apparatus as defined in Article 1 (1) of the EMC Directive (89/336/EEC). These products, as individual components, do not perform in themselves a direct function for the user of the end product. They are not intended to be placed on the market with a direct function to a final user! As such, the products described by this manual are not subject to the provisions of the EMC Directive (89/336/EEC, with amendment 92/31/EEC).

The products described by this manual are intended for incorporation into a final product by a professional assembler. It is the responsibility of the assembler to ensure that the final apparatus or system incorporating our products complies with all relevant EMC standards for that final product.

OPERATING ENVIRONMENT

The operating environment as defined by TDK-Lambda Americas Inc., for the products described by this manual is stated as follows:

The Power Supplies described by this manual are intended for use in a protected industrial environment or in proximity to industrial power installations. These locations are often referred to as industrial locations containing establishments that are not connected to the low voltage public mains network.

Industrial locations are characterized by the existence of one or more of the following conditions:

- 1) industrial, scientific and medical (ISM) apparatus are present;
- 2) heavy inductive or capacitive loads are frequently switched;
- 3) currents and associated magnetic fields are high;
- 4) location supplied by their own transformer.

These components are not intended for connection to a public mains network, but are intended to be connected to a power network supplied from a high or medium-voltage transformer dedicated for the supply of an installation feeding manufacturing or similar operations. They are suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

TDK-Lambda

Description of symbols used in product labeling

SYMBOL	PUBLICATION	DESCRIPTION
	EC Council Directive 93/68/EEC	European Community Conformity Assessment Product Mark
	IEC 348	Attention, consult Accompanying documents
	IEC 60417-1-5036	Dangerous voltage
	IEC 60417-1-5019	Protective earth (e.g. power line earth ground)
	IEC 60417-1-5017	Functional earth (e.g. chassis ground)
	IEC 60417-1-5134	Electrostatic Discharge (ESD) Sensitive Device

ELECTRICAL STANDARDS

All company primary standards are either certified or are traceable to certification by the National Institute of Standards and Technology.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspection before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals damage in any way, a claim should be filed with the carrier. A full report of damage should be obtained by the claim agent and this report should be forwarded to us. We will then provide a disposition of the equipment and arrange for repair or replacement.

When referring to this equipment, always include the model and serial numbers.

The “WARRANTY”, “CLAIM FOR DAMAGE IN SHIPMENT”, and “RETURNING EQUIPMENT” information applies to equipment purchased directly from TDK-Lambda Americas Inc. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps shall be taken.

1. Notify TDK-Lambda Americas Inc. at 732-918-6888 or follow the instructions at www.US.TDK-Lambda.com/HP/service.htm. Give a full description of the difficulty including the model and serial number of the unit in question. Upon receipt of this information, we will assign a Return Material Authorization (RMA) number and provide shipping instructions.
2. The customer shall prepay shipping charges. Equipment returned to us must be packed in a manner to reach us without damage. The shipping container must be marked with the RMA number in an area approximate to the shipping label with numbers that are easy to read. All returned units that do not show the RMA number on the outside of the container will be refused.
If the equipment is repaired within the warranty agreement, than TDK-Lambda Americas Inc. shall pay for the return shipping to the customer.
3. For non-warranty repairs, we will submit a cost estimate for your approval prior to proceeding. The customer shall pay return shipping charges.

MECHANICAL INSTALLATION

Most power supplies are heavy and, when rack mounted, they should be supported by rails along the sides of the supply from front to rear. The rails must adequately support the unit and not block airflow. Do not support the power supply from the front panel only.

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CHAPTER 1 INTRODUCTION

1.1 DESCRIPTION

The Series 500A/102A/152A/202A are High Voltage Switching Power Supplies designed specifically for charging capacitors in laser systems and other pulsed power applications. The 500A provides 500 J/s, the 102A is 1000 J/s, 152A is 1,500 J/s, and the 202A provides 2000 J/s of average power and can be paralleled indefinitely for higher total system power. TDK-Lambda Americas Inc. also offers the 402 Series, 802 Series, and 303 Series rated at 4,000, 8,000 and 30,000 J/s respectively.

The 500A/102A/152A/202A power supplies incorporate a new high-frequency IGBT parallel resonant inverter topology for efficient generation of the output power. A high-performance control module precisely regulates the output voltage, automatically compensating for line, load, temperature, and rep rate variations. Normal external fault conditions such as line dropout open or short circuit load, HV arc and over-temperature will not damage the unit. The latest development in the parallel resonant inverter topology and control circuitry also drastically improves pulse-to-pulse repeatability by reducing the ripple or “bucket effect” even at very high pulse repetition frequencies. The output voltages of the 500A/102A/152A/202A supplies are fully adjustable over each range.

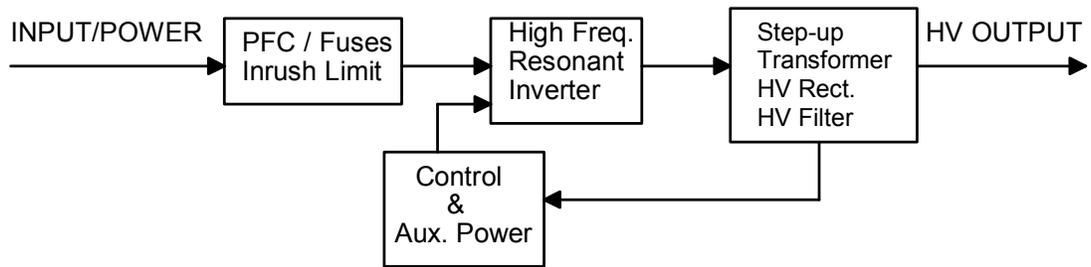


Figure 1-1 500A/102A/152A/202A Block Diagram

CHAPTER 2 SPECIFICATIONS

2.1 AVERAGE CHARGING RATE

500J/s, 1000J/s, 1500J/s, 2000J/s at rated Output Voltage

2.2 PEAK CHARGING RATE

550J/s, 1100J/s, 1650J/s, 2200J/s at rated Output Voltage

2.3 NUMBER OF MODELS IN SERIES

12 Standard (others at extra cost)

2.4 STANDARD VOLTAGE RANGES

1kV, 1.5kV, 2kV, 3kV, 4kV, 5kV, 5kV, 10kV, 15kV, 20kV, 30kV and 40kV. All models continuously variable from 0 to 100% of rated output voltage.

2.4.1 LINEARITY

Linear to within 1% of full scale.

2.4.2 ACCURACY

1% of rated.

2.5 POLARITY

Available as fixed Positive or Negative

2.6 HIGH VOLTAGE ASSEMBLY

Insulating Medium/Cable

Voltage	Medium	Output Cable
1kV to 6kV	Air	Coax. RG58
10kV to 40kV	Oil	12 AWG, HV Silicon

Table 2-1: High Voltage Cable

2.7 INPUT CONNECTOR

VDE, UL approved.

2.8 INPUT CHART

Input Voltage selective by Terminal block position

Input Voltage (VAC)		Current (No PFC)			Current (PFC)			
Nameplate Range	Design Range	500A	102A	152A	500A	102A	152A	202A
230 50/60Hz	180-253 50/60Hz	5A	10A	14.5A	3.5A	6.6A	10A	13.5
115 50/60Hz	90-140 50/60Hz	10A	20A	30A	7A	–	–	–

*Note: Input current ratings given are maximum when output Repetition Rate is =>10Hz Consult Factory if model used at less than 10Hz.

Table 2-2: Input Voltage Chart

2.9 POWER FACTOR

	Non PFC	PFC
All models	0.65	0.98

Table 2-3 Power Factor

2.10 EFFICIENCY

Better than 85%

2.11 STORED ENERGY

Less than 0.3 Joules all models

2.12 STABILITY

0.2% TO 300 Hz. For higher repetition rates, consult factory

2.13 PULSE TO PULSE REPEATABILITY

±0.2% TO 300 Hz. For higher repetition rates, consult factory

2.14 TEMPERATURE COEFFICIENT

100ppm per °C

2.15 AMBIENT TEMPERATURE

Storage -40 to +85°C. Operating -20 to +45°C

2.16 HUMIDITY

90%, non-condensing

2.17 PROTECTION

The power supply is protected against Open Circuits, Short Circuits, Overloads and Arcs

2.18 AGENCY APPROVALS

500A/102A/152A are approved to UL 60601-1 and IEC 60601-1, Class I. 202A pending approvals.

2.19 TRANSIENT LINE PROTECTION

Meets requirements of IEC 801-4, 801-5

2.20 ESD

All Remote Control Functions meet requirements of IEC 801-2

2.21 NOTE FOR PFC UNITS

When High Voltage is enabled by using either the "HV Enable" Line or deactivation of the "Inhibit" Line the power supply will reach normal operation mode (and therefore all other published specifications) within 50 ms.

2.22 ACCESSORIES

- Detachable 8 feet (2.4 meters) HV Cable (see Table 2.1)
- 15 pin “D” plug mating control connector
- Operating Manual

2.23 OPTIONS

2.23.1 Suffix –SYS

Parallel Operation

2.23.2 Suffix –LH

“Low Inhibit” - A +10 to 15 volt (high) signal will allow power supply operation. A 0 to +1.5 volt (low) signal will inhibit the supply.

2.23.3 SUFFIX –EN

“Low Enable” - A +10 to 15 volt (high) signal will disable power supply operation. A 0 to +1.5 volt (low) signal will enable the supply.

2.23.4 Suffix -5V

0 to +5 volt voltage (0 to full-scale output) programming.

2.23.5 Suffix –LP

Latching overload protection.

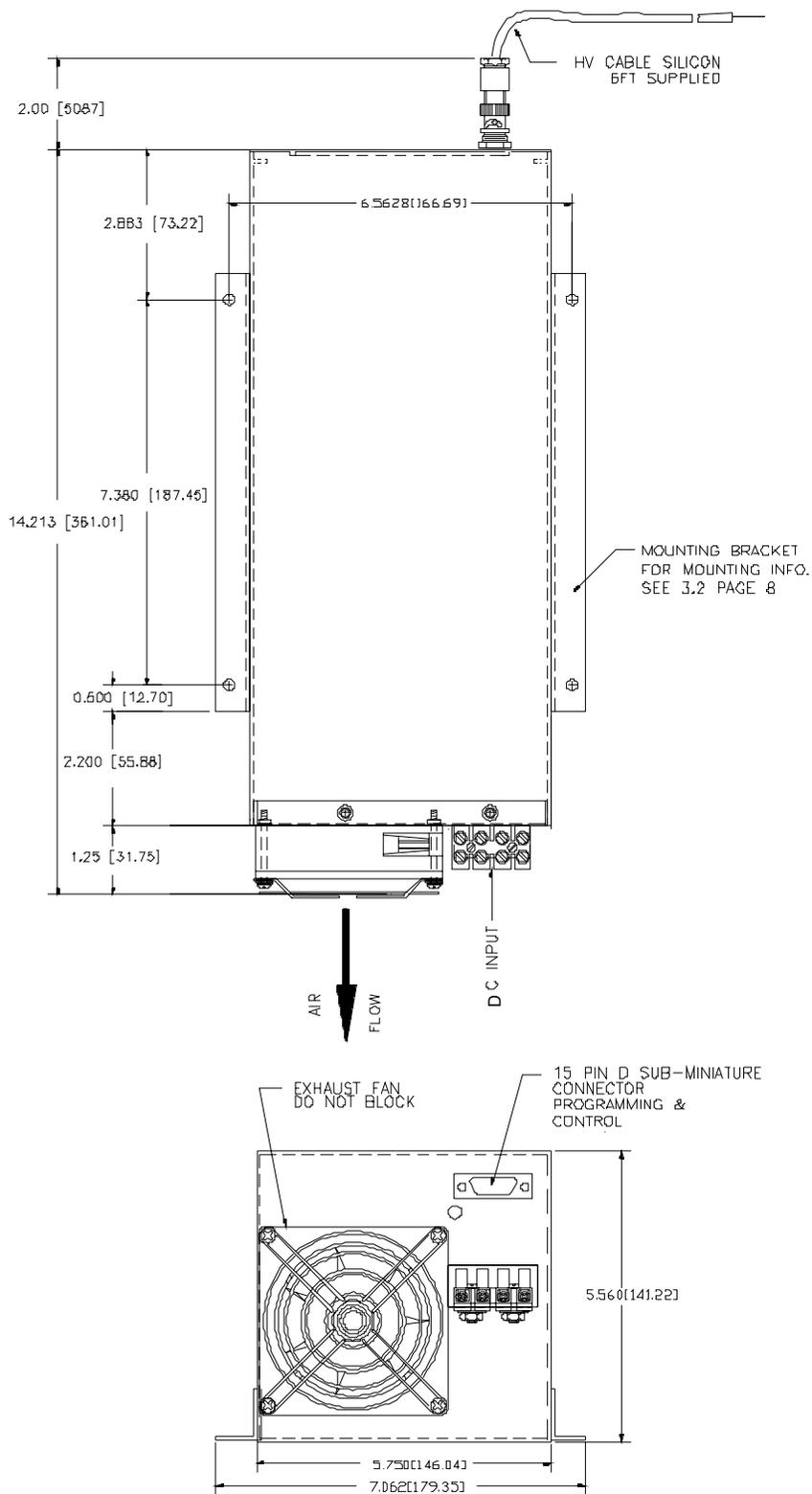
2.23.6 SUFFIX -110

100 to 120 VAC input option for power factor corrected 102A, 152A (1500 J/s) model.

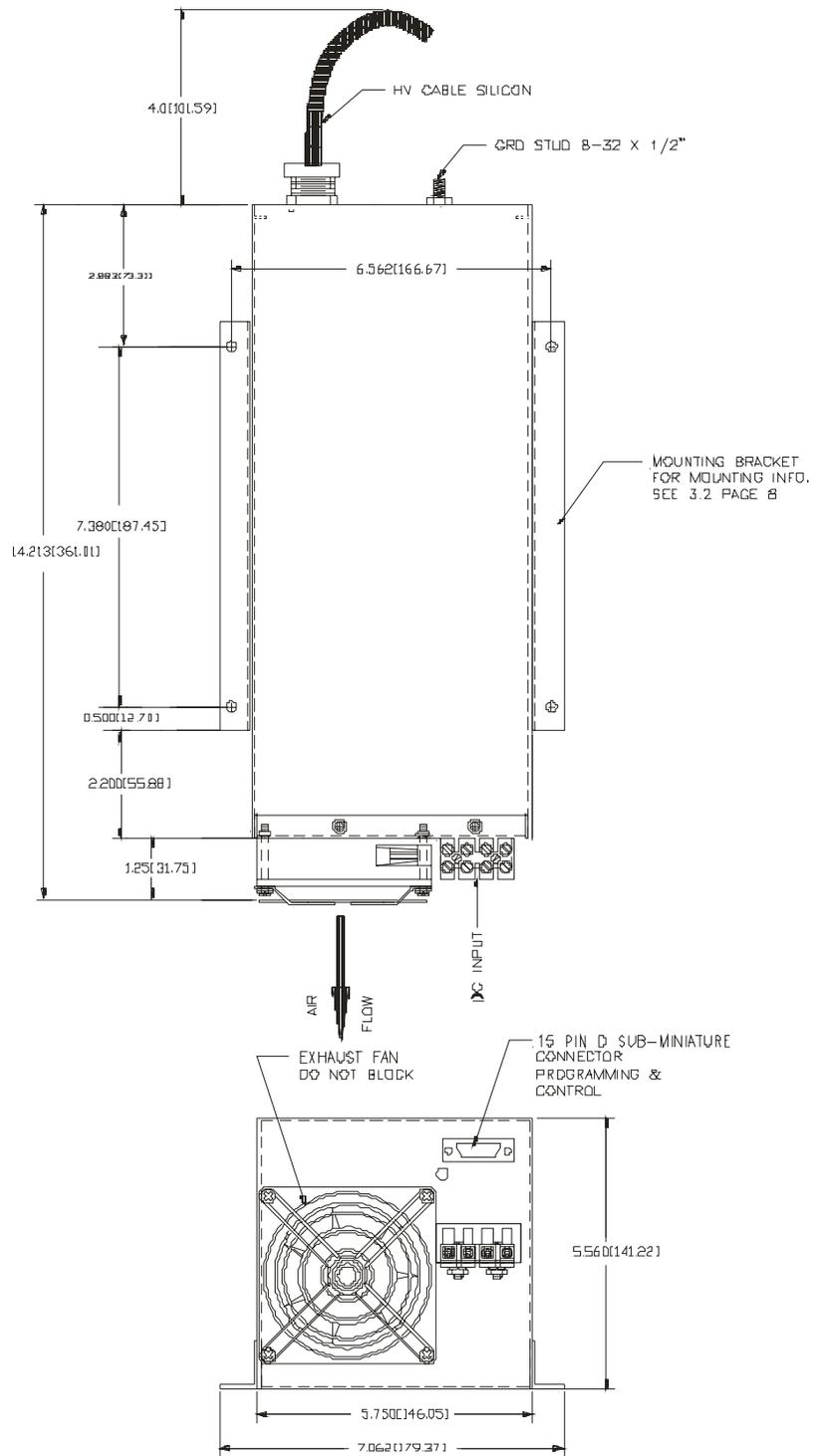
<p>NOTE: 102A, 152A power supply with suffix 110 at 100-120VAC must be operated with internal 20A fuses F1 & F2 (on inverter board) replaced by copper bus provided with the supply. Use external 30A UL/VDC approved fuse/circuit breaker.</p>

2.24 ORIENTATION

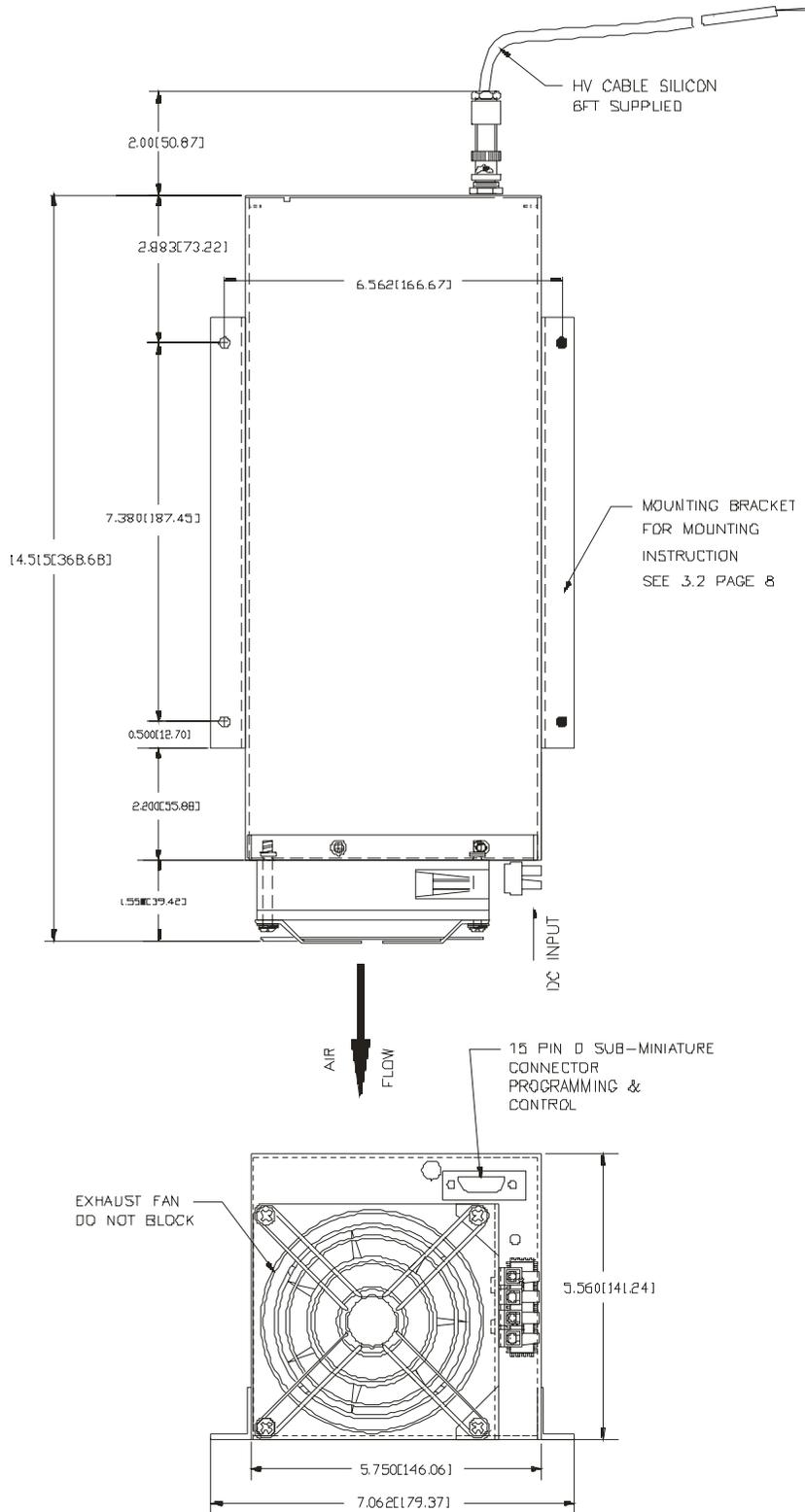
Power supplies >6kV with Oil H.V. section must be operated in an upright position. i.e., with the mounting bracket parallel to the ground plane.



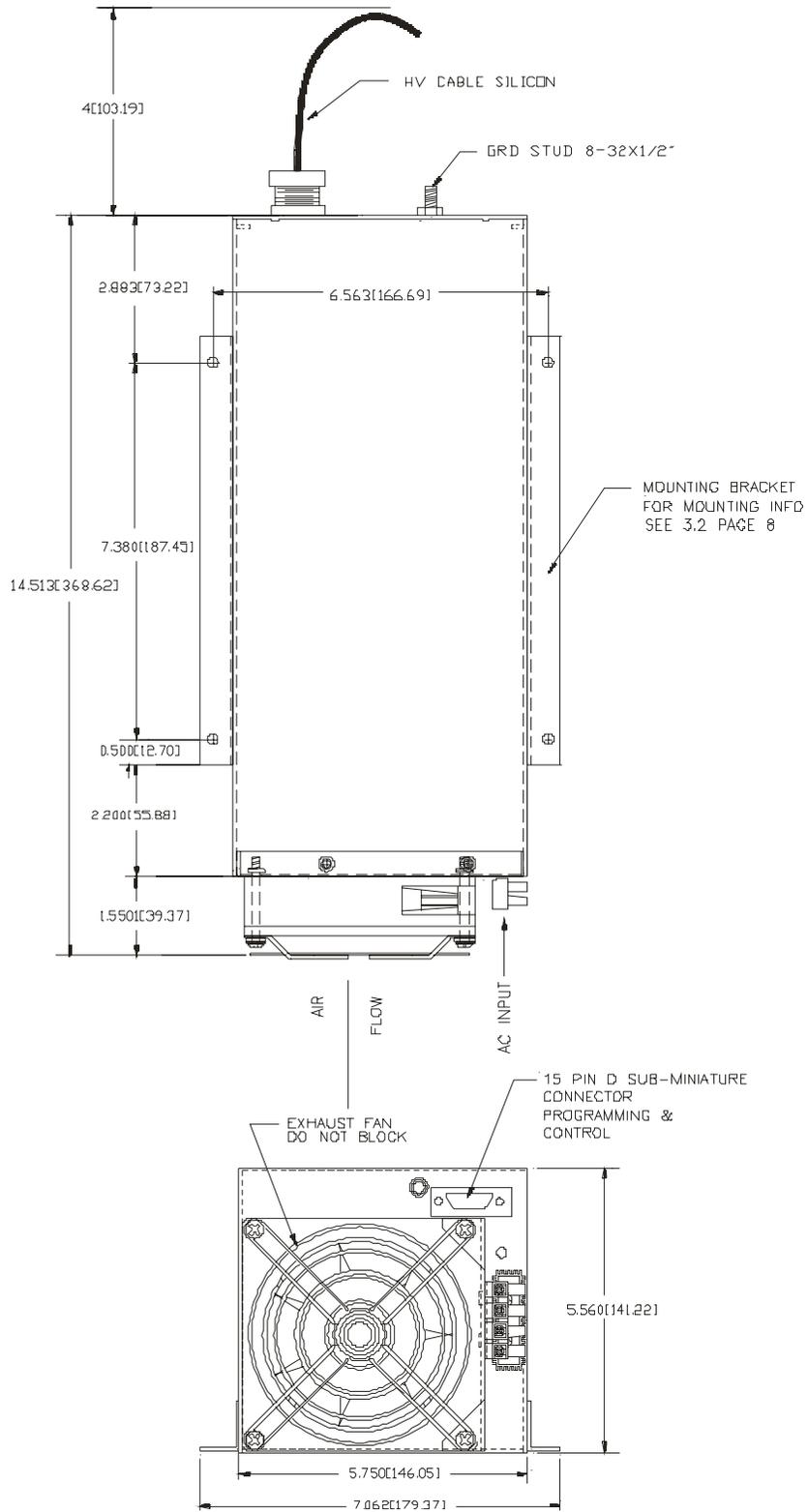
**Figure 2-1 Mechanical Dimensions for 500A, 102A, 152A Outputs up to 6KV
(for grounding instructions see SECTION 3.6)**



**Figure 2-2 Mechanical Dimensions for 500A, 102A, 152A Outputs from 7KV to 40KV
(for grounding instructions see SECTION 3.6)**



**Figure 2-3 Mechanical Dimensions for 202A Outputs up to 6KV
(for grounding instructions see SECTION 3.6)**



**Figure 2-4 Mechanical Dimensions for 202A Outputs from 7KV to 40KV
(for grounding instruction see SECTION 3.6)**

CHAPTER 3 INSTALLATION

3.1 INITIAL INSPECTION

The shipping container should contain the following items: power supply, HV output cable, male 15-pin “D” remote control connector 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 the TDK-Lambda Americas Inc. Customer Service Department.



3.2 MOUNTING AND COOLING REQUIREMENTS

The power supply can be mounted by the chassis support brackets (see Figure 2-1, 2-2, 2-3 and 2-4 for details). The mounting brackets are attached to the supply. The supply must be mounted using four PHMS 8-32NC X 0.250 screws. Using wrong (longer) screws may short HV parts to ground, causing permanent damage to power supply. The power supply can also operate on a bench or table top. Power supplies >6kV with Oil H.V. section must be operated in upright position i.e. mounting bracket parallel to ground plane. In all cases adequate clearances must be provided for proper air flow and cable bends. Keep the minimum HV cable bend radius greater than 4 inches (101.6mm) to minimize stress on the insulation. Generally, at least 4 inches (101.6mm) of clearance should be allowed at the inlet of the power supply and 2 inches (50.8mm) 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 45°C. This often requires addition of a system heat exchanger.

3.3 INPUT AC POWER

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 earthing wire at the input AC power terminal block. A protective ground connection by way of the grounding conductor in the input terminal is essential for safe operation. Use extreme caution when connecting input AC power and never apply the incorrect input power. (Figure 2-1, 2-2, 2-3 & 2-4).

The PFC version and version without PFC should be connected as explained in the following 2 paragraphs.

A.. Version with no PFC.

For this version, the supply can be connected to either 115VAC for 230VAC input voltage (See table 2.2). These connections are shown in Figure 3-1.

For 115VAC connect the input line wires to L1 and COM terminals.

For 230VAC connect the input wires to L2 and COM terminals.

B. Version with PFC.

The PFC version connection is shown in Figure 3-2. Connect the input voltage line wires to L2 and COM terminals.

WARNING: 102A, 152A AND 202A PFC Models are only available with 220 VAC Nominal. For 152A Models Suffix 110 at 110-120 VAC must be operated with the internal fuses F1 and F2 (on the Inverter Board) replaced by copper bus provided with the supply. Use external 30A UL/VDC Approved Fuse/Circuit Breaker.

NOTE: For Application at less than 10 Hz, please see section 5.7.

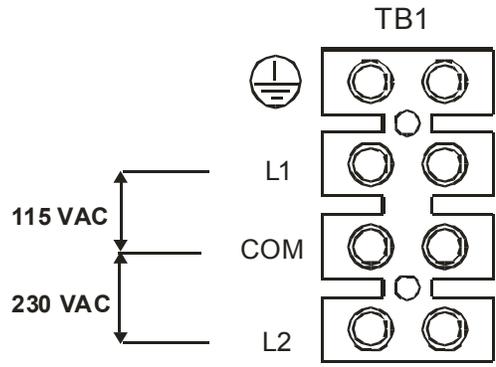


Figure 3-1 Input AC Power Connection NON-PFC Version

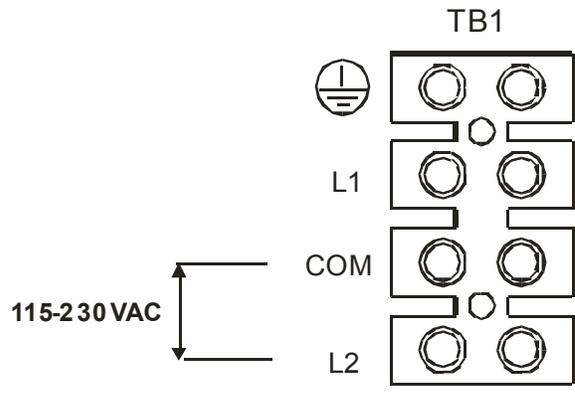


Figure 3-2 Input AC Power Connection, PFC Version

3.4 POWER CORD SPECIFICATION:

Use wire with minimum .064 inches (1.6mm) diameter and 600 V insulation.

3.5 CONNECTING HIGH VOLTAGE OUTPUT

POTENTIAL LETHAL VOLTAGE



Ensure that the power supply is off and disconnected from the input power and never operate the power supply without a load capacitor. Make sure that all load capacitors are discharged and shorted to ground before making any connections. TDK-Lambda Americas Inc. recommends the use of safety dump switches in high voltage discharge circuits.

Never handle the HV cable during operation.

This power supply is designed to operate with a capacitive load. Operation of the power supply without an external load capacitor may result in damage to internal circuitry.

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

NOTE: When operating above 20kV and/or 200 Hz rep. rate, ensure that silicone grease (such as Dow Corning DC-4) is applied to the HV cable before insertion into the HV connector. This displaces the air in the connector and reduces long term corona effect.

Keep the minimum HV cable bend radius greater than 4 inches (101.6mm) 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 under damped 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. The currents developed with voltage reversal at high rep. rates, could damage the power supply. A resistor in series with the HV output can be added to limit this current to an acceptable level. Refer to Section 5.2, Page 16 for more information.

The oil-filled HV assembly should not be opened. The oil and components have been specially cleaned and vacuum impregnated at the factory and the assembly hermetically sealed. Opening the assembly will compromise performance and void the warranty. Tanks must only be serviced at TDK-Lambda Americas Inc.

3.6 GROUNDING THE PRODUCT

3.6.1 GROUNDING OF INPUT LINE

The supply is grounded through the ground terminal of the input connector. A protective ground connection by the way of the grounding conductor in the input terminal is essential for safe operation.

3.6.2 OUTPUT GROUND CONNECTION

It is important that there be a ground connecting the supply to the load as shown in Figure 3-3.

See Figure 2-1 and 2-2, for grounding cable configuration.

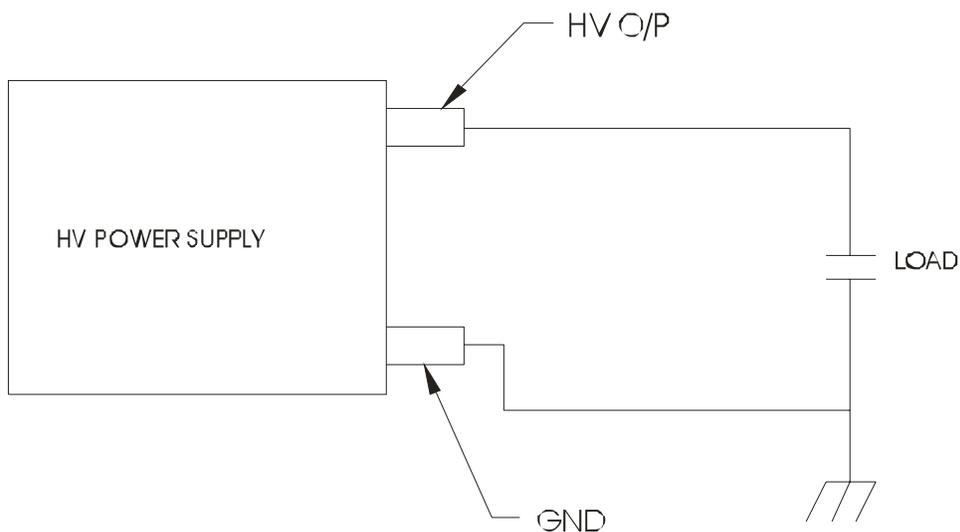


Figure 3-3 Output Ground Connection

3.6.3 FOR UNITS WITH O/P VOLTAGE $\leq 6\text{kV}$

The ground connection is made via the shield of the RG58 coaxial HV output cable provided with the supply.

3.6.4 FOR UNITS WITH O/P VOLTAGE $> 6\text{kV}$:

The ground connection between the load and the supply must be made with a separate wire to the 8-32, $\frac{1}{2}$ " NC long grounding stud provided on the supply.

CHAPTER 4 OPERATION

4.1 REMOTE CONTROL

The Series 500A/102A/152A/202A is easily controlled through the remote connector on the input panel of the unit. Only the ENABLE/RESET, V PROGRAM and GND signals are required for operation. The remaining signals are provided for status monitoring and fault diagnosis. A schematic diagram showing the suggested interface circuit is shown in Figure 4-1. This table is for a standard configuration.

PIN	SIGNAL NAME	I/O	DESCRIPTION
1	ENABLE/RESET	INPUT	A high signal (+10 to 15V) with respect to ground (pin 14) will enable the power supply. Latching faults can be cleared by cycling this switch. Ground or open disables the supply.
5	V PROGRAM	INPUT	A 0-10V signal with respect to ground at this pin programs the output voltage proportionally from zero to rated output.
7	VPEAK	OUTPUT	A 0-10V signal with respect to ground proportional to the peak of the output charging voltage. Can be used to drive a meter displaying peak output voltage.
8	V ANALOG	OUTPUT	0-10V analog of output charging voltage waveform.
10	INHIBIT	INPUT	A +10 TO 15V with respect to ground, disables the unit. Open or ground allows operation. This input can be used to disable charging during HV switch recovery.
9, 11	+15V	OUTPUT	15V regulated. Can be used or user programming applications 20mA max.
14	GND	OUTPUT	Control circuit return. Also chassis/earth ground
15	INHIBIT LED	OUTPUT	Open collector. Indicates that the power supply is receiving an INHIBIT signal.
13	EOC LED	OUTPUT	Open collector. Indicates that the power supply is reaching end-of-charge, i.e. the V PROGRAM set point.
3, 6	SUMMARY FAULT LED	OUTPUT	Open collector. Indicates an output overvoltage. Temperature fault or low input voltage condition.
2	LOAD FAULT	OUTPUT	Indicates a shorted O/P or a very large load capacitor.

Table 4-1 Control Interface Connection for Standard 500A/102A/152A/202A Series

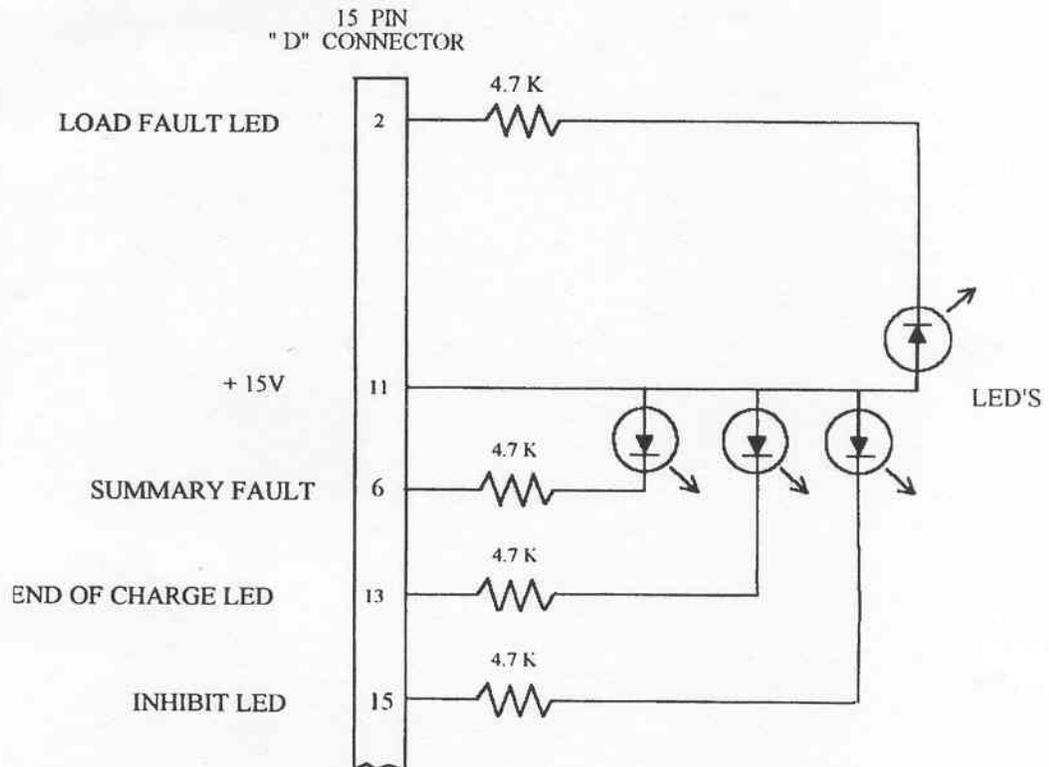
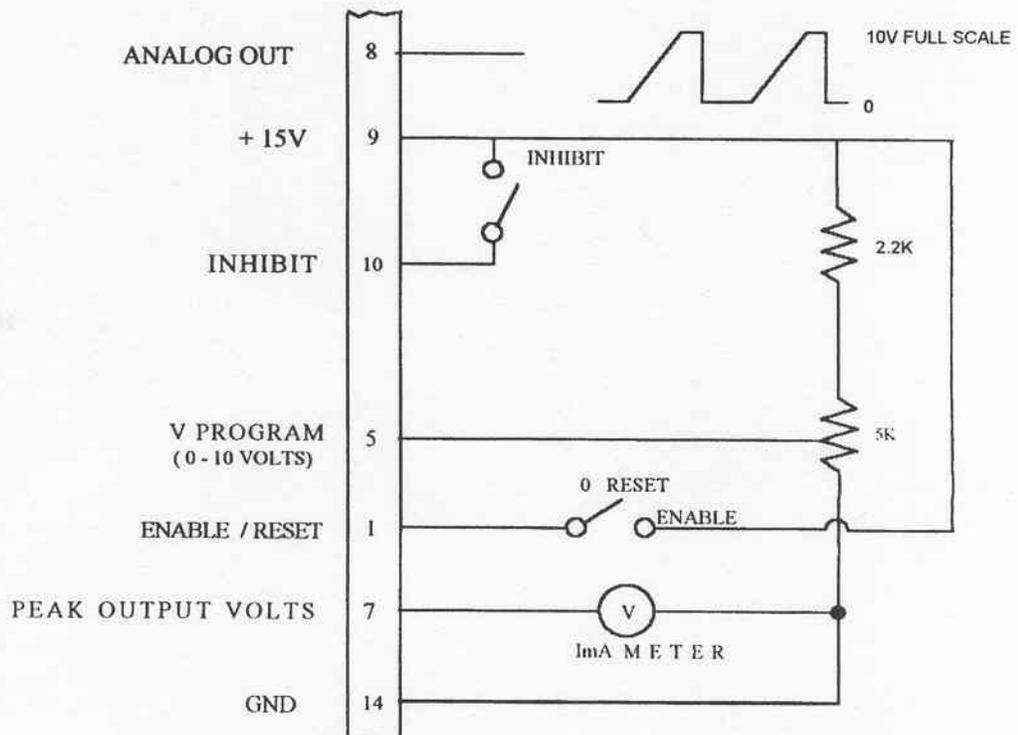
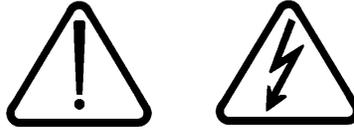


Figure 4-1 Example of Interface Connection

4.2 INITIAL CHECK-OUT PROCEDURE



LETHAL VOLTAGES PRESENT

ONLY QUALIFIED PERSONNEL TRAINED IN THE SAFETY ASPECTS OF HIGH VOLTAGE SHOULD PERFORM INITIAL CHECKOUT PROCEDURES.

The power supply should have no visible damage or defects and the cover should be securely fastened. Properly connect the input power (Section 3.5), control connector (Sec. 4.1) and HV output (Sec. 3.5, and 3.6).

If there is no load connected, the power supply will regulate the output voltage to the programmed voltage level or sense an open circuit and immediately shut down indicating a 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, allowing HV switch to latch-up. It can also occur if 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 VPROGRAM at zero volts, turn the power supply on in the following sequence:

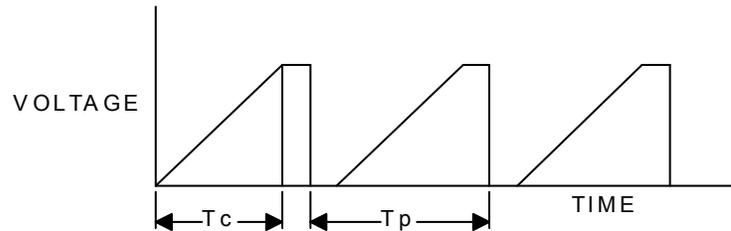
1. Connect power supply to the HV load.
2. Increase load rep. rate to prevent a full charge.
3. VPROGRAM signal (pin 5) at zero volts.
4. ENABLE/RESET signal (pin 1) at zero volts.
5. Assert ENABLE/RESET signal to 15V.
6. Verify HV output is at approx. zero volts.
7. Increase HV (by increasing VPROGRAM voltage) output slowly and verify adjustability.
8. Decrease load rep rate to allow full charge.

CHAPTER 5 APPLICATIONS

For clarification and further technical assistance specific to your applications, please contact TDK-Lambda Americas Inc.

5.1 DETERMINING CAPACITOR CHARGE TIME

The ratings of these supplies are as follows: 500A – 500 J/s, 102A – 1000 J/s, 152A – 1500J/s, 202A-2000J/s average charge rate. Although the measure of Joules/sec equates to Watts, Stored Energy per unit time is more convenient when working with energy storage capacitors. The peak charge rate determines the capacitor charge time. The average charge rate determines the total power delivered from the power supply. It is possible to charge a capacitor at 1650 J/sec, but to discharge it at a low rep. rate producing an average of 100 J/sec. The following formulas can be used to determine the average and peak charge rate.



$$\text{Peak Charge Rate} = \frac{\frac{1}{2}CV^2}{T_C}$$

C - OUTPUT LOAD CAPACITOR
V - PROGRAMMED OUTPUT VOLTAGE

$$\text{Average Charge Rate} = \frac{\frac{1}{2}CV^2}{T_P}$$

T_C and T_P are shown in figure

Figure 5-1 Output Voltage Waveform

5.2 VOLTAGE REVERSAL

When the capacitor or PFN is discharged, a high peak current may flow out of the power supply as a result of voltage reversal. This occurs in a system which is underdamped in order to clear the high voltage switch after each pulse. The average value of this peak current added to the normal output current may exceed the rating of the HV diodes in the power supply. This current can be measured with a current transformer as shown in Figure 5.2.

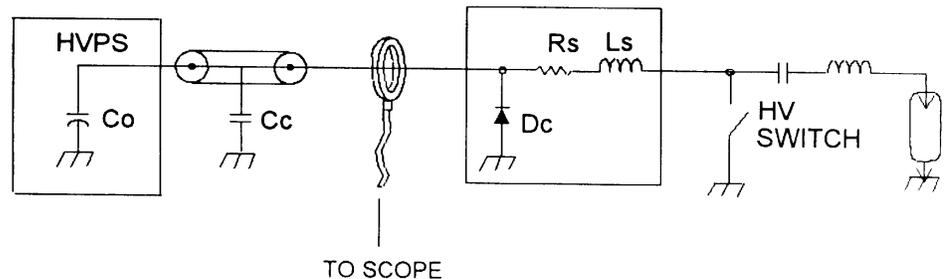


Figure 5-2 Output Current Measurement

A series terminating resistor (or series inductor or clamp diode) must be added as shown if the average value of the peak current exceeds 110% of the normal output current.

When choosing R_s , ensure it can withstand the full output voltage across it as well as the power dissipation caused by discharging C_o (see Table 5.1) and C_c (20pF/ft) (65.62 pf/m) each cycle as well as conducting the normal output current. It's power dissipation can be calculated as $P_d = (I_o^2 R_s) + \frac{1}{2} (C_o + C_c) V^2 (\text{REP RATE})$.

Output Voltage	C_o
1-2.8kV	60nF
3kV-6kV	15nF
10-30kV	460pF
40kV	230pF

Table 5-1 Output Capacitance

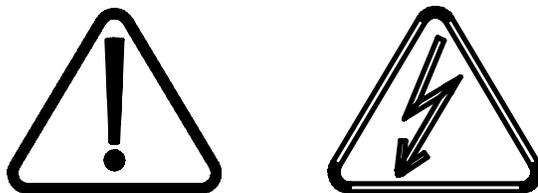
5.3 PARALLELING UNITS

The 500A/102A/152A/202A power supplies are designed for simple parallel operation. The input power and HV output should be connected directly together. The REMOTE connectors on the input panel can also be connected directly together using a “daisy chain” ribbon cable from the system controller. Each of the power supplies operate at the same time with the total charge rate equal to the sum of each.

Sometimes when operating several units in parallel, the high total power generates noise which interferes with the power supply control. This is usually due to the many interconnecting control cables acting as an antenna picking up noise. The problem usually appears as one or more of the power supplies shuts down when the output voltage increases beyond a certain level. Dressing the control cables as short as possible and close to ground or using shielded cables should help. In severe cases, it is necessary to wrap the cables several times through high permeability ferrite cores at the input panel of each unit.

The 500A/102A/152A/202A power supplies can also be used as an Isolated High Voltage continuous DC power source by adding an external filter capacitor. The value of the filter capacitor depends upon the value of the allowable output voltage ripple value. For parallel operation into DC loads, please contact TDK-Lambda Americas Inc. Customer Service Department. (See Section 5.6).

5.4 MEASURING HIGH VOLTAGES



WARNING: EXTREME CAUTION MUST ALWAYS BE EXERCISED WHEN TAKING ANY HIGH VOLTAGE MEASUREMENTS. IT SHOULD BE DONE ONLY BY QUALIFIED PERSONNEL WHO ARE TRAINED IN THE SAFETY ASPECTS OF WORKING WITH HIGH VOLTAGE.

A sample of the output voltage is available in the REMOTE connector. If it is desired to measure the HV output externally, care must be taken to understand the accuracy of the measurement.

When making a DC measurement, such as when the power supply is holding voltage on a capacitor, any HV probe and DVM combination can be used. The Fluke 80K-40 probe with any 10M input resistance DVM is adequate up to 40kV. Building a simple resistor divider using appropriate HV resistors is also very straightforward. Keep in mind that all HV resistors, including the one in the Fluke probe, exhibit a negative voltage coefficient, changing by up to 4% from zero to max. voltage. Derating the resistors and calibrating at the operating point solves this problem.

The value of the resistor R1 and R2 (Figure 5.3) can be calculated as follows:

$$V_M = \frac{R_2}{R_1 + R_2} \times V_O$$

where V_O is the High Voltage being measured.

Making a pulsed measurement with an oscilloscope requires a compensated HV probe having a wide bandwidth. Simply connecting a DC probe, through the proper resistance, into a scope yields a slow response only adequate for low rep. rate systems. As with DC probes, the pulsed probe resistor voltage coefficient is a problem. In addition, damage to the resistors can occur during pulsing due to high electric field gradients. Also, stray capacitance to nearby objects can significantly alter the pulse response. For a high-performance, shielded probe to 40KV use a Tektronix P6015 or Ross Engineering VD60-8.3-A-K-LB.

Measurements accurate to better than 0.1% can be achieved using a bias technique. For example, if a 40V signal (40kV divided by 1000) is to be measured accurately, the minus input of the DVM would be biased up 40V. The original signal, with respect to ground, is fed to the plus input of the DVM. The bias can be measured accurately for absolute measurements, or relative measurements read directly as the line or load is varied. In the same manner, an oscilloscope return can be biased for accurate peak measurements during pulsing.

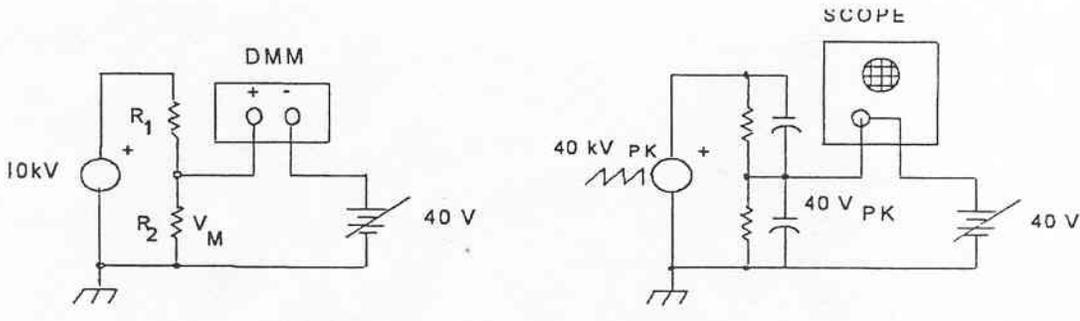


Figure 5-3 HV Bias Measurements

5.5 DETERMINING AC LINE CURRENT

$$I_L = \frac{P}{V_L P_F \times EFF}$$

IL = Line current

P = Average output power

VL = Line voltage

PF = Power factor (.65 min)

EFF = 0.85

Ex: A 152A operating from 115V – 10% and delivering 1000W average.

$$I_L = \frac{1000}{(115)(.65)(0.85)} \times 0.9 = 17.5A$$

When charging very large capacitor banks requiring many seconds or minutes to reach end-of-charge, the power supply will display a load fault and go into a 50% duty cycle protection mode. If this feature is defeated and the power supply is allowed to charge for an extended period, the peak output power, not the average power, must be used to determine line current. (See Section 5.7).

5.6 CONTINUOUS HV DC OPERATION (CONSTANT VOLTAGE)

The 500A/102A/152A/202A supplies can be used as a constant voltage supply by the addition of an external filter capacitor. The value of this capacitor will determine the ripple voltage on the DC output.

$$\Delta V_{PK - PK} = \frac{1.4(P_o \max)}{V_o(C_o)(F_s)}$$

Where: Po max = Maximum output power in watts

Vo = Output voltage in volts

Co = Total output capacitance in microfarads

Fs = Lowest switching frequency (40KHz)

When operating as a DC supply care must be taken not to draw more than the J/sec rating of the unit.

Also, if the filter capacitor is inadvertently shorted, it may ring which can damage the supply (Section 5.2).

5.7 LONG CHARGE TIME WITH POWER FACTOR CORRECTED (PFC) UNITS

It is advised that you consult the factory if this type of operation is required.

On supplies with active Power Factor Correction there is a limit to the length of the charge time. With all capacitor charging supplies, the peak output power capability is twice the joule per second rating. At pulse rates greater than approximately 20Hz, the internal filter capacitors can average the power drawn from the power factor correcting circuit. At lower pulse rates, the output stage will attempt to draw twice the rated average power from the PFC circuit. The internal current limit of the PFC circuit will be activated and the supply will shut down. To avoid this type of fault condition, the output power can be reduced by providing an inhibit pulse of fixed or variable duty cycle to keep the average output within the PFC rating (See Figure 5.4).

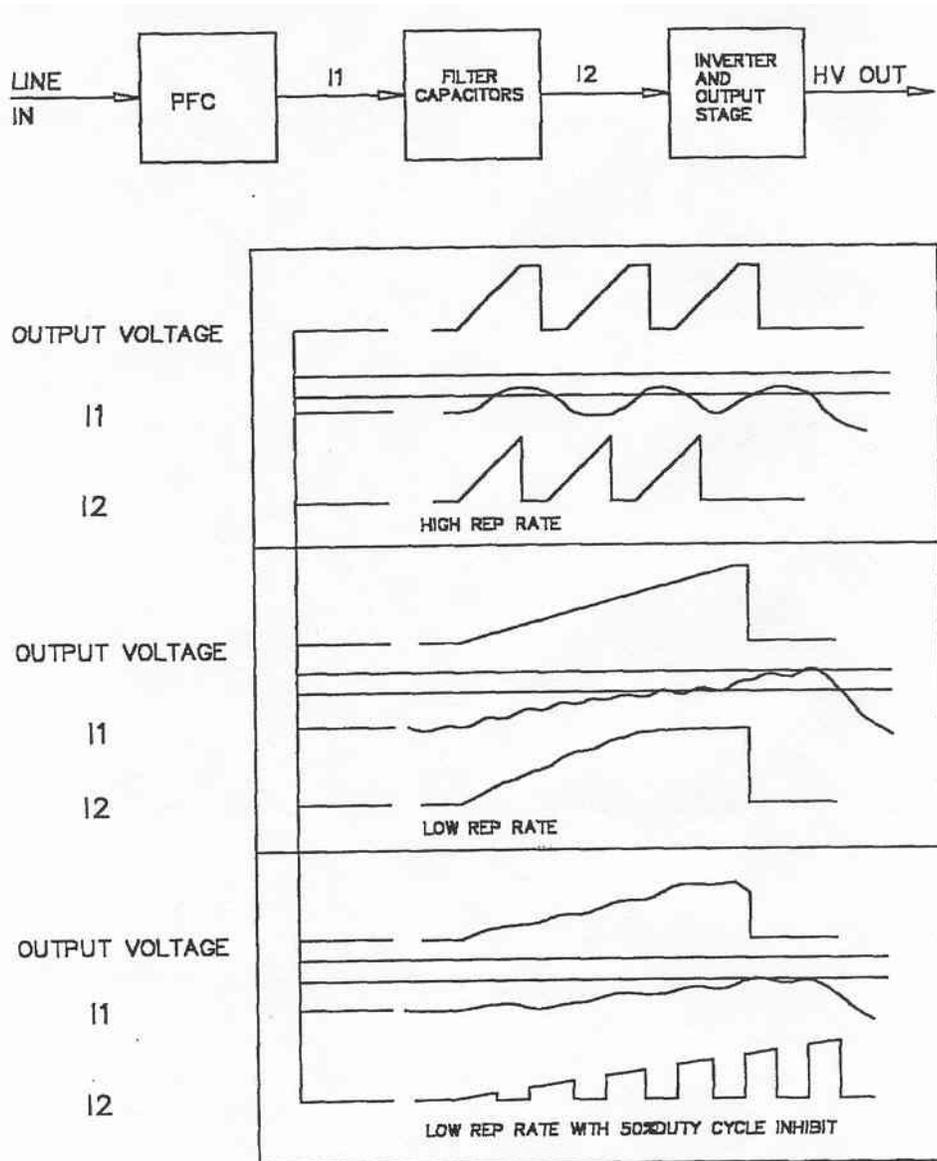
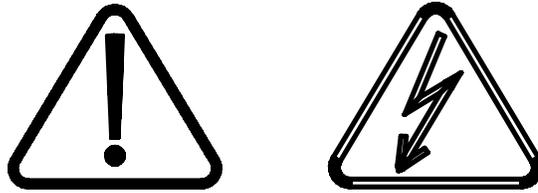


Figure 5-4 Long Charge Time Operation



6.1 SAFETY PRECAUTIONS

ONLY QUALIFIED PERSONNEL TRAINED IN THE SAFETY ASPECTS OF HIGH VOLTAGE SHOULD PERFORM CALIBRATION.

The calibration steps described in this section require operation of the power supply with the cover removed. Proceed with extreme caution as hazardous voltages are exposed throughout the unit.

Safety glasses must be worn to prevent serious injury in the event of a component failure (e.g., power transistors readily explode during fault conditions).

Because the power supply does not receive proper cooling with the cover removed, it must be cooled by an external fan placed next to the supply to cool the inverter and HV section (min. air flow 100 CFM (2.83 M3/min.)) when operating at full power. Operation at full power with cover removed should be limited to less than five minutes.

6.2 MAINTENANCE

No maintenance is required under normal operating conditions. Occasional vacuum or blow-out of the chassis may be required when operated in extremely dirty environments. The oil-filled HV assembly must not be opened. The oil and components have been specially cleaned and vacuum impregnated at the factory and the assembly hermetically sealed. Opening assembly will compromise performance and void warranty. HV Tanks must only be serviced at TDK-Lambda Americas Inc.

6.3 CALIBRATION

Calibration of the output voltage is accomplished with trim pot RP4 located on the control board. This is the top PC board of the inverter assembly. RP4 is a 25 turn trimpot. Slowly turn it clockwise to decrease the output voltage for a given VPROGRAM. Factory set for 10V rated voltage for standard version. Refer to Sections 4.1 and 4.2 of product specification for Linearity and Accuracy.

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: UNIVOLT N 61 B
Product Description: Base Oil and Additives
Product Code: 730846-00, 97P847
Intended Use: Electrical insulating oils

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA
24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300
ExxonMobil Transportation No. 281-834-3296
MSDS Requests 713-613-3661
Product Technical Information 800-662-4525, 800-947-9147
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

Name	CAS#	Concentration*
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	90 - 100%

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

SECTION 3 HAZARDS IDENTIFICATION

This material is considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL HEALTH EFFECTS

If swallowed, may be aspirated and cause lung damage. May be irritating to the eyes, nose, throat, and lungs. Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis.

Target Organs: Skin |

NFPA Hazard ID: Health: 0 Flammability: 1 Reactivity: 0
HMIS Hazard ID: Health: 0* Flammability: 1 Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4	FIRST AID MEASURES
------------------	---------------------------

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIAN

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

SECTION 5	FIRE FIGHTING MEASURES
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EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Aldehydes, Oxides of carbon, Sulfur oxides, Smoke, Fume, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: >145C (293F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: >315°C (599°F)

SECTION 6	ACCIDENTAL RELEASE MEASURES
------------------	------------------------------------

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. U.S. regulations require reporting releases of this material to the environment which exceed the reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National

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Response Center can be reached at (800)424-8802.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required due to toxicity or flammability of the material. See Section 5 for fire fighting information. See Section 3 for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for Personal Protective Equipment.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid contact with skin. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMIT VALUES

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL, 5 mg/m³ - OSHA PEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly effect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

If prolonged or repeated contact is likely, chemical resistant gloves are recommended. If contact with forearms is likely, wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

If prolonged or repeated contact is likely, chemical, and oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES
------------------	-----------------------------------------

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid
Color: Yellow
Odor: Characteristic
Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.88
Flash Point [Method]: >145C (293F) [ASTM D-92]

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Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: >315°C (599°F)

Boiling Point / Range: 260C (500F) - 371C (700F)

Vapor Density (Air = 1): > 5 at 101 kPa

Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 C

Evaporation Rate (n-butyl acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 6.5

Solubility in Water: Negligible

Viscosity: 12 cSt (12 mm2/sec) at 40 C | 3 cSt (3 mm2/sec) at 100C

Oxidizing Properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -40°C (-40°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY
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STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION
-------------------	----------------------------------

ACUTE TOXICITY

<u>Route of Exposure</u>	<u>Conclusion / Remarks</u>
Inhalation	
Toxicity (Rat): LC50 > 5000 mg/m3	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Elevated temperatures or mechanical action may form vapors, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs. Based on assessment of the components.
Ingestion	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test

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data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Prolonged and/or repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis.

Small amounts of liquid aspirated into the lungs during ingestion or from vomiting may cause chemical pneumonitis or pulmonary edema.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

Additional information is available by request.

The following ingredients are cited on the lists below: None.

1 = NTP CARC
2 = NTP SUS

--REGULATORY LISTS SEARCHED--

3 = IARC 1
4 = IARC 2A

5 = IARC 2B
6 = OSHA CARC

SECTION 12

ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13

DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

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DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

RCRA Information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Empty Container Warning PRECAUTIONARY LABEL TEXT: Empty containers may retain residue and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION 14	TRANSPORT INFORMATION
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LAND (DOT) : Not Regulated for Land Transport

LAND (TDG) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION
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OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purpose, this material is classified as hazardous in accordance with OSHA 29CFR 1910.1200.

NATIONAL CHEMICAL INVENTORY LISTING: AICS, DSL, EINECS, KECI, TSCA

EPCRA: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: Delayed Health.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The Following Ingredients are Cited on the Lists Below:

Chemical Name	CAS Number	List Citations
---------------	------------	----------------

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HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	4, 13
------------------------------------------------------	------------	-------

--REGULATORY LISTS SEARCHED--

- | | | | |
|---------------|------------------|-------------------|-------------|
| 1 = ACGIH ALL | 6 = TSCA 5a2 | 11 = CA P65 REPRO | 16 = MN RTK |
| 2 = ACGIH A1 | 7 = TSCA 5e | 12 = CA RTK | 17 = NJ RTK |
| 3 = ACGIH A2 | 8 = TSCA 6 | 13 = IL RTK | 18 = PA RTK |
| 4 = OSHA Z | 9 = TSCA 12b | 14 = LA RTK | 19 = RI RTK |
| 5 = TSCA 4 | 10 = CA P65 CARC | 15 = MI 293 | |

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16	OTHER INFORMATION
-------------------	--------------------------

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

- Revision Changes:
 Section 09: Pour Point C(F) was modified.
 Section 15: List Citations Table was modified.
 Section 08: Exposure Limits Table was deleted.
 Section 08: OEL Table - Form Column - Header was deleted.
 Section 08: OEL Table - Limit Column - Header was deleted.
 Section 08: OEL Table - Notation Column - Header was deleted.
 Section 08: OEL Table - Source Column - Header was deleted.
 Section 08: Exposure Limit Values - Header was deleted.

PRECAUTIONARY LABEL TEXT:

Contains: HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)

WARNING!

HEALTH HAZARDS

Repeated exposure may cause skin dryness or cracking. If swallowed, may be aspirated and cause lung damage.

Target Organs: Skin |

FIRST AID

Oral: Seek immediate medical attention. Do not induce vomiting.

Skin: Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse.

FIRE FIGHTING MEDIA

Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

SPILL/LEAK

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Report spills as required to appropriate authorities. Seek the advice of a specialist before using dispersants.

Use

Not intended or suitable for use in or around a household or dwelling.

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Internal Use Only

MHC: 2A, 0, 0, 0, 0, 1

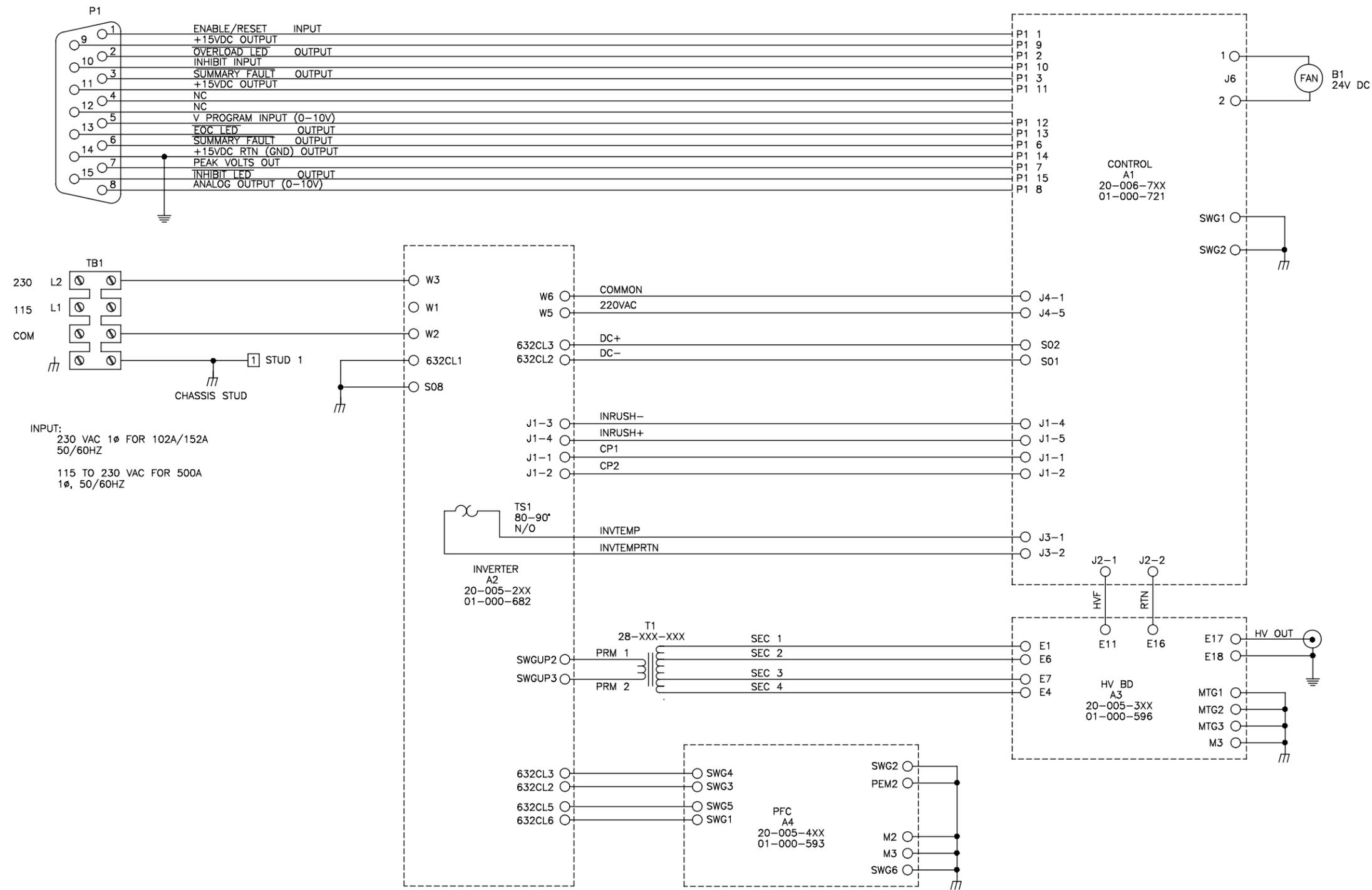
PPEC: C

DGN: 2011629XUS (548632)

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LTR	E.C.O. NO.	BY	APP.
00	INT. REL.	11/1/94	SAdB
01	ADD 1.25KV	11/10/94	SAdB
02	RMVD J5/L6	11/14/94	SAdB
03	REV FOR VER 2	12/29/94	SAdB
04	REDESIGN DWG	2/16/94	SAdB
05	RMV COLOR WIRE	3/30/95	SAdB
A	TG REL.	4/24/95	SAdB
B	ECO #15243	4/24/96	CJS
C	ECO #16240	3/17/97	CJS
D	ECO #19212	5/29/01	LWR



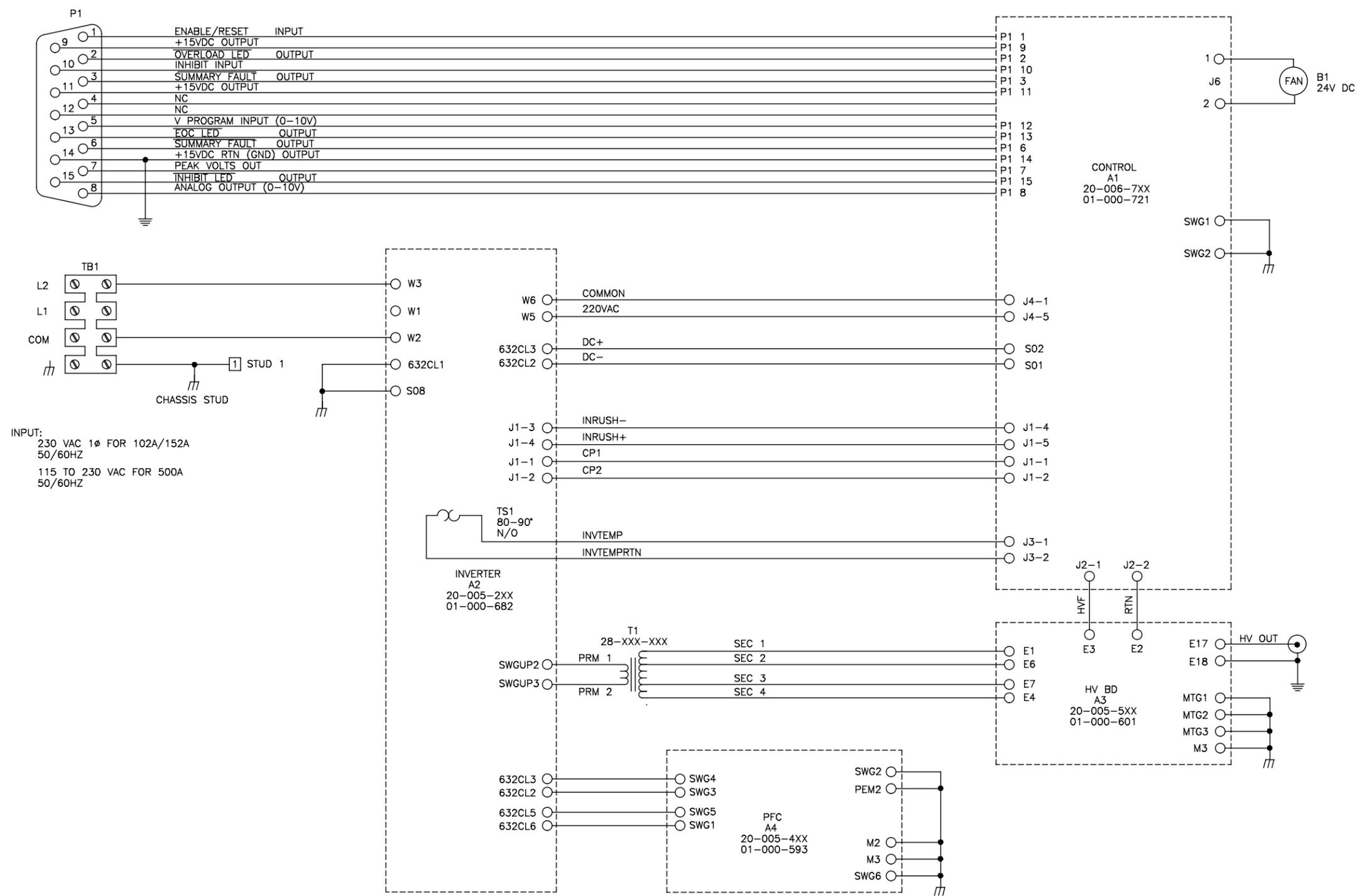
SHEET 1 OF 1

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

REL. TO MFG.	ENG. CTL.	LAMBDA MI	
DATE: 4/24/95	DATE: 9/14/94	TITLE: SCHEMATIC SYSTEM NEW CAP CHARGER PFC 500A, 102A, 152A	
DATE: 4/24/95	DATE: 11/10/94		
DATE: 4/24/95	DATE: 11/10/94		
DATE: 4/24/95	DATE: 11/11/94		
P/L: 493	SCALE: NONE	DWG. NO. 01-493-001	REV. D

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

LTR	E.C.O. NO.	BY	APP.
00	INT. REL.	11/1/94	SAdB
01	ADD 1.25KV	11/10/94	SAdB
02	RMVD J5/L6	11/14/94	SAdB
03	REV FOR VER 2	12/29/94	SAdB
04	REDISIGN DWG	2/16/94	SAdB
05	RMV COLOR WIRE	3/30/95	SAdB
A	TG REL.	4/24/95	SAdB
B	ECO #15241	4/25/96	CJS
C	ECO #16240	3/18/97	CJS
D	ECO #19912	5/29/01	LWR



INPUT:
230 VAC 1 ϕ FOR 102A/152A
50/60HZ
115 TO 230 VAC FOR 500A
50/60HZ

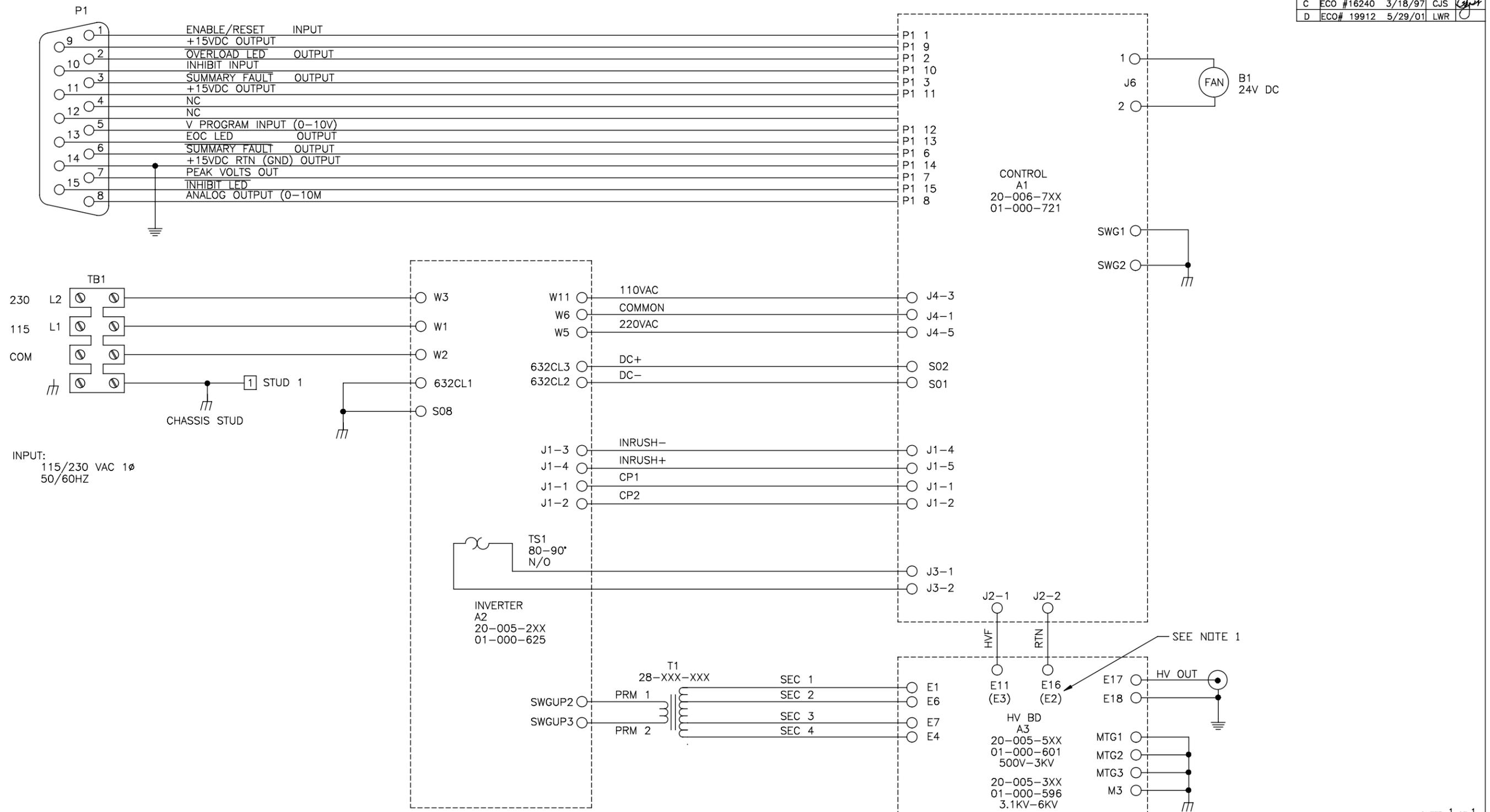
SHEET 1 OF 1

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

REL. TO MFG.	ENG. CTL.	LAMBDA MI	
DATE: 11/5/95	DATE: 9/14/94	TITLE: SCHEMATIC SYSTEM 500A, 102A, 152A 500V THRU 3KV PFC	
DATE: 11/5/95	DATE: 11/10/94		
DATE: 11/5/95	DATE: 11/10/94		
DATE: 11/5/95	DATE: 11/10/94		
SCALE: NONE	APP. DATE: 11/11/94	DWG. NO. 01-493-002	REV. D

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

LTR	E.C.O. NO.	BY	APP.
1	INT. REL. 2/18/95	SAdB	<i>[Signature]</i>
2	ADD L1 & L2 3/30/95	SAdB	<i>[Signature]</i>
A	TG REL. 5/95	SAdB	<i>[Signature]</i>
B	ECO #15242. 4/22/96	CJS	<i>[Signature]</i>
C	ECO #16240 3/18/97	CJS	<i>[Signature]</i>
D	ECO# 19912 5/29/01	LWR	<i>[Signature]</i>



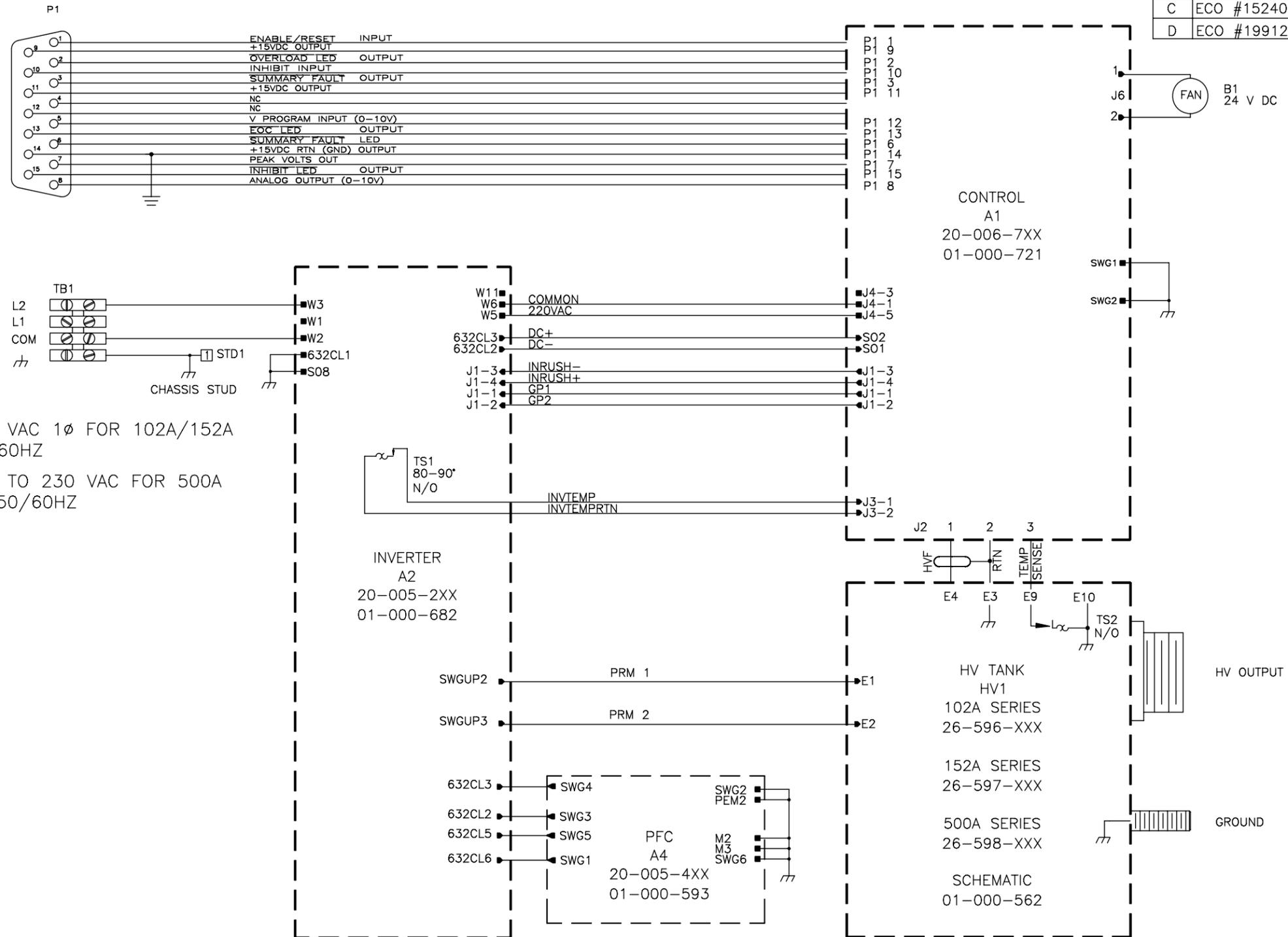
NOTES:
1. E11,E16 FOR 3.1K TO 6KV
E3,E2 FOR 500V TO 3KV.

AUTOCAD DRAWING
THIS IS A STANDARD FORMAT.
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DRAWING AND MAY NOT BE FILLED IN.

REL. TO MFG.	ENG. CTL.	LAMBDA MI	
DATE: 6/6/95	DATE: 4/18/96	TITLE: SCHEMATIC SYSTEM	
DATE: 6/6/95	DATE: 2/20/95		
DATE: 6/6/95	DATE: 2/21/95	500A,102A NON-PFC	
DATE: 6/6/95	DATE: 2/17/95		
P/L: 493	SCALE: NONE	DWG. NO. 01-493-005	REV. D

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

LTR	E.C.O. NO.	BY	APP.
1	INITIAL RELEASE 02/18/95	SAdB	<i>[Signature]</i>
2	ADD L1 & L2 03/30/95	SAdB	<i>[Signature]</i>
A	TG REL 10/3/95	S.E.	<i>[Signature]</i>
B	ECO #15244 5/2/96	CJS	<i>[Signature]</i>
C	ECO #15240 3/18/97	CJS	<i>[Signature]</i>
D	ECO #19912 5/29/01	LWR	<i>[Signature]</i>



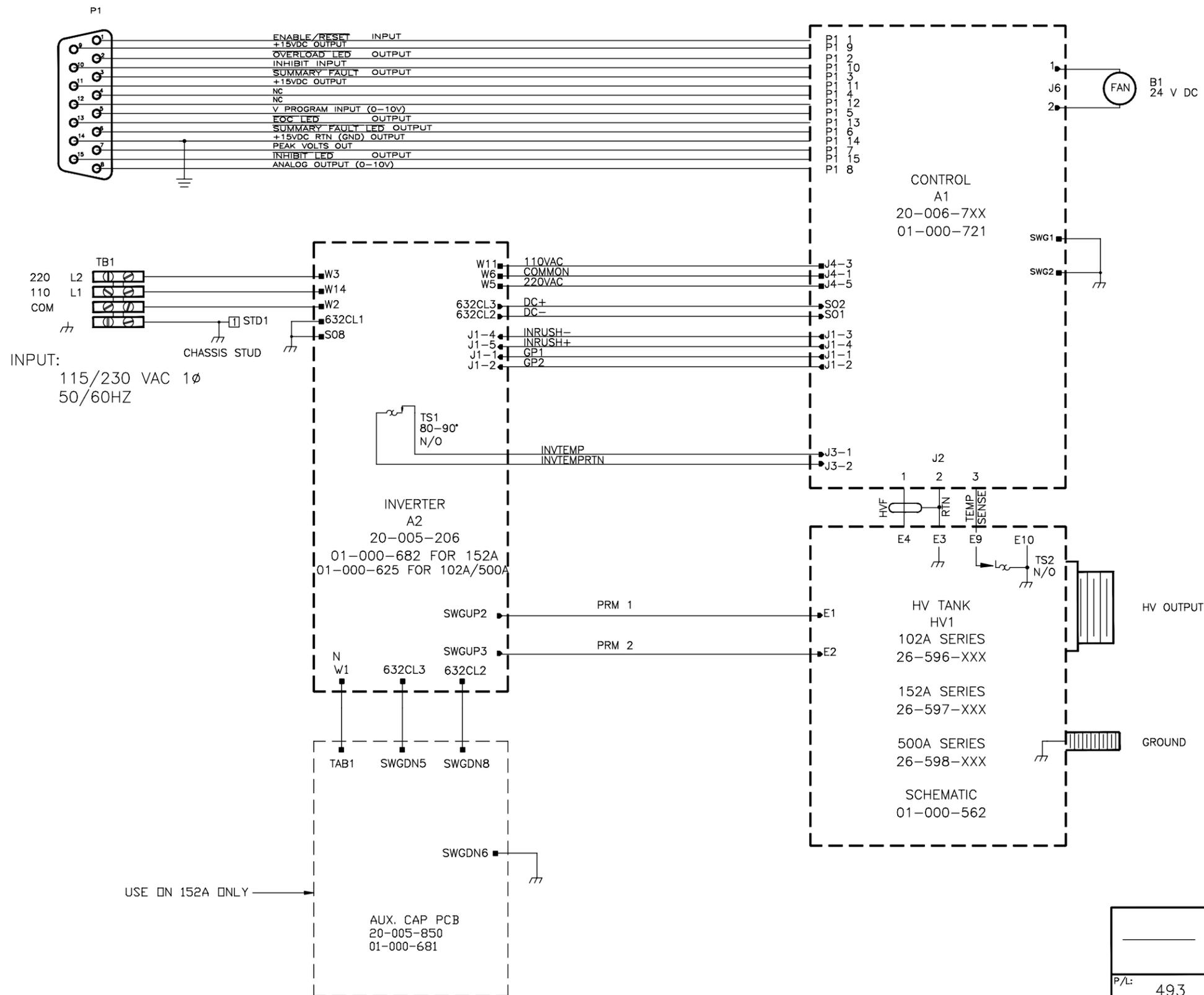
SHEET 1 OF 1

REL. TO MFG.	ENG. CTL.	TITLE: SCHEMATIC SYSTEM	
REL. TO MFG. DATE: 12/28/95	ENG. CTL. DATE: 02/18/95	500A, 102A, 152A	
MFG. DATE: 1/2/96	CHK. DATE: 02/20/95	7KV & UP OIL PFC	
DOC. REL. DATE: 12/28/95	ENG. DATE: 02/21/95	DWG. NO. 01-493-006	REV. D
SCALE: NONE	APP. DATE: 02/17/95		

AUTOCAD DRAWING
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LTR	E.C.O. NO.	BY	APP.
1	INITIAL RELEASE 02/18/95	SAdB	<i>[Signature]</i>
2	ADD L1 & L2 03/30/95	SAdB	<i>[Signature]</i>
3	ADD AUX. CAP PCB 8/95	CB	<i>[Signature]</i>
A	TG REL 10/17/95		<i>[Signature]</i>
B	ECO #16240 3/18/97	CJS	
C	ECO #19912 5/29/01	LWR	



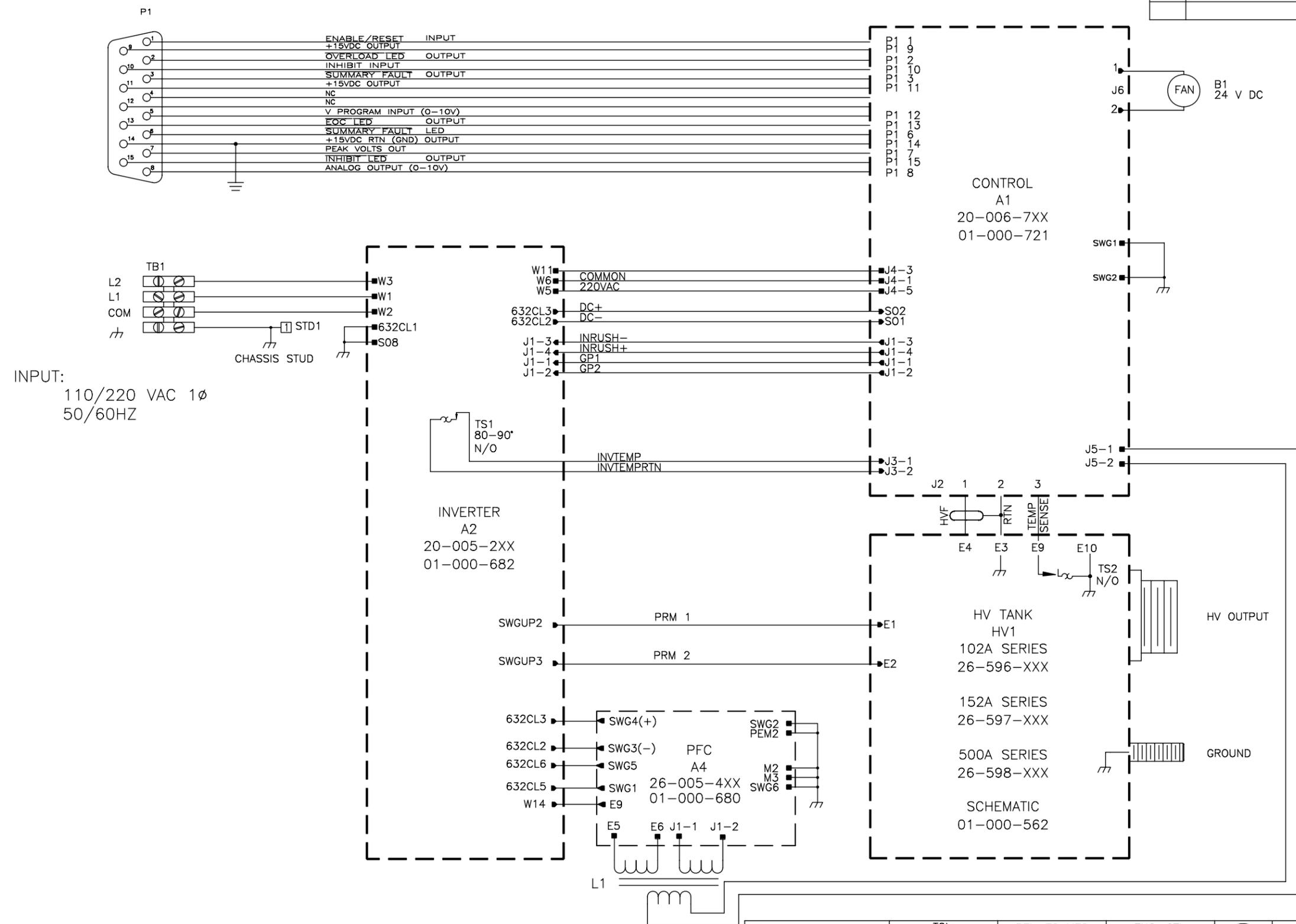
AUTOCAD DRAWING
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING AND MAY NOT BE FILLED IN.

SHEET 1 OF 1

REL. TO MFG.	ENG. CTL.	LAMBDA MI	
PR: ENG. DATE: 2/29/96	DWN: DATE: SAdB 02/18/95	TITLE: SCHEMATIC SYSTEM 500A, 102A, 152A 7KV & UP W/OIL, W/O PFC	
MFG: DATE: 2/26/96	CHK: DATE: JJR 02/20/95		
P/L: 493	DOC. REL. DATE: 1/5/96	ENG: DATE: MD 02/21/95	DWG. NO. 01-493-007
SCALE: <i>[Handwritten]</i>	DO NOT SCALE DWG.	APP: DATE: 10/17/95	REV. C

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

APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	1	INITIAL RELEASE 02/5/97	SA	
102A , 152A 500A	FINAL ASSY	REF	A	TG REL 5/16/97	CJS	



INPUT:
110/220 VAC 1Ø
50/60HZ

SHEET 1 OF 1

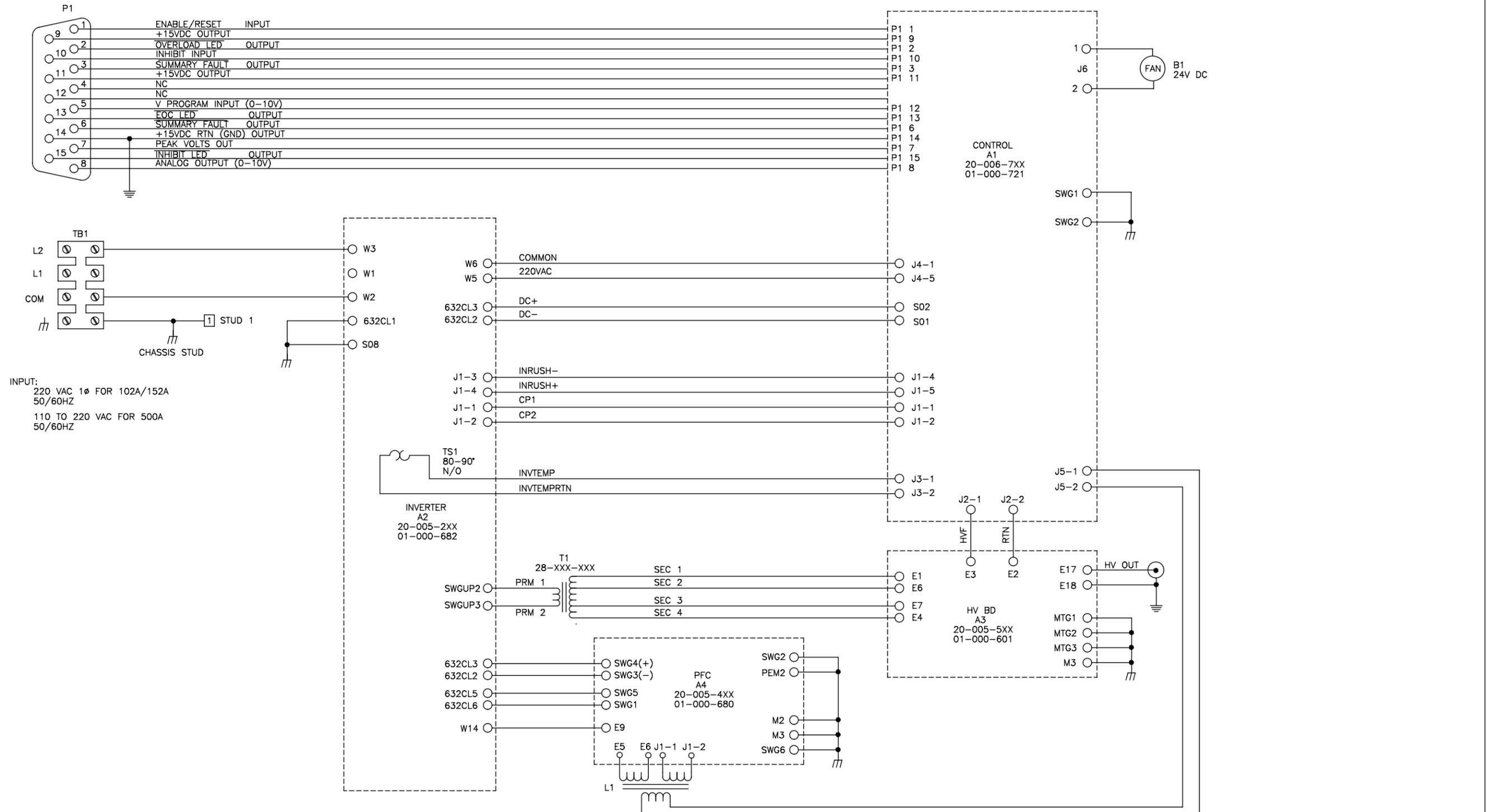
MTL:	N/A	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. PRJ. ENG. DATE:	ENG. CTL. DWN: DATE: C.SEIBERT 5/16/97	<p>ELECTRONIC MEASUREMENTS, INC.</p> <p>TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 7KV & UP OIL</p>
FIN:	N/A	P/L: 493	DOC. REL. DATE:	ENG: DATE:	
		SCALE: NONE	CHK: DATE:	APP: DATE:	
				DWG. NO. 01-493-010	REV. A

M147R1

DO NOT SCALE DWG.

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

APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	1	INT. REL. 4/16/97	SA	
102A,500A 152A,202A	FINAL ASSY	REF	A	TG REL. 5/16/97	CJS	

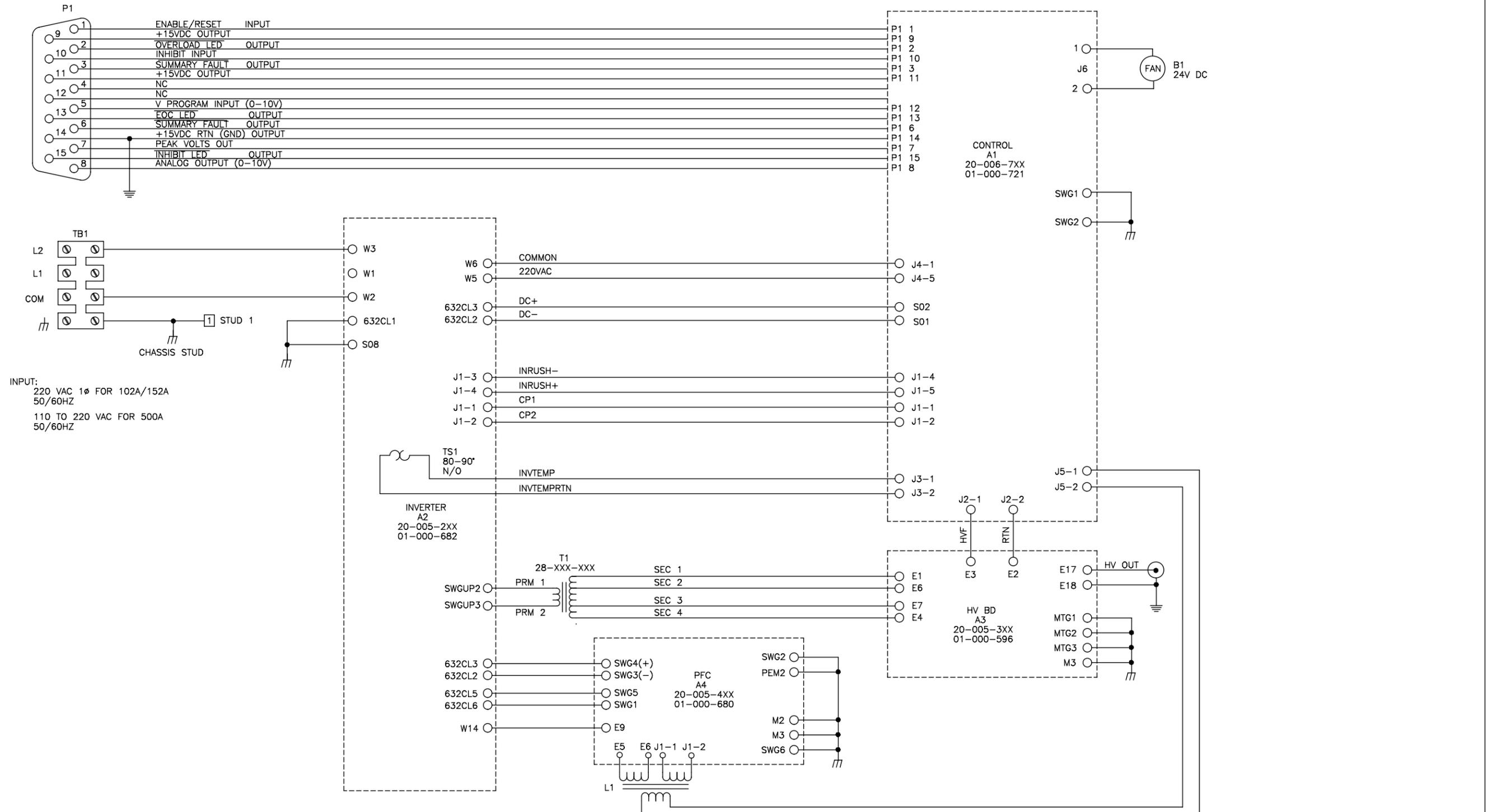


SHEET 1 OF 1

MTL:	N/A	TOL: .X = ±.02" .XX = ±.01" .XXX = ±.005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. PRJ. ENG. DATE:	ENG. CTL. DATE: C. SEIBERT 5/16/97	 ELECTRONIC MEASUREMENTS, INC. TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 500V - 1.7KV DWG. NO. 01-493-012 REV. A
FIN:	N/A	P/L: 493 SCALE: NONE	DOC. REL. DATE: DO NOT SCALE DWG.	APP: DATE:	

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

APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	1	INT. REL. 8/19/97	SA	
102A,500A 152A,202A	FINAL ASSY	REF	A	TG REL. 9/2/97	CJS	

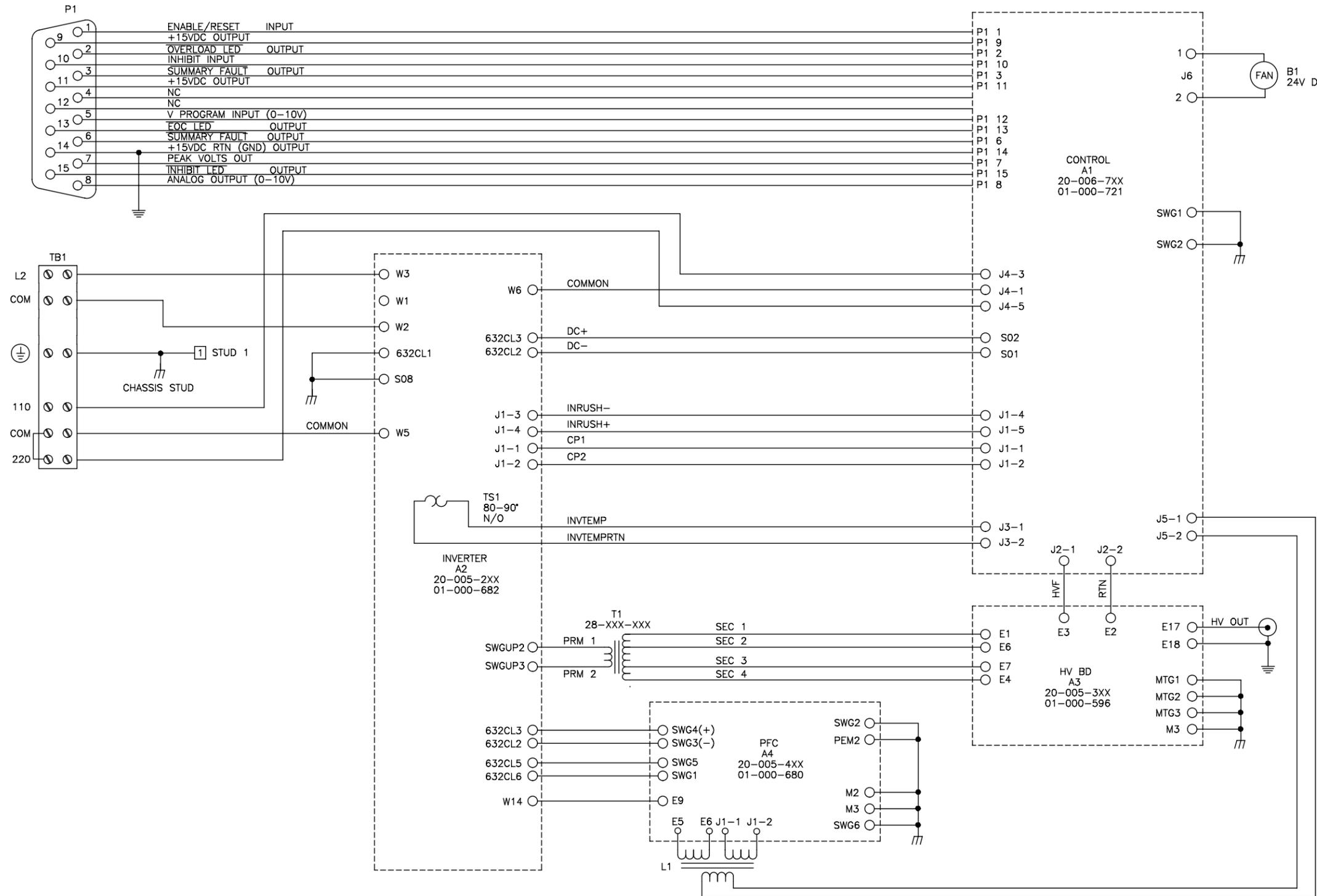


SHEET 1 OF 1

MTL:	TOL:	REL. TO MFG.	ENG. CTL.	ELECTRONIC MEASUREMENTS, INC.
N/A	.X = ±.02" .XX = ±.01" .XXX = ±.005" FRAC. = ± 1/64" ANGLES = ± 1/2°	PRJ. ENG. DATE:	DWN. DATE: 9/2/97	
FIN:	P/L: 493 SCALE: NONE	DOC. REL. DATE:	ENG. DATE:	TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 3.1KV-6KV
		DO NOT SCALE DWG.	APP. DATE:	DWG. NO. 01-493-013 REV. A

THIS IS A COMPUTER GENERATED DWG.
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APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	1	INITIAL RELEASE 3/16/99	B.H.	
102A,500A 152A,202A	FINAL ASSY	REF	A	TG RELEASE 4/14/99	LPN	



SHEET 1 OF 1

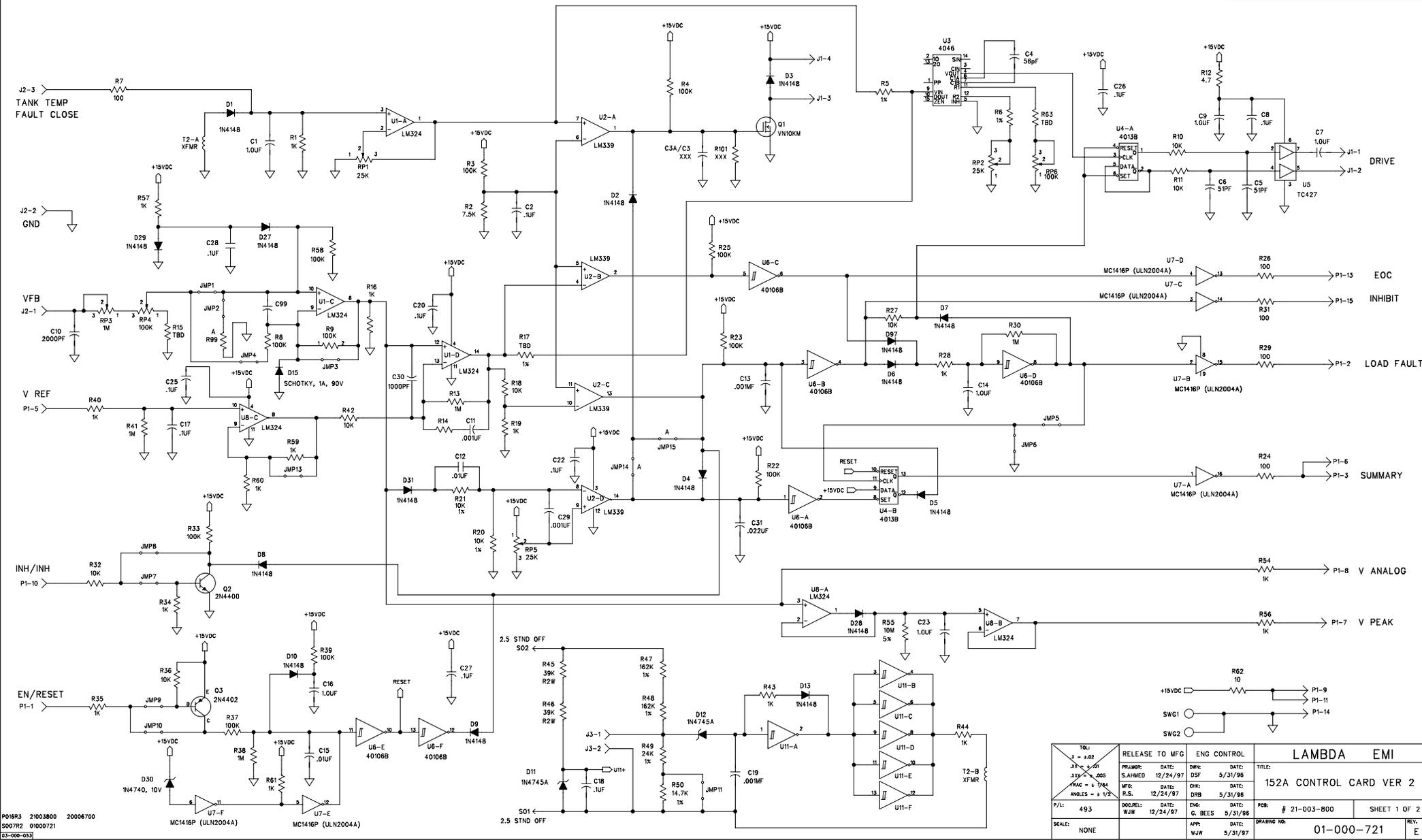
MTL:	TOL:	REL. TO MFG.	ENG. CTL.
N/A	.X = ±.02" .XX = ±.01" .XXX = ±.005" FRAC. = ± 1/64" ANGLES = ± 1/2°	PRJ. ENG. DATE:	DWG. DATE: 4/13/99
N/A	P/L: 493	MFG. DATE:	CHK. DATE:
	SCALE: NONE	DOC. REL. DATE:	ENG. DATE:
	DD NOT SCALE DWG.	APP. DATE:	DWG. NO. 01-493-014

TITLE: SCHEMATIC SYSTEM
152A/PFC VER.3
W/LOGIC PWR SEL

REV. A

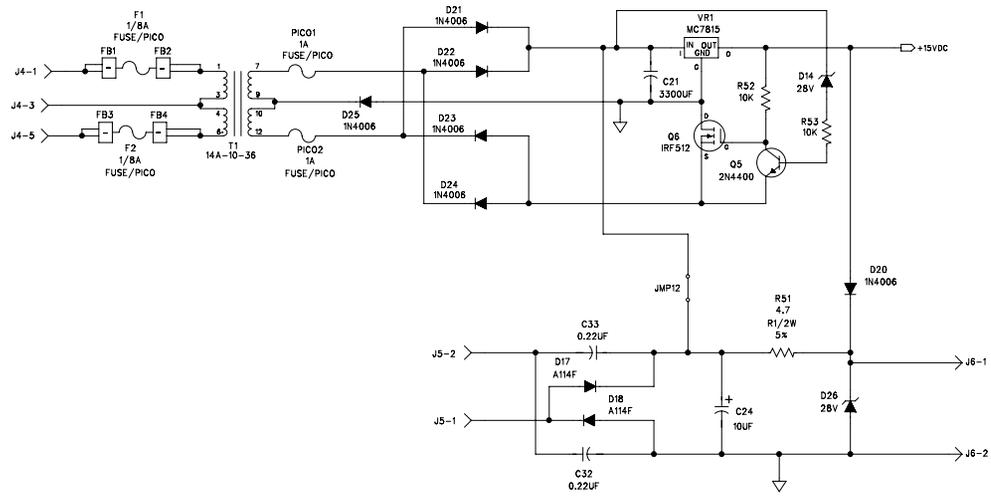
NOTES:
 CHECK SHEET 2 FOR JUMPER CHART
 R63, R5, R6, R14, R16 VALUES DEFINED BY MODEL OUTPUT VOLTAGE
 R99 AND C99 FOR NEGATIVE UNITS ONLY
 R59 DEFINED BY VREF
 R101, C3A INSTALLED ONLY IN UNITS WITH INRUSH TIME DELAY.

APPLICATIONS			REVISIONS			
USED ON	NEXT ASSY	QTY	LTR	DESCRIPTION	BY/DATE	APP/DATE
			1	INITIAL RELEASE	G BEES 5/31/96	GB 5/31/96
			A	TG RELEASE	WJW 8/5/96	WJW 8/9/96
			B	ECO #16240	CJS 3/16/97	WJW
			C	ECO #18208	CJS 3/26/97	WJW
			D	ECO #18088	LPN 1/26/99	WJW
			E	ECO #18786	LPN 11/2/99	



TOL: ± = ±0.2 .XX = ±.01 .XXX = ±.005 .RAC = ±.001 ANGLES = ± 1/2°		RELEASE TO MFG S.A.HMED 12/24/97 MFR: DATE: 12/24/97 WJW DATE: 12/24/97		ENG CONTROL DATE: 5/31/96 DSF DATE: 5/31/96 DATE: 5/31/96 DATE: 5/31/96		LAMBDA EMI 152A CONTROL CARD VER 2 # 21-003-800 SHEET 1 OF 2	
P/1: 493	SCALE: NONE	APP: WJW	DATE: 5/31/97	DRAWING NO:	01-000-721		REV: E

REVISIONS			
LTR	DESCRIPTION	BY/DATE	APP/DATE
	SEE SHIT 1 FOR REVISIONS		



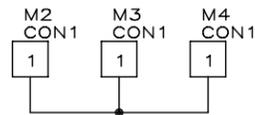
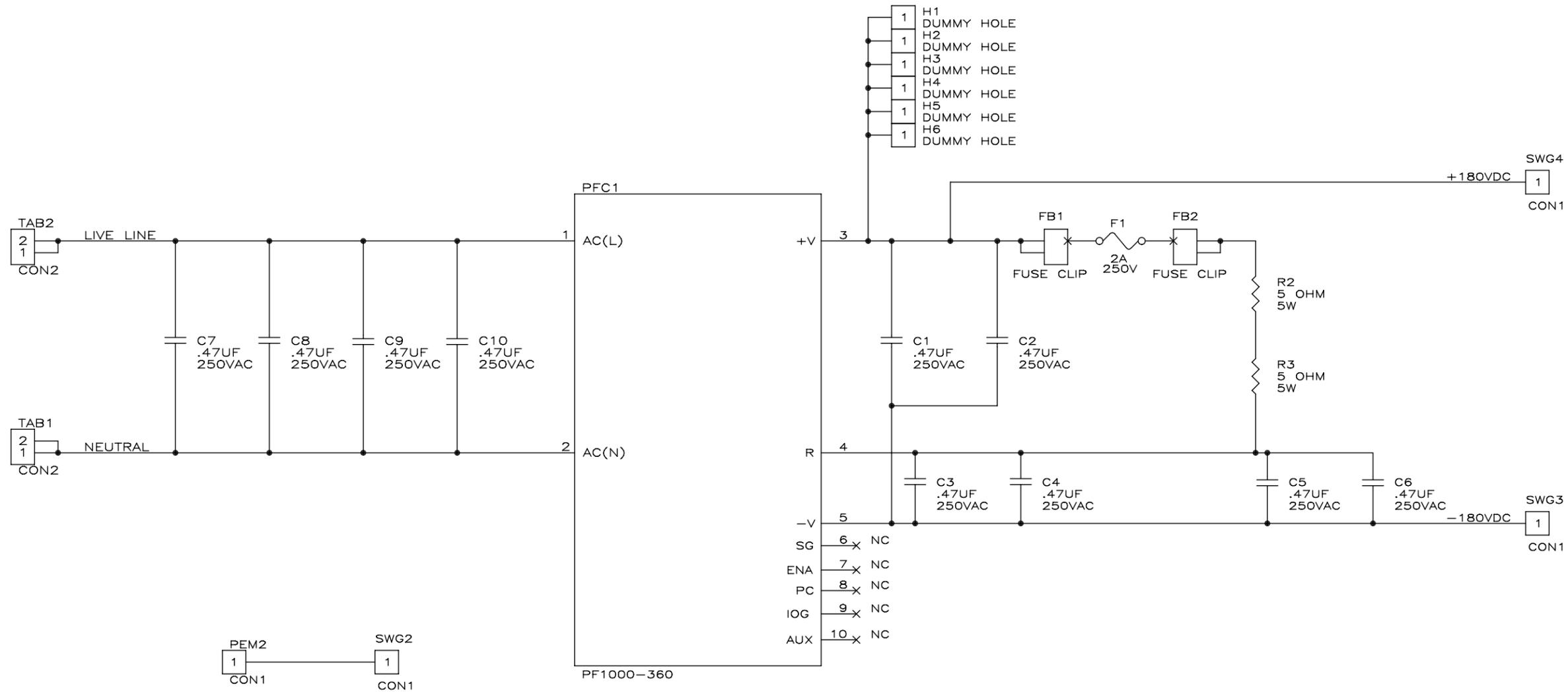
OPTION TABLE

OPTIONS	JMP CLOSED	JMP OPEN	SUFFIX
POS O/P	J1, J3	J2, J4	POS
NEG OP	J2, J4	J1, J3	NEG
INH HIGH	J7	J8	-
INH LOW	J8	J7	LH
ENABLE HIGH	J10	J9	-
ENABLE LOW	J9	J10	EN
PFC	J11	-	PFC
NON PFC	-	J11	-
LOAD FAULT LATCHING	J5	J6	IL
LOAD FAULT NON LATCHING	J6	J5	-
PROGRAMMING 0-5V	J13		5V
PROGRAMMING 0-10V	J13	-	-
102A/152A/202A	J12	-	-
202A	-	J12	-
NORMAL FAULTS	J14	J15	-
INH/OV FAULTS ONLY	J15	J14	-

LAMBDA EMI	
TITLE: CONTROL CARD 152A VER 2	
SHEET 2 OF 2	
DRAWING NO: 01-000-721	REV. E

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APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	00	INITIAL RELEASE 9/6/94	DRB	<i>[Signature]</i>
20-004-401	23-229-000	1	A	TG 3 RELEASE 5/1/95	SAdB	<i>[Signature]</i>
			B	ECO #16240 3/18/97	CJS	
			C	ECO #16204 3/26/97	CJS	

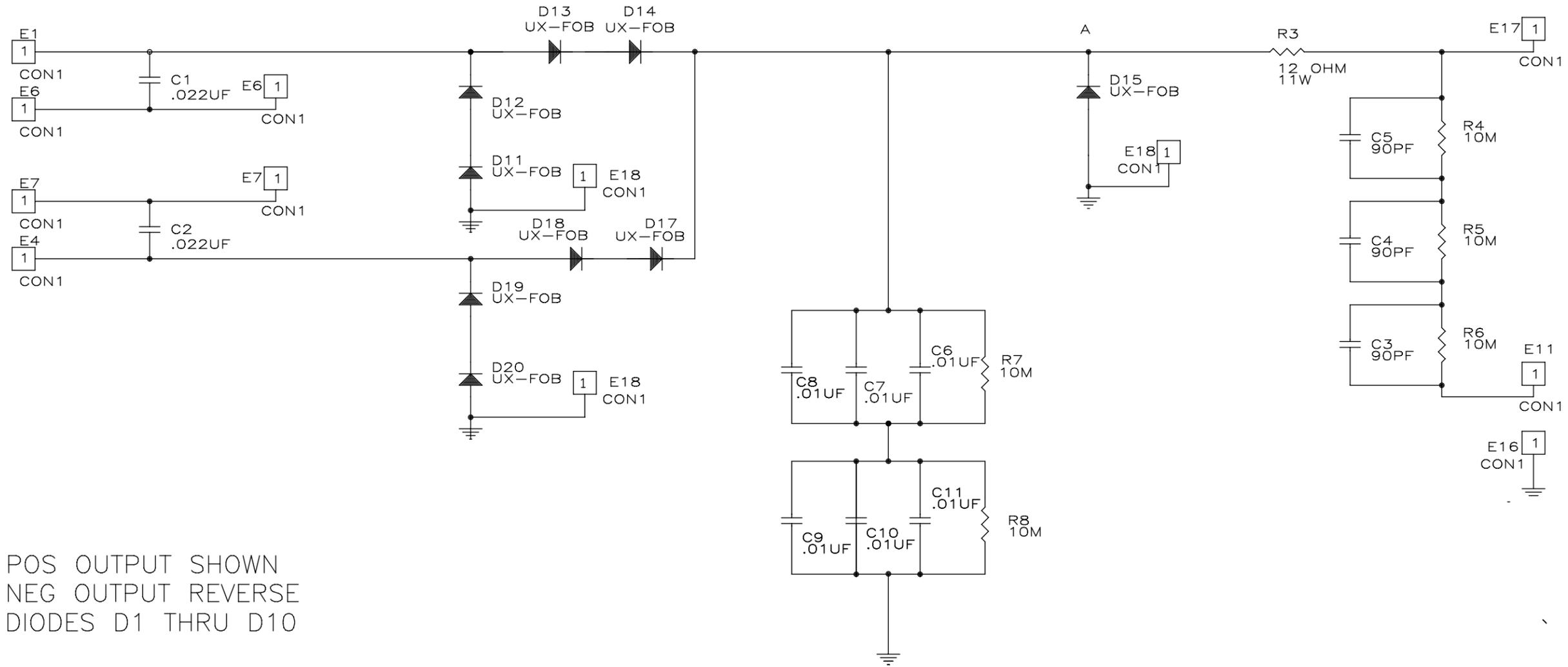


SHEET 1 OF 1

MTL:	TOL:	REL. TO MFG.	ENG. CTL.	ELECTRONIC MEASUREMENTS, INC.
	.X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	DATE: 10/23/95 MFG: R. Laparis 10/23/95	DATE: 9/6/94 DATE: 02/20/95	
FIN:	P/L: 493 SCALE: NONE	DATE: 10/9/95 DO NOT SCALE DWG.	DATE: 02/21/95 DATE: 02/17/95	TITLE: POWER FACTOR CORRECTION PCB SCHEMATIC DWG. NO. 01-000-593 REV. C

THIS IS A COMPUTER GENERATED DWG.
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APPLICATION			LTR	E.C.O. NO.	BY	APP
USED ON	NEXT ASSY.	QTY.	00	INITIAL RELEASE 9/12/94	DRB/SAB	<i>[Signature]</i>
102A-152A-500A 6KV	HV BD A3	REF	01	ENG REV 10/11/94	SAdB	<i>[Signature]</i>
			2	REDESIGN DWG03/30/95	SAdB	<i>[Signature]</i>
			A	RELEASE TG 3 4/28/95	SAdB	<i>[Signature]</i>
			B	ECO #16240 3/18/97	CJS	<i>[Signature]</i>



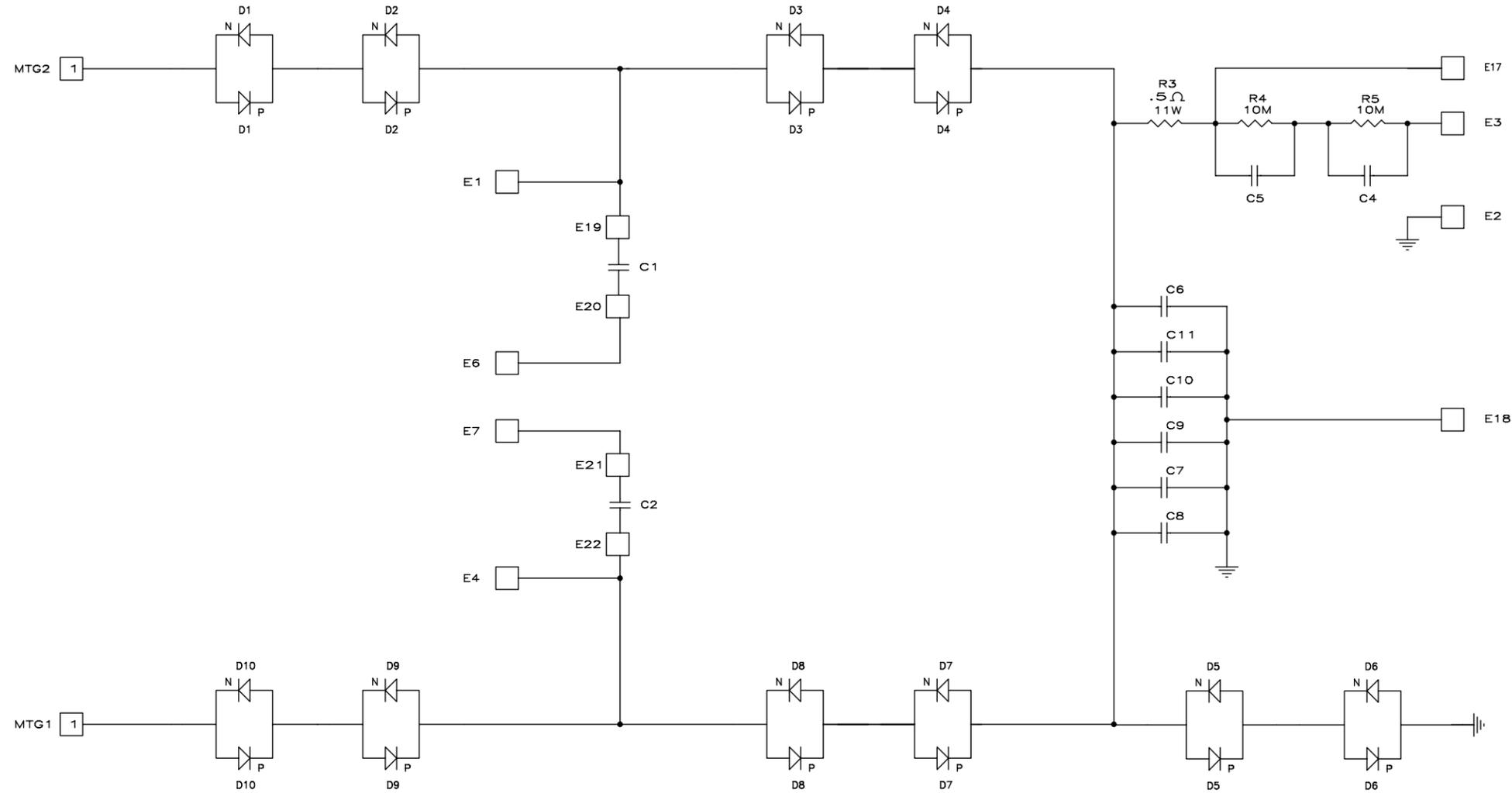
POS OUTPUT SHOWN
NEG OUTPUT REVERSE
DIODES D1 THRU D10

SHEET 1 OF 1

MTL:	TOL:	REL. TO MFG.	ENG. CTL.		ELECTRONIC MEASUREMENTS, INC.
	.X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	DATE: 6/20/95 MFG: 8/8/95	DATE: 09/12/94 CHK: 02/20/95		
FIN:	P/L: 493	DOC. REL. DATE: 6/21/95	ENG: 02/21/95		TITLE: HV OUTPUT 102A-152A-500A 3.1KV TO 6KV
	SCALE: NONE	DO NOT SCALE DWG.	APP: 02/17/95		

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APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	00	INITIAL RELEASE 10/12/94	SAB	<i>[Signature]</i>
102A,152A & 500A	HV BD A3	REF	01	REDESIGN 12/30/94	SAB	<i>[Signature]</i>
			A	TG3 RELEASE 10/95	CB	<i>[Signature]</i>
			B	ECO #16240 3/18/97	CJS	<i>[Signature]</i>



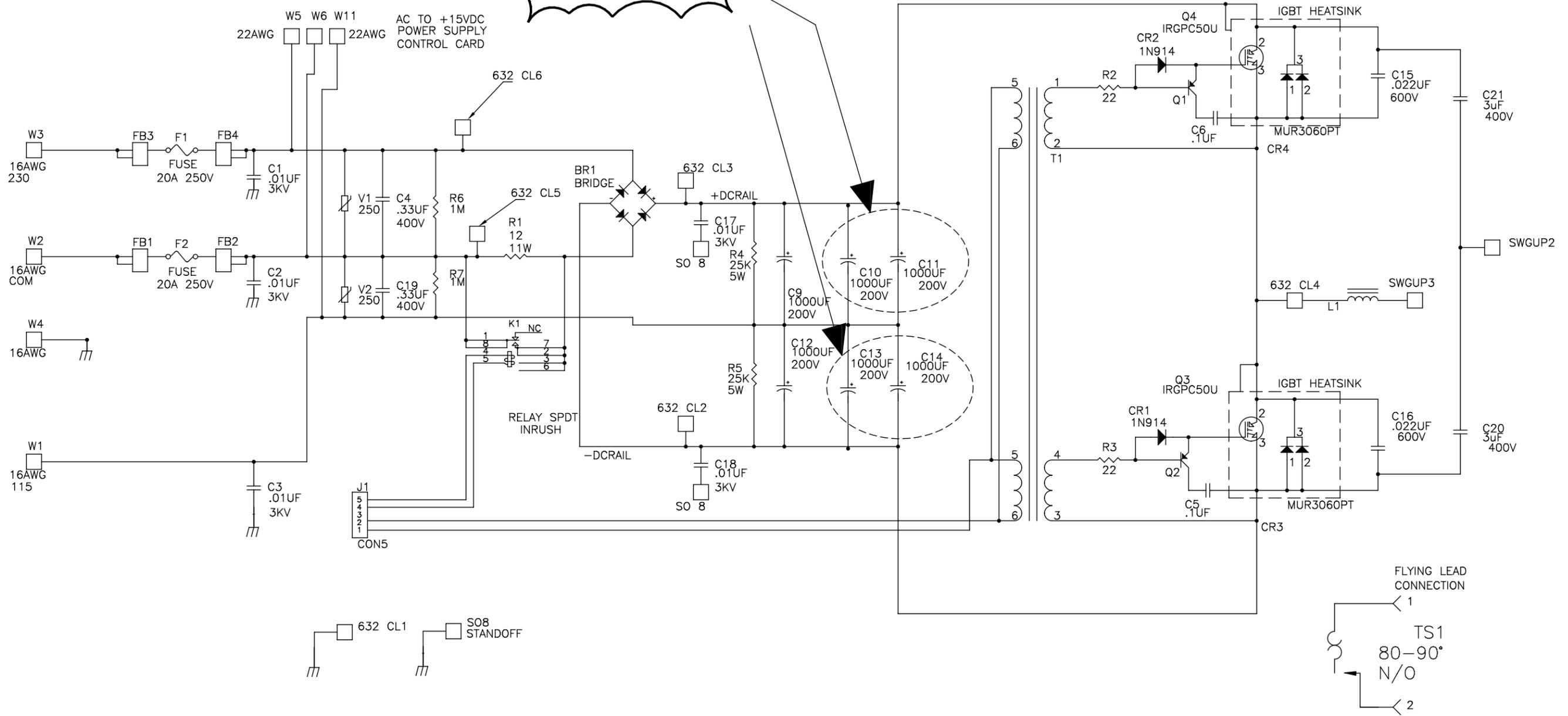
SHEET 1 OF 1

MTL:	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. DATE: 11/3/95 MFG: <i>[Signature]</i> DATE: 11/5/95	ENG. CTL. DWN: DATE: 02/16/95 CHK: <i>[Signature]</i> JJR DATE: 2/20/95	 <p>ELECTRONIC MEASUREMENTS, INC.</p>	<p>TITLE: HV OUTPUT 102A,152A & 202A 500V TO 3KV</p>
FIN:	P/L: 493 SCALE: NONE	DOC. RFL. DATE: 10/26/95 MFG: <i>[Signature]</i> DATE: 10/26/95	APP: <i>[Signature]</i> DATE: 2/21/95		

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

LTR	E.C.O. NO.	BY	APP.
00	INITIAL RELEASE 9/1/94	DRB	<i>[Signature]</i>
A	IG 3 RELEASE 8/1/95	SAD	<i>[Signature]</i>
B	ECO #16240 3/18/97	CJS	<i>[Signature]</i>
C	ECO #19912 5/29/01	LWR	<i>[Signature]</i>

NOTE:
C10, C11, C13 and C14
REMOVED FROM THIS ASSY.



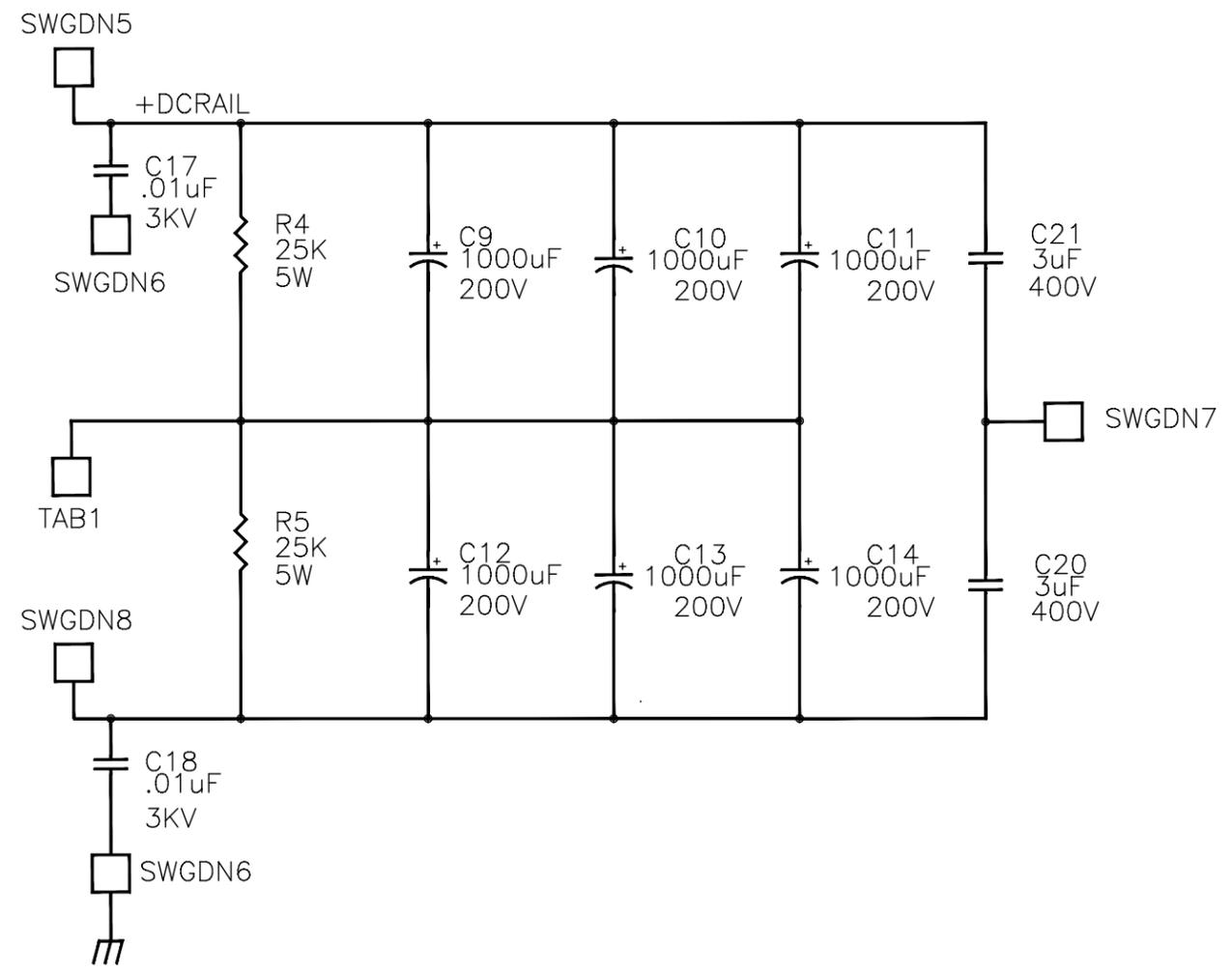
AUTOCAD DRAWING
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING AND MAY NOT BE FILLED IN.

REL. TO MFG.	ENG. CTL.	LAMBDA MI	
DATE: 2/21/95	DATE: 01/10/95	P/L: 493	
DATE: 02/20/95	DATE: 02/21/95	SCALE: NONE	
DATE: 10/23/95	DATE: 02/21/95	TITLE: SCHEMATIC DIAGRAM PCB A2 INVERTER (VER-2) 500A, 102A, 152A	
DATE: 02/17/95	DATE: 02/17/95	DWG. NO. 01-000-625	

SHEET 1 OF 1

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APPLICATION		LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY:	1	INITIAL RELEASE 8/95	C.B.
152A-W/O PFC	20-005-850	REF	A	TG REL 10/19/95	



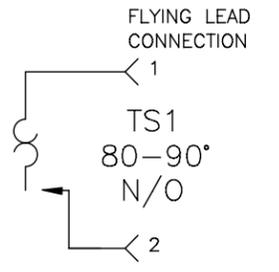
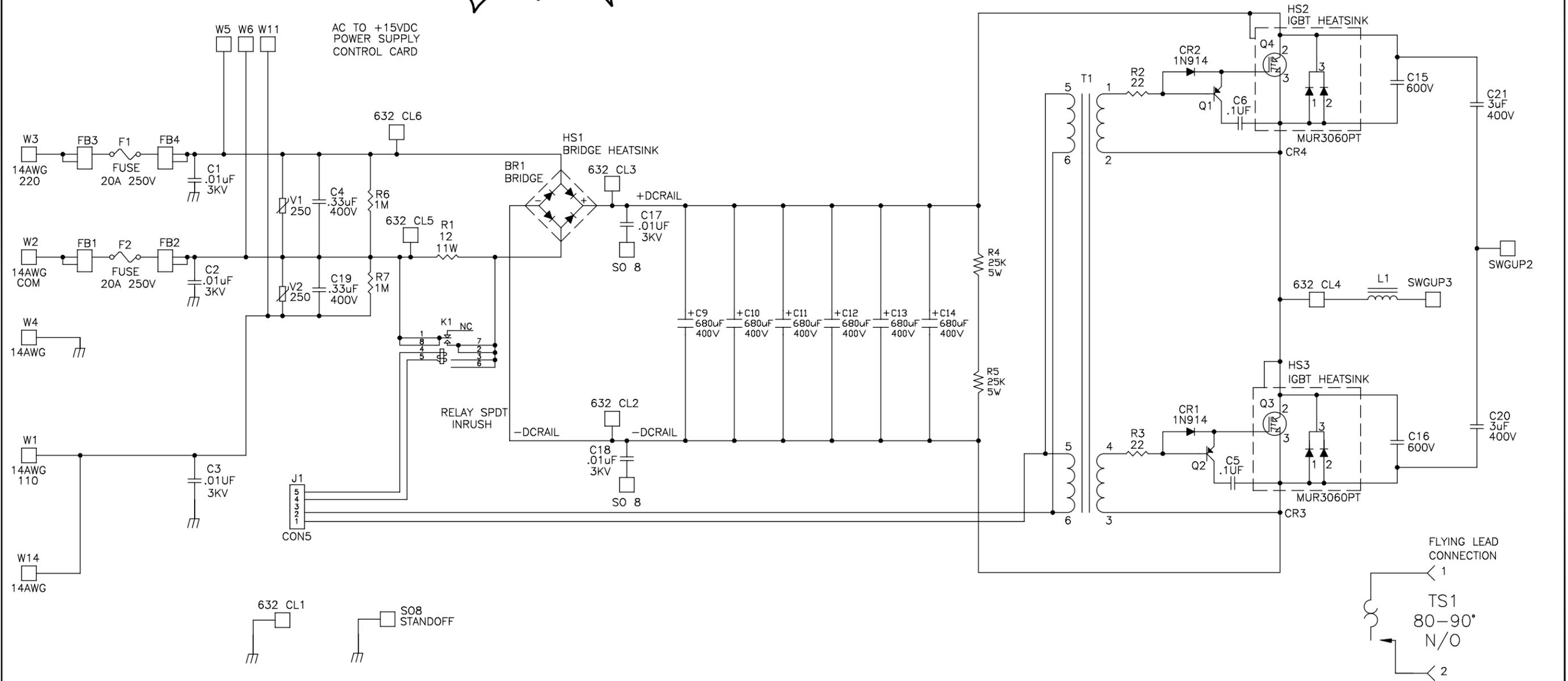
MPL:		TOL:	REL. TO MFG.	ENG. CTL.	SHEET 1 OF 1	
.X	= ± .02"	PRJ. ENG. DATE:	DWN. DATE:	DATE:	ELECTRONIC MEASUREMENTS, INC.	
.XX	= ± .01"	MFG. DATE:	CHK. DATE:	DATE:	TITLE: SCHEMATIC DIAGRAM	
.XXX	= ± .005"	DOC. REL. DATE:	ENG. DATE:	DATE:	AUX. CAP BOARD	
FRAC.	= ± 1/64"		APP. DATE:	DATE:	DWG. NO. 01-000-681	
ANGLES	= ± 1/2°				REV. A	
P/L:	493					
SCALE:	NONE					

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

APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.	0	INITIAL RELEASE 9/94	DRB	<i>[Signature]</i>
500A/102A/152A PFC	26-594-XXX	REF	1	ENG. CHG. 8/95	C.B.	<i>[Signature]</i>
				TG RELEASE 10/16/95	SE	<i>[Signature]</i>
				ECO #15257 3/4/96	CJS	<i>[Signature]</i>
				ECO #16240 3/18/97	CJS	<i>[Signature]</i>

ON PFC UNITS DO NOT MOUNT BRIDGE, HS1, R1 AND RELAY K1. ADD JUMPER IN PLACE OF R1. MOUNT Q3, Q4, CR3, CR4, HS2 AND HS3 ON TOP (COMPONENT) OF PCB.

ON NON PFC UNITS MOUNT Q3, Q4, CR3, CR4, HS2 AND HS3 ON BOTTOM OF PCB (SOLDERSIDE) F1 & F2 SHOULD BE 30A, 250V

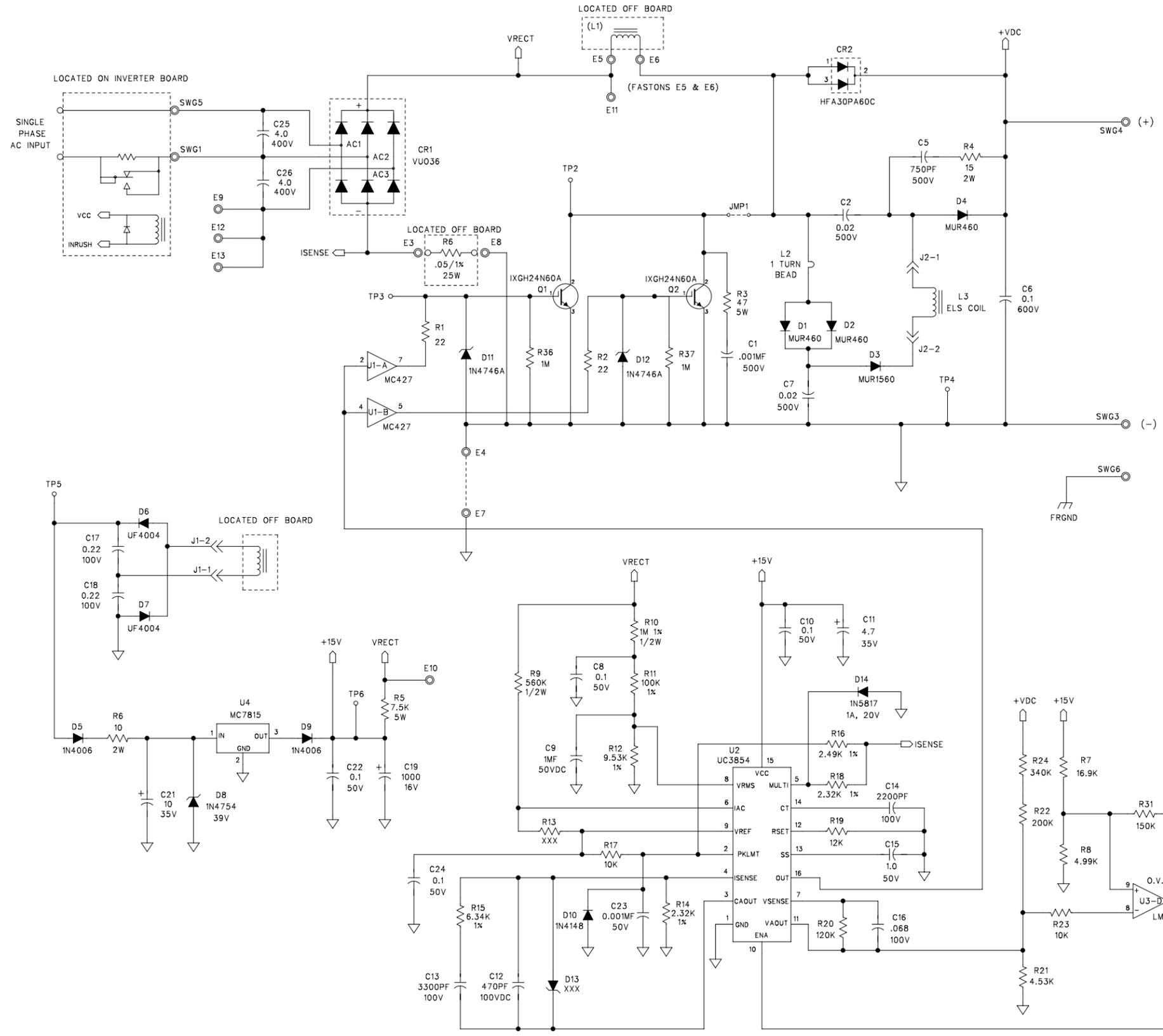


630-M148R

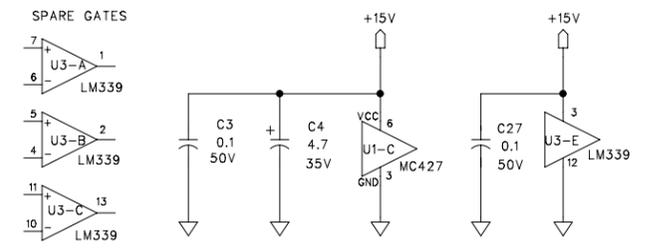
MTL:	TOL:	REL. TO MFG.	ENG. CTL.	ELECTRONIC MEASUREMENTS, INC.			
	.X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	DATE: 2/21/96 MFG. DATE: 3/7/96	DATE: 8/95 CHK: DATE: 1/10/96				
FIN:	P/L: 486	DATE: 1/10/96	DATE: 2/21/96			TITLE: SCHEMATIC DIAGRAM PCB 400V INVERTER	
	SCALE:	DO NOT SCALE DWG.	DATE: 1/10/96			DWG. NO. 01-000-682 REV. C	

PADS POWER LOGIC DRAWING.
THIS IS A STANDARD FORMAT.

LTR	DESCRIPTION	REVISIONS	
		BY/DATE	APP/DATE
1	INIT. REL.	LPN 4/29/96	WJW
2	REVISED CIRCUITRY	LPN 10/16/96	WJW
3	REVISED CIRCUITRY	LPN 1/23/97	WJW
4	COMPONENT CHANGES	2/5/97	S. AHMED
A	TG RELEASE	LPN 11/11/97	GFS
B	ECO # 19438	LPN 9/28/00	GFS
C	ECO # 19674	RFC 12/13/00	WJW
D	ECO # 20724	RFC 3/21/02	



- NOTES:
- UNLESS NOTED, ALL RESISTORS ARE 1/4W, 5% CARBON COMPOSITION WHERE K=1000, M=1000000.
 - UNLESS NOTED, ALL CAPACITORS ARE IN MICROFARADS.



PADS POWER LOGIC DRAWING.
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING S MAY NOT BE FILLED IN.

TOL: X = +/- .02 .XX = +/- .01 .XXX = +/- .005 FRAC = 1/164 ANGLES = +/- 1/2		RELEASE TO MFG PRJ.MGR: S. AHMED DATE: 11/12/97	ENG CONTROL DWN: L. NYMAN DATE: 4/15/96	ELECTRONIC MEASUREMENTS, INC. TITLE: SCHEMATIC DIAGRAM A4 PCB PFC CKT 152A VER. 3
P/L: 493	DOC.REL: GFS	DATE: 11/12/97	ENG: S. AHMED DATE: 1/27/97	PCB: 21-003-600 SHEET 1 OF 1
		APP: WJW DATE: 1/27/97	DRAWING NO: 01-000-680	REV. D