

Sorensen

PRO-T SERIES **10 KW** Power Supplies

Instruction Manual

This manual covers PRO-T models:

16-625T	110-90T
32-310T	160-62T
55-180T	300-33T
80-125T	600-16T

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Safety Notice

Before applying power to the system, verify that the DCS Series unit is configured properly for the user's particular application.



WARNING!

HAZARDOUS VOLTAGES IN EXCESS OF 280 VRMS, 600V PEAK MAY BE PRESENT WHEN COVERS ARE REMOVED. QUALIFIED PERSONNEL MUST USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT. CIRCUIT BOARDS, TEST POINTS, AND OUTPUT VOLTAGES MAY BE FLOATING ABOVE (BELOW) CHASSIS GROUND.

Installation and service must be performed by qualified personnel who are aware of dealing with attendant hazards. This includes such simple tasks as fuse verification.

Ensure that the AC power line ground is connected properly to the DCS Series unit input connector or chassis. Similarly, other power ground lines including those to application and maintenance equipment must be grounded properly for both personnel and equipment safety.

Always ensure that facility AC input power is de-energized prior to connecting or disconnecting the input/output power cables.



During normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on the user's application configuration, HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY may be generated normally on the output terminals. Ensure that the output power lines are labeled properly as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated. To guard against risk of electrical shock during open cover checks, do not touch any portion of the electrical circuits. Even when the power is off, capacitors can retain an electrical charge. Use safety glasses during open cover checks to avoid personal injury by any sudden failure of a component.

Due to filtering, the unit has high leakage current to the chassis. Therefore, it is essential to operate this unit with a safety ground.

Some circuits are live even with the front panel switch turned off. Service, fuse verification, and connection of wiring to the chassis must be accomplished at least five minutes after power has been removed via external means; all circuits and/or terminals to be touched must be safety grounded to the chassis.

After the unit has been operating for some time, the metal near the rear of the unit may be hot enough to cause injury. Let the unit cool before handling.

Qualified service personnel need to be aware that some heat sinks are not at ground, but at high potential. For safe operation, it is required that output power neutral be connected to chassis ground. The PRO-T system is shipped with two braided wires on the PDU connected from output power neutral to chassis ground.

These operating instructions form an integral part of the equipment and must be available to the operating personnel at all times. All the safety instructions and advice notes are to be observed.

Neither Sorensen, San Diego, California, USA, nor any of the subsidiary sales organizations can accept any responsibility for personal, material or consequential injury, loss or damage that results from improper use of the equipment and accessories.

About This Manual

This manual has been written expressly for the Sorensen PRO-T series of power supplies which have been designed and certified to meet the 1997 Low Voltage and Electromagnetic Compatibility Directive Requirements of the European Community.

Since the goal of the Low Voltage Directive is to ensure the safety of the equipment operator, universal graphic symbols (see below) have been used both on the unit itself and in this manual to warn the operator of potentially hazardous situations.

SAFETY SYMBOLS



WARNING
Risk of Electrical Shock



CAUTION
Refer to Accompanying Documents



OFF (Supply)



STANDBY (Supply)



ON (Supply)

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SECTION 1

INTRODUCTION

1.1 INTRODUCTION

This manual contains installation and operation data on the 10 kilowatt units of the PRO-T Series Sorensen Power Supplies. It is intended to familiarize the user with the function of the unit and to introduce the varied applications to which the unit may be adapted, and to furnish sufficient maintenance data to assure long operating life.

Three major sections form the manual divisions. Section 1 contains a brief functional description of the PRO-T series power supplies along with complete unit specifications. Initial inspection and checkout procedures are outlined in Section 2. Operating instructions, including methods for adapting units to various applications, comprise Section 3.

1.2 DESCRIPTION

1.2.1 General

The PRO-T series is designed for either rack or floor mounting, and to provide stable, highly regulated dc outputs from a wide range of three phase input voltages and frequencies. (For complete unit specifications refer to section 1-4.) The series exhibits excellent transient response and low ripple in both voltage regulating and current limiting modes. Other design features include: provisions for remote programming, remote sensing, and series and parallel operation. Increased versatility is also provided by the use of an industrial control technique for main power disconnect and line protection. This feature facilitates the remote control of the line power to the supply.

A variety of Sorensen power supply application notes are available through your Sorensen Service Representative. These notes detail many hook-up configurations available to meet most power supply applications.

1.2.2 Automatic Crossover

There are two basic operating modes: voltage and current. In the voltage mode, the voltage is held constant while the current varies with the load. In the current mode, the voltage varies and current is held constant. The automatic crossover feature enables the unit to switch operating modes as a function of load requirements. If, for example, load currents attempt to increase above a preset current limit, the unit will switch operation automatically from the voltage to the current mode. In this mode, the current will be regulated at the value preset on the front panel. If load requirements are lowered, a return to the voltage regulating mode will occur automatically.

1.2.3 Remote Sensing

Terminals located on the rear-mounted connector (J-2) offer a means of extending a unit's regulating point from the output terminals to the load. This effectively compensates for variations in the load lead voltage drop. Section 3 outlines the connections for remote sensing.

1.2.4 Series Operation

For applications requiring output voltages higher than a single unit can provide, PRO-T power supplies may be connected in series (see Section 3). Regulation in series operation is the sum of the regulations for all units.

1.2.5 Parallel Operation

Parallel operation may be used to service those applications requiring an output current higher than a single unit can provide. PRO-T power supplies may be direct paralleled with no limit to the number of units which can be paralleled. However, the regulation will deteriorate, and will be the sum of the regulations for the individual settings plus the output voltage differences between units at no load.

1.2.6 Remote Programming

Output voltage or current of PRO-T power supplies may be remotely programmed in either the voltage or current mode by resistance or voltage signal. Details and consideration are given in Section 3.

1.2.7 Failure Protection

In addition to the constant limiting protection provided by automatic crossover and the current regulator, the PRO-T power supply incorporates several other protection systems. Loss of one input phase drops the output to zero. Thermal overload, usually resulting from a cooling fan failure, will also drop the output to zero and energize an indicator lamp on the front panel. Control circuitry is protected by rear mounted fuses and internal fuses.

In the event of an overvoltage condition at the output, such as a failure in the power supply or an externally induced condition, the adjustable overvoltage protection (OVP) will drop the output to zero and disconnect the AC power from the main power components. Protection against the effects of overloads and internal short circuits is also provided.

1.3 OPTIONAL MODIFICATIONS

SCR Crowbar (Option M5), IEEE-488.2 GPIB or RS 232 interface card with voltage and current READBACK and adjustable OVP (Option M9C). CE mark available on T2, T3 and T11 input options (M36), and slave multichannel interface control (M85), to be used with the M9C option.

1.4 SPECIFICATIONS

1.4.1 Common Specifications

Input

Available Options:

208 V ac @ 60 Hz:	T1	440 V ac @ 60 Hz:	T4	220 V ac @ 60 Hz:	T8
380 V ac @ 50 Hz:	T2	480 V ac @ 60 Hz:	T5	230 V ac @ 60 Hz:	T10
415 V ac @ 50 Hz:	T3	575 V ac @ 60 Hz:	T6	400 V ac @ 50 Hz:	T11

Standard Input Power: Current at 432-528 V ac, 60 ±1 Hz, 3-phase (line current at min line voltage)—

MODEL	CURRENT	MODEL	CURRENT
16-625T5	22 A	110-90T5	21 A
32-310T5	22 A	160-62T5	20 A
55-180T5	21 A	300-33T5	20 A
80-125T5	21 A	600-16T5	20 A

Operating Data

Series Operation:	200 V dc max. (Consult factory concerning series operation of more than 2 units.)
Parallel Operation:	Direct paralleling of any number of units.
Overvoltage protection:	Standard on all units
Ambient Operating Temp:	0-50 °C (Above 50 °C: See <i>Constant Voltage Mode, Model Dependent Parameters</i> table and <i>Constant Current Mode, Model Dependent Parameters</i> table, <u>Temp Coeff</u> columns, below.)
Storage Temperature:	-45 °C to +70 °C
Humidity:	0-90% (noncondensing)
Cooling Method:	Forced Air
Power Factor:	0.75

Output Power:

PRO-T Model	Eo (Vdc)	Io (A dc)			Efficiency* (Typical)
		50 °C	60 °C	70 °C	
16-625T5	0-16	625	531	375	80%
32-310T5	0-32	310	264	186	80%
55-180T5	0-5	180	153	108	80%
80-125T5	0-80	125	106	75	80%
110-90T5	0-110	90	77	54	80%
160-62T5	0-160	62	53	37	85%
300-33T5	0-300	33	28	20	85%
600-16T5	0-600	16	14	10	85%

* Efficiency taken at max power output and nominal AC volts input.

Constant Voltage Mode



- Voltage Regulation: 0.1% of Eo max
- Temperature Coefficient: 0.002 Eo max per °C
- Voltage Signal Programming: 100 mV per 1% of rated output (0-10 V for 0-100% rated output)
- Resistive Programming: 100 Ω per 1% of rated output (0-10 k Ω for 0-100% rated output)
- Stability: 0.1% Eo max (for 8 hr after 0.5 hr warm-up, fixed line, load & temp)
- Remote Sensing: 5 V max drop in POS or NEG power load.
- Transient Response (typical): 40 ms to return to ±1% band for step load change of 50-100% of 50-100% full load.



Operating Specification only apply over a range of 5% to 100% of the output voltage and current ranges

Model Dependent Parameters:

PRO-T Model	Regulation (mV) Line or Load	Ripple (PARD)		Temp Coeff mV/°C	Programming Constants	
		mV rms	mV pp		Ω/V	V/V
16-625T5	16	30	120	3.2	625	1.6
32-310T5	32	30	120	6.4	313	3.2
55-180T5	55	30	120	11.0	182	5.5
80-125T5	80	30	140	16.0	125	8.0
110-90T5	110	40	140	22.0	91	11.0
160-62T5	160	60	180	32.0	63	16.0
300-33T5	300	100	300	60.0	33	30.0
600-16T5	600	150	600	120.0	17	60.0



Constant Current Mode

Current Regulation:	0.1% of I_o max
Temperature Coefficient:	0.0004 I_o max per °C
Current Signal Programming:	100 mV per % of rated output (0-10 V for 0-100% rated output)
Resistive Programming:	100 Ω per 1% of rated output (0-10 k Ω for 0-100% of rated load)
Stability:	0.1% I_o max (for 8 hr after 0.5 hr warmup, fixed line, load & temp)

Model Dependent Parameters:

PRO-T Model	Regulation mA max	Ripple(PARD) mA rms	Temp Coeff mA/°C	Programming Constants	
				Ω/I	V/I
16-625T5	625	2000	250	16.0	62.5
32-310T5	310	1500	124	32.0	31.0
55-180T5	180	900	72	56.0	18.0
80-125T5	125	900	50	80.0	12.5
110-90T5	90	800	36	110.0	9.0
160-62T5	62	480	25	161.0	6.2
300-33T5	33	240	13	303.0	3.3
600-16T5	16	120	6	625.0	1.6

Dimensions

Height: 12.25 in (311.2 mm)

Width: 19 in (482.6 mm)

Length: 24 in (609.6 mm)

Weight: 350 in (160 mm)

SECTION 2

INSTALLATION

2.1 GENERAL

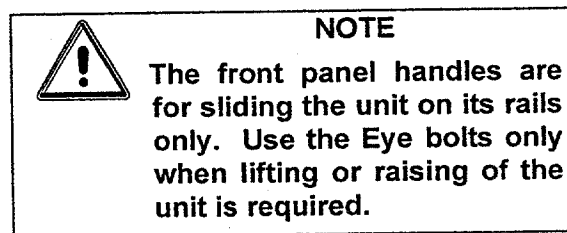
After unpacking, general inspection and preliminary checkout procedures should be performed to assure that the unit is in proper working order. These consist of visually checking for damage, and performing an electrical check. If it is determined that the unit has been damaged, the carrier should be notified immediately. Repair problems should be directed to Sorensen, 1-800-458-4258.

2.2 INSPECTION

Proceed as follows to inspect for damage incurred during shipment:

- A. Look for cracked or broken lenses on the indicator lights.
- B. Rotate the VOLTAGE and CURRENT potentiometers.
- C. **Remove the top cover and check to make sure that all printed circuit card plugs are firmly in place.**
- D. Check remote plug (P1) to insure that the remote AC control jumpers are in place.


2.3 MECHANICAL INSTALLATION



The PRO-T series power supply is shipped ready for floor or bench use. If the unit is to be rack mounted, the eye hooks on the top and the feet on the bottom must be removed. As these power supplies have a relatively large mass, they should be mounted at or near the bottom of the rack. Insure that there is a minimum of 6 inches of clearance behind the fan on the rear of the unit, so that the cooling air flow is not obstructed.

The air filter screen behind front panel grill must be visually checked and cleaned every 6 months (recommended).

2.4 GENERAL PRECAUTIONS

	<p style="text-align: center;">WARNING</p> <p>This unit requires a 3 pole, wall-mounted, fused disconnect switch with the proper current limiting fuse for safe operation.</p> <p><u>DO NOT</u> turn on the wall switch until AC and DC wires are attached to the PRO-T unit.</p> <p>Accidental shorts or hand contact inside the PRO-T can cause burns or electrical shock.</p>
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All PRO-T units must be hard-wired for fixed installation. The following precautions should be taken when connecting power supplies to an AC main. The latest NEC or local European electrical code should be consulted and followed when wiring a PRO-T with the electrical mains. For Europe, the unit must be installed by qualified personnel in accordance with local requirements.

2.4.1 AC Line Protection

All Sorensen power supplies are designed with a mechanical disconnect and overload protection. The components most often used are circuit breakers or fused switches. All Sorensen power supplies, including the PRO-T, require careful coordination of the AC mains connections with the AC line protection system within the unit. This will insure not only that an AC fault will be cleared, but that the AC line protection system will not be damaged by the fault. Protection must be located near the installed equipment and be marked as the disconnect device for this unit.

The following components are required for a complete AC line protection system:

MAIN DISCONNECT SWITCH - Customer-installed 3 pole, wall-mounted fused disconnect switch. The main disconnect switch mechanically removes the AC lead wires and the unit from the AC mains. See Table 2.1 for current rating.

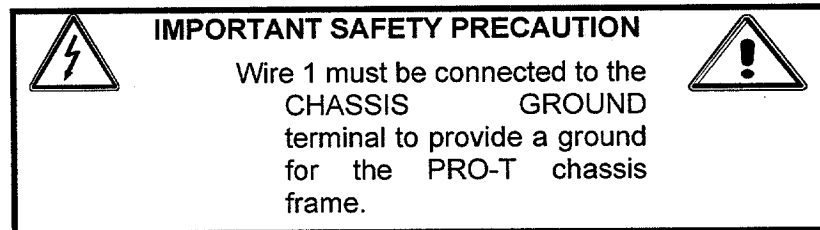
MAIN SHORT CIRCUIT PROTECTION - Customer-installed main short circuit protection (usually a fuse). The ratings of the short circuit protection should be large enough to handle the units attached.

UNIT AC OVERLOAD PROTECTION - Included in all Sorensen power supplies. Mechanically connects and disconnects as much of the wiring within the unit as is possible. Prevents the AC line (from the main AC disconnect to the unit) from causing damage within the unit should a fault occur. Acts as a safety feature preventing shock or burns due to a possible fault within the unit.

2.5 ELECTRICAL INSTALLATION

Follow these steps in wiring:

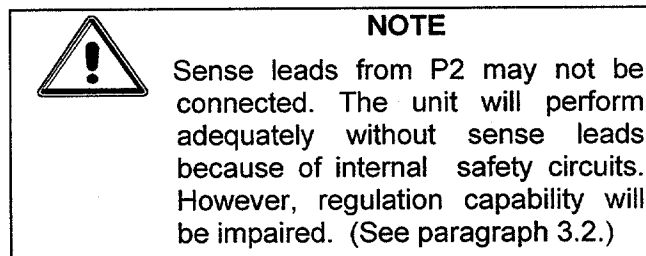
1. Identify the proper safety ground at the wall switch. (The neutral and/or a separate ground may be provided. Check the power company and local codes for a proper connection.)
2. Label four wires for the input connection. Wires 2 - 3 - 4 are connected to the three phase terminals, and wire 1 is connected to the safety ground terminal. See Table 2.1 for suggested wire size.
3. Connect the 4 wires to the PRO-T ac input terminals which are marked GND-ØA-ØB-ØC.



4. Connect the two dc output wires. Label these wires (+) and (-).

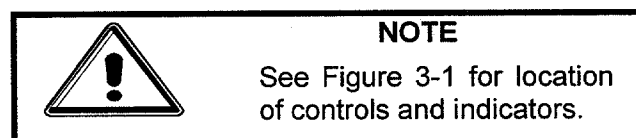
2.6 INITIAL CHECKOUT

2.6.1 Voltage Mode



To perform a check of voltage mode operation, proceed as follows:

- A. Assure that proper input connections have been made. Refer to Sections 2.5 and 2.6.
- B. Turn VOLTAGE and CURRENT controls fully counterclockwise.



- C. Set ON/OFF switch to STAND-BY mode. Red STOP lamp will be illuminated.
- D. Press START button, note sound of fan. Green ON lamp will be illuminated.
- E. Turn VOLTAGE and CURRENT control slowly clockwise and observe the unit voltmeter. The pointer should move upscale.
- F. Press STOP button. Unit will return to the STAND-BY mode.

2.6.2 Current Mode

To check operation of the unit in the current mode, proceed as follows:

- A. Turn VOLTAGE and CURRENT controls fully counterclockwise.
- B. Connect a heavy gauge wire across the output terminals. One of the intended output leads is recommended for this purpose.
- C. Set ON/OFF switch to STAND-BY. Red STOP light will be illuminated.
- D. Press START button, note sound of fan. Green ON lamp will be illuminated.
- E. Rotate VOLTAGE control about 30° from the left hand stop and observe output meters. Both should be zero.
- F. In small increments, raise CURRENT control while observing the ammeter. If current does not increase, rotate the VOLTAGE adjustment another 30°.
- G. Press STOP button. Unit will return to the STAND-BY mode.
- H. Remove shorting wire from the output terminals.

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Table 2.1 MAXIMUM LINE CURRENT - 10KW

AMPS RMS										
LINE VOLTAGE	T1	T2	T3	T4	T5	T6	T8	T10	T11	
	208	380	415	440	480	575	220	230	400	
UNIT										
16-625T	50	26	23	21	22	16	41	40	25	
32-310T	50	26	23	21	22	16	41	40	25	
55-180T	50	26	23	21	21	16	41	39	25	
80-125T	49	26	22	20	21	16	40	39	24	
110-90T	49	25	22	20	21	15	40	38	24	
160-62T	49	25	21	20	20	15	39	38	23	
300-33T	48	25	21	20	20	15	39	38	23	
600-16T	48	25	21	20	20	15	39	38	23	
INPUT WIRE SIZE (AWG)	#8	#10	#10	#10	#10	#12	#8	#8	#10	
FUSE RATINGS										
CHASSIS										
F1	T, 5A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 5A, 500V	T, 5A, 500V	T, 3A, 500V	T, 3A, 500V
F2	T, 5A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 3A, 500V	T, 5A, 500V	T, 5A, 500V	T, 3A, 500V	T, 3A, 500V
F3	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 20A, 600V	T, 60A, 600V	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V
F4	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 20A, 600V	T, 60A, 600V	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V
F5	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 30A, 600V	T, 20A, 600V	T, 60A, 600V	T, 60A, 600V	T, 30A, 600V	T, 30A, 600V
A2 CONTROL PCB										
F1	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V	F, 2A, 250V
F2	T, 0.5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V
F3	T, 0.5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V
F4	T, 0.5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V
F5	T, 0.5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V	T, 5A, 125V

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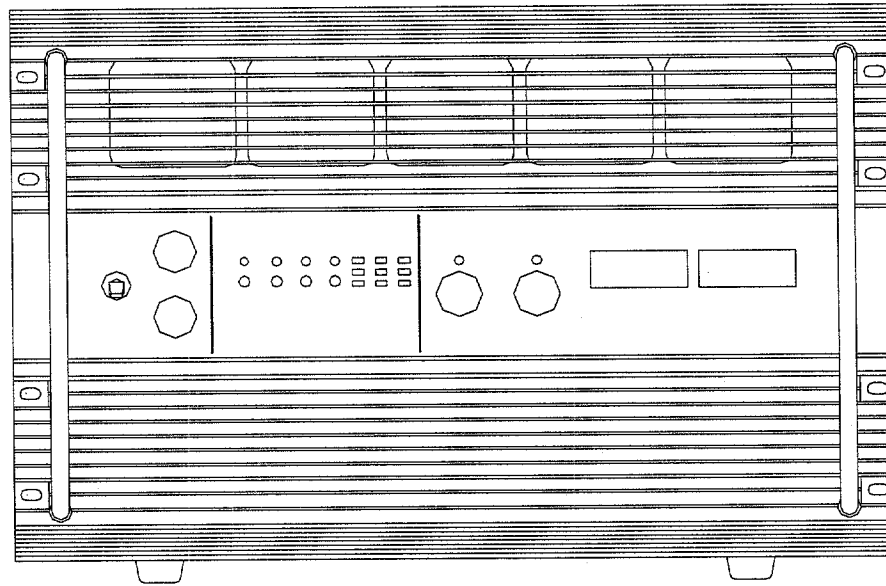
SECTION 3 OPERATION

3.1 GENERAL

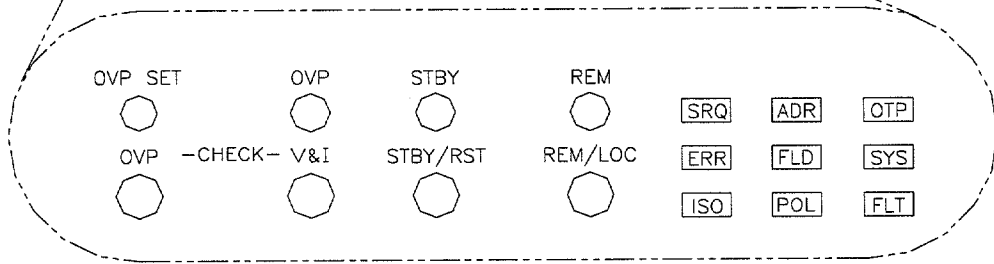
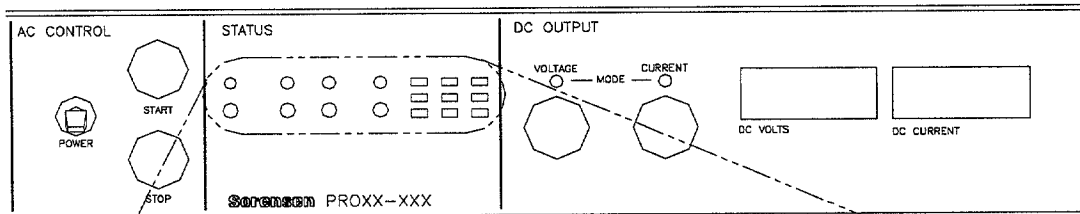
This section provides a tabular listing of the unit's controls and indicators along with a brief description of their function. Physical location of the controls and indicators is shown in Figure 3.1. The physical location of the rear panel terminals and connectors is shown in Figure 3.2.

Table 3.1 CONTROLS AND INDICATORS

Control/Indicator	Function
On/Off Switch	Energizes control circuitry and provides power for contactor disconnect. Puts unit in Stand-By.
Stand-By Lamp	Indicates unit is in Stand-By.
STOP Button	Causes contactor to be opened. Contactor is held energized through the STOP button, the contactor auxiliary contact, and a triac on the Control PCB.
ON Lamp	Indicates Main Power ON.
Thermal Indicator	Indicates an overtemperature condition.
OVP Indicator	Indicates that the OVP has been activated.
Reset Button	Brings output to zero. Resets the unit OVP or thermal shutdown without recycling.
OVP Adjust Button	OVP Adjustment control
REM Indicator	Indicates unit is in remote operation. ON when in remote operation. Flashes if a remote line is open.
Voltage Control	Multi-turn pot to set output voltage.
Volt Mode Indicator	Indicates when unit is in the voltage regulating mode.
Current Control	Multi-turn pot to set output current.
Current Mode Indicator	Indicates when unit is in the current regulating mode
Unit Ammeter	An ammeter connected to a shunt in the negative leg of the unit output. Indicates output current.
Unit Voltmeter	A voltmeter connected internally across the SENSE.

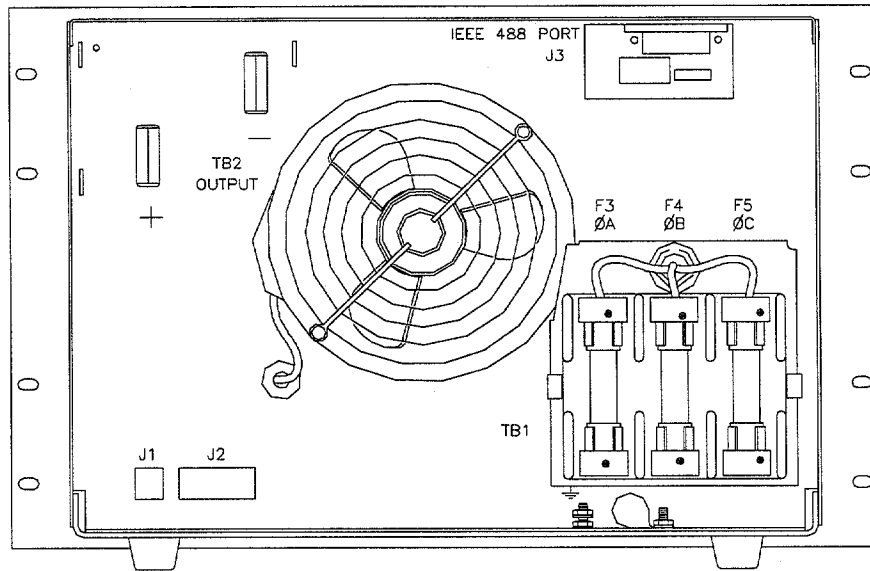


FRONT VIEW



PANEL CONFIGURATION

Figure 3.1 Front Panel Controls and Indicators



REAR VIEW

J1 REMOTE CONTROL	
1	- COM
2	- STOP
3	- START

J2 PROGRAM AND SENSE			
1	- REM OVP READ	19	- MODE IND
2	- COM	20	- MODE FLAG
3	- STBY/RST	21	-
4	- OVP IND	22	-
5	- OTP INC	23	-
6	-	24	- ISO STBY/RST-
7	- REM IND	25	- ISO STBY/RST+
8	- REM/LOC	26	-
9	-	27	-
10	-	28	-
11	- COM	29	-
12	- OVP SET	30	-
13	- I SET	31	-
14	- V SET	32	-
15	- STBY/RST	33	-
16	- VMTR	34	-
17	- IMTR	35	-
18	- +15	36	-

REMOTE
SENSE
(SEE
SEPARATE
DIAGRAM)

Figure 3.2 Rear Panel Terminals and Connectors



NOTE

For safety purposes (TUV requirement), the output return should not be referenced to any point with a voltage greater than 60 Vdc or, 30 RMS AC to earth ground.

This section also provides instructions for adapting the supplies to of their varied applications. Included are procedures to be followed for conversion to: remote sensing operation; voltage, current and programming modes; and series and parallel operation. Also included are procedures for use of the various remote control and remote indicator features of the power supply.



NOTE

Throughout the following discussion, voltage and current levels will be expressed in percentages of full scale label values. This is necessary due to the large variety of outputs available in the PRO-T Series. Full scale label values are determined by the model number, (e.g.) PRO16-625T5 is 16 volts and 625 amps full scale, PRO55-180T5 is 55 volts and 180 amps, etc.

3.2 LOCAL SENSING

The supplies are shipped without the sense leads connected. The supplies are protected against open sense leads. To realize specified performance of the unit, however, the sense leads must be connected. Local sensing simply means that the sensing circuit is connected across the unit output terminals and not at the load. For applications where the voltage drop in the load wires is prohibitive, use remote sensing (paragraph 3.5). Figure 3.3 illustrates the local sensing configuration of remote connector (J-2). The mating connector housing, strain relief and connector pins are included with the PRO-T unit. Connector pins will accept #18 through #24 AWG insulated wire.



NOTE

Care must be exercised when connecting sense leads. Reversing the connections will result in damage to the unit.

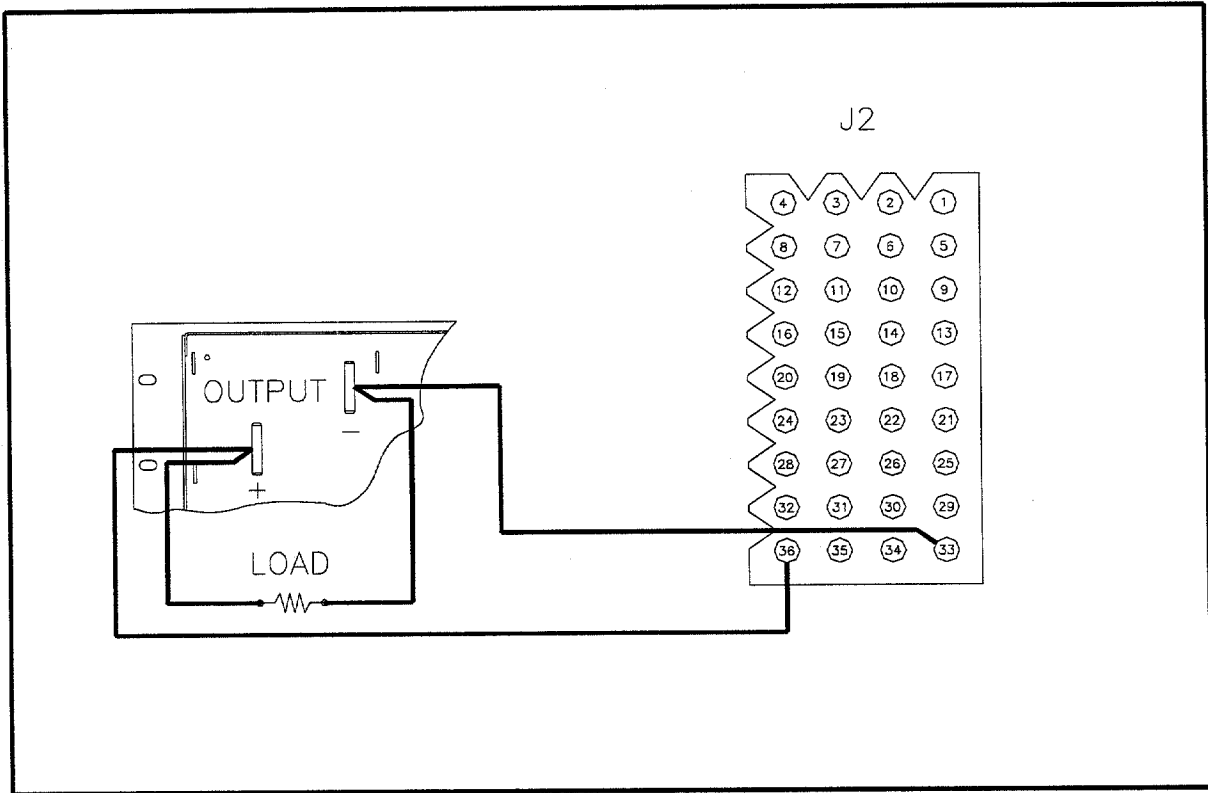


Figure 3.3 Local Sensing Configuration

3.3 VOLTAGE MODE

To put the unit in voltage mode operation, proceed as follows:

- A. Rotate the VOLTAGE and CURRENT control potentiometers fully counterclockwise.
- B. With the main disconnect switch OFF, connect the three phase input leads as indicated in Section 2.6.
- C. Set ON/OFF switch to ON. Red STOP lamp should be illuminated.
- D. Press START button. Green ON lamp should illuminate.
- E. Rotate VOLTAGE control until the unit voltmeter indicates the desired output voltage.



NOTE

To prevent random firing of the SCR's, for voltage outputs below 5% of maximum rated output voltage, it is recommended that a bleeder resistor be connected across the output of sufficient value to draw approximately 10% of rated output current. For example, for a PRO16-625 below .8V use a bleeder to draw approximately a 62 amp load. This would be approximately .013 ohms (use a 100 watt rating).

- F. Set ON/OFF switch to OFF, and set the main disconnect switch to OFF.
- G. Connect load to the unit terminals on the rear of the unit.
- H. Set CURRENT control to a value at least 10% above the actual load current.



NOTE

Regulation falls off if output current is within 10% of limiting value. Current mode indicator begins to glow when current output is within approximately 10% of limiting value.

- I. Set the Main Disconnect switch to ON and the ON/OFF switch to ON.
- J. Press START button. The green ON lamp will light and the unit will be in voltage operation mode.



NOTE

With the unit in the voltage mode, an increase in load current requirements above the value set in step H will cause an automatic crossover to current mode (current limiting) operation.

3.4 CURRENT MODE

To operate the unit in current mode, proceed as follows:

- A. Rotate the VOLTAGE and CURRENT controls fully counterclockwise.
- B. With the Main Disconnect switch OFF, connect three phase input as indicated in Section 2.6
- C. Set ON/OFF switch to ON. Stand-By lamp should illuminate.
- D. Press START button. ON lamp should illuminate.
- E. Rotate VOLTAGE control until unit voltmeter indicates a level 10% above the desired dynamic voltage.



NOTE

Current regulation falls off if the dynamic (compliance) voltage is within 5% of the voltage limiting value.

- F. Set ON/OFF switch to OFF, and set the Main Disconnect switch to OFF.
- G. Connect load lines to unit output terminals on the rear of the unit.
- H. Set the Main Disconnect switch to ON and the ON/OFF switch to ON.
- I. Press START button. ON lamp will light, and the unit is in voltage mode operation.

Turn CURRENT control to desired current regulating value. CURRENT MODE lamp will light and the unit is in current mode operation.




NOTE

If dynamic (compliance) voltage rises above limit set in step "E", the unit automatically crosses over to voltage mode operation. (Current mode light goes off.)


3.5 REMOTE SENSE


In the remote sensing mode, voltage regulation is at the load rather than at the unit output terminals, thus correcting for voltage drops in the load leads.

	NOTE
<p>Voltage drop in the output leads of 10V is the maximum for which remote sensing will compensate. To avoid exceeding the rated maximum unit voltage, the maximum load voltage (as read on the panel voltmeter) must be less than the rated maximum by the sum total of the drops. Example: If each load line drops 3 volts, (6 volts total), then on a 55 volt rated unit, the PRO55-90T, the voltmeter reading must not exceed $55 - 6 = 49$ volts.</p>	

To adapt a unit for remote sense operation, proceed as follows:

- A. Set unit ON/OFF switch to OFF and the Main Disconnect switch to OFF.
- B. Remove the local sense leads from both the output terminals and J2 mating connector, if already connected.
- C. Install the remote sense leads to plus and minus SENSE terminals in J2 using the J2 mating connector provided. Note which lead is connected to the plus terminal (remote sensing configuration is shown in Figure 3.4).

	NOTE
<p>Care must be exercised when connecting sense leads. Reversing the connections will result in damage to the unit.</p>	


	NOTE
<p>Use a twisted or shielded pair of wires for the remote sensing leads. Sensing current is approximately 1.0 mA.</p>	

- D. Connect the lead from the positive sense terminal to the positive load terminal, and connect the negative sense lead to the negative load terminal.
- E. Reset current limit per paragraph 3.3.
- F. If the unit is being placed on-line for the first time or is being returned to service following a maintenance check, etc., proceed as outlined in paragraph 3.3 or 3.4. Otherwise, set the Main Disconnect switch to ON, set the unit ON/OFF switch to ON and press the START button. POWER ON indicator light will illuminate and the unit supplies the load.


3.6 OVERVOLTAGE PROTECTION (OVP)

The OVP circuit protects the load by limiting the output voltage to a preset value. Load protection is accomplished by bringing the output current and voltage to zero and opening the contactor which brings the unit to a Stand-By mode when the preset OVP value is reached. The unit is shipped with the OVP factory set at 10 to 15% above the maximum output voltage.

To set the OVP at another value, proceed as follows:

	NOTE
To avoid nuisance tripping of the OVP circuit, the preset value should be set at 10% minimum above the operating output voltage.	

- A. Set the unit for operation as outlined in paragraph 3.3 or 3.4.
- B. To read the OVP set value on the front panel voltmeter, simply press the OVP set switch.
- C. Set the desired OVP value using the front panel OVP Adjust Control while depressing the OVP set switch.
- D. At any time, the OVP set value may be read without affecting the normal operation of the unit.

	NOTE
When unit is set for external programming, both voltage and current settings must be externally programmed. Both front panel output adjustment controls are disabled, but should be set fully ccw. If either programming line is open, the unit output will go to zero and the front panel Remote Indicator Lamp will flash. The OVP is unaffected.	

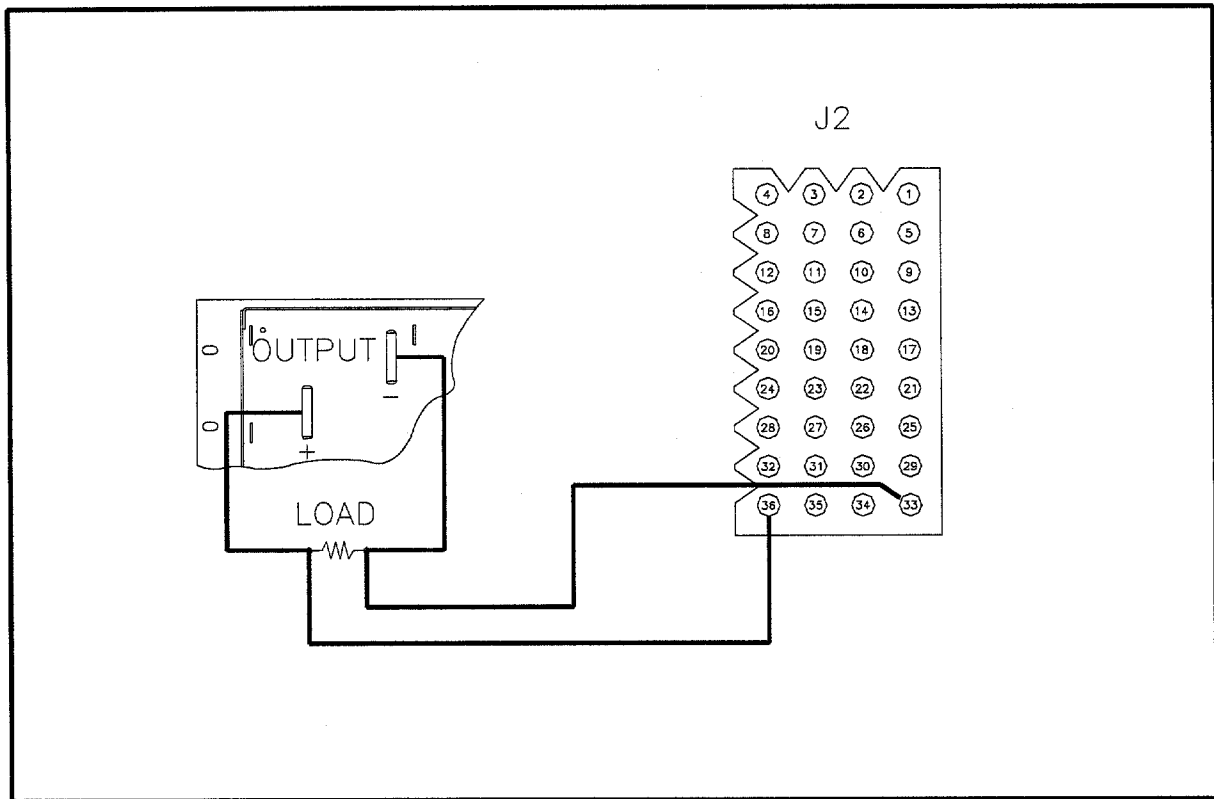


Figure 3.4 Remote Sensing Configuration

3.7 RESET

The front panel STBY/RST switch is used to clear those faults which latch the unit in the zero output state. These faults are: OVP shutdown, thermal shutdown and phase loss. When the RESET switch is depressed the unit output voltage and current will go to zero. When the RESET switch is released, the unit will soft start and return to the preset operating conditions.

To RESET the unit after a fault has occurred, proceed as follows:

1. **OVP SHUTDOWN:** After an OVP fault, the unit will be in Stand-By mode and the OVP indicator lamp will be illuminated. Press the RESET switch. The OVP indicator lamp will go off, and the unit can be re-started by pressing the START switch.
2. **THERMAL SHUTDOWN:** Should the thermal shutdown circuit activate, check first to make sure the unit cooling fan is operating. Fan failure is the primary cause of a thermal shutdown fault. Allow approximately 10 minutes time with the cooling fan operating before resetting the unit. Press the RESET switch and release. The unit output voltage and current will return to the preset operating conditions when green START button is pressed.

3. PHASE LOSS: The loss of one input phase line will latch the output voltage and current to zero. The unit can only be reset when the phase has been restored to the unit. When the lost phase has been restored, press and release the RESET switch. The unit output voltage and current will return to the preset operating conditions when the green START button is pushed.

3.8 EXTERNAL RESISTANCE PROGRAMMING

The unit output voltage, current and OVP set points may be resistance-programmed remotely to a predetermined regulated value. Three 1 mA precision current sources are provided, one each for programming voltage, current and OVP set. External resistance programming is accomplished by connecting a resistance from the current source output to common (J2 pin 11).

External Resistance Programming Constants are:

- 10,000 Ohms for 100% Output Setting.
- 1,000 Ohms for 10% Output Setting.
- 100 Ohms for 1% Output Setting.

3.8.1 Voltage and Current Mode

Remote programming sensitivity varies according to the full scale voltage and current output of the unit. Table 1-1 lists the proper ohms/volt and ohms/amp for each model. For example, a PRO32-310T has a 32 volt full scale output. The ohms/volt sensitivity from Table 1-1 is 313 ohms/volt. For a certain voltage output, therefore, the voltage value to be programmed must be multiplied by the ohms per volt sensitivity to arrive at the correct value for programming resistance.

Example for programming a 25 volt output from a 32 volt full scale unit: $(25) \times (313 \text{ ohms}) = (7825 \text{ ohms})$

Current output programming is accomplished in the same manner. For example, the PRO32-310T has a 310 Amp full scale output. The ohms/amp sensitivity from Table 1-1 is 32 ohms/amp.

Example for programming a 300 amp output: $(300) \times (32 \text{ ohms}) = (9600 \text{ ohms})$.



NOTE

The resistor used should have a low temperature coefficient (± 100 PPM) to maintain the units rated temperature characteristics as well as stability. Programming current is about 1 mA. Use a 1% resistor with a wattage rating of 1/8W or larger.

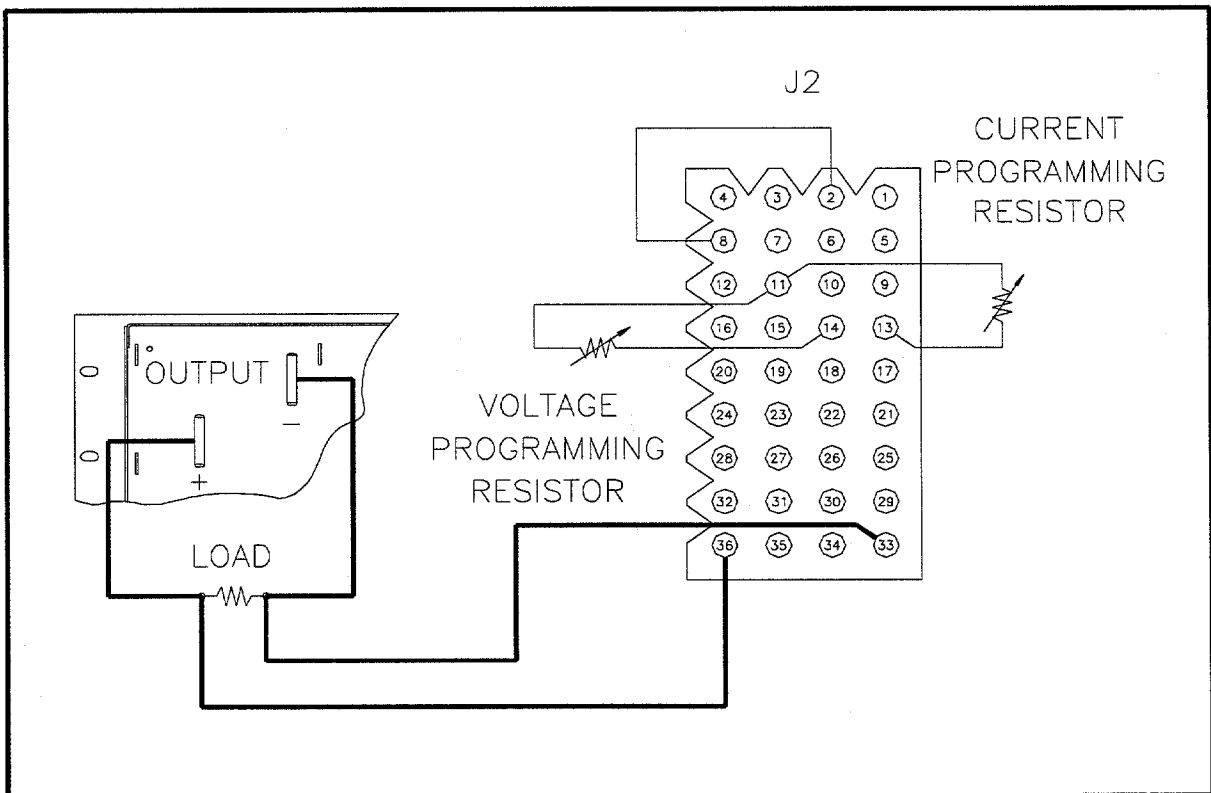
To adapt the unit to external resistance programming, proceed as follows:

- A. Set unit ON/OFF switch to OFF and Main Disconnect switch to OFF.
- B. Connect jumper wire from J2 pin 2 (Logic Ground) to J2 pin 8 (Remote/ Local).

- C. Connect both voltage and current programming resistors. (See Figure 3.5 for diagram of programming connections.) The voltage programming resistor is connected from J2 pin 14 (Remote Voltage Set) to J2 pin 11 common. The current programming resistor is connected from J2 pin 13 (Remote Current Set) to J2 pin 11.
- D. Set the Main Disconnect switch to ON and set the ON/OFF switch to ON. The Remote Indicator Lamp on the front panel will illuminate. Press the START button. The unit will regulate to the values set by the external programming resistors.

NOTE


If remote programming is to be discontinued, remove the programming device, and disconnect the jumper from J2 pin 2 to J2 pin 8.



**Figure 3.5 External Resistance Programming
(with Remote Sense)**

3.8.2 OVP Set

The unit OVP Trip Point may be externally resistance programmed. This would be desirable in those applications where one or more OVP Trip Points are required (different than the front panel OVP Trip Set adjustment).

	NOTE
External OVP set programming is independent of external voltage and current mode programming. The jumper from J2 pin 2 to J2 pin 8 is not required to remote program the OVP Trip Set Point.	

Example for setting the OVP Trip Set point to 8 volts on a PRO16-625T:

To determine the External Programming resistor value, proceed as follows:

1. First, determine OVP Trip Voltage needed for Section B.

Note: 0-10 volts corresponds to the 0 to 110% of full scale output of the unit to be programmed.

$$\frac{8 \text{ volts}}{16 \text{ volts full scale}} \quad (\text{desired operating Point}) \quad \times \quad 10\text{V (full scale programming voltage)} \quad = \quad 5 \text{ volts}$$

2. To determine the value of the program resistor, use a voltage from 0 to 10 volts, calculated above, in the following formula:

$$R_p = \frac{(X \text{ volts})}{.001 \text{ A}} \quad = \quad \frac{5 \text{ V}}{.001 \text{ A}} \quad = \quad 5\text{K ohms}$$

This value (5K ohms) would externally program the 16 volt full scale unit OVP Trip Set Point to 8.8V, and provide a 10% margin above the operating point to avoid nuisance tripping.

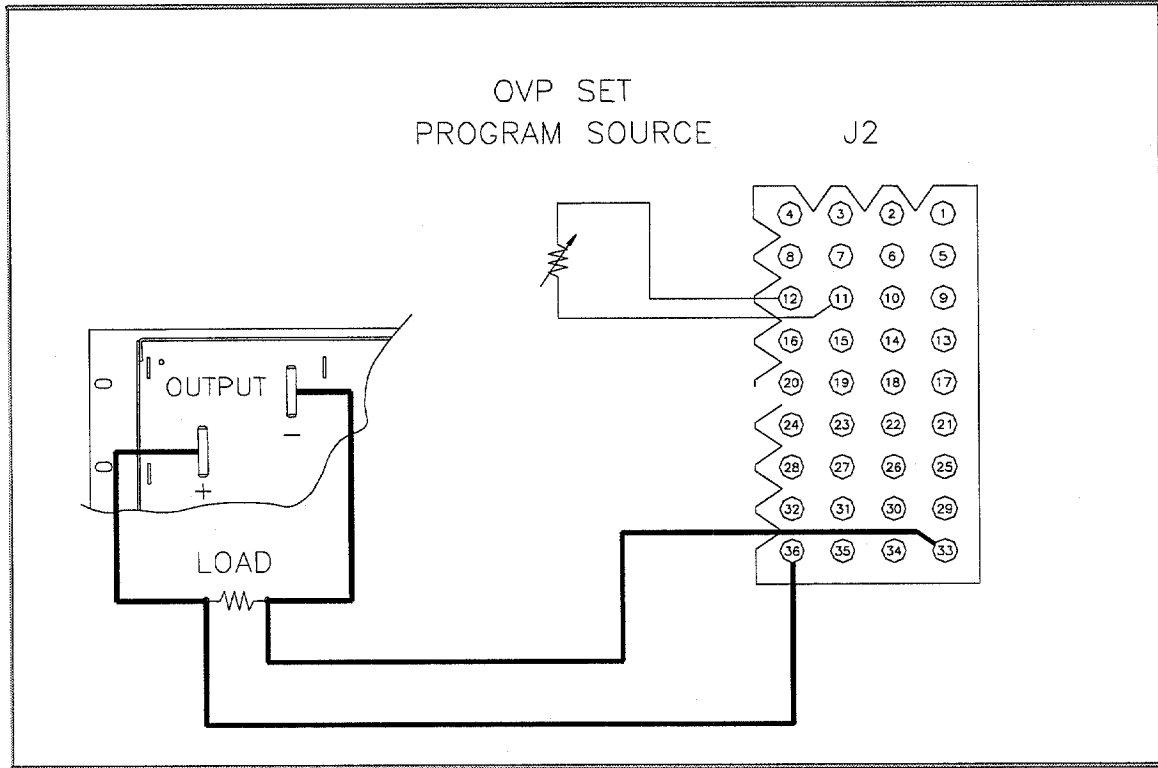
To adapt the unit to external resistance programming of the OVP Trip Point, proceed as follows:

- A. Set unit ON/OFF switch to OFF and the Main Disconnect switch to OFF.
- B. Set the front panel OVP set adjustment fully clockwise.
- C. Connect the program resistor from J2 pin 12 (Remote OVP Set) to J2 pin 11 common. See Figure 3.6 for diagram of OVP set programming connections.



NOTE

The remote programmed OVP set point may be read on the front panel voltage meter by depressing the OVP Set switch (see paragraph 3.6).



**Figure 3.6 External OVP Resistance Programming
(With Remote Sense)**

3.9 EXTERNAL SIGNAL PROGRAMMING

The unit output voltage, current and OVP set point, may be externally programmed to provide a variable output as a function of an input voltage signal. This is done by introducing the external signal to the current source outputs provided for programming voltage, current, and OVP set.

External Signal Programming Constants are switch selectable as follows:

0 - 10V:

10 volts for 100% Output Setting
1 volt for 10% Output Setting
0.1 volt for 1% Output Setting
SW1-2, SW2-2, SW3-2 ON (Closed)

0 - 5V:

5 volts for 100% Output Setting
0.5 volts for 10% Output Setting
.05 volts for 1% Output Setting
SW1-2, SW2-2, SW3-2 OFF (Open)



NOTE

When unit is set for external programming, both voltage and current settings must be externally programmed. Both front panel output adjustment controls are disabled, but should be set fully ccw. If either programming line is open, the unit will go to zero and the front panel remote indicator lamp will flash. The OVP is unaffected.

3.9.1 Voltage and Current Mode

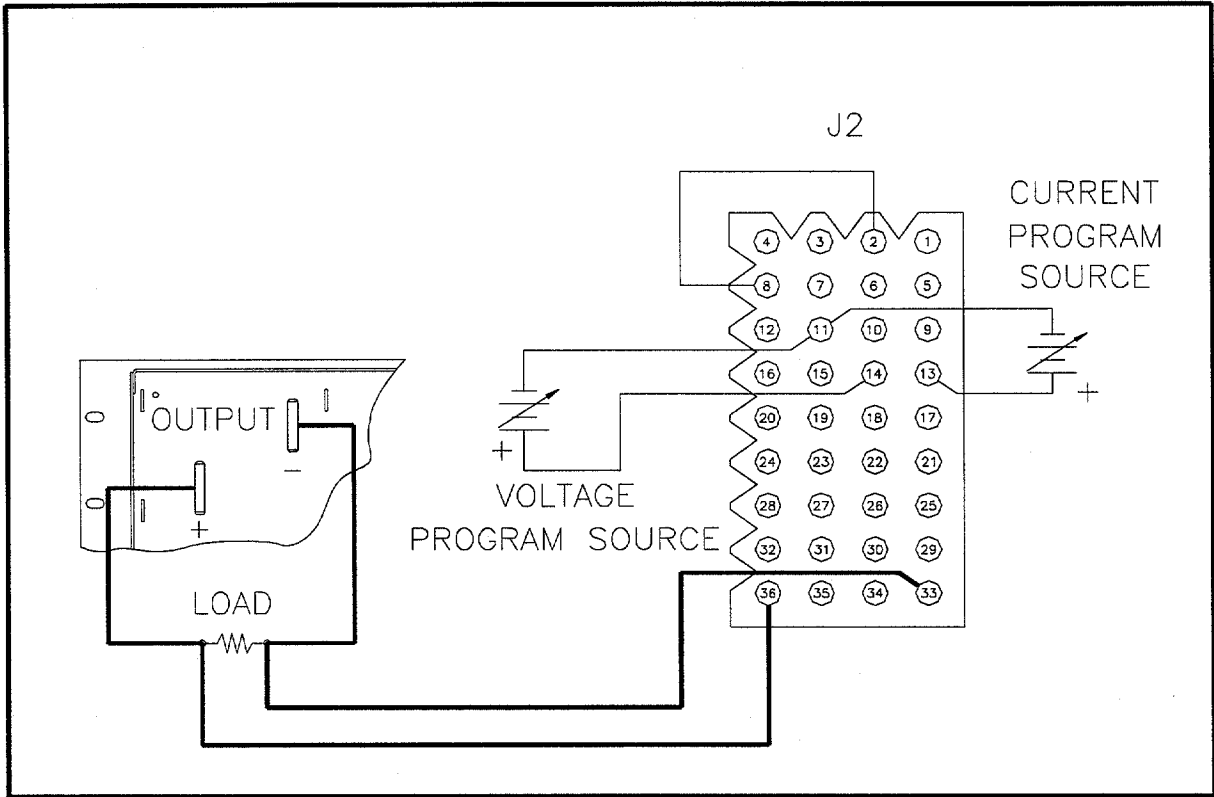
Remote signal programming sensitivity is 0 to 10 volts, or 0-5 volts for 0 to full scale output for all models in both voltage and current mode.

In selecting a signal source, the following should be considered:

1. The source must be capable of sinking approximately 1 mA (the Programming Current).
2. A floating (ungrounded) source must be used. All signal programming voltages will, however, have a common return.
3. To obtain a full scale voltage or current output range, the source provides a 0 to 10 volt signal, or 0-5V signal.

To adapt the unit to external programming, follow the procedure as outlined in paragraph 3.8.2, with one exception.

EXCEPTION: When Step C calls for connection of a resistor across the programming terminals on J2, instead connect the signal source. See Figure 3.7 for connections and observe the program signal polarity.



**Figure 3.7 External Signal Programming
(With Remote Sense)**

3.9.2 OVP Set

The unit OVP Trip Point may be externally signal programmed. This would be desirable in those applications where one or more OVP Trip Points are required to be different from the OVP Trip Set Adjustment.

NOTE

External OVP Set programming is independent of external voltage and current mode programming. The jumper from J2 pin 2 to J2 pin 8 is not required to remote program the OVP Trip Set Point.

The OVP Trip Set signal programming sensitivity is 0-10 volts, or 0-5 volts (SW1-2 OPEN), for 0 to full scale output for all models. The signal source requirements are the same as for the voltage and current mode signal programming source (see paragraph 3.9.1).

To adapt the unit to external signal programming of the OVP Trip point, follow the procedures outlined in paragraph 3.8.2, with one exception.

EXCEPTION: Where step C calls for connection of a resistor across the programming terminals of J2, connect the signal source instead. See Figure 3.8.2 for connections and observe the program signal polarity.



NOTE

The remote programming OVP set point may be read on the front panel voltage meter by depressing the OVP Set switch.

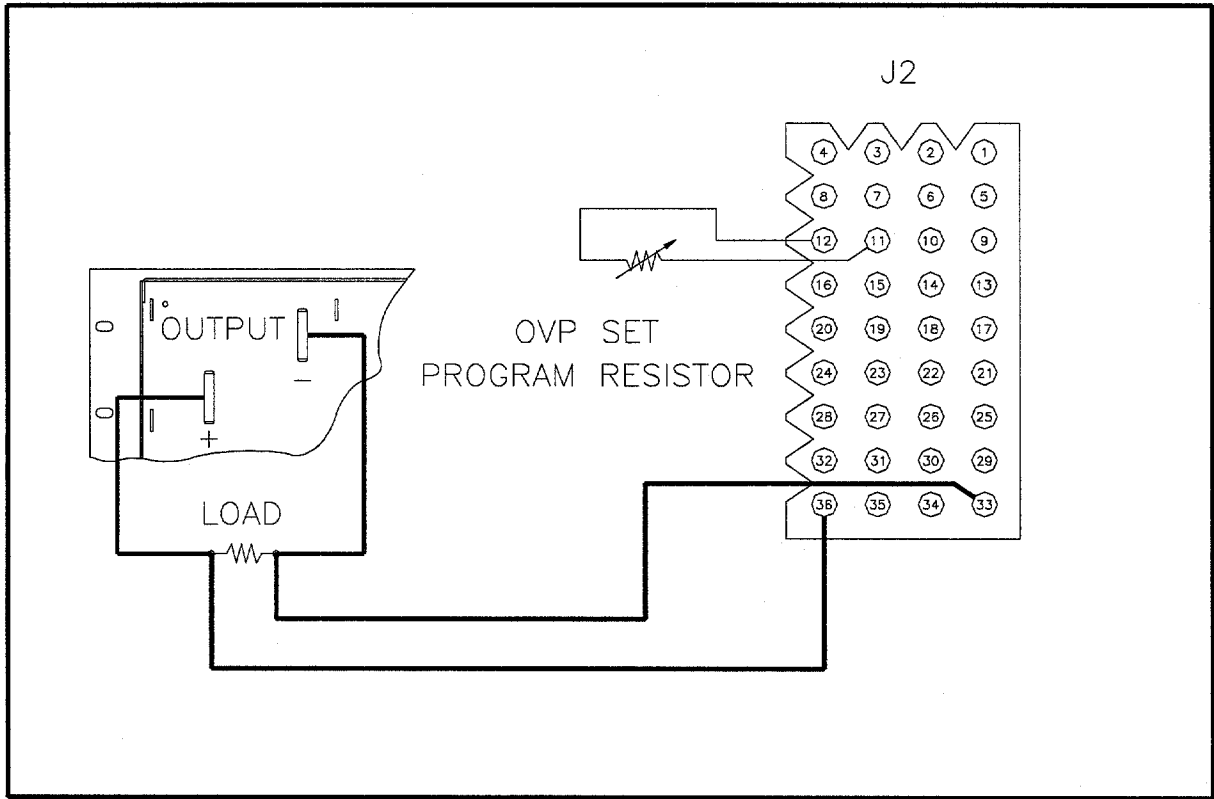
3.10 PARALLEL OPERATION

Paralleling of three-phase PRO-T units is accomplished directly by connecting the individual supplies to the load. Using this method, no current derating due to composite tolerances of wire resistance, components, etc., is required. There are no restrictions on the number of units that may be paralleled. However, paralleling units does result in lower overall regulation. This lower regulation value is equal to the sum of the regulations for each paralleled unit, plus the difference in their output voltage set points.




NOTE

When operating units connected directly in parallel, the AC switch on each unit must be on. This will activate each unit's fan and prevent internal overheating.



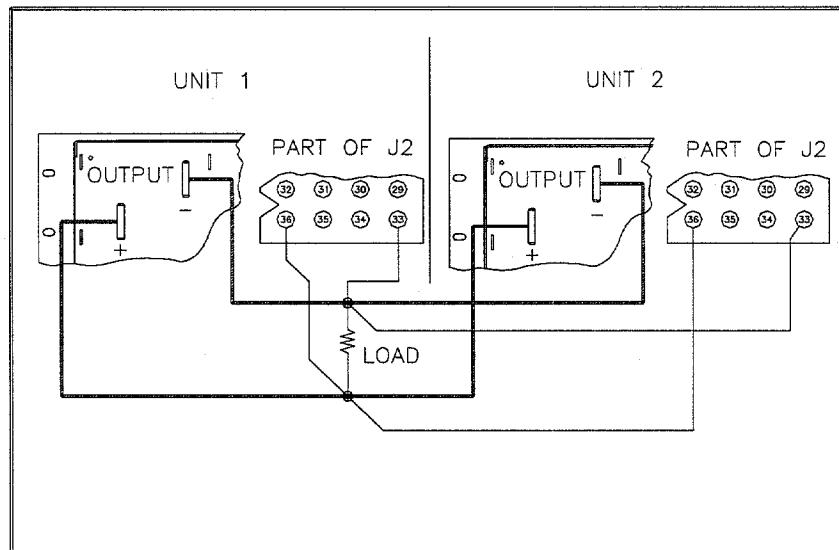
**Figure 3.8 External OVP Signal Programming
(With Remote Sense)**

 **NOTE**
The paralleled units may be adapted for remote sensing as illustrated in Figure 3.9. They may also be adapted for resistance programming. None of these are required for paralleled operations, however.

The following lists the procedures to be followed in directly paralleling two units. The procedure is applicable to any number of units, however. (See Figure 3.9 for connections.)

- A. Set the ON/OFF switch of both units to OFF. Disconnect main power to both units by setting the Main Power Disconnect switch to OFF.
- B. If applicable, disconnect output lines and sensing leads to both units.
- C. Re-energize the units.

- D. Rotate the VOLTAGE ADJUST control of one unit to the desired output. Repeat the procedure for the other unit. Match the two unit outputs as close as possible.
- E. Set CURRENT ADJUST AMPS control on each unit to one-half of the total desired limiting current; (e.g.) if desired, to limit load current at 15A, set each control to 7.5A, etc.
- F. Set the ON/OFF switch of both units to OFF. Disconnect main power to both units by setting the Main Disconnect switch to OFF.
- G. Connect output cables from each unit to load. If desired, connect the remote sensing leads of each unit to load.
- H. Re-energize both units. POWER ON indicators light. The unit which is supplying the highest voltage (it is possible to identically match the output voltages) will supply load. If the load requirements exceed the setting on CURRENT ADJUST AMPS control, this unit will automatically crossover to current mode operation, and its output voltage will drop. The second unit will assume that portion of the load rejected by the first. Any further increases in load will be supplied by the second unit up to its current limit setting. Regulation, therefore, will be the sum of the regulation of the two units plus the difference in the voltage settings. Set each current limit as needed to limit current to 100% of rated.



**Figure 3.9 Parallel Operation
(With Remote Sense)**

3.11 SERIES OPERATION

Series operation allows the user to connect as many as five 10 or 32 volt PRO-T units in series. Only three of the 55, 80 and 110 volt units and only two of the 160 volt units may be connected in this manner, while the 300 and 600 volt units may not be connected in series configuration. No derating is inherent in series operation and regulation is the sum of the regulation of all units.



NOTE

Series units may be connected for remote sensing as indicated in Figure 3.10, or they may be adapted to resistance or signal programming. None of these, however, are required for series operation.

The following outlines procedures for connecting two units in series. The same procedure may be used for series connecting up to five units. (See Figure 3.10 for schematic of connections.)

- A. Set desired voltage output of each unit at no load using VOLTAGE ADJUST. Select current limiting value.
- B. Set the ON/OFF switch of both units to OFF. Disconnect main power to both units by setting the Main Disconnect switch to OFF.
- C. Connect an output lead from the positive output terminal of one unit (for the sake of clarity, call this unit 1) to the negative output terminal of unit 2.
- D. Connect an output lead from unit 1 (negative terminal) to the load; connect the other output lead from unit 2 (positive terminal) to the load.



CAUTION

In series operation, rectifiers must be connected across each set of output terminals as shown in Figure 3.10. Failure to do so may result in damage to output capacitors. See paragraph 3.11.1 for information on rectifier selection.

- E. If remote sensing is desired, proceed as follows:
 1. Connect a sensing lead from the (- SENSE) terminal on unit 1, remote connector J2, to the load termination of unit 1 negative output lead.
 2. Connect a sensing lead from the (+ SENSE) terminal on unit 1, remote connector J2, to the negative output terminal of unit 2.
 3. Connect a sensing lead from the (- SENSE) terminal on unit 2, remote connector J2, to the negative output terminal of unit 2.

4. Connect a sensing lead from the (+ SENSE) terminal on unit 2, remote connector J2, to the load termination of unit 2 positive out-put lead.
- F. Re-energize both units. POWER ON indicator lights. Each unit operates as a separate entity, with the output of each independently adjustable. Each may be turned ON and OFF separately. (The rectifiers protect the OFF unit.)

3.11.1 Series Operation Rectifier

When operating units in series, connect rectifiers across the individual unit outputs. Assure the diodes have current and voltage capability at least equal to its associated supply. Adequate heatsinking must be used. (See Figure 3.10.)

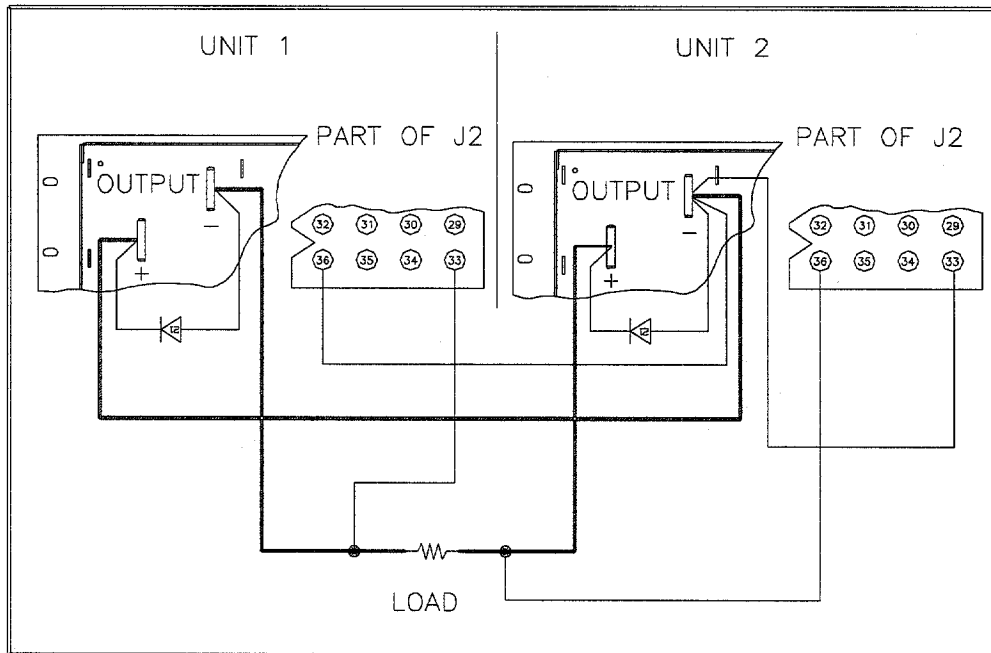



Figure 3.10 Series Operation
(With Remote Sensing)

3.12 REMOTE SHUTDOWN

The unit output voltage and current may be remotely shutdown without putting the unit into the Stand-By mode. The shutdown circuit is activated by connecting J2 pin 15 (SHUTDOWN) to J2 pin 18 (+15 VDC). This connection may be made by means of a switch or relay. A transistor switch may also be used. (See Figure 3.11 for typical remote shutdown configuration.)

	<p>NOTE</p> <p>The voltage magnitude on J2 pin 18 is +15 VDC referenced to J2 pin 2 (Common).</p>
---	--

3.13 REMOTE AC CONTROL

The front panel START and STOP functions may be remotely controlled through the J1 connector on the rear panel. This would be useful in those applications where the unit could be cycled between the Stand-By and ON modes. Momentarily closing SW2 will energize the AC contactor and start the unit (see Figure 3-11A). Momentarily opening SW1 will re-energize the AC contactor and stop the unit putting it in a standby mode.


3.14 REMOTE INDICATORS

The front panel status, voltage mode and current mode indicators, may be remotely accessed on the J2 connector. The indicator drivers may be used to turn on a remote indicator lamp or activate a remote circuit.

3.14.1 Status Indicator Drivers

The following indicator drivers are available on the J2 connector:

INDICATOR	J2
OVP	Pin 4 (OVP IND)
THERM	Pin 5 (THERM IND)
REMOTE	Pin 7 (OPERATE REMOTE IND)

	NOTE
<p>All status indicator driver voltage levels are +15 VDC when activated. The maximum load current per driver is 20 mA, therefore, a current limiting resistor must be used. The circuit common for all status indicators is J2 pin 2 (Common). (See Figure 3.12 for typical remote status indicator configurations).</p>	

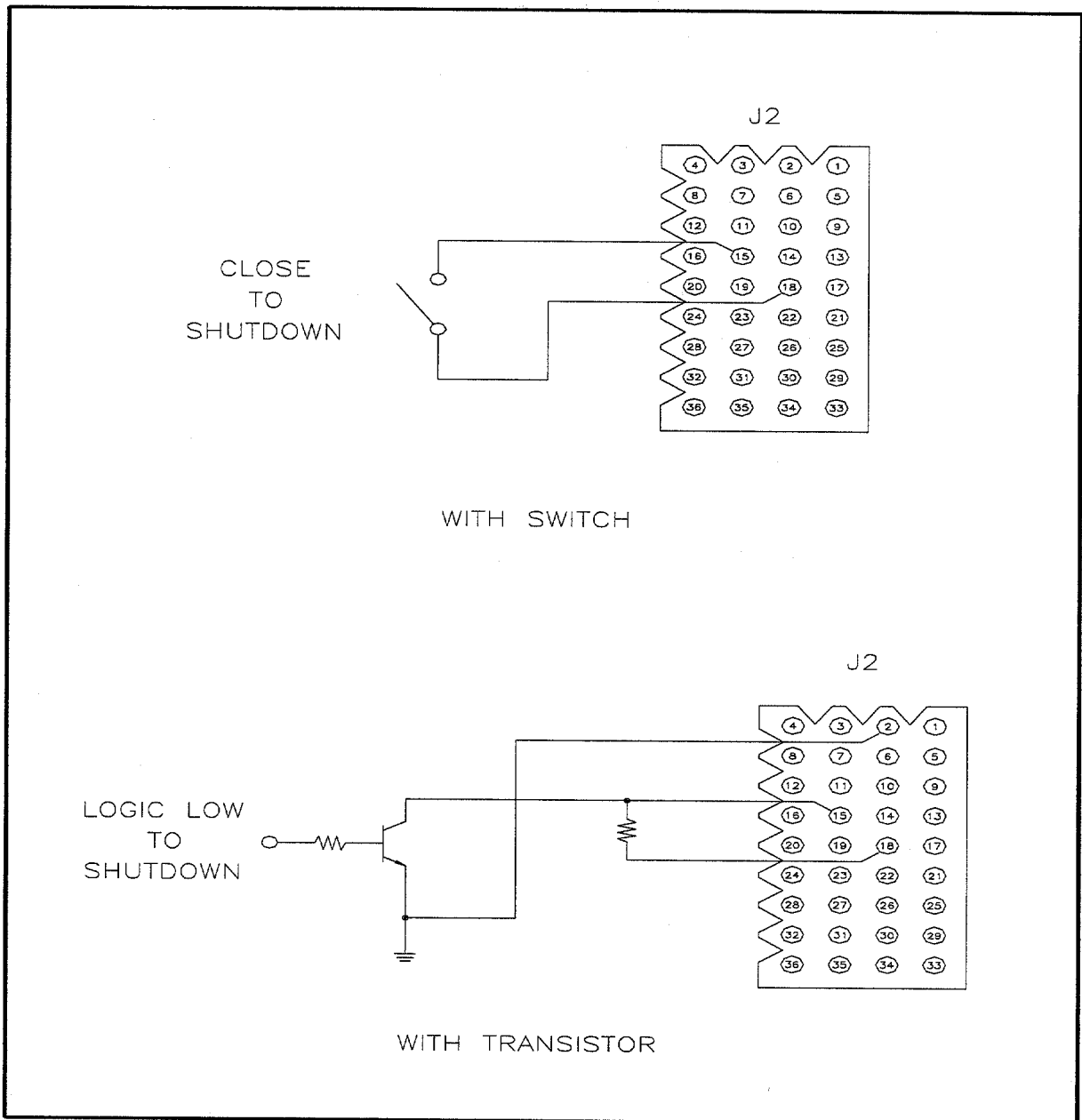


Figure 3.11 Remote Shutdown

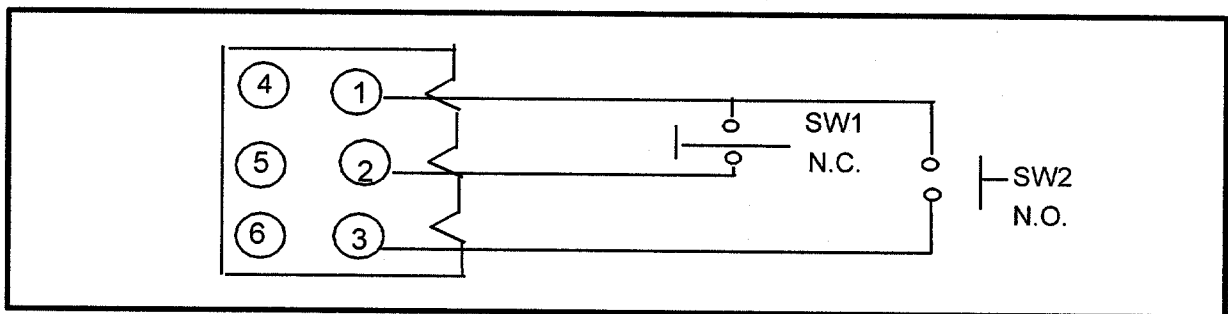


Figure 3.11A

NOTE: SW1 normally CLOSED, OPEN to stop.
SW2 normally OPEN. momentarily CLOSE to START.

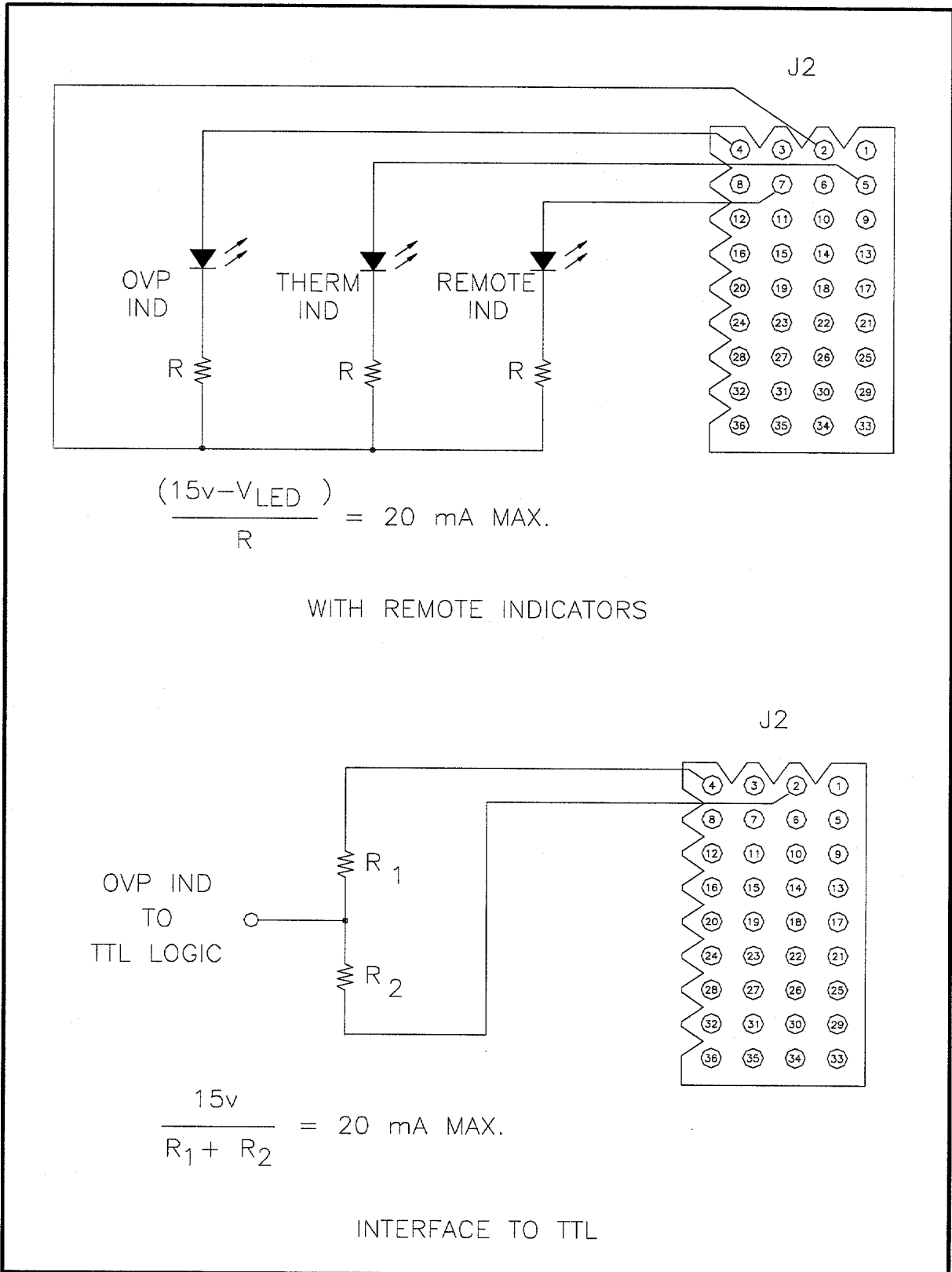


Figure 3.12 Remote Status Indicators

3.14.2 Mode Indicator Functions

Two voltage and current mode indicator functions are available on the J2 connector. The first is a mode indicator driver on J2 pin 19 (MODE DRIVE) and the second is an open collector mode flag on J2 pin 20 (MODE IND). The same precautions observed for the Status Indicator Drive (paragraph 3.14.1) also applies to the Mode Indicator Functions. (See Figure 3.13 and 3.14 for typical mode indicator configurations).

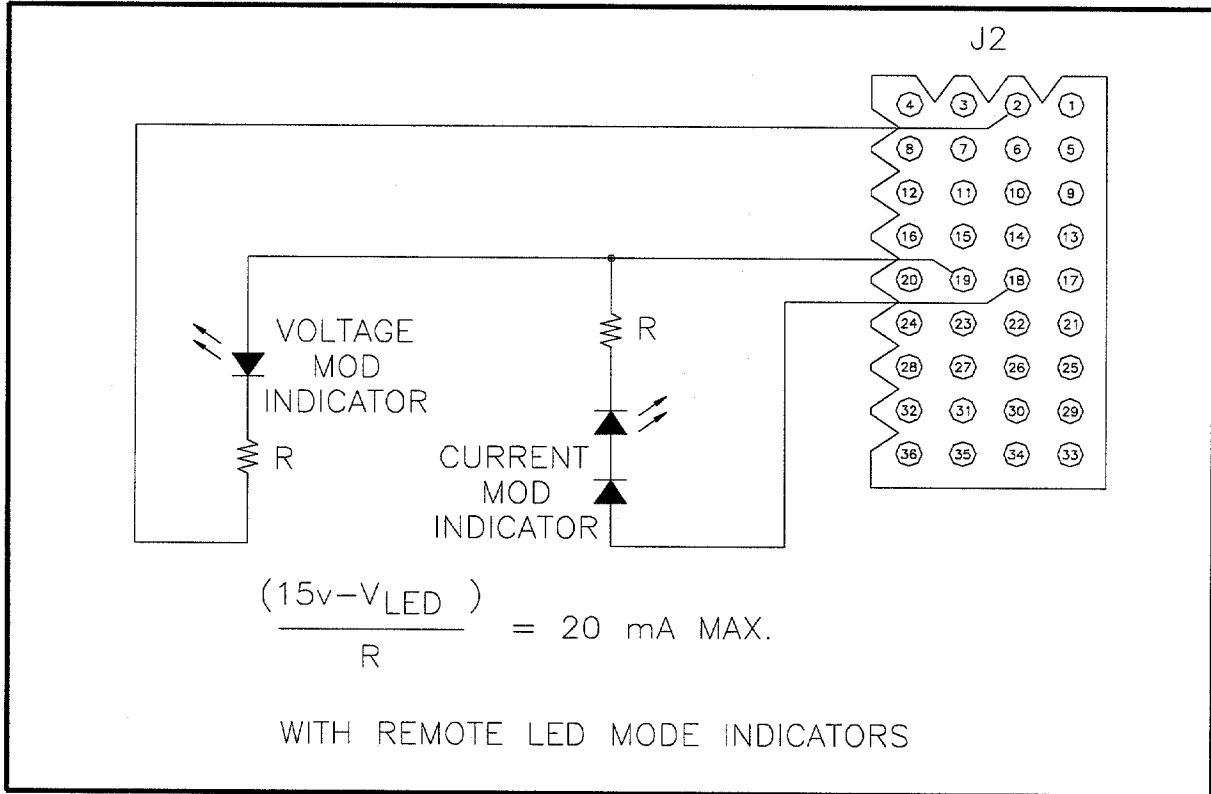


Figure 3.13 Remote Led Mode Indicators

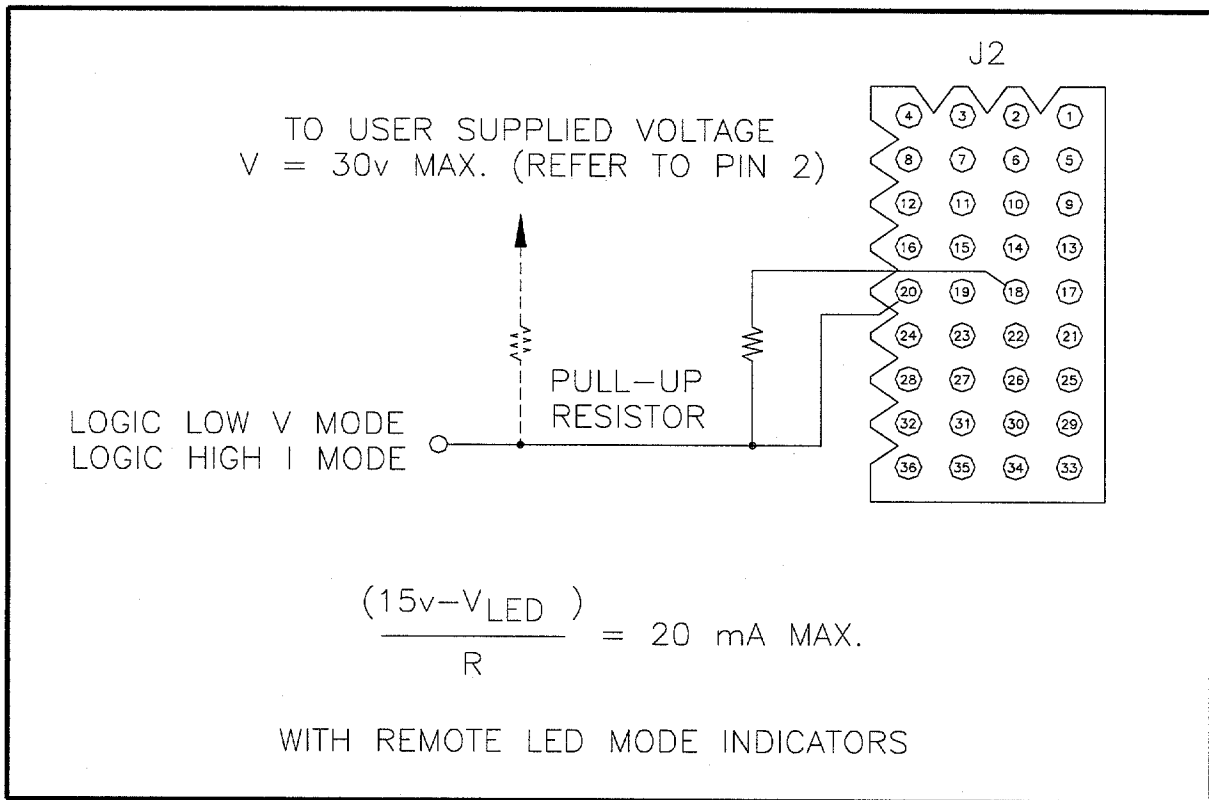


Figure 3.14 Mode Flag

3.15 REMOTE RESET

The front panel RESET function may be remotely activated. See paragraph 3.7 for details on the RESET function. The RESET function is activated by momentarily connecting J2 pin 3 (RESET) to J2 pin 2 (LOGIC GND). A momentary switch or transistor circuit may be used. (See Figure 3.15 for typical remote RESET configurations).

NOTE

The RESET current is approximately 1mA when connected to J2-2. Use a switch or transistor rated for 15 Vdc minimum.

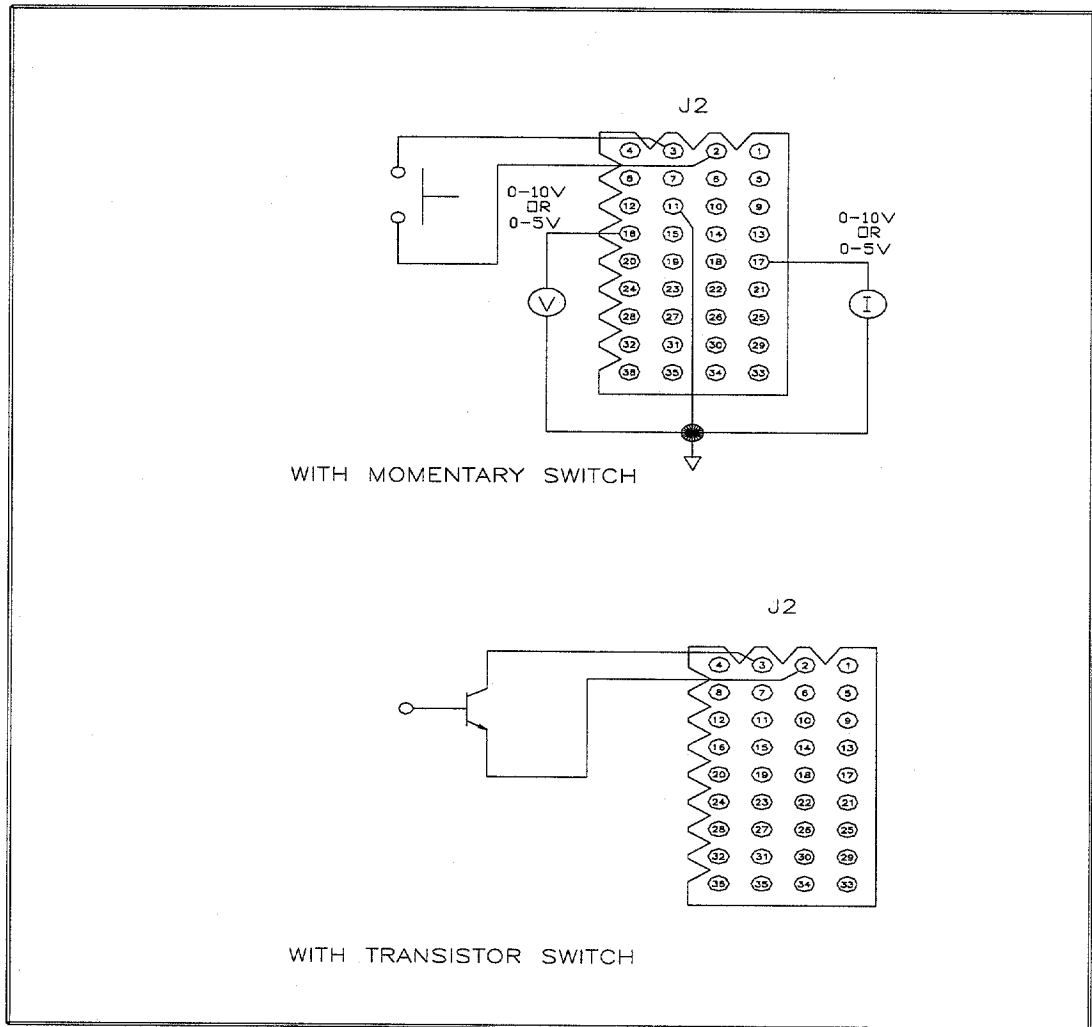


Figure 3.15 Remote Reset

3.16 REMOTE VOLTAGE AND CURRENT MONITOR

The output voltage and current may be monitored from the J2 connector (See Figure 3.15). Two 0 - 10V or 0-5V (jumper select) proportional voltage sources are provided.