

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

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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.

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.

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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.

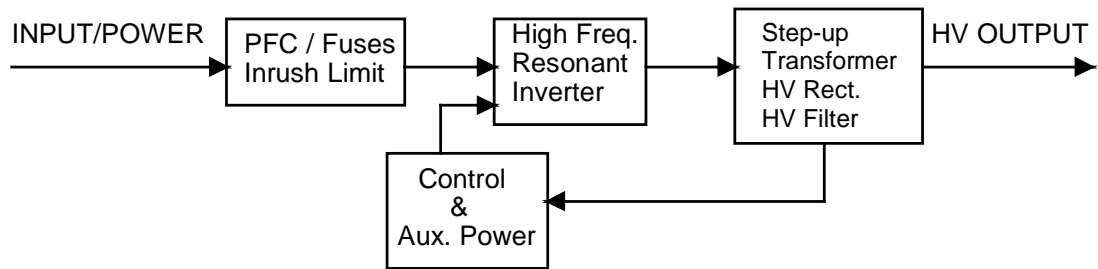


Figure 1-1 500A/102A/152A/202A Block Diagram

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. RG59
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	N/A	7A	N/A	N/A	N/A

*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% per hour after 1 hour warm up

2.13 PULSE TO PULSE REPEATABILITY

±0.2% to 300Hz. 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

The 500A, 102A, 152A power supplies are safety approved by UL to UL 60601-1: 1990+A1+A2: 1995. All of the standard supplies with output voltages between 1kV and 40kV with or without active PFC are certified UL to meet the safety requirements of UL60601-1 with the following exceptions.

1. Conducted RFI to be assessed in the installed application.
2. IEC601-1 approved isolation transformer is required to meet leakage current.

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 50ms.

2.22 ACCESSORIES

- Detachable 8 foot (2.4 meter) HV Cable
- 15 pin “D” plug mating control connector
- Operating Manual

2.23 OPTIONS

2.23.1 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.

2.23.2 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.

2.23.3 Suffix -5V

0 to +5 volt voltage (0 to full-scale output) programming. For controlling the unit VPROGRAM is 0-5V (remote pin 5). The value for VPEAK is 0-5.5V (remote pin 7) and the value for VANALOG is 0-5.5V (remote pin 8).

2.23.4 Suffix –LP

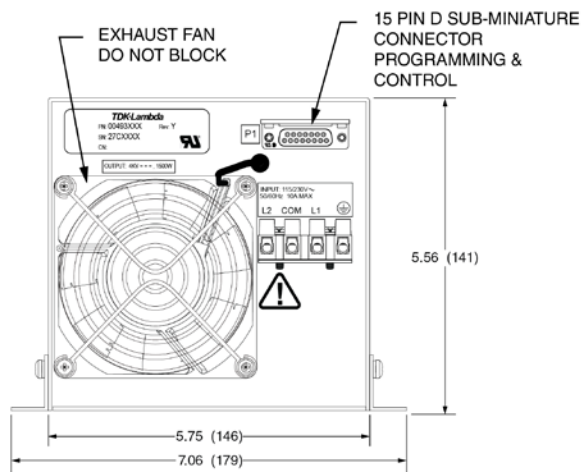
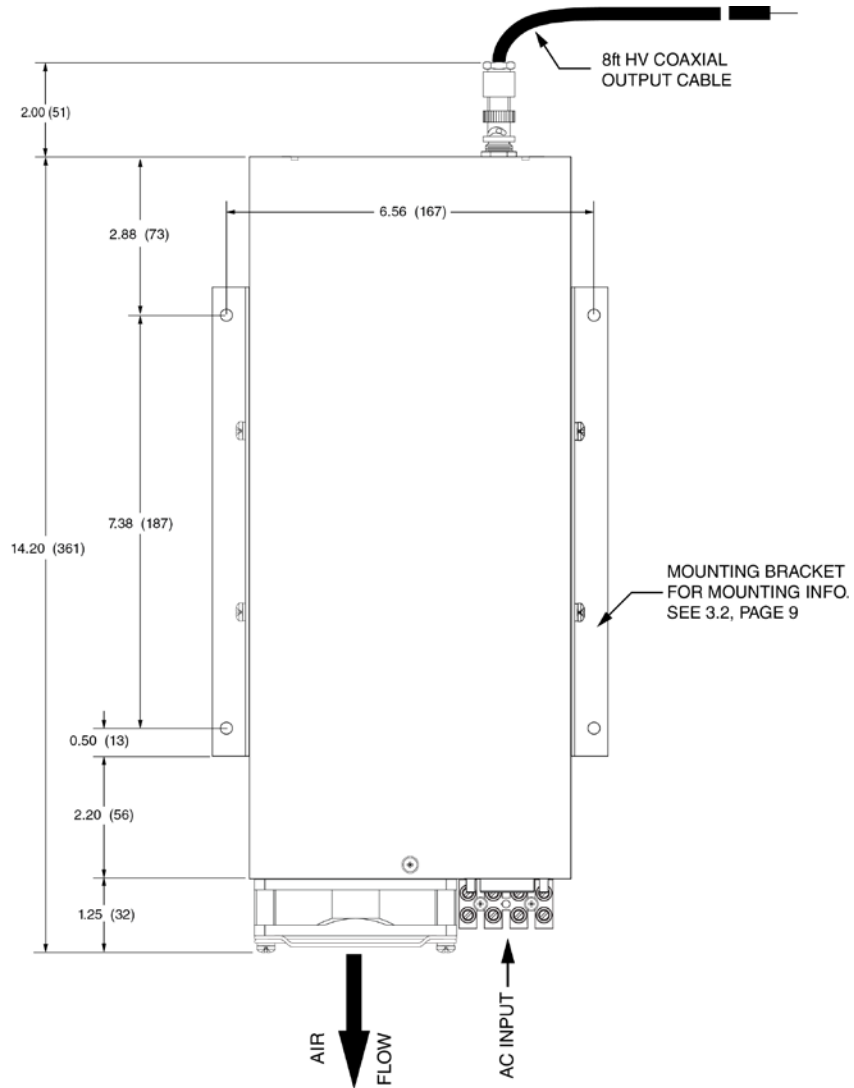
Latching overload protection.

2.23.5 SUFFIX -110

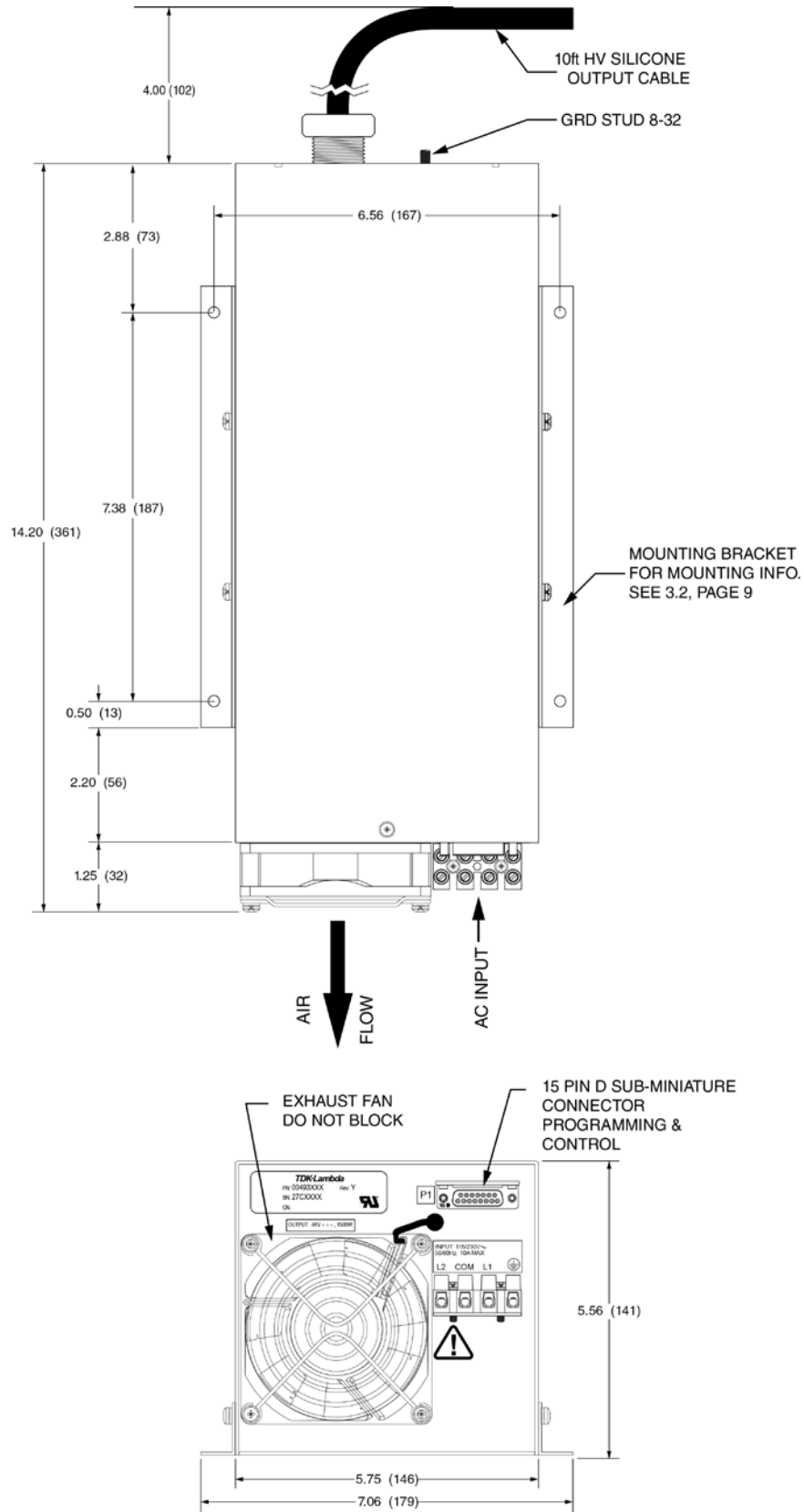
100 to 120 VAC input option (availability limited).

2.24 ORIENTATION

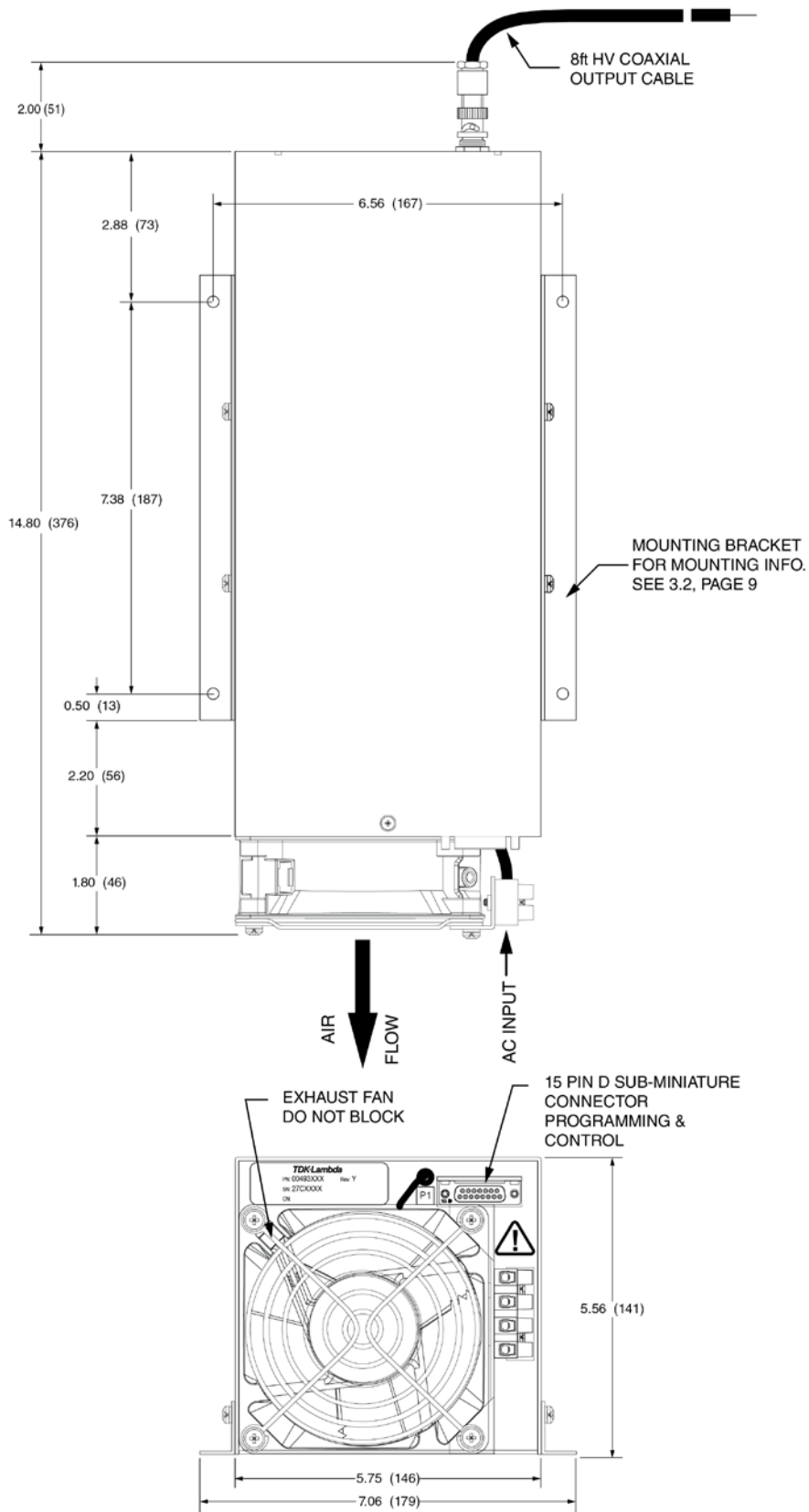
Power supplies >6kV with a oil-filled H.V. section must be operated in an upright position. i.e., with the mounting bracket parallel to the ground plane.



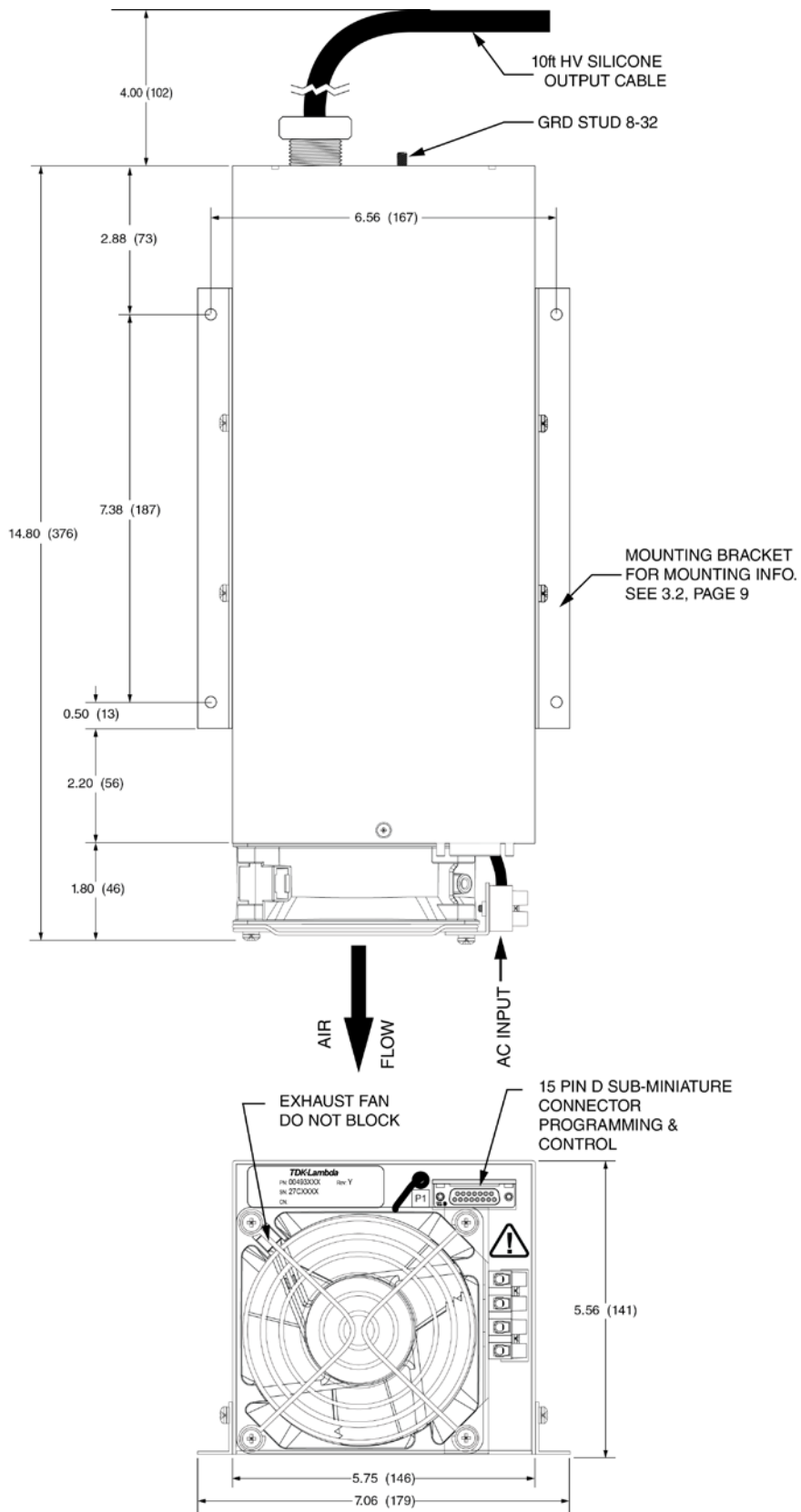
**Figure 2-1 Mechanical Dimensions for 500A, 102A, 152A Outputs up to 6kV
(for grounding instructions see SECTION 3.6)**



**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 contains the following items: power supply, HV output cable, male 15-pin “D” remote control mating connector, mounting bracket and operator’s manual. Examine the items immediately for damage. Locate the serial number label on the end 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 using the four PHMS 8-32NC X 0.250 screws included. Using longer screws may internal components to ground, causing permanent damage to power supply. The power supply can also operate on a bench or table top. Power supplies above 6kV with an oil-filled H.V. section must be operated in an 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 (102mm) to minimize stress on the insulation and at least 4 inches (102mm) of clearance at the inlet of the power supply and 2 inches (51mm) 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.

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.

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 may be connected to either 115VAC for 230VAC input voltage (See table 2.2 for availability). 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.

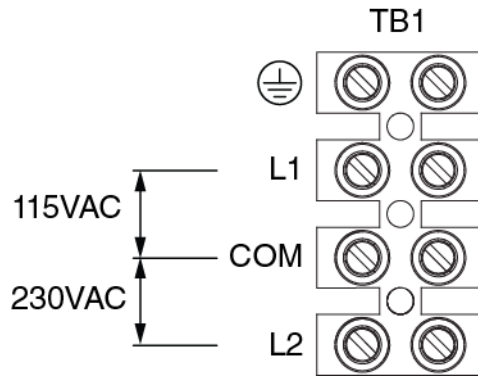


Figure 3-1 Input AC Power Connection NON-PFC Version

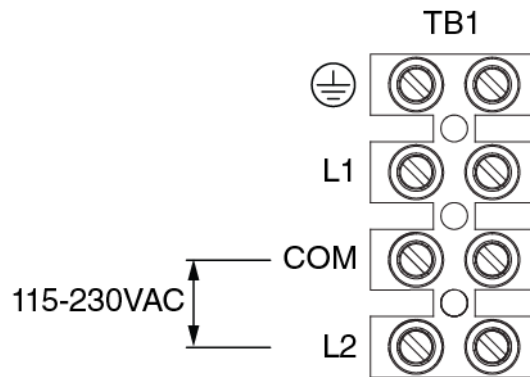


Figure 3-2 Input AC Power Connection, PFC Version

The 500A, 102A, 152A power supplies are safety approved by UL to UL60601-1. An IEC601-1 approved isolation transformer is required to meet leakage current.

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 damage.

Keep the HV cable bend radius greater than 4 inches (102mm) 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 or the TDK-Lambda High Power online application notes 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.

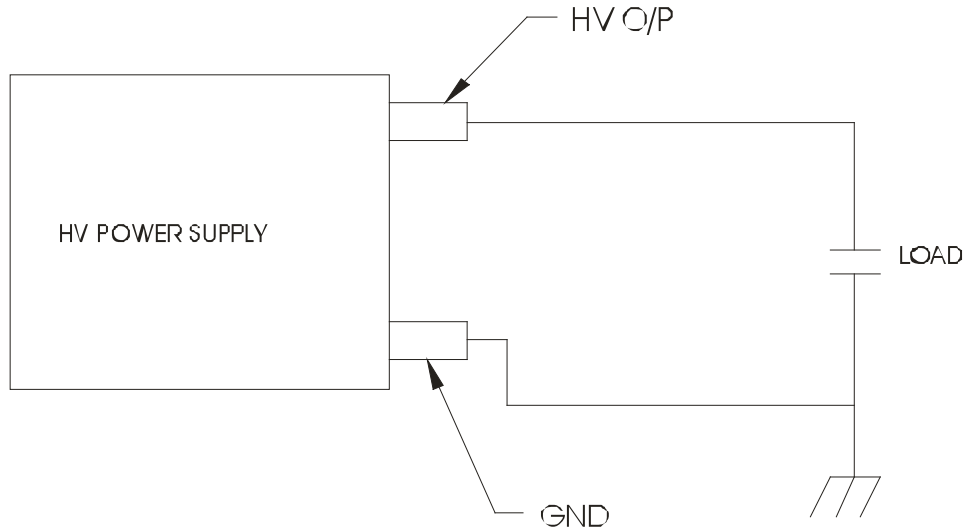


Figure 3-3 Output Ground Connection

3.6.3 FOR UNITS WITH O/P VOLTAGE \leq 6kV

The ground connection is made via the shield of the RG59 coaxial HV output cable provided with the supply.

3.6.4 FOR UNITS WITH O/P VOLTAGE $>$ 6kV:

The ground connection between the load and the supply must be made with a separate wire to the 8-32 UNC, $\frac{1}{2}$ " 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	VPROGRAM	INPUT	A 0-10V signal with respect to ground at this pin programs the output voltage proportionally from zero to rated output. For a “-5V” option the unit VPROGRAM is 0-5V.
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. For a “-5V” option the value for VPEAK is 0-5.5V.
8	VANALOG	OUTPUT	0-10V analog of output charging voltage waveform. For a “-5V” option the value for VANALOG is 0-5.5V (remote pin 8).
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	INHIBIT LED displays the logical OR of all the internal and external signals that prevent HV output current, including EOC, EXTERNAL INHIBIT, OVERLOAD, and any fault.
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

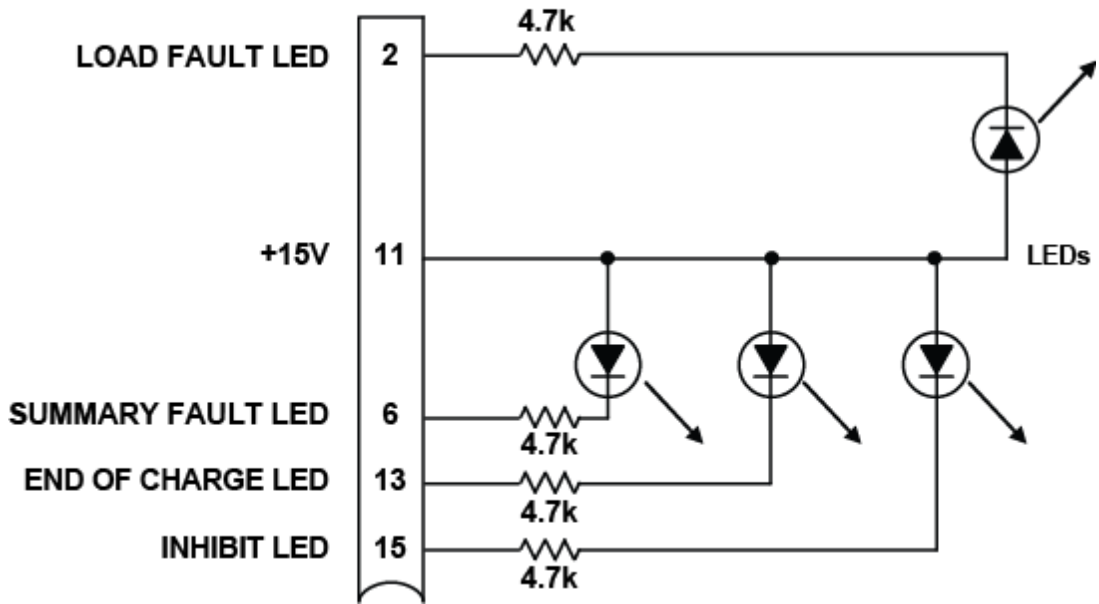
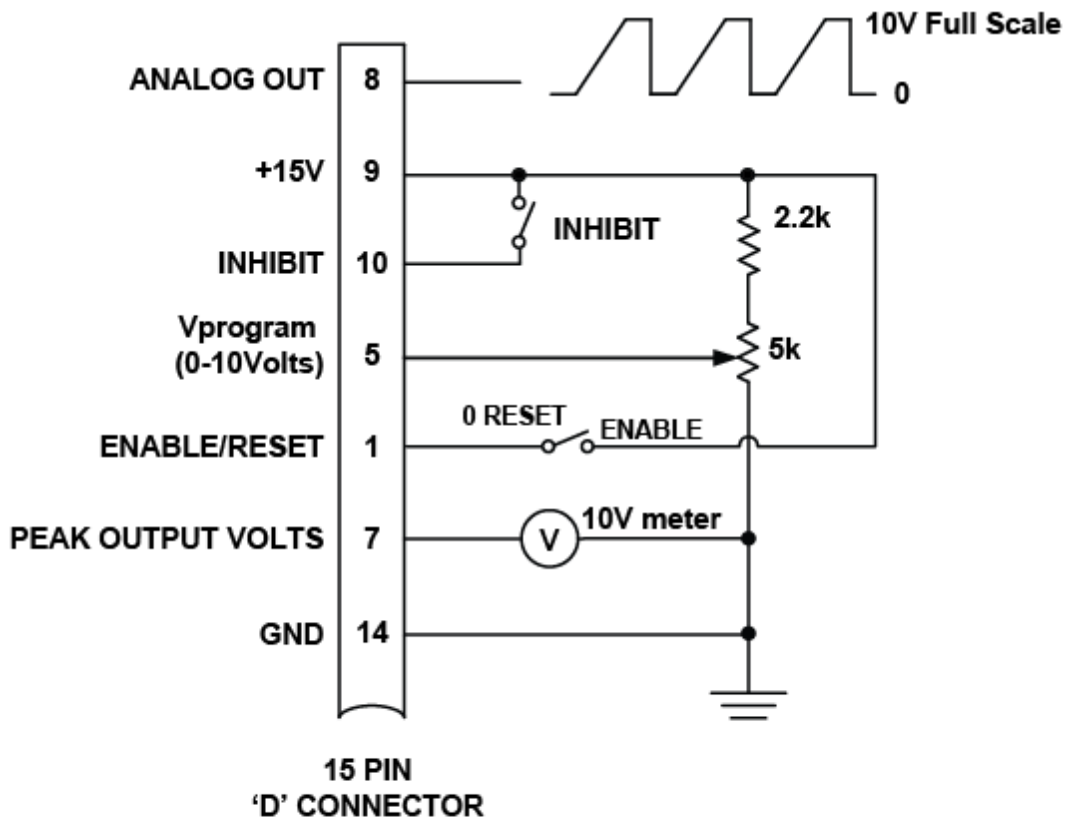
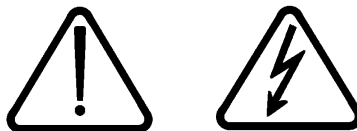


Figure 4-1 Example of Interface Connection

4.2 OUT-OF-BOX-INSPECTION



LETHAL VOLTAGES PRESENT

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

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

4.2.2 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. This test is described below.

4.2.2.1 TEST 1

Purpose: Verify general overload operation.

1. With AC power "OFF" and disconnected, short the H.V. output by connecting the center conductor of the output cable to its return shield (or ground). This dead short forces the unit to generate full output current at zero voltage.
2. Set the output voltage control to zero. Connect the AC power to the unit. Turn the AC power "ON".
3. Turn the H.V. on and turn up the H.V. control until the power supply is generating output current into the dead short. 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 (500mS on and 500mS off). The power supply will go into overload when max. current is drawn for more than half a second.
4. Turn off the H.V. and A.C. power.

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

4.2.2.2 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 502A/102A/152A/202A 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. Turn the voltage control all the way down to zero, apply AC power and turn the HV ON. By turning up the H.V. control knob the capacitor will charge to the programmed voltage. The power supply may be turned all the way up to its maximum output voltage provided the load capacitor is sufficiently rated.

4. By turning the voltage control down or turning the H.V. OFF, the capacitor will "bleed" down through the internal voltage divider resistors used for regulation feedback.

NOTE: 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.

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. If equipped with an oil-filled tank this assembly should not be opened unless. This oil filled tank has been hermetically sealed at the factory. Opening the supply or the assembly will void the factory warranty, and may compromise performance.

4.3 CONTACTING TDK-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: hp.service@us.tdk-lambda.com

Fax: (732) 922-5403

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.

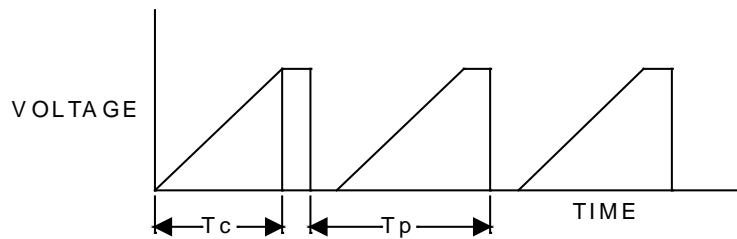
At the discretion of TDK-Lambda Americas, the customer may be granted permission to break the warranty seal and open the chassis covers. Customer Service shall confirm the permission by sending a replacement seal. Once the unit has been serviced, the customer shall close the cover and apply the replacement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

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 under damped 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.

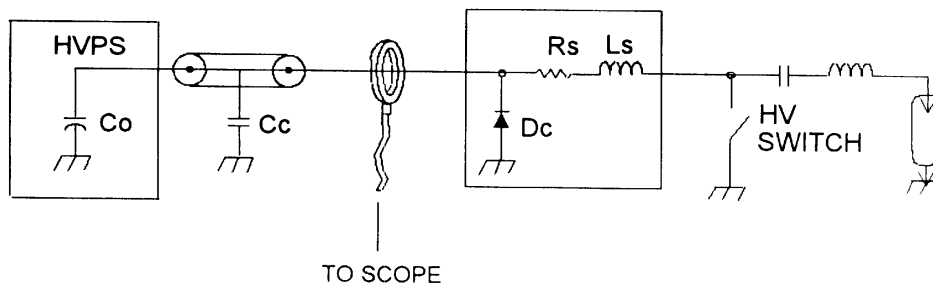


Figure 5-2 Output Current Measurement

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

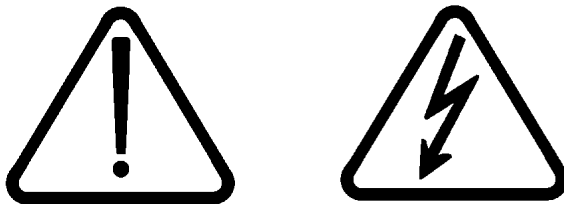
5.3 PARALLELING UNITS

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 at 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. De-rating 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.

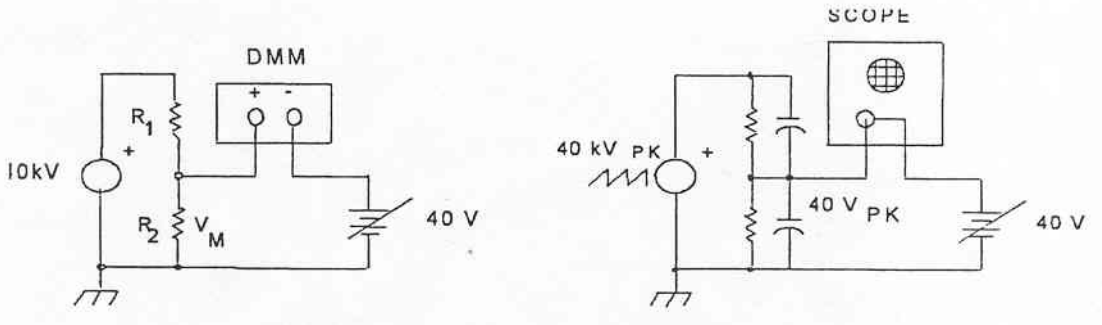


Figure 5-3 HV Bias Measurements

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.

$$\Delta V_{PK - PK} = \frac{1.4(Po \max)}{Vo(Co)(Fs)}$$

Where: Po max = Maximum output power in watts

Vo = Output voltage in volts

Co = Total output capacitance in microfarads

Fs = Lowest switching frequency (40KHz)

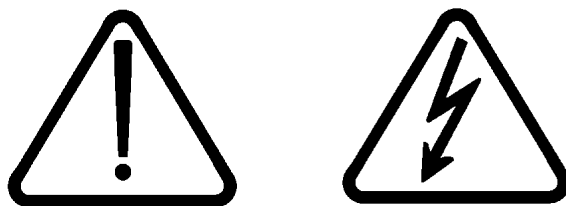
When operating as a DC supply care must be taken not to draw more than the J/sec rating of the unit.

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.

A special long charge programming adaptor is available for applications with charge times greater than 500 milliseconds. Visit the TDK-Lambda High Power website or contact customer service for details.



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 trim pot. 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.

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SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: UNIVOLT N 61 B
Product Description: Base Oil and Additives
Product Code: 201580102520, 730846-00, 97P847
Intended Use: Electrical insulating oils

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
22777 Springwoods Village Parkway
Spring, TX. 77389 USA

24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300 or 703-527-3887 CHEMTREC
Product Technical Information 800-662-4525
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 HAZARDS IDENTIFICATION

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

CLASSIFICATION:

Aspiration toxicant: Category 1.

LABEL:

Pictogram:



Signal Word: Danger

Hazard Statements:

H304: May be fatal if swallowed and enters airways.

Precautionary Statements:

P273: Avoid release to the environment. P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P391: Collect spillage. P405: Store locked up. P501: Dispose of contents and container in accordance with local regulations.

Other hazard information:

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HAZARD NOT OTHERWISE CLASSIFIED (HNOC): None as defined under 29 CFR 1910.1200.

PHYSICAL / CHEMICAL HAZARDS

No significant hazards.

HEALTH HAZARDS

Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis. May be irritating to the eyes, nose, throat, and lungs.

ENVIRONMENTAL HAZARDS

Expected to be toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

NFPA Hazard ID:	Health: 1	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 1*	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 3	COMPOSITION / INFORMATION ON INGREDIENTS
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This material is defined as a mixture.

Hazardous Substance(s) or Complex Substance(s) required for disclosure

Name	CAS#	Concentration*	GHS Hazard Codes
2,6-DI-TERT-BUTYL-P-CRESOL	128-37-0	1 - < 5%	H400(M factor 1), H410(M factor 1)
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	90 - < 100%	H304

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

As per paragraph (i) of 29 CFR 1910.1200, formulation is considered a trade secret and specific chemical identity and exact percentage (concentration) of composition may have been withheld. Specific chemical identity and exact percentage composition will be provided to health professionals, employees, or designated representatives in accordance with applicable provisions of paragraph (i).

SECTION 4	FIRST AID MEASURES
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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.

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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]: >145°C (293°F) [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
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NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National 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 the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders.

For emergency responders: Respiratory protection: respiratory protection will be necessary only in special cases, e.g., formation of mists. Half-face or full-face respirator with filter(s) for dust/organic vapor or Self Contained Breathing Apparatus (SCBA) can be used depending on the size of spill and potential level of

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exposure. If the exposure cannot be completely characterized or an oxygen deficient atmosphere is possible or anticipated, SCBA is recommended. Work gloves that are resistant to hydrocarbons are recommended. Gloves made of polyvinyl acetate (PVA) are not water-resistant and are not suitable for emergency use. Chemical goggles are recommended if splashes or contact with eyes is possible. Small spills: normal antistatic work clothes are usually adequate. Large spills: full body suit of chemical resistant, antistatic material is recommended.

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
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HANDLING

Avoid contact with skin. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source). When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations). Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Consult local applicable standards for guidance. Additional references include American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practice on Static Electricity) or CENELEC CLC/TR 50404 (Electrostatics - Code of practice for the avoidance of hazards due to static electricity).

Static Accumulator: This material is a static accumulator.

STORAGE

The container choice, for example storage vessel, may effect static accumulation and dissipation. Do not store in open or unlabelled containers.

SECTION 8	EXPOSURE CONTROLS / PERSONAL PROTECTION
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EXPOSURE LIMIT VALUES

Exposure limits/standards (Note: Exposure limits are not additive)

Substance Name	Form	Limit / Standard		NOTE	Source
2,6-DI-TERT-BUTYL-P-CRESOL	Inhalable fraction and	TWA	2 mg/m3	N/A	ACGIH

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	vapor					
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m ³		N/A	OSHA Z1
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Inhalable fraction.	TWA	5 mg/m ³		N/A	ACGIH
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m ³		N/A	ACGIH

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 (inhalable fraction), 5 mg/m³ - OSHA PEL.

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

No biological limits allocated.

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. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. 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:

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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

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

GENERAL INFORMATION

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

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.883
Flammability (Solid, Gas): N/A
Flash Point [Method]: >145°C (293°F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D
Autoignition Temperature: >315°C (599°F)
Boiling Point / Range: N/A
Decomposition Temperature: N/D
Vapor Density (Air = 1): > 5 at 101 kPa [Estimated]
Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 °C [Estimated]
Evaporation Rate (n-butyl acetate = 1): N/D
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): > 6.5 [Estimated]
Solubility in Water: Negligible
Viscosity: 8.18 cSt (8.18 mm²/sec) at 40 °C | 2.18 cSt (2.18 mm²/sec) at 100°C
Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: -55°C (-67°F)
Pour Point: -40°C (-40°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10 STABILITY AND REACTIVITY

REACTIVITY: See sub-sections below.

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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.

POSSIBILITY OF HAZARDOUS REACTIONS: Hazardous polymerization will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION
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INFORMATION ON TOXICOLOGICAL EFFECTS

<u>Hazard Class</u>	<u>Conclusion / Remarks</u>
Inhalation	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Elevated temperatures or mechanical action may form vapors, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs.
Ingestion	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin Corrosion/Irritation: No end point data for material.	May dry the skin leading to discomfort and dermatitis. Based on assessment of the components.
Eye	
Serious Eye Damage/Irritation: No end point data for material.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.
Sensitization	
Respiratory Sensitization: No end point data for material.	Not expected to be a respiratory sensitizer.
Skin Sensitization: No end point data for material.	Not expected to be a skin sensitizer. Based on assessment of the components.
Aspiration: Data available.	May be fatal if swallowed and enters airways. Based on physico-chemical properties of the material.
Germ Cell Mutagenicity: No end point data for material.	Not expected to be a germ cell mutagen. Based on assessment of the components.
Carcinogenicity: No end point data for material.	Not expected to cause cancer. Based on assessment of the components.
Reproductive Toxicity: No end point data for material.	Not expected to be a reproductive toxicant. Based on assessment of the components.
Lactation: No end point data for material.	Not expected to cause harm to breast-fed children.
Specific Target Organ Toxicity (STOT)	
Single Exposure: No end point data for material.	Not expected to cause organ damage from a single exposure.
Repeated Exposure: No end point data for material.	Not expected to cause organ damage from prolonged or repeated exposure. Based on assessment of the components.

TOXICITY FOR SUBSTANCES

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NAME	ACUTE TOXICITY
2,6-DI-TERT-BUTYL-P-CRESOL	Oral Lethality: LD50 0.89 g/kg (Rat)

OTHER INFORMATION

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.

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

--REGULATORY LISTS SEARCHED--

1 = NTP CARC
2 = NTP SUS

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 -- Expected to be toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

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.

Product Name: UNIVOLT N 61 B

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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.

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. Protect the environment. Dispose of used oil at designated sites. Minimize skin contact. Do not mix used oils with solvents, brake fluids or coolants.

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 Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. **DO NOT PRESSURISE, 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.**

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

Marine Pollutant: No

AIR (IATA): Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION
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OSHA HAZARD COMMUNICATION STANDARD: This material is considered hazardous in accordance with OSHA HazCom 2012, 29 CFR 1910.1200.

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Listed or exempt from listing/notification on the following chemical inventories: AICS, DSL, ENCS, IECSC, KECI, PICCS, TSCA

EPCRA SECTION 302: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: Immediate Health. 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
2,6-DI-TERT-BUTYL-P-CRESOL	128-37-0	1, 13, 16, 17, 18
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	1, 4, 13, 17, 18

--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

KEY TO THE H-CODES CONTAINED IN SECTION 3 OF THIS DOCUMENT (for information only):

H304: May be fatal if swallowed and enters airways; Aspiration, Cat 1

H400: Very toxic to aquatic life; Acute Env Tox, Cat 1

H410: Very toxic to aquatic life with long lasting effects; Chronic Env Tox, Cat 1

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Updates made in accordance with implementation of GHS requirements.

 The information and recommendations contained herein are, to the best of ExxonMobil's knowledge and belief, accurate and reliable as of the date issued. You can contact ExxonMobil to insure that this document is the most current available from ExxonMobil. The information and recommendations are offered for the user's consideration and examination. It is the user's responsibility to satisfy itself that the product is suitable for the intended use. If buyer repackages this product, it is the user's responsibility to insure proper health, safety and other necessary information is

Product Name: UNIVOLT N 61 B

Revision Date: 16 Mar 2015

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included with and/or on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, re-publication or retransmission of this document, in whole or in part, is not permitted. The term, "ExxonMobil" is used for convenience, and may include any one or more of ExxonMobil Chemical Company, Exxon Mobil Corporation, or any affiliates in which they directly or indirectly hold any interest.

Internal Use Only

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

PPEC: C

DGN: 2011629XUS (548632)

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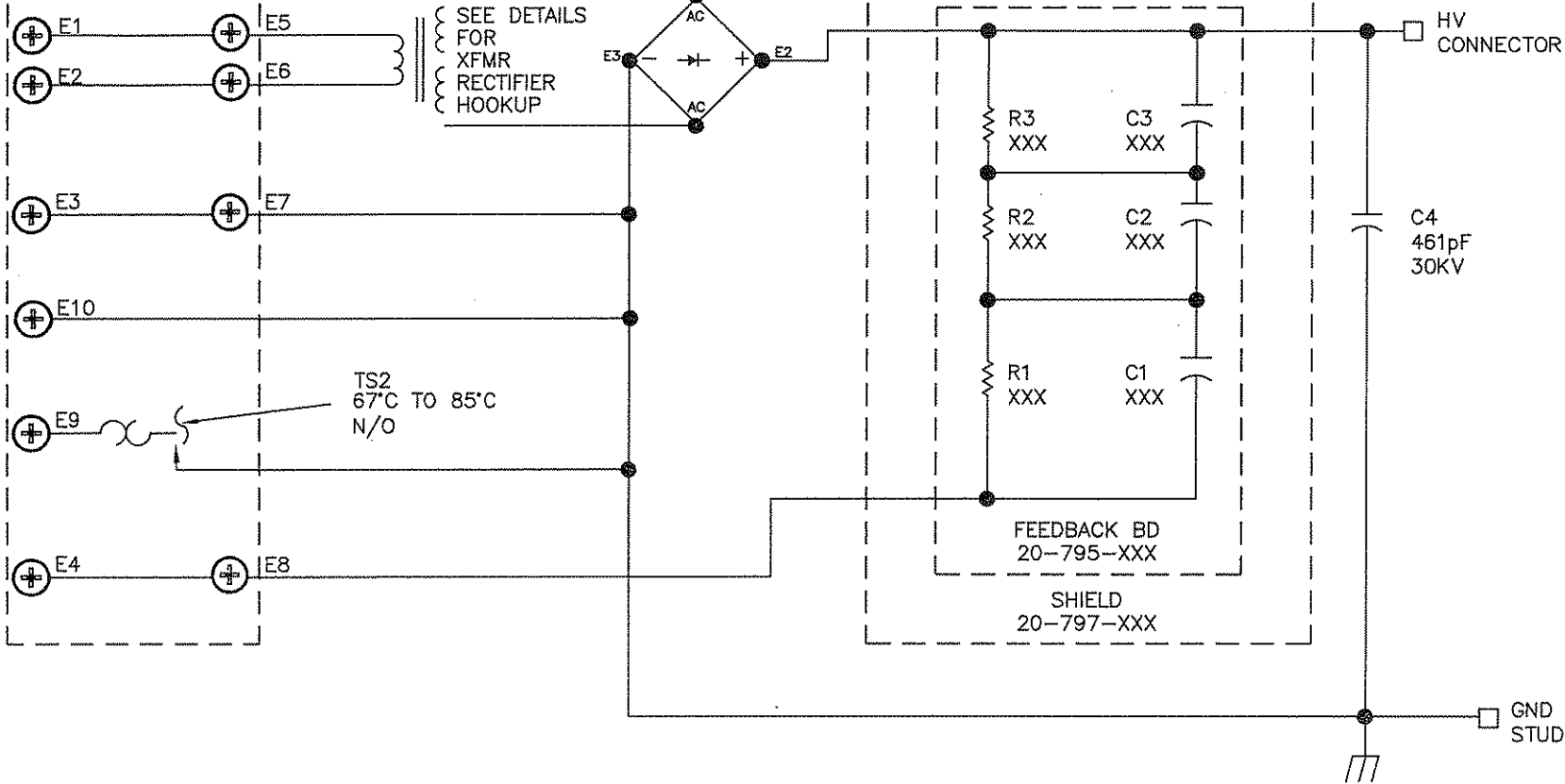
THIS IS A COMPUTER GENERATED DWG.
NO MANUAL REVISIONS ARE PERMITTED.

COVER BOARD
20-005-900

T1
HV

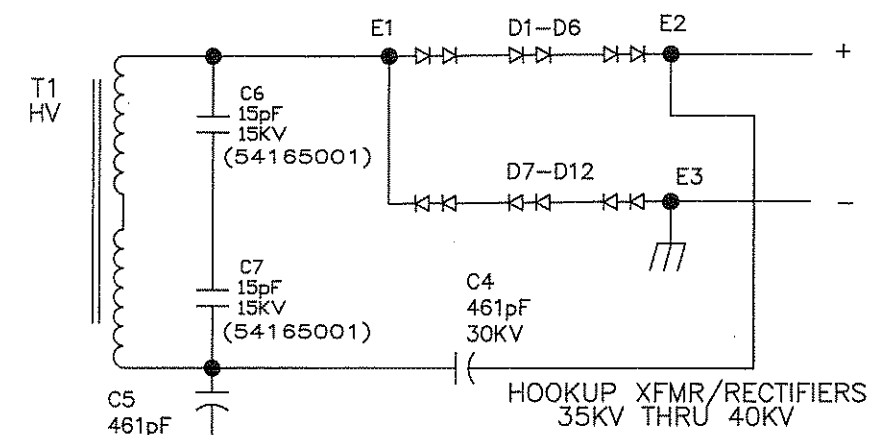
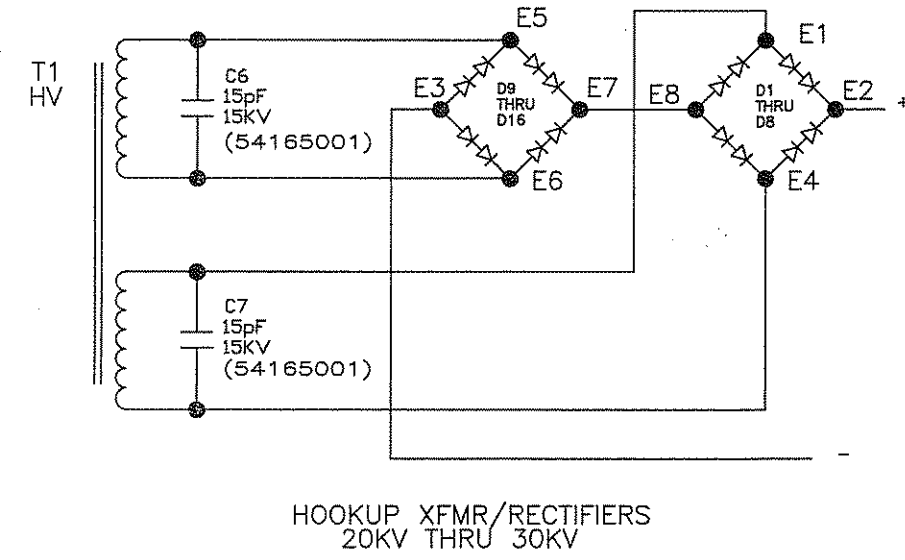
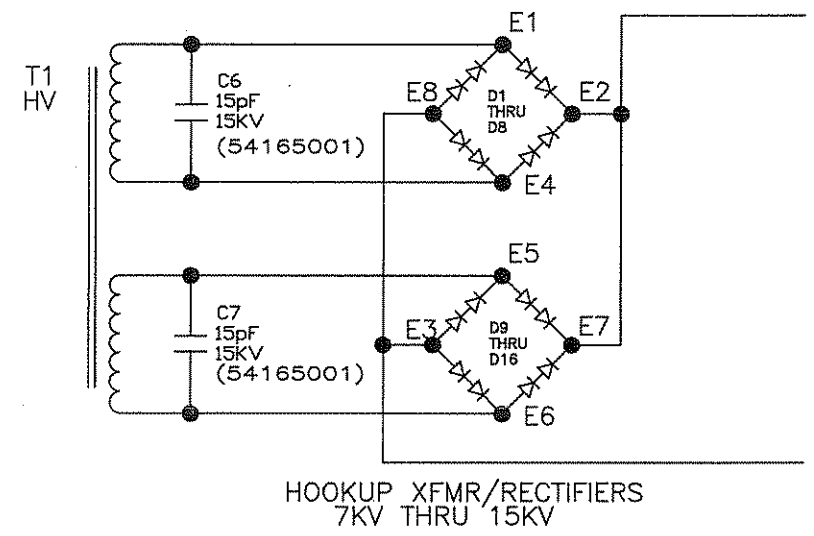
RECTIFIER BD
20-796-XXX

SEE DETAILS FOR
XFMR
RECTIFIER
HOOKUP



ADD C6 AND C7 PER BOM
ON 152A AND 102A.

USED ON	APPLICATION	QTY.	LTR	E.C.O. NO.	BY
152A	26-596-XXX	REF	1	INITIAL RELEASE 02/21/95	SAdB
102A	26-597-XXX	REF	2	ADD 15pF CAPS 8/95	CB
500A	26-598-XXX	REF	A	TG REL 10/16/95	SE
			B	ECO #16240 3/19/97	CJS
			C	ECO #21341 7/23/04	LWR



OUTPUT
KV

FEED BACK BOARD

RECTIFIER BOARD

OUTPUT KV	C1	C2	C3	R1	R2	R3	DIODES	QTY	W1	W2	W3
10KV	OMIT	15pF	OMIT	JUMPER	50M X2 PAR	JUMPER	X100FG	16		X	X
15KV	OMIT	15pF	OMIT	JUMPER	50M X2 PAR	JUMPER	X100FG	16		X	X
20KV	15pF	OMIT	15pF	50M X2 PAR	JUMPER	50M X2 PAR	X100FG	16	X		
25KV	15pF	OMIT	15pF	50M X2 PAR	JUMPER	50M X2 PAR	X100FG	16	X		
30KV	15pF	OMIT	15pF	50M	JUMPER	50M	X100FG	16	X		
35KV	15pF	15pF	15pF	50M	50M	50M	X100FG	12		DOUBLER PCB	
40KV	15pF	15pF	15pF	50M	50M	50M	X100FG	12		DOUBLER PCB	

HOOKUP XFMR/RECTIFIERS
20KV THRU 30KV

HOOKUP XFMR/RECTIFIERS
35KV THRU 40KV

SHEET 1 OF 1

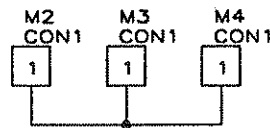
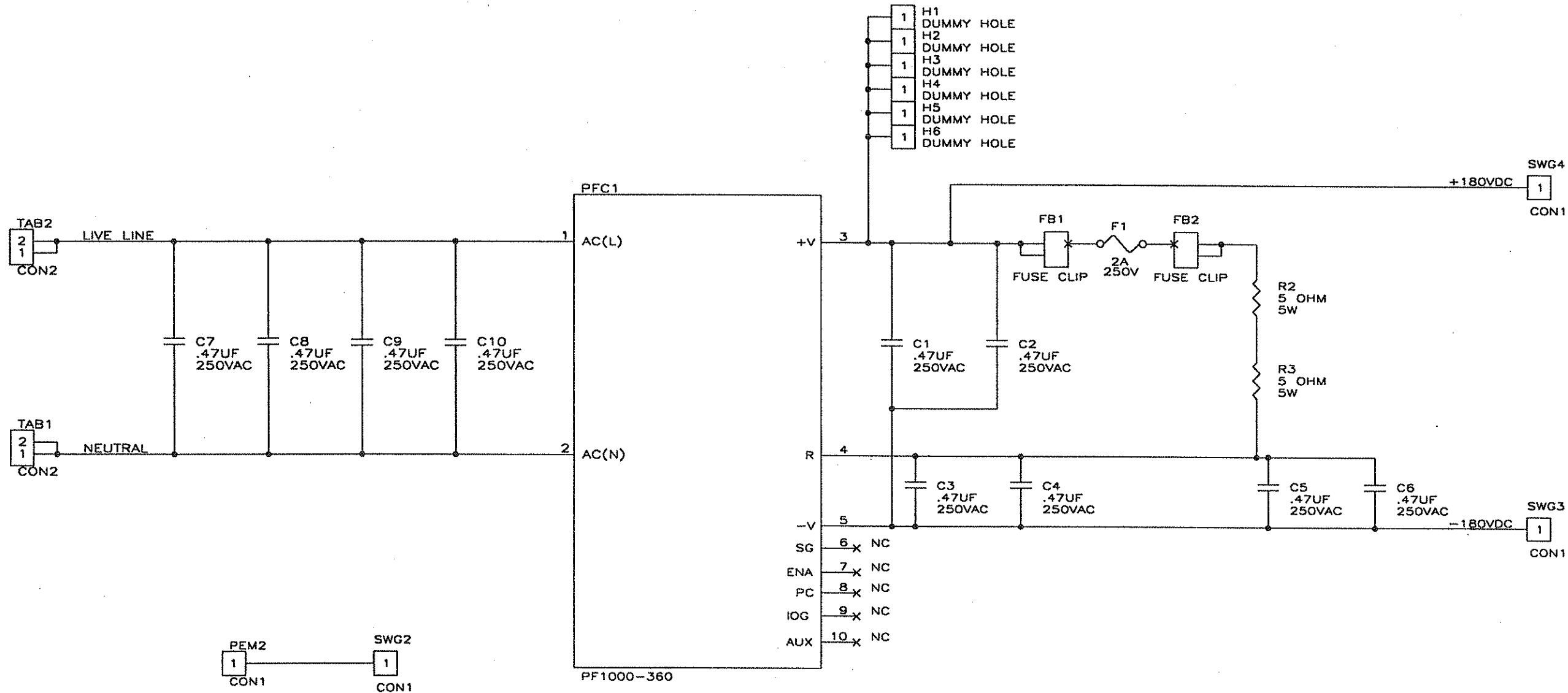
MTL:	TOL: X = ±.02" XX = ±.01" XXX = ±.005" FRAC. = ±1/64" ANGLES = ±1/2°	REL. TO MFG. DATE: 12/28/95 CHK: SAdB	ENG. CTL. DATE: 02/20/95 CHK: JJR	LAMBDA EMI
FIN:	P/L: 493	DOC. REL. DATE: 12/5/95 CHK: JJR	DATE: 02/21/95 CHK: JJR	TITLE: SCHEMATIC DIA HIGH VOLTAGE TANK 7KV & UP NEW CAP CHARGER
	SCALE: NONE	DATE: 02/17/95	DATE: 02/17/95	DWG. NO. 01-000-562 REV. C

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

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.	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	<i>[Signature]</i>
			C	ECO #16204 3/26/97	CJS	<i>[Signature]</i>

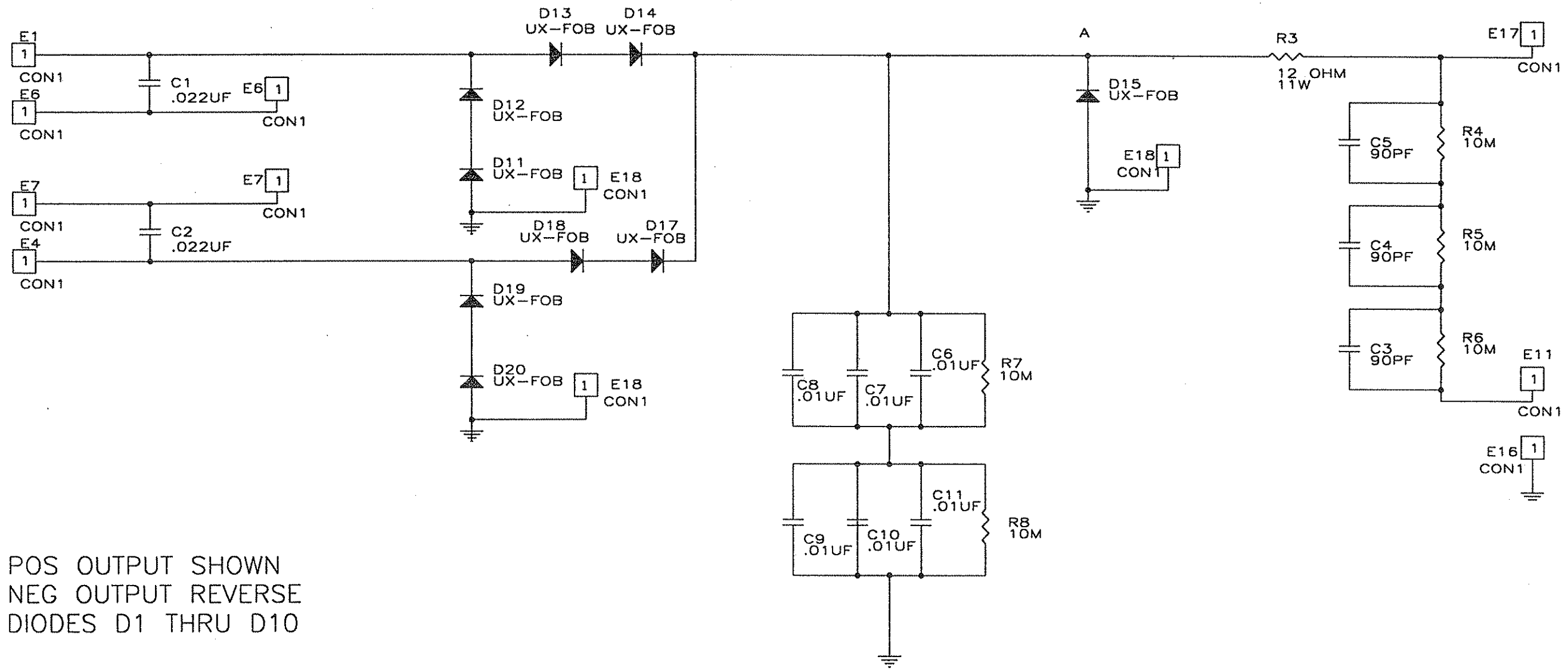


SHEET 1 OF 1

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



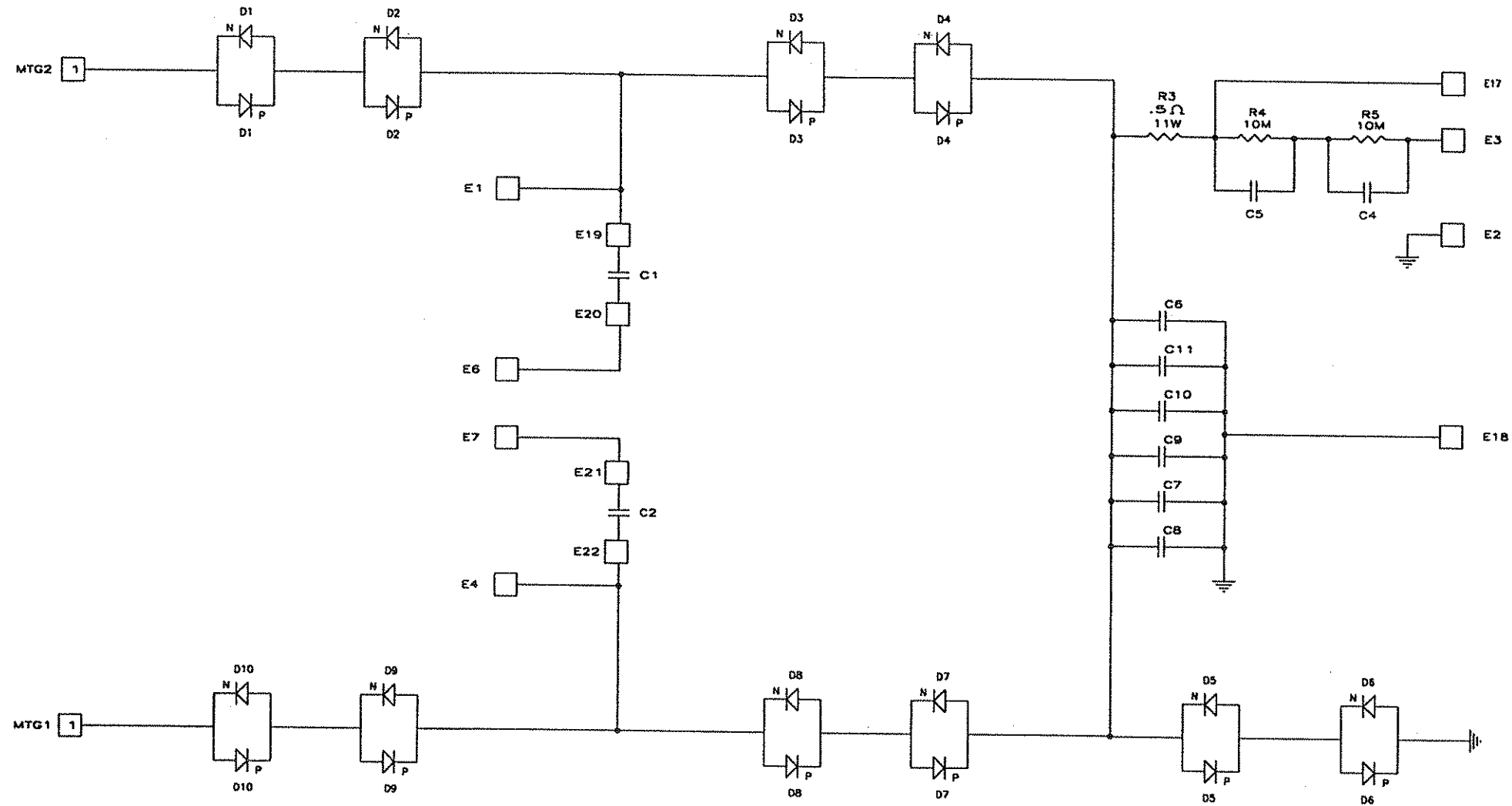
POS OUTPUT SHOWN
NEG OUTPUT REVERSE
DIODES D1 THRU D10

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	DATE: 09/12/94		
FIN:	P/L: 493	DATE: 8/8/95	DATE: 02/20/95	102A-152A-500A 3.1KV TO 6KV	DWG. NO. 01-000-596
	SCALE: NONE	DATE: 6/21/95	DATE: 02/21/95		

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

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



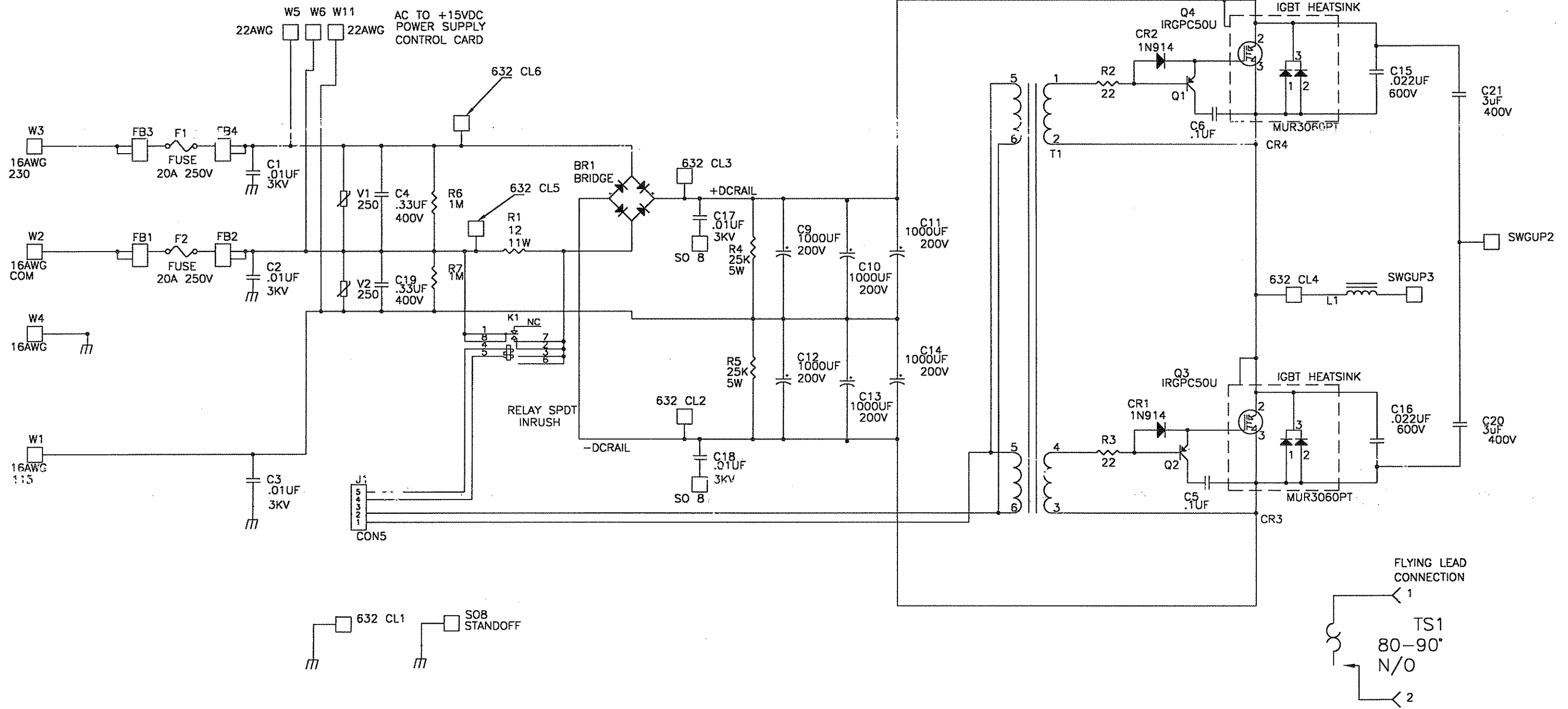
SHEET 1 OF 1

MTL:	TOL: .X = ± .02" .XX = ± .01" .XXX = ± .005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. TO MFG. DATE: 11/3/95 MFG: R. Kovacs 11/5/95	ENG. CTL. DWN: DRB 02/16/95 CHK: JSR 2/20/95	 ELECTRONIC MEASUREMENTS, INC.
FIN:	P/L: 493	DATE: 10/26/95	DATE: 2/21/95	
SCALE: NONE	NOT SCALE DWG.	DATE: 2/21/95	DATE: 2/21/95	
TITLE: HV OUTPUT 102A,152A & 202A 500V TO 3KV				DWG. NO. 01-000-601
				REV. B

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

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

ON PFC UNITS
REMOVE BRIDGE & HS1,R1
AND RELAY K1.
ADD JUMPER IN PLACE OF R1

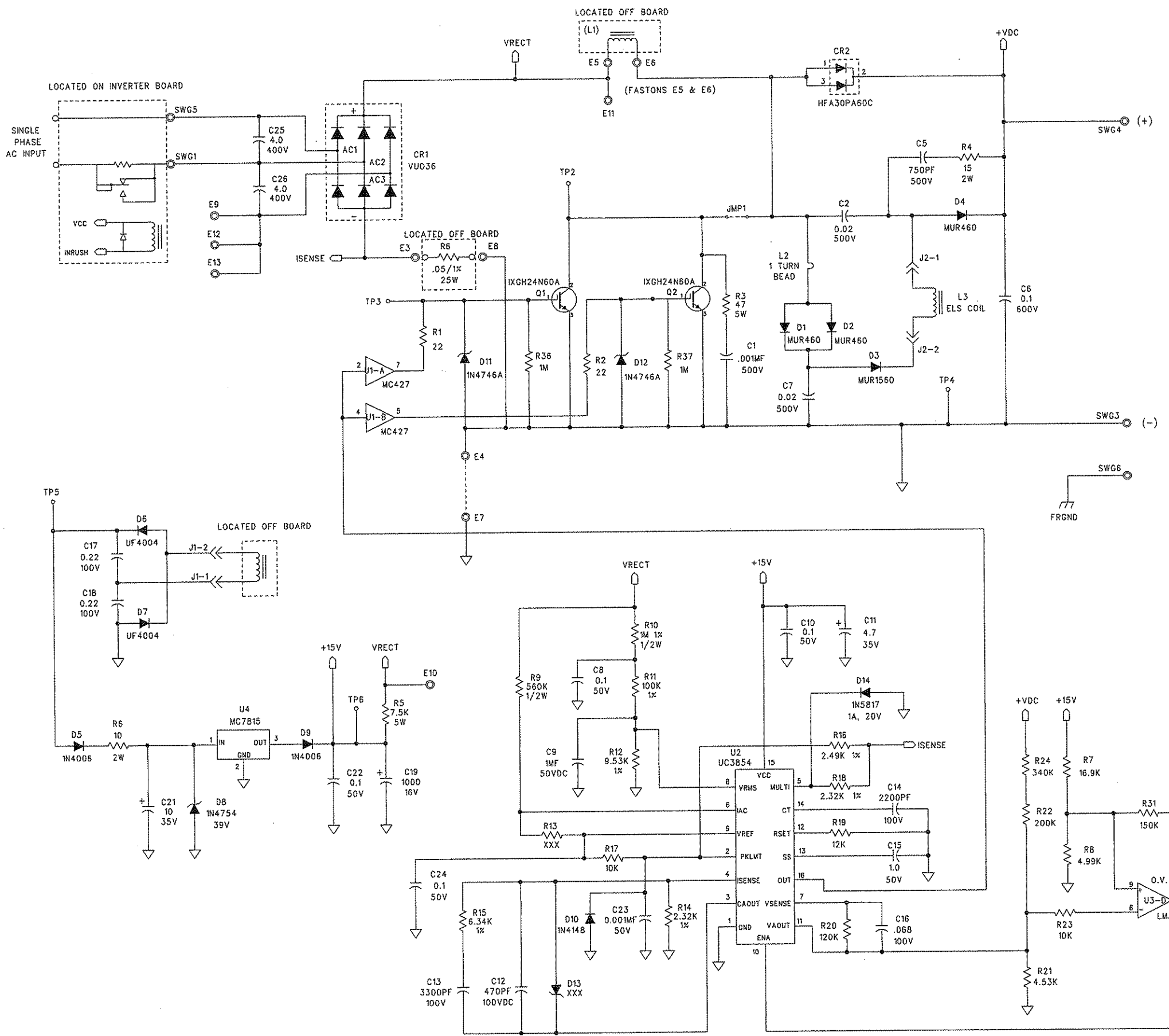


AUTOCAD DRAWING
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING AND MAY NOT BE FILLED IN.

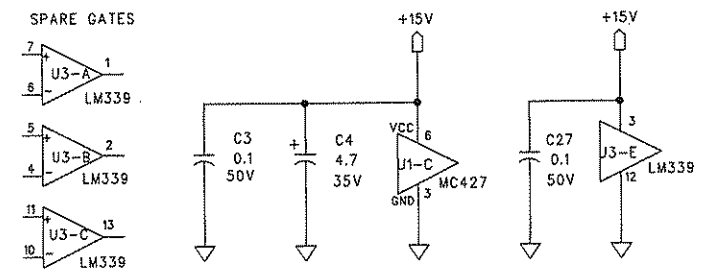
REL. TO MFG.	ENG. CTL.	LAMBDA EMI	
DATE: 2/21/95	DATE: DRB 01/10/95	TITLE: SCHEMATIC DIAGRAM PCB A2 INVERTER (VER-2) 500A, 102A, 152A	
DATE: 10/23/95	DATE: 02/21/95		
P/L: 493	SCALE: NONE	DATE: 02/17/95	DWG. NO. 01-000-625

PADS POWER LOGIC DRAWING.
THIS IS A STANDARD FORMAT.

REVISIONS			
LTR	DESCRIPTION	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	ECD # 19438	LPN 9/28/00	GFS
C	ECD # 19674	RFC 12/13/00	WJW
D	ECD # 20724	RFC 3/21/02	WJW



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

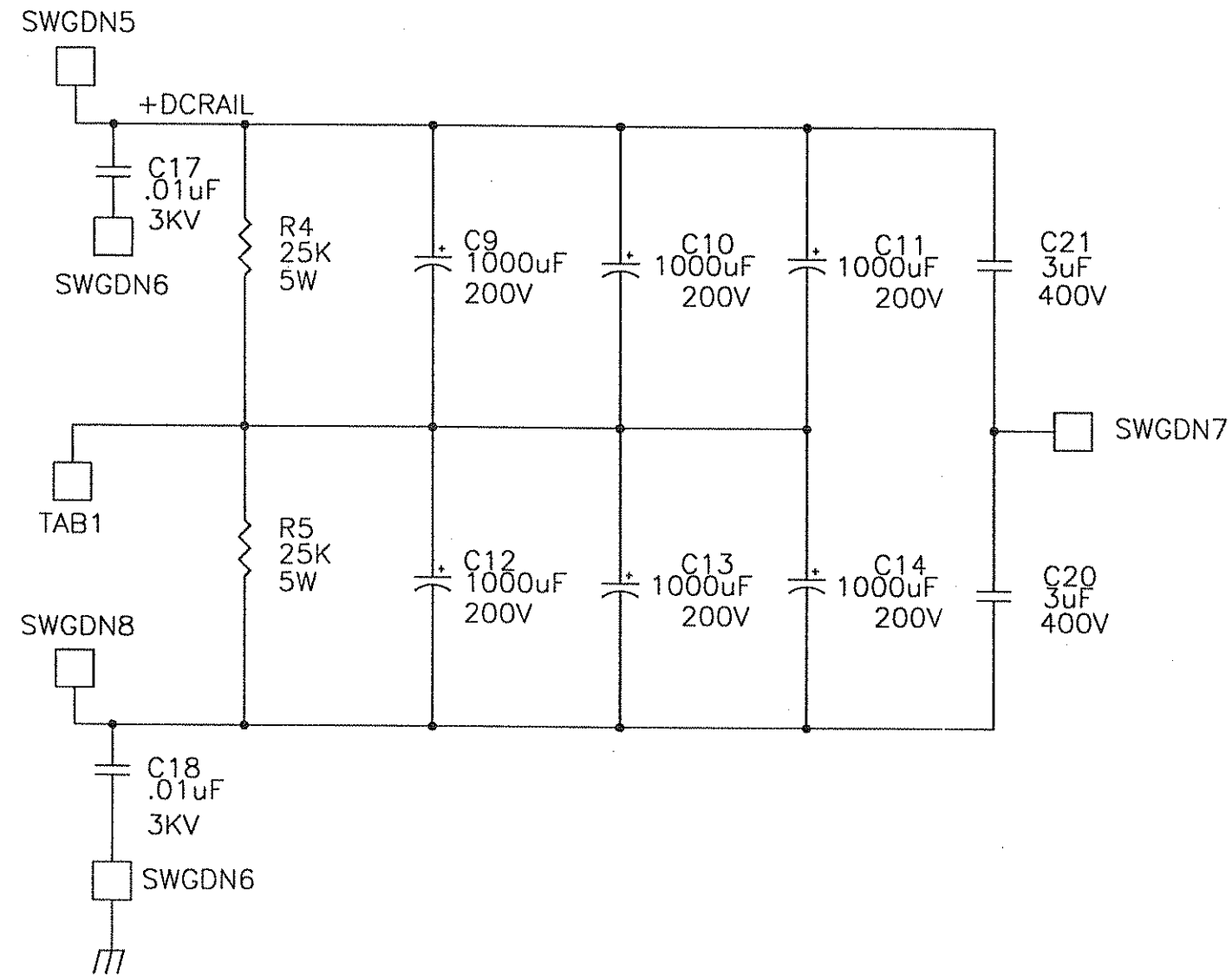


PADS POWER LOGIC DRAWING.
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING S MAY NOT BE FILLED IN.

TOL: X = +/- .02 .XX = +/- .01 .XXX = +/- .005 FRAC = +/- 1/64 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

THIS IS A COMPUTER GENERATED DWG.
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APPLICATION			LTR	E.C.D. 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		



SHEET 1 OF 1

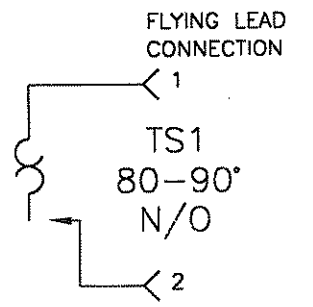
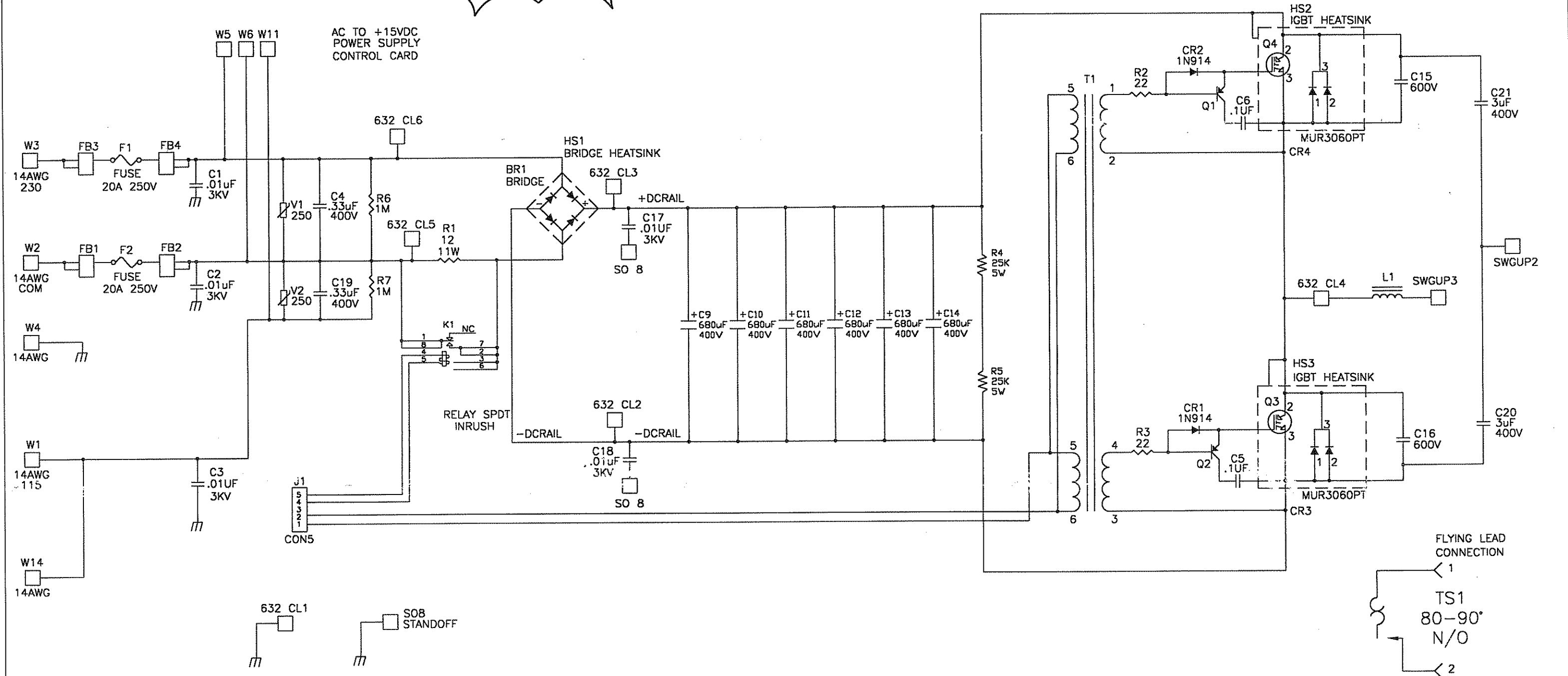
HTL	TOL:	REL. TO MFG.	ENG. CTL.	ELECTRONIC MEASUREMENTS, INC.
	.X = ±.02" .XX = ±.01" .XXX = ±.005" FRAC. = ± 1/64" ANGLES = ± 1/2°	REL. DATE: 1/26/96	DATE: 10/19/95	
FIN	P/L: 493	REL. DATE: 1/26/96	DATE: 10/19/95	 TITLE: SCHEMATIC DIAGRAM AUX. CAP BOARD DWG. NO. 01-000-681
	SCALE: NONE	APP. DATE: 1/15/96	DATE: 10/19/95	

THIS IS A COMPUTER GENERATED DWG.
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LTR	E.C.O. NO.	BY	APP.
0	INITIAL RELEASE 9/94	DRB	<i>[Signature]</i>
1	ENG. CHG. 8/95	C.B.	<i>[Signature]</i>
A	TG RELEASE 10/16/95	S.E.	<i>[Signature]</i>
B	ECO #15257 3/4/96	CJS	<i>[Signature]</i>
C	ECO #16240 3/18/97	CJS	<i>[Signature]</i>
D	ECO #19912 5/29/01	LWR	<i>[Signature]</i>

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



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

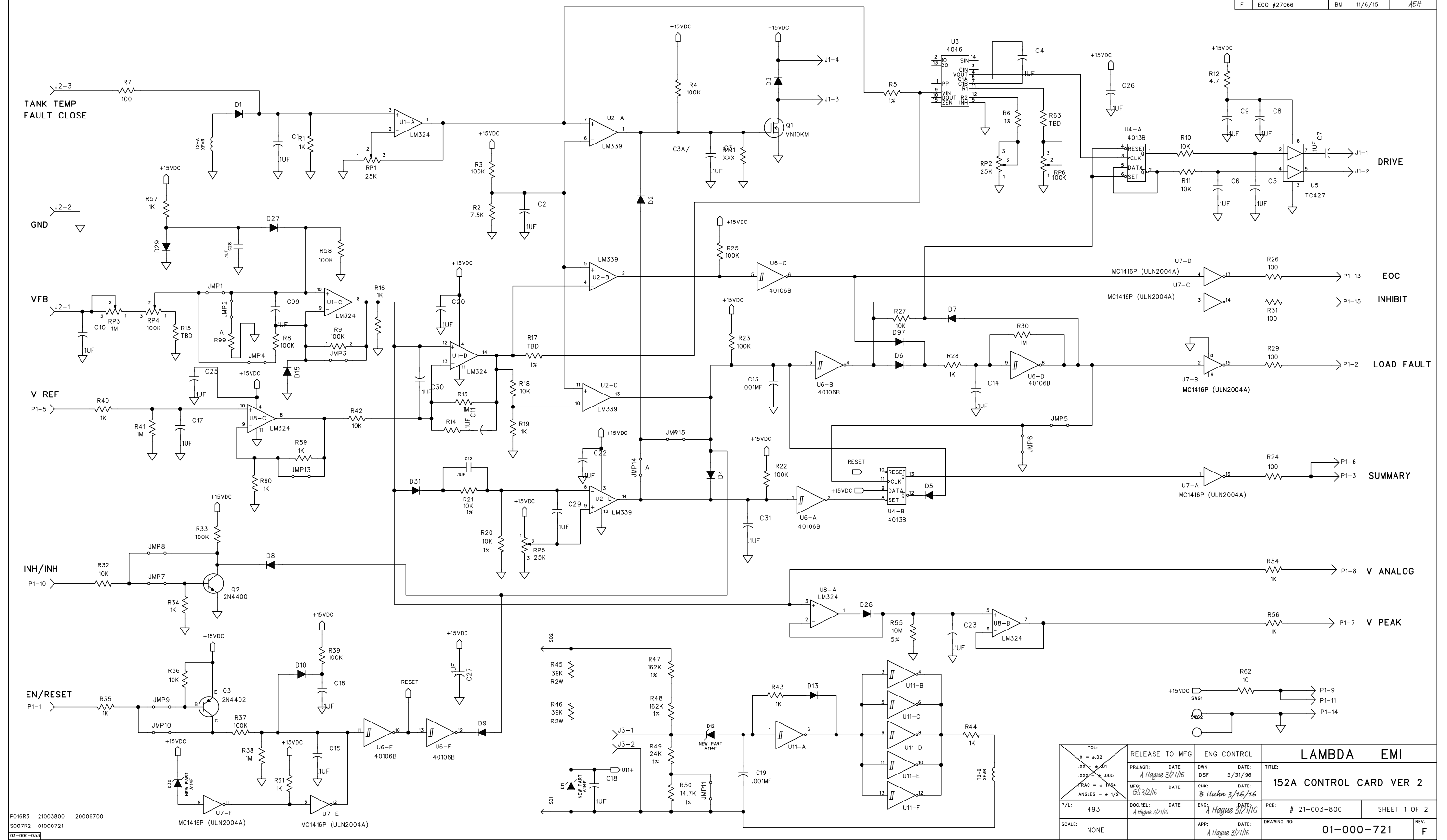
TOL:	REL. TO MFG.	ENG. CTL.	DATE:	DATE:	DATE:	DATE:
.X = ±.02"	DATE: 2/21/96	DWN: C.B.	DATE: 8/95			
.XX = ±.01"						
.XXX = ±.005"						
FRAC. = ± 1/64"						
ANGLES = ± 1/2°						
P/L: 493	DATE: 1/10/96	DATE: 2/21/96	DATE: 1/10/96	DATE: 2/21/96	DATE: 1/10/96	DATE: 2/21/96
SCALE: ~	DO NOT SCALE DWG.	APP: <i>[Signature]</i>	DATE: 1/10/96	DATE: 1/10/96	DWG. NO. 01-000-682	REV. D



TITLE: SCHEMATIC DIAGRAM
PCB 400V INVERTER
500A, 102A, 152A

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.

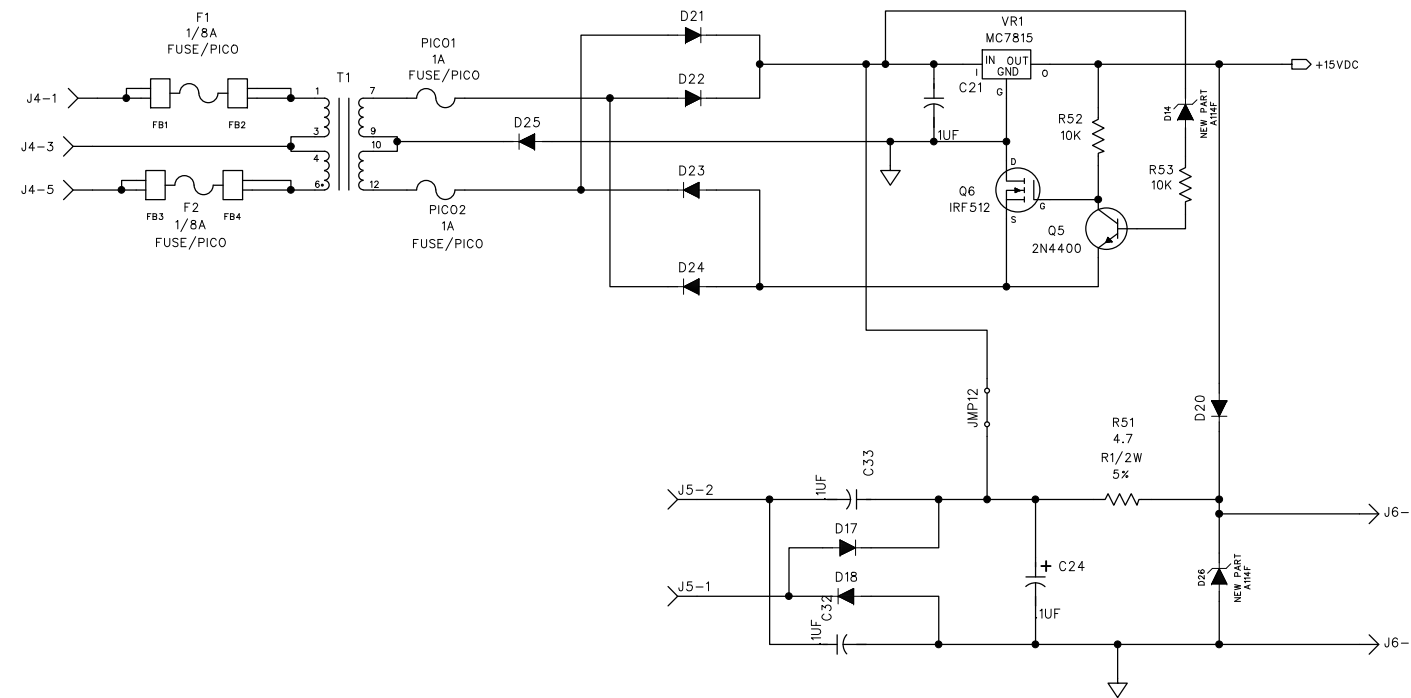
APPLICATIONS			REVISIONS			
USED ON	NEXT ASSY	QTY	LTR	DESCRIPTION	BY/DATE	APP/DATE
			1	INITIAL RELEASE	G BEES 5/31/96	GB 5/31/96
			A	TG RELEASE	WJW 8/9/96	WJW 8/9/96
			B	ECO #16240	CJS 3/18/97	WJW
			C	ECO #16208	CJS 3/26/97	WJW
			D	ECO #18088	LPN 1/26/99	WJW
			E	ECO #18786	LPN 11/2/99	GFS
			F	ECO #27066	BM 11/6/15	AET



P016R3 21003800 20006700
 S007R2 01000721
 03-000-053

TOL: .X = ±.02 .XX = ±.01 .XXX = ±.005 FRAC = ± 1/4 ANGLES = ± 1/2	RELEASE TO MFG DATE: A Hague 3/21/16	ENG CONTROL DATE: DSF 5/31/96	LAMBDA EMI		
	PROJ MGR: A Hague 3/21/16	DATE: 6/3/2/16	CHK: B Huhn 3/16/16	TITLE: 152A CONTROL CARD VER 2	
P/L: 493	DOC REL: A Hague 3/21/16	ENG: A Hague 3/21/16	PCB: # 21-003-800	SHEET 1 OF 2	
SCALE: NONE	APP: A Hague 3/21/16	DATE: A Hague 3/21/16	DRAWING NO: 01-000-721	REV. F	

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

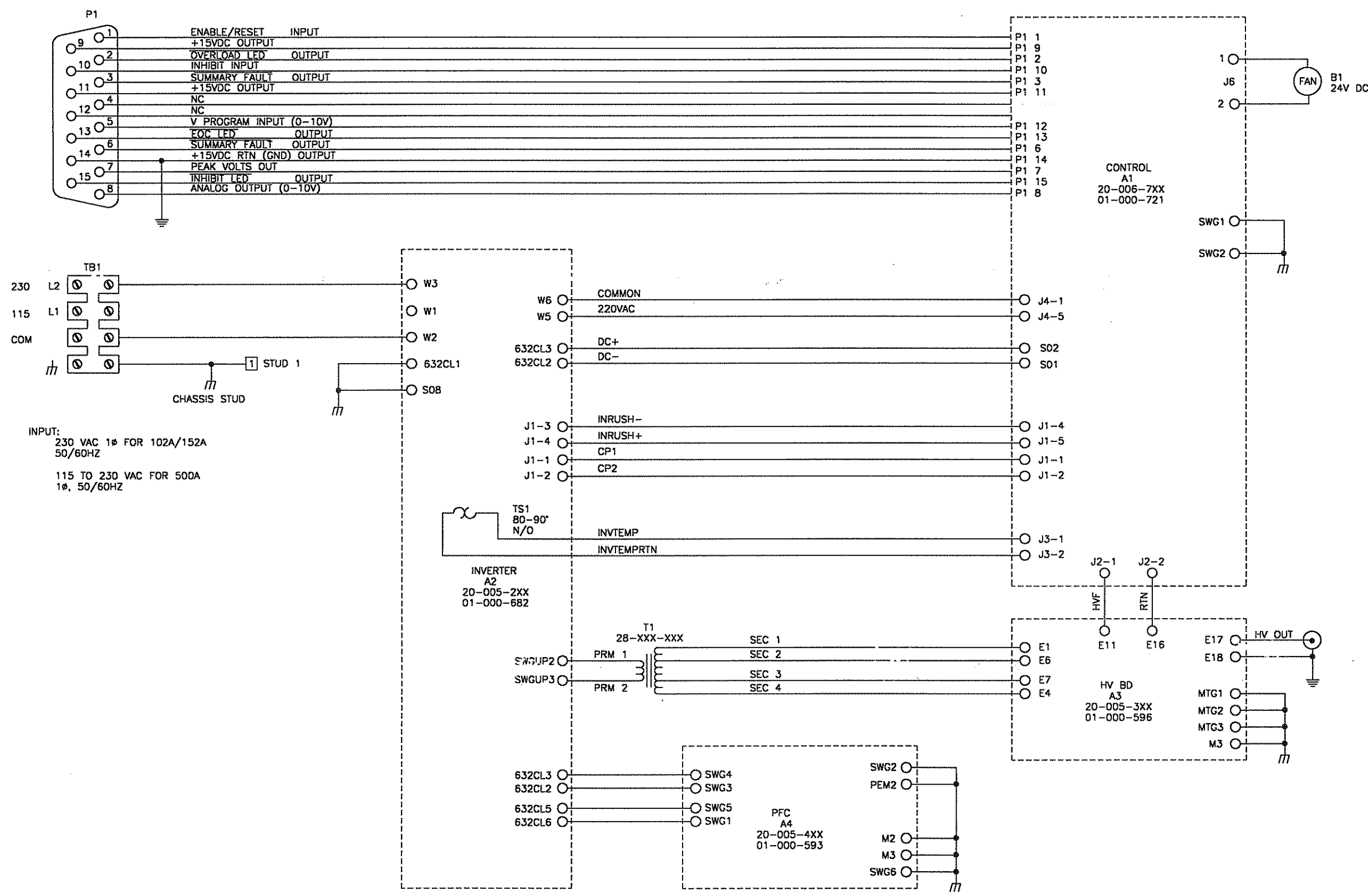


OPTION TABLE			
OPTIONS	JMP CLOSED	JMP OPEN	SUFFIX
POS O/P	J1, J3	J2, J4	POS
NEG OP	J2, J4	J1, J3	NEG
INH HIGH	J7	J8	-
INH LOW	J8	J7	LH
ENABLE HIGH	J10	J9	-
ENABLE LOW	J9	J10	EN
PFC	J11	-	PFC
NON PFC	-	J11	-
LOAD FAULT LATCHING	J5	J6	IL
LOAD FAULT NON LATCHING	J6	J5	-
PROGRAMMING 0-5V		J13	5V
PROGRAMMING 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:	REV: F
01-000-721	

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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 #15243	4/24/96	CJS
C	ECO #16240	3/17/97	CJS
D	ECO #19212	5/29/01	LWR



INPUT:
230 VAC 1Ø FOR 102A/152A
50/60HZ

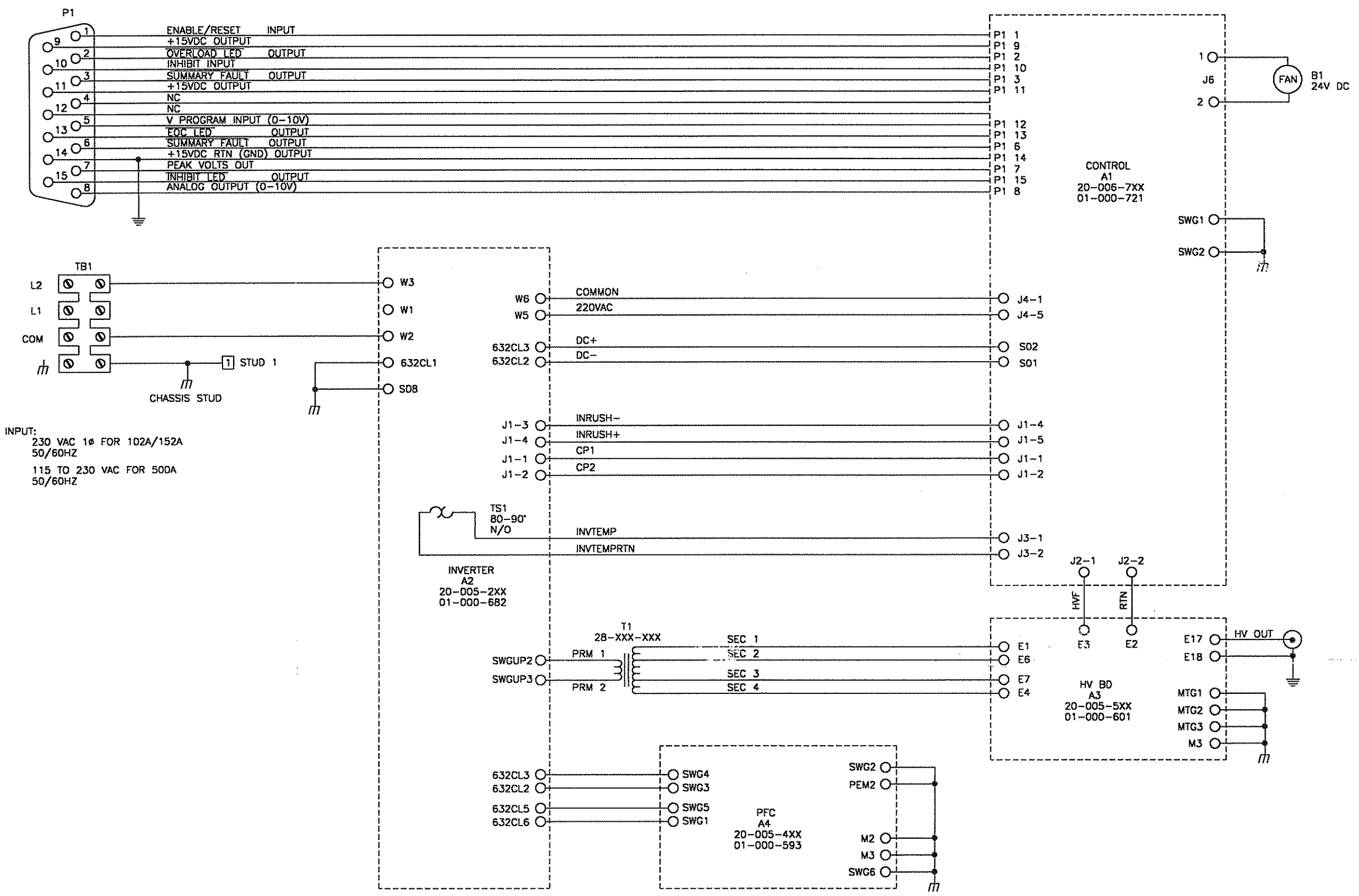
115 TO 230 VAC FOR 500A
1Ø, 50/60HZ

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.		TITLE:
DATE:	DATE:	DATE:	DATE:	
4/24/95	9/14/94	11/10/94	11/10/94	
DATE:	DATE:	DATE:	DATE:	DWG. NO.
4/24/95	11/10/94	11/10/94	11/10/94	01-493-001
SCALE:	SCALE:	SCALE:	SCALE:	REV.
NONE	NONE	NONE	NONE	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

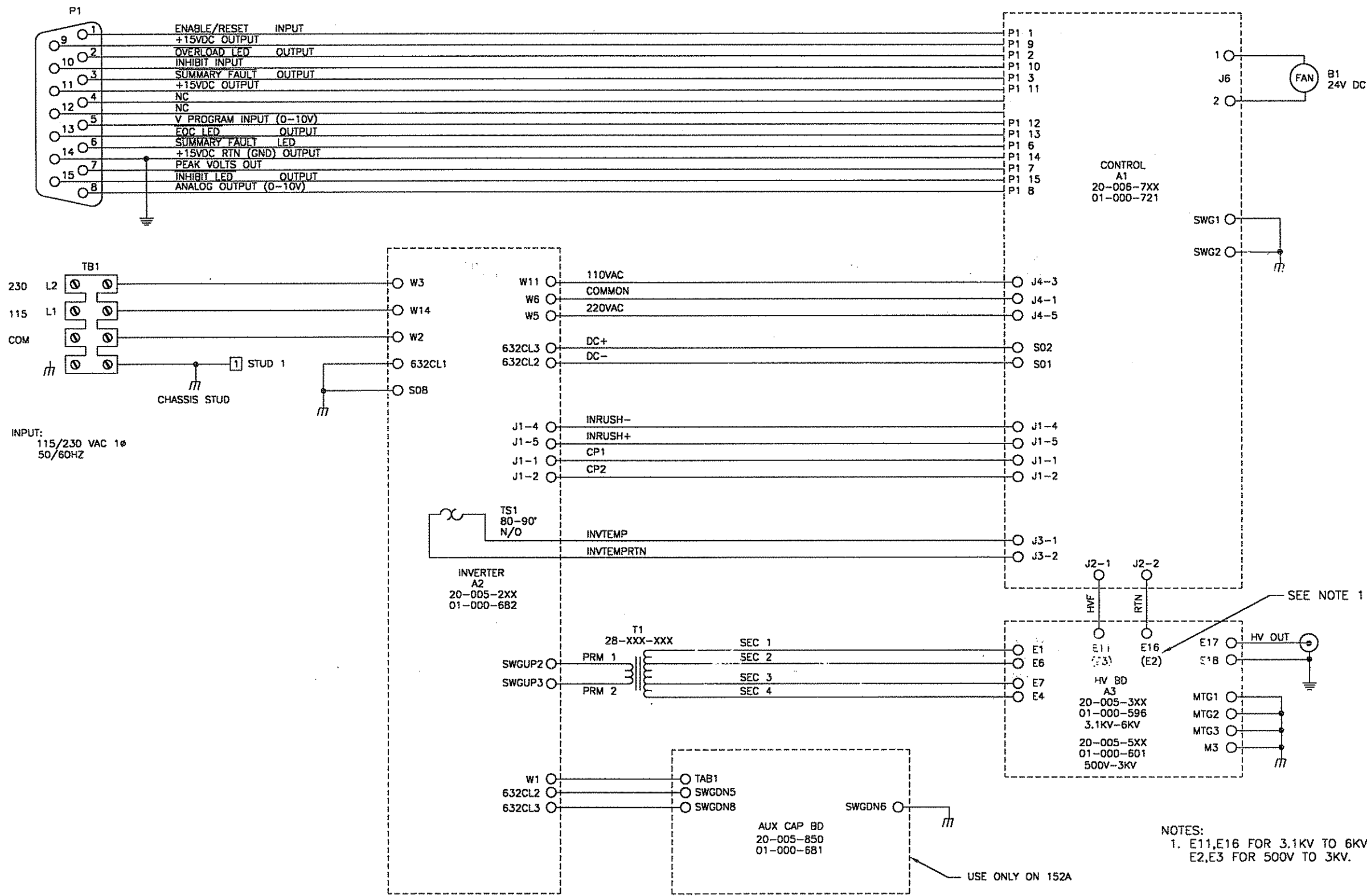


INPUT:
230 VAC 1φ FOR 102A/152A
50/60HZ
115 TO 230 VAC FOR 500A
50/60HZ

REL TO MFG.	ENG. CTL.	LAMBDA EMI			
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	SCALE: NONE	APP: [Signature]	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. 2/16/95	SAdB	<i>[Signature]</i>
2	ADD L1 & L2 3/30/95	SAdB	<i>[Signature]</i>
A	ECO #15230 5/2/96	CJS	<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 3.1KV TO 6KV
E2,E3 FOR 500V TO 3KV.

SHEET 1 OF 1

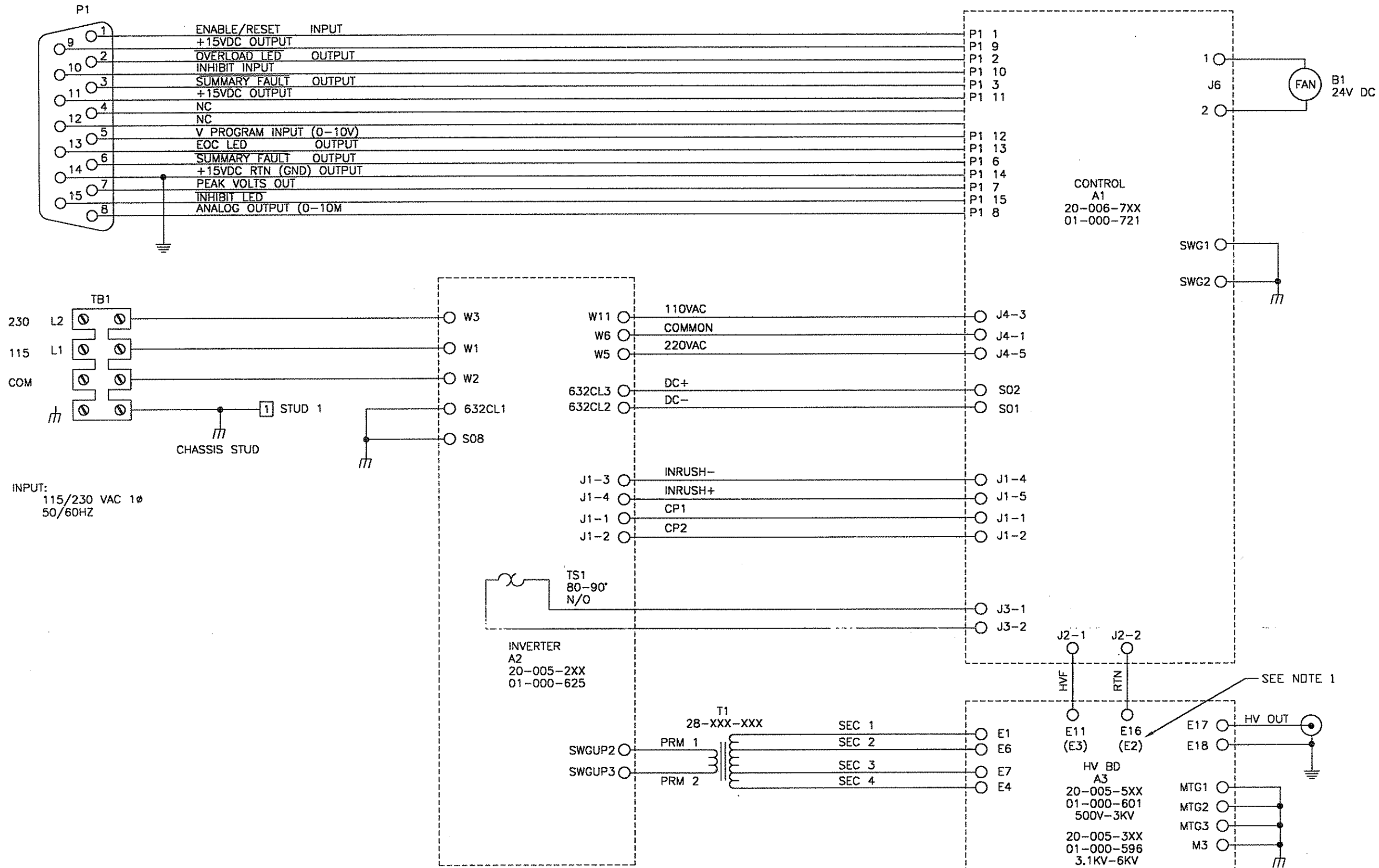
AUTOCAD DRAWING
THIS IS A STANDARD FORMAT.
NOT ALL BOXES APPLY TO EVERY
DRAWING AND MAY NOT BE FILLED IN.

REL. TO MFG.		ENG. CTL.		TITLE	DWG. NO.	REV.
P/L	DATE	DATE	DATE			
	4/24/95	9/14/94		SCHEMATIC SYSTEM 152A NON-PFC	01-493-004	D
P/L: 493	4/24/95	11/10/94				
SCALE: NONE		11/11/94				



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.

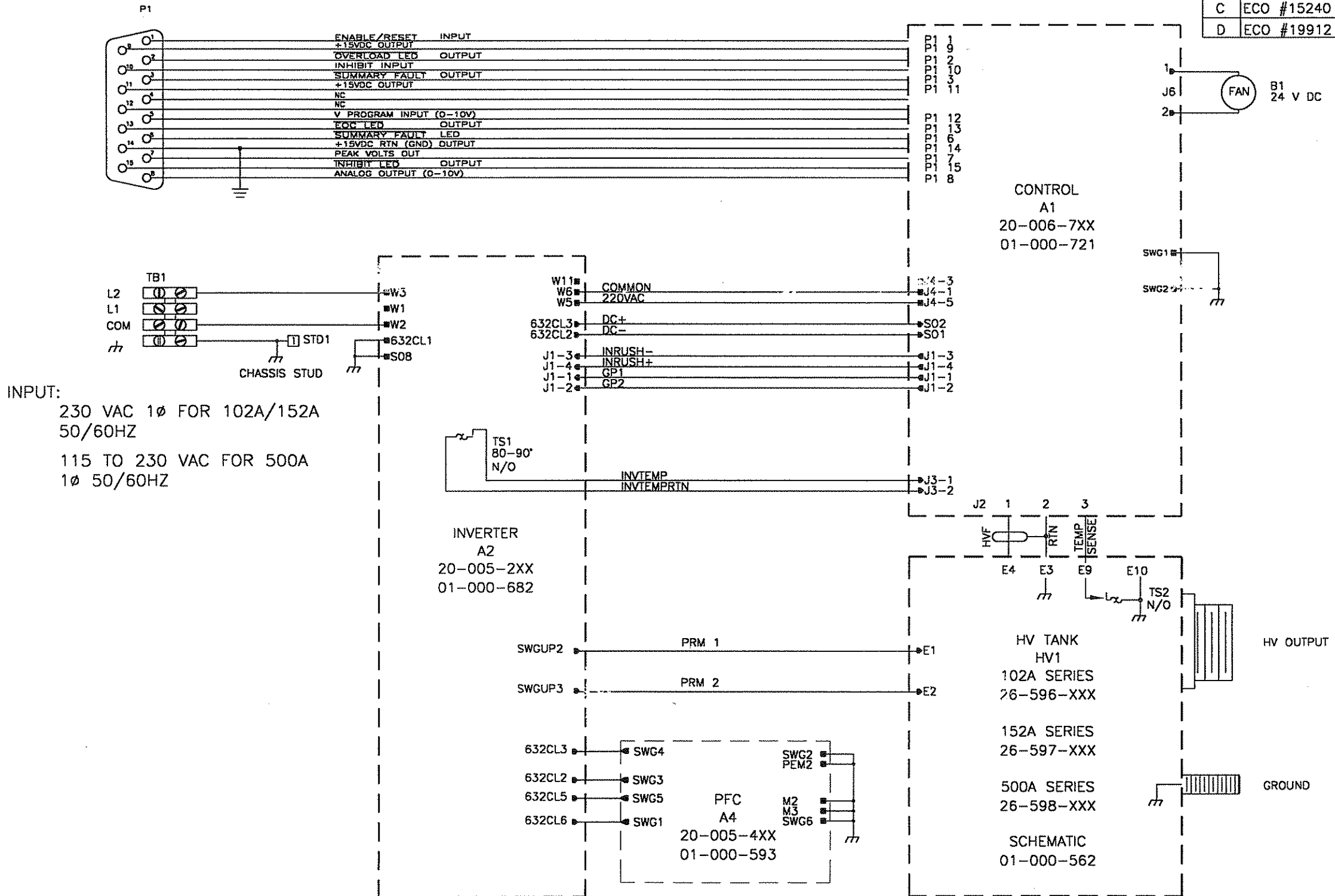
REL. TO MFG.		ENG. CTL.		TITLE: SCHEMATIC SYSTEM	DWG. NO. 01-493-005	REV. D
P/L:	DATE:	DWN:	DATE:			
493	6/6/95	C. SEIBERT	4/18/96			
	6/6/95	JJR	2/20/95			
	6/6/95	JJR	2/21/95			
SCALE: NONE	DO NOT SCALE DWG.	APP: <i>[Signature]</i>	DATE: 2/17/95			

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.
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

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.		TITLE: SCHEMATIC SYSTEM 500A, 102A, 152A 7KV & UP OIL PFC
DATE:	12/28/95	DATE:	02/18/95	
DATE:	1/2/96	DATE:	02/20/95	
DATE:	12/28/95	DATE:	02/21/95	
DATE:		DATE:	02/17/95	

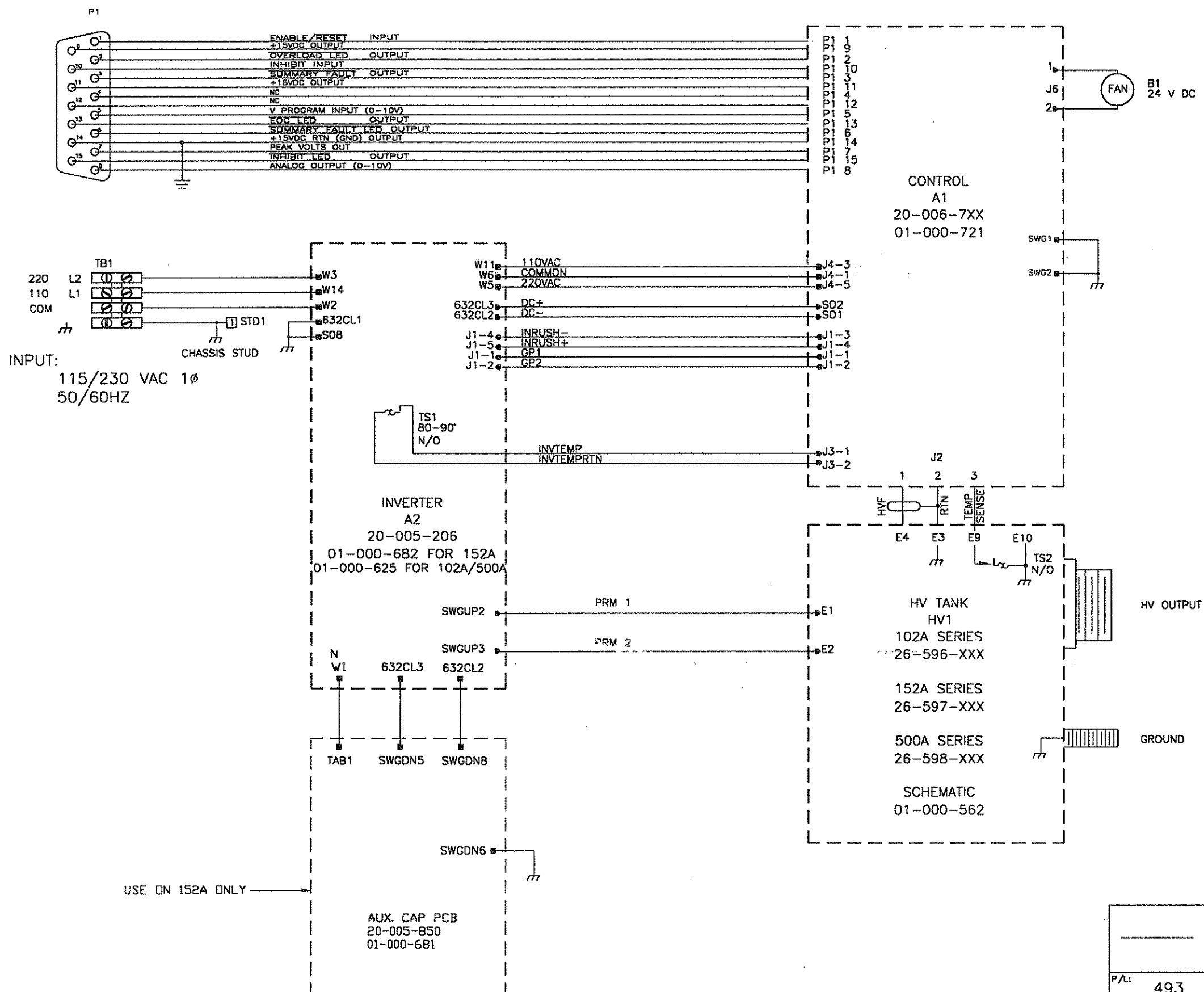
P/L: 493
SCALE: NONE

LAMBDA EMI

DWG. NO. 01-493-006
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>
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	<i>[Signature]</i>
C	ECO #19912 5/29/01	LWR	<i>[Signature]</i>



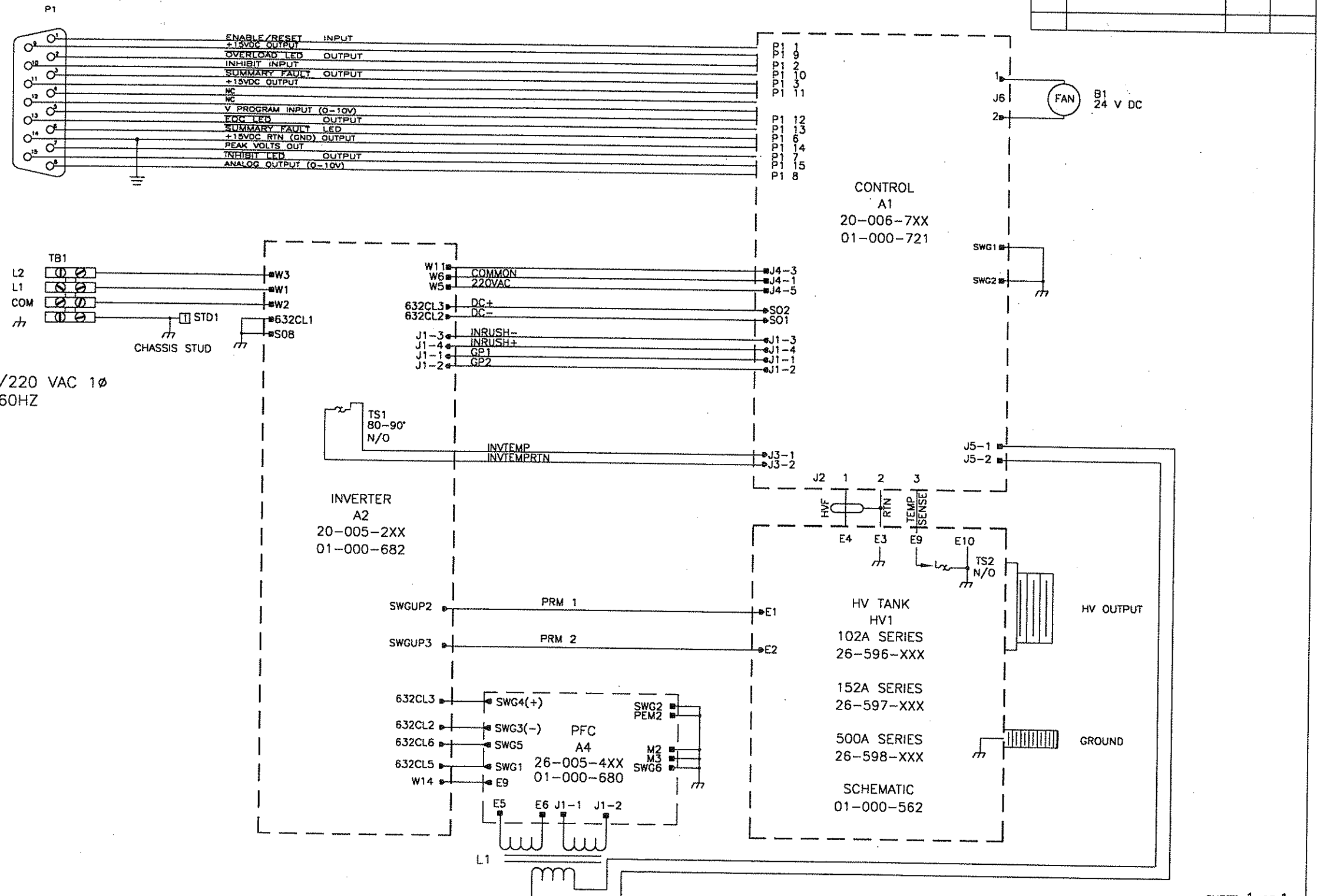
SHEET 1 OF 1

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 EMI	
REL. ENG. DATE:	2/29/96	DWN. DATE:	02/18/95	TITLE: SCHEMATIC SYSTEM 500A, 102A, 152A 7KV & UP W/OIL, W/O PFC	
MFG. DATE:	2/26/96	CHK. DATE:	02/20/95		
DOC. REL. DATE:	1/5/96	ENG. DATE:	02/21/95	DWG. NO. 01-493-007	
DO NOT SCALE DWG.		APP. DATE:	02/17/95		

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

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



INPUT:
110/220 VAC 1Ø
50/60HZ

SHEET 1 OF 1

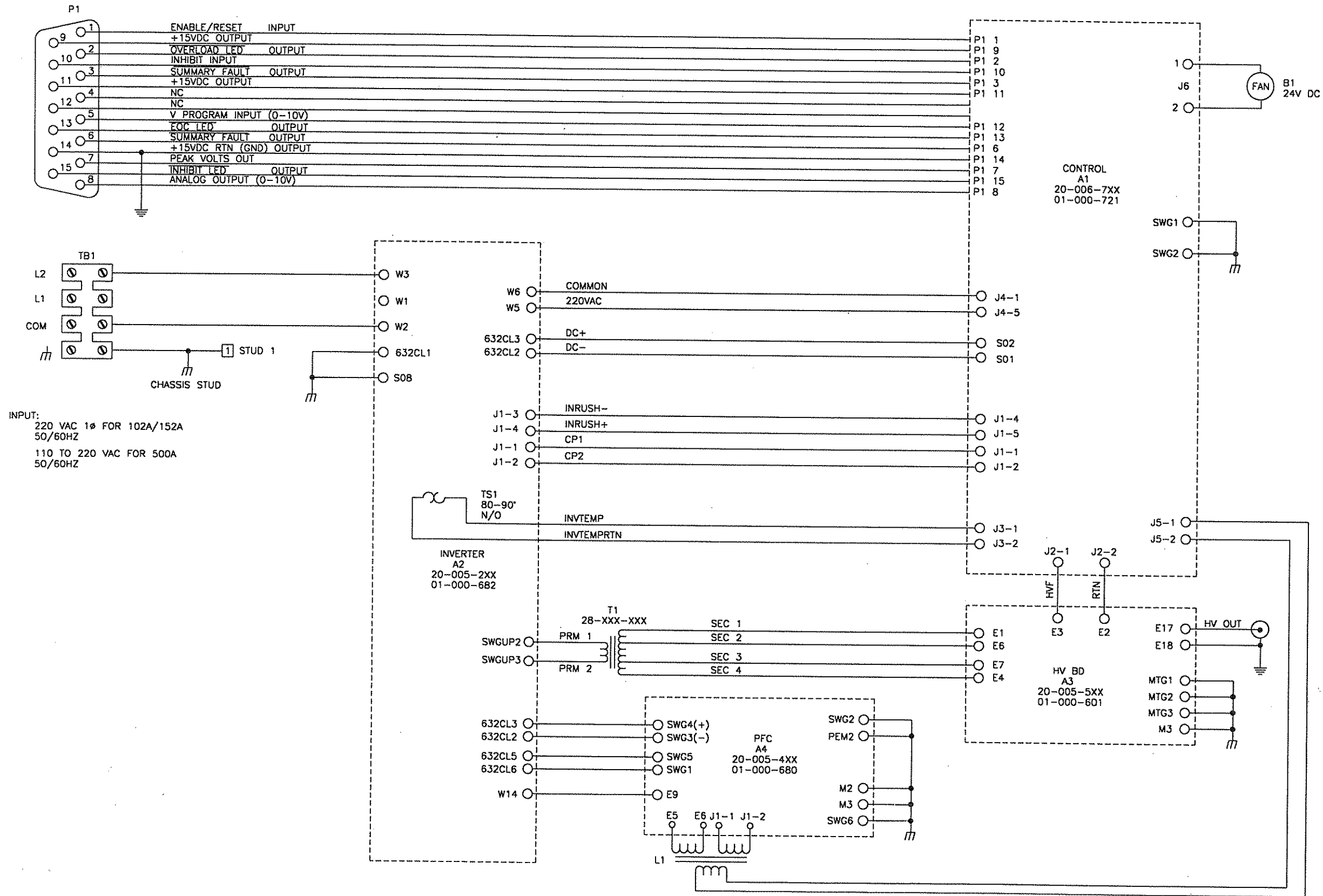
MTL:	N/A	TOL: .X = ±.02" .XX = ±.01" .XXX = ±.005" FRAC. = ± 1/64" ANGLES = ± 1/2"	REL. TO MFG. ENG. DATE: 5/20/97 MFG. DATE: 5/21/97	ENG. CTL. DWN: DATE: 5/16/97 C. SEIBERT CHK: DATE: 5-19-97 GFS	<p>ELECTRONIC MEASUREMENTS, INC.</p> <p>TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 7KV & UP OIL</p>
FIN:	N/A	P/L: 493	DOC. REL. DATE: 5-19-97 GFS	DWG. NO. 01-493-010	
		SCALE: NONE	CHK: DATE: 5-19-97 GFS	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	NT. REL.	4/16/97
102A,500A 152A,202A	FINAL ASSY	REF	A	TG REL.	5/16/97
				CJS	GFS



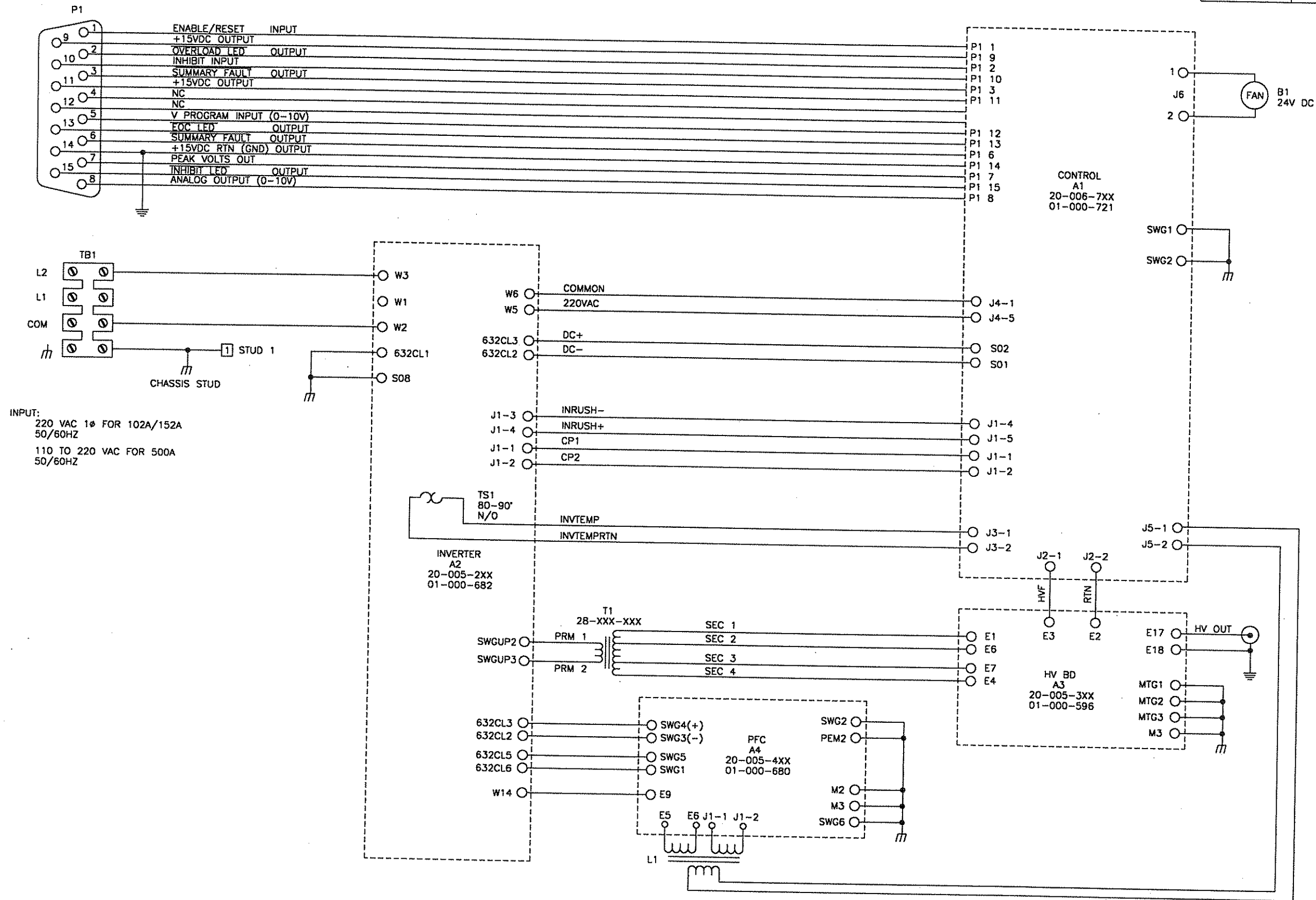
INPUT:
220 VAC 1ϕ FOR 102A/152A
50/60HZ
110 TO 220 VAC FOR 500A
50/60HZ

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°	REL TO MFG. DATE: 5/16/97 ENG. DATE: 5/16/97 MFG. DATE: 5/16/97	ENG. CTL. DATE: 5/16/97 DWN. DATE: 5/16/97 CHK. DATE: 5/16/97	
FIN:	P/L: 493 SCALE: NONE	DOC. REL. DATE: 5/16/97 MFG. DATE: 5/16/97	APP. DATE: 5/16/97 DATE: 5/16/97	TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 500V - 1.7KV DWG. NO. 01-493-012 REV. A

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

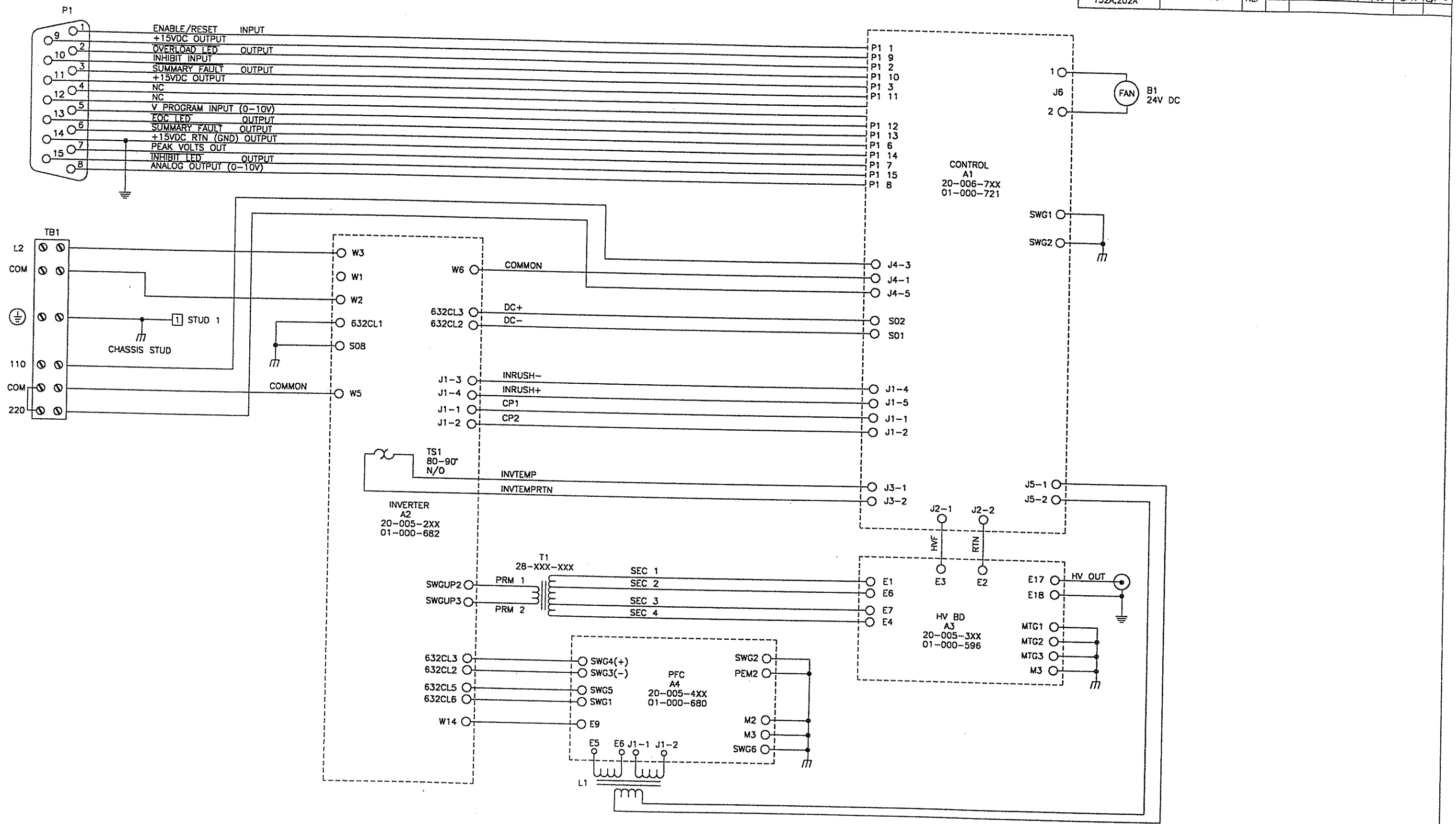
APPLICATION			LTR	E.C.O. NO.		BY	APP.
USED ON	NEXT ASSY.	QTY.	1	INT. REL.	8/19/97	SA	GPS
102A,500A 152A,202A	FINAL ASSY	REF	A	TG REL.	9/2/97	CJS	GPS



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: C. SEIBERT 9/2/97	DWN. DATE: C. SEIBERT 9/2/97	
FIN:	P/L: 493 SCALE: NONE	DOC. REL. DATE: GPS 9-4-97	CHK. DATE: GPS 9-4-97	TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 3.1KV-6KV
		DO NOT SCALE DWG.	APP. DATE: GPS 9-4-97	DWG. NO. 01-493-013 REV. A

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	3/16/99	B.H. GFS
102A,500A	FINAL ASSY	REF	A	TG RELEASE	4/14/99	LPN GFS
152A,202A						



MTL	YOL	REL. TO MFG.	ENG. CTL.	SHEET 1 OF 1	
N/A	X = ±.02" JXX = ±.01" XXX = ±.005" FRAC. = ± 1/64 ANGLES = ± 1/2°	PRJ ENG. DATE: 5-5-99 B.H. 5-5-99	OWN DATE: 4/13/99 LPN	TITLE: SCHEMATIC SYSTEM 152A/PFC VER.3 W/LOGIC PWR SEL	
N/A	P/L: 493 SCALE: NONE	DOC. REL. DATE: 4-15-99 GFS 4-15-99	ENG. DATE: 4-15-99 GFS 4-15-99	APP. DATE: 4-15-99 GFS 4-15-99	DWG. NO. 01-493-014 REV. A