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Sorensen
A **Raytheon** Company

Instruction Manual for

SRL Series Power Supplies

Includes the following SRL models:

Convection Models	Fan Models
10-25	10-50
20-12	10-100
20-25	20-50
40-6	40-25
40-12	40-50
60-4	60-17
60-8	60-35

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FIVE-YEAR WARRANTY

Sorensen Company warrants all parts of equipment of its manufacture, except special purpose tubes and semiconductor devices which carry their own manufacturer's warranty, to be free from defects caused by faulty material or poor workmanship. Sorensen Company warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgment form to be free from defects caused by faulty material or poor workmanship. Sorensen Company's obligation is limited under the warranty to repair or replacement of products in kind, or at its option to issuance of a credit of original purchase price.Returns must be accompanied by a Sorensen Company Return Material Authorization form and conform to standard conditions for adjustment. The aforesaid warranty shall expire five (5) years following the last day of the month of shipment from Sorensen Company's plant. The foregoing states the entire warranty extended by Sorensen Company. No other warranty, expressed or implied, is made and, specifically, Sorensen Company makes no warranty of merchantability or fitness for any purpose. In no case shall Sorensen Company be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

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SECTION 1

INTRODUCTION

1.1 PURPOSE

This manual contains operation and maintenance data on the SRL series power supplies. The purpose of the manual is to familiarize the user with unit functions, to introduce the varied configurations to which the unit is convertible, and to provide the necessary maintenance data to assure long operating life.

Six major sections form the content of this manual. Section 1 contains a description of the series, highlights important features, and tabulates complete specifications. Inspection and initial checkout procedures are covered in section 2. Operation procedures are outlined in section 3. Section 4 details the theory of operation, and section 5 provides maintenance, service and repair instructions. Schematics, parts lists, operating curves and waveforms are included in section 6.

1.2 DESCRIPTION

The SRL series consists of seven convection cooled models in the 250W to 500W range, and seven fan cooled models in the 500W to 2 kW range. Both have outputs ranging to 60 Vdc. Differences in models are noted as applicable.

1.2.1 Physical

SRL power supplies are designed for either bench or rack mounted use, and for easy component accessibility. All controls used in normal operation are mounted on the front panel. Power outputs up to 25 Amperes may be taken from the unit front mounted binding posts. The mode selector terminal board is at the rear of the supply. Through manipulation of the terminal board links, the functions of voltage/current mode programming, remote sensing and parallel operation are obtained. Output terminals are also provided at the rear of the unit.

Models 20-12, 40-6 and 60-4 have an input fuseholder, and use a front panel power switch. The other convection cooled models (SRL 10-25, 20-25, 40-12, and 60-8) and all fan cooled models (SRL 10-50, 10-100, 20-50, 40-25, 40-50, 60-17, and 60-35) use a circuit breaker.

1.2.2 Functional

The SRL power supplies provide a precisely regulated dc output, adjustable over a wide range. They operate from any of three available ac inputs, and exhibit rapid response to transients, both load and line. Unit characteristics are outlined in specifications table 1-3 and 1-4.

All semiconductors used in the SRL series are silicon types, and contribute significantly to the unit ambient temperature characteristics. High dissipation transistors are mounted to a cast aluminum alloy heatsink; low dissipation devices are located on a plug in printed circuit board.

Table 1-1 SRL Panel Controls/Indicators (Convection Models)

Control	Function
POWER Switch: (CB 1/S1) S1 (Models 20-12, 40-6, 60-4) CB1 (Models 10-25, 20-25, 40-12, 60-8)	Applies ac line voltage to input of put of power supply.
POWER Light (DS1)	Illuminates when POWER switch is in the ON position. (And internal fuse is not blown).
OVERVOLTAGE SET (S2)	Momentary toggle switch, when depressed causes panel dc VOLTS meter to indicate overvoltage trip level.
OVERVOLTAGE ADJ (R85)	Recessed potentiometer to adjust trip level of overvoltage circuit.
OVERVOLTAGE INDICATOR (DS2)	Illuminates when limit set by OVERVOLTAGE ADJ (R85) has been exceeded by the power supply output voltage.
VOLTAGE Controls (R53A, R53B)	Provide coarse and fine adjustment of output voltage. (Voltage Mode)
DC VOLTS Meter (M1)	Provides direct readout of voltage selected by voltage controls.
DC AMPERES Meter (M2)	Provides direct readout of load current.
CURRENT Controls (R18A, R18B)	Provide coarse and fine adjustment of output current. (Current Mode)

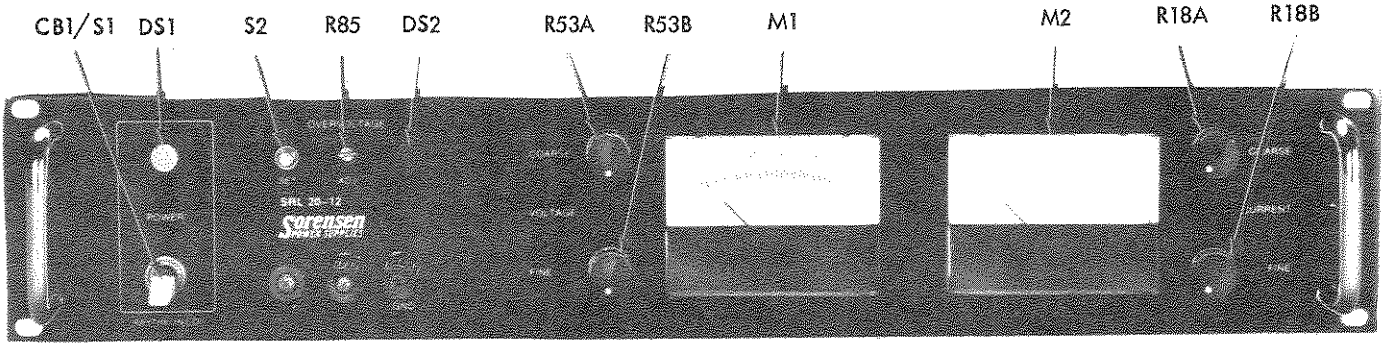


Figure 1-1 Front Panel Controls and Indicators (Typical) (Convection Models)

Table 1-2 SRL Panel Controls/Indicators (Fan Cooled Models)

Control	Function
POWER light (DS1)	Illuminates when POWER switch is in the on position.
OVERVOLTAGE SET (S2)	Momentary toggle switch, when depressed causes panel DC VOLTS meter to indicate overvoltage trip level.
OVERVOLTAGE ADJ (R85)	Recessed potentiometer to adjust trip level of overvoltage circuit.
OVERVOLTAGE INDICATOR (DS2)	Illuminates when limit set by OVERVOLTAGE ADJ (R85) has been exceeded by the power supply output voltage.
DC VOLTS Meter (M1)	Provides direct readout of voltage.
DC AMPERES Meter (M2)	Provides direct readout of load current.
CURRENT Controls (R18A), (R18B)	Provide coarse and fine adjustment of output current. (Current Mode)
VOLTAGE Controls (53A, R53B)	Provide coarse and fine adjustment of output voltage. (Voltage Mode)
THEMAL OVERLOAD (DS3)	Illuminates when unit temperature exceeds a preset limit.
POWER Switch (CB1)	Turns on the power supply.

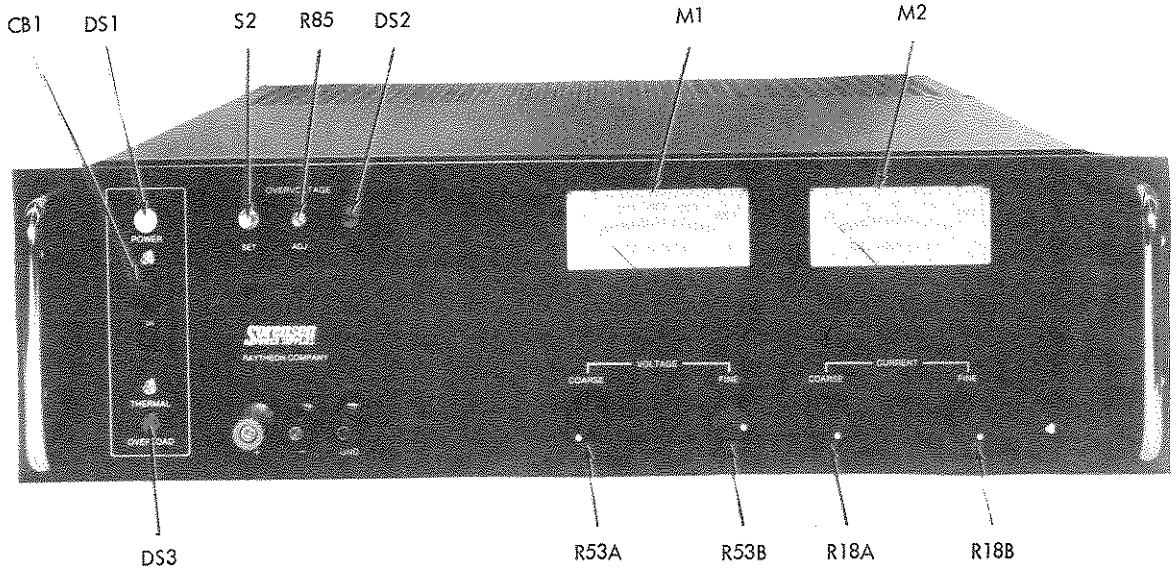


Figure 1-2 Front Panel Controls and Indicators (Typical) (Fan Models)

1.2.2.1 Operating Modes

SRL models have two basic operating modes: constant voltage and constant current. In the former, the output voltage is regulated by the front panel selected or programmed value, and the output current varies with the load. In constant current operation, the output current is regulated at the selected value while the output voltage varies as a function of load.

1.2.2.2. Automatic Crossover

The automatic crossover capability enables the unit to transfer operating modes as a function of load requirements. If, for example, load current attempts to increase above the setting of the current adjust control, the unit will switch operation automatically from the voltage to the current mode. If the load requirements are lowered, return to the voltage mode will occur automatically.

1.2.2.3 Remote Programming

Any SRL model may be remotely programmed, that is, its output may be altered from a distant location in either the voltage or current mode by introducing a calculated resistance or signal into the appropriate programming circuit. This may be readily accomplished through the link arrangements at the rear terminal board.

1.2.2.4 Remote Sensing

Terminals located on the rear terminal board offer the means of extending a unit's regulating point from the output terminals to the load. This, in effect, compensates for variations in the load lead voltage drop. The maximum drop for which a unit will compensate is one volt per load lead.

1.2.2.5 Series Operation

For applications requiring voltages higher than a single SRL can provide, a number of units may be connected in series. Maximum system output is specified at 200 Vdc. Unit connections are illustrated in Section 3. Regulation in series operation is the sum of the regulations for all units. In series operation, external rectifiers to protect units against reverse voltage, developed by a unit malfunction, are unnecessary. Reverse voltage protection is designed into the unit.

1.2.2.6 Parallel Operation

Parallel operation may be used to service those applications requiring a higher output current than a single SRL can provide. Unit connections are illustrated in section 3. Paralleling is indirect through a master/slave approach, i.e., the amplifier of the master unit controls the output of all units in the system. In parallel operation, the maximum output current of each unit is derated to 90%.

1.2.2.7 Protection Features

Protection against the effects of overloads and internal short circuits is provided; in the first case, by automatic crossover, and in the second by the input fuse or

circuit breaker. In addition, open sensing leads or links will not drive the unit into high output voltage. Internal rectifiers preclude this by clamping the output to approximately 1-1/2 volts above output setting.

Internal control circuitry is protected by a fuse connected in the primary of the input transformer.

Fan cooled units are additionally protected by a thermostatic control circuit to automatically shut the unit down in the event of thermal overload.

Table 1-3 Convection Cooled Unit Specifications (Sheet 1 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
INPUT RATINGS	105-125V (Standard) 190-230V (M1)							
Voltage Range	210-250V (M2)							
Frequency	47-53/57-63Hz							
Phase	1							
Current (Adc Max)								
@ 115Vac		7.8	6.3	6.0	7.5	13.6	13.2	12.5
@ 210Vac		4.3	3.5	3.3	4.1	7.5	7.3	6.9
@ 230Vac		3.9	3.2	3.0	3.75	6.8	6.6	6.25
Power Factor (typical)		0.65	0.58	0.66	0.67	0.64	0.56	0.54
Efficiency (typ)		42%	56%	50%	45.5%	52.5%	60%	64%
OUTPUT RATINGS								
Voltage Mode:								
Voltage Range (Vdc)		0-20	0-40	0-60	0-10	0-20	0-40	0-60
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.01% of Full Range							
Current Range (Adc)								
@ 55°C	0-Io Max.	0-12	0-6	0-4	0-25	0-25	0-12	0-8
@ 71°C		0-67% Io Max	0-67% Io Max	0-67% Io Max	0-77% Io Max	0-50% Io Max	0-67% Io Max	0-67% Io Max
Current Mode:								
Current Range:	Same as in Voltage Mode.							

Table 1-3 Convection Cooled Unit Specifications (Sheet 2 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Current Range (cont)								
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.015% of Full Range							
Voltage Compliance	Full Voltage Range							
Crossover Characteristics	Figure 6-6 (Section 6)							
PERFORMANCE								
Voltage Mode:								
Regulation [1]	0.01% or 2 mV							
PARD (ripple) 50-60Hz input:[2]								
Max. RMS, 10Hz-7MHz (μV)		200	200	300	350	300	300	300
Max. P-P, 0-25MHz (mV, grounded output)		30	30	30	20	30	30	30
Transient Response (typ. recovery time-μSec)[3]		30 30	30 30	70 70	150 150	150 150	150 150	70 70
Output Impedance								
Typical	Figure 6-5 (Section 6)							
Low Freq. (R & JwL):								
R=(μOhms)		80	320	750	20	40	170	375
L=(μHy)		1.3	1.0	0.8	1.0	0.8	1.6	0.8
Temp. Coefficient	0.01% +200 μV/°C							

[1]For a combined full line swing, and a NF-FL (no load-to-load) or FL-NL change.
[2]With chassis tied to ground.
[3]For a step load change of NL-FL or FL-NL, recovery to ± 10mV band.

Table 1-3 Convection Cooled Unit Specifications (Sheet 3 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Drift (typical)[1]	0.025% + 500μV							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/volt)[2]	200±0.5%							
Volt.Gain (volt/-volt)[3]	1							
Remote Sensing	1V/Load Lead							
Overload Protection	Crossover to Current Mode							
Output voltage Over-Shoot	None							
Current Mode:								
Regulation, full line and load (mA)	0.02% + B, where B= :	4	1	1	4	4	4	1
PARD (ripple) 50-60Hz input:								
Max. RMS 10Hz-7MHz (mA) Full Compliance (FC)		3	0.5	0.5	10	10	1	1

[1]For 8hrs after warmup, @ constant line voltage, load and ambient temperature.
[2]Can be varied.
[3]Can be varied-signal source can be connected to negative output.

Table 1-3 Convection Cooled Unit Specifications (Sheet 4 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Output Impedance (typ)	Figure 6-5 (Section 6)							
Temperature Coeff. (/°C) (typ)	0.01% + C Where C=	1mA	0.5mA	0.5mA	1mA	1mA	1mA	1mA
Drift (after 8hrs warmup) (typ)	0.03% + 3mA							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/amp)		80±10%	150±10%	250±10%	40±10%	40±10%	80±10%	125±10%
Voltage (volts/amp)		0.08±10%	0.150±10%	0.25±10%	0.02±10%	0.02±10%	0.08±10%	0.125±10%
Overload Protection	Crossover to Voltage Mode							
Output Current Overshoot	None							
SPECIFICATIONS (MISC.)								
Overvoltage Protection								
Crowbar: Response Time (typ)[1]	To Erated (typ) +6V, 50 µSec							

[1]10uSec response can be achieved by removing C51, although nuisance tripping may result.

Table 1-3 Convection Cooled Unit Specifications (Sheet 5 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Crowbar (cont)								
Temperature Coeff. (typ)	0.05%/°C							
Open Sensing Protection	Yes							
Reverse Voltage Protection	Yes							
Ambient Temperature Range	0°C-71°C							
Derate Per Characteristics	Figure 6-6 (Section 6)							
Series Operation (direct connection or master-slave	Up to 200 Vdc Output							
Parallel Operation (by current limiting feature or master-slave)	Up to 3 Units							
Cooling	Convection							
Isolation Voltage to Ground:								
Input	1000Vdc							
Output	200Vdc							

Table 1-3 Convection Cooled Unit Specifications (Sheet 6 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
MECHANICAL DATA								
Size in. (mm):								
Width	19(483)							
Height		3-15/32(88)	3-15/32(88)	3-15/32(88)	5-7/32(133)	5-7/32(133)	5-7/32(133)	5-7/32(133)
Depth	17-3/4(451)							
Weight lbs. (kg)		45(20.4)	44(20)	44(20)	64(29)	64(29)	64(29)	64(28)
AC Input Conditions	Line Cord							

Table 1-4 Fan Cooled Unit Specifications (Sheet 1 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
INPUT RATINGS	105-125V (Standard) 190-230V (M1 Option)						*	*
Voltage Range	210-250V (M2 Option)							
Frequency	47-53/57-63Hz							
Phase	1							
Current (Adc Max)								
@ 115Vac		14.7	22	22	32.5	28	N/A	N/A
@ 210Vac		8	12	12	18.5	15.4	25	26
@ 230Vac		7.3	11	11	16.3	14	23	24
Power Factor (typical)		0.73	0.675	0.685	0.66	0.64	0.66	0.6
Efficiency (typ)		42.4%	59.7%	61.7%	45.5%	53.6%	62.5%	67.8%
OUTPUT RATINGS								
Voltage Mode:								
Voltage Range (Vdc)		0-10	0-40	0-60	0-10	0-20	0-40	0-60
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.01% of Full Range							
Current Range (Adc)								
@ 55°C	0-Io Max.	0-50	0-25	0-17	0-100	0-50	0-50	0-35
@ 71°C	0-67% Io Max.							
Current Mode:								
Current Range:	Same as in Voltage Mode.							

*105 - 125-volt input not provided. 190-230V (standard).

Table 1-4 Fan Cooled Unit Specifications (Sheet 2 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Current Range (cont)								
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.015% of Full Range							
Voltage Compliance	Full Voltage Range							
Crossover Characteristics	Figure 6-6 (Section 6)							
PERFORMANCE								
Voltage Mode:								
Regulation [1]	The greater of 0.01% or 2 mV							
PARD (ripple) 50-60Hz input:[2]								
Max. RMS, 10Hz-7MHz (μV)		300	500	500	300	500	700	700
Max. P-P, 0-25MHz (mV, grounded output)		25	40	25	20	40	40	40
Transient Response (typ. recovery time-μSec)[3]	150 μSec							
Output Impedance								
Typical	Figure 6-5 (Section 6)							
Low Freq. (R & JwL):								
R=(μOhms)		10	80	180	5	20	40	85
L=(μHy)		0.5	1.2	1.6	0.3	1.6	0.8	1.6
Temp. Coefficient	0.01% +200 μV/°C							

[1]For a combined full line swing, and a NF-FL (no load-to-load) or FL-NL change.
[2]With chassis tied to ground.
[3]For a step load change of NL-FL or FL-NL, recovery to ± 10mV band.

Table 1-4 Fan Cooled Unit Specifications (Sheet 3 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Drift (typical)[1]	0.025% + 500μV							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/volt)[2]	200±0.5%							
Volt.Gain (volt/-volt)[3]	1							
Remote Sensing	1V/Load Lead							
Overload Protection	Crossover to Current Mode							
Output voltage Over-Shoot	None							
Current Mode:								
Regulation, full line and load (mA)	0.02% + B, where B= :	4	4	4	6	4	4	4
PARD (ripple) 50-60Hz input:								
Max. RMS 10Hz-7MHz (mA) Full Compliance (FC)		20	10	3	35	10	10	10

[1]For 8hrs after warmup, @ constant line voltage, load and ambient temperature.
[2]Can be varied.
[3]Can be varied-signal source can be connected to negative output.

Table 1-4 Fan Cooled Unit Specifications (Sheet 4 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Output Impedance (typ)	Figure 6-5 (Section 6)							
Temperature Coeff. (/°C) (typ)	0.01% + C Where C=	1mA	1mA	1mA	2mA	1mA	1mA	1mA
Drift (for 8 hrs after warmup) (typ)	0.03% +D where D=	3mA	3mA	3mA	10mA	3mA	3mA	3mA
Remote Programming								
Prgrm. Constant:								
Res. (ohms/amp)		20±10%	40±10%	60±10%	10±10%	20±10%	20±10%	28±10%
Voltage (volts/amp)		0.08±10%	0.02±10%	0.04±10%	0.0025 ±10%	0.08±10%	0.008±10%	0.015±10%
Overload Protection	Crossover to Voltage Mode							
Output Current Overshoot	None							
SPECIFICATIONS (MISC.)								
Overvoltage Protection								
Crowbar: Response Time (typ)[1]	To Erated (typ) +6V, 50 µSec							

[1] 10 µSec response can be achieved by removing C51, although nuisance tripping may result.

Table 1-4 Fan Cooled Unit Specifications (Sheet 5 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Crowbar (cont)								
Temperature Coeff. (typ)	0.05%/°C							
Open Sensing Protection	Yes							
Reverse Voltage Protection	Yes							
Ambient Temperature Range	0°C-71°C							
Derated Per Characteristics	Figure 6-6 (Section 6)							
Series Operation (direct connection or master-slave)	Up to 200 Vdc Output							
Parallel Operation (by current limiting feature or master-slave)	Up to 3 Units							
Cooling	Fan							
Isolation Voltage to Ground:								
Input	1000Vdc							
Output	200Vdc							

Table 1-4 Fan Cooled Unit Specifications (Sheet 6 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
MECHANICAL DATA								
Width	19(483)							
Height		5-7/32(133)	5-7/32(133)	5-7/32(133)	6-31/32(177)	6-31/32(177)	6-31/32(177)	6-31/32(177)
Depth		21 (533)	21 (533)	21 (533)	23 (584)	21 (53.3)	21 (533)	21 (533)
Weight lbs. (kg)		81 (36.74)	95 (43.1)	95 (43.1)	132 (59.8)	128 (58)	120 (54.4)	120 (54.4)

SECTION 2

INSTALLATION

2.1 GENERAL

After unpacking, initial inspections and preliminary checkout procedures should be performed to assure that unit is in good working order. Basically, these consist of visually checking for damaged parts and components, and making an electrical check. Procedures are given in this section to check the unit in voltage and current modes of operation. If it is determined that the unit is damaged, the carrier should be notified immediately. The carrier claim agent will then prepare a report of damage. The user is required to send this report to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, New Hampshire, 03103. Sorensen Company will advise the user as to what action is required to repair or replace the supply.

2.2 INITIAL INSPECTION

Proceed as follows to inspect for damage incurred during shipment, prior to applying ac power:

1. Inspect panel and chassis for dents, paint chips and obvious signs of structural damage.

2. For units with rear mounted fuseholder, assure that holder contains a properly rated fuse. Fuse ratings for both 115 and 220/230 Vdc inputs appear above the holder.

3. Turn front panel controls from stop to stop. Rotation should be smooth.

4. Set POWER switch to ON and then OFF, then test OVERVOLTAGE switch for proper mechanical action.

5. Check for cracked or broken indicator lamp lens.

6. Inspect for cracked meter windows. If pointer is off zero, reset using adjust screw. (To minimize effects of static electricity causing deflection, touch meter window and chassis with fingers of one hand).

7. Check input cord for physical damage. Tug lightly on cord near chassis to make certain relief grommet grips cord.

8. Inspect terminal boards. On TB2, links should be firmly connected across terminals 1, 2, 3 and 4, 7 and 8, 9 and 10. Check that sensing leads are properly connected between TB3-1 and TB2-5, and TB3-3 and TB2-6.

9. Remove screws retaining top cover to chassis. Inspect printed circuit board and components for damage.

Unit mounting and installation dimensions are shown in figures 2-1, 2-2, and 2-3.

2.3 ELECTRICAL INSTALLATION

Sorensen's high power SRL models 40-50 and 60-35 are factory wired for 190-230 Vac inputs (order M2 for 210-250 Vac input). Other models of SRL power supplies are factory wired to accept 105-125 Vac (standard model), 190-230 Vac (M1 model) or 210-250 Vac (M2 model). Low power units are provided with a factory wired power cord. This cord terminates externally in a three prong polarized plug through the line cord, and therefore insertion of the plug into a compatible receptacle will automatically ground the unit. If a grounded input is not available, use an adapter, making sure that the external lead of the adapter is well grounded. For units not equipped with a line cord intact, connect 3 wire input leads to terminals 1, 2 (GRD) and 3 on input terminal board TB1 at the rear of the supply.

CAUTION

If chassis is not grounded, case will be at approximately 55 Vac due to RFI capacitors connected between AC line and chassis. This can produce an unpleasant (although not dangerous) electrical shock.

2.4 ELECTRICAL INSPECTION

The following paragraphs describe the procedure for making an initial electrical inspection. If specification verification is required, refer to section 5, Maintenance.

2.4.1 Voltage Mode

To check voltage mode operation, proceed as follows:

1. Rotate COARSE CURRENT control and COARSE VOLTAGE controls fully counterclockwise.

2. Rotate FINE CURRENT control fully clockwise.

NOTE

Do not loosen or remove interconnecting links of terminal boards.

3. Insert power cord into a suitable receptacle, and set POWER switch to ON.

4. Slowly rotate the COARSE VOLTAGE control clockwise. Minimum range should be from 0 to maximum rated output voltage (table 1-3 or 1-4).

5. Set POWER switch to OFF.

2.4.2 Current Mode

To check current mode operation, proceed as follows:

1. Rotate COARSE VOLTAGE control and COARSE CURRENT controls fully counterclockwise.

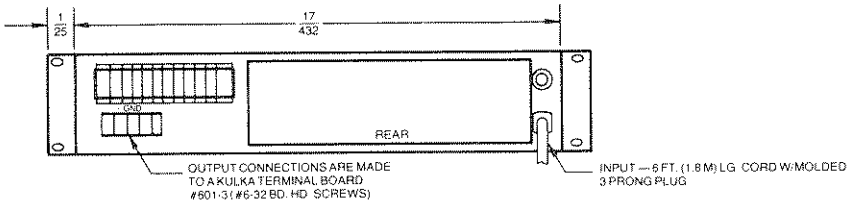
2. Turn FINE VOLTAGE control fully clockwise.

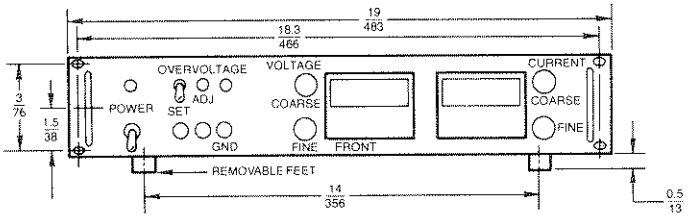
3. Short output terminals, using appropriate size wire. (rear terminals only for units of 25 amperes and above).

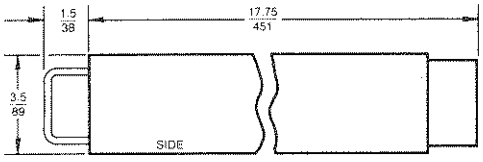
4. Set POWER switch to ON.

5. Rotate COARSE CURRENT control slowly clockwise. The control range should be from "0" to the maximum rated output (table 1-3 or 1-4).

6. Set POWER switch to OFF.





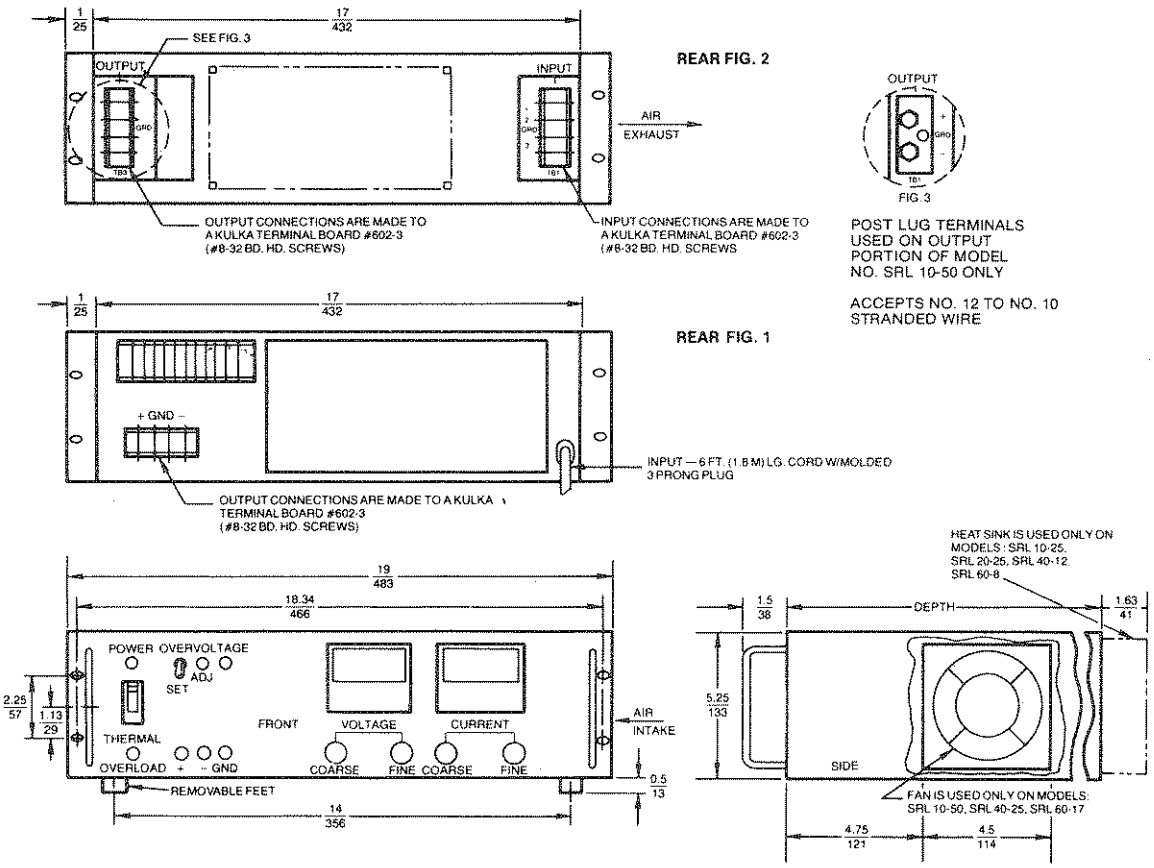


Model	Weight lbs (kg) Net
SRL 20-12	45 (20.4)
SRL 40-6	44 (20.0)
SRL 60-4	44 (20.0)

ALL DIMENSIONS ARE IN INCHES / MM

Dwg No. E585325
Rev.-

Figure 2-1 SRL Outline Drawing 3 1/2" Panel Series

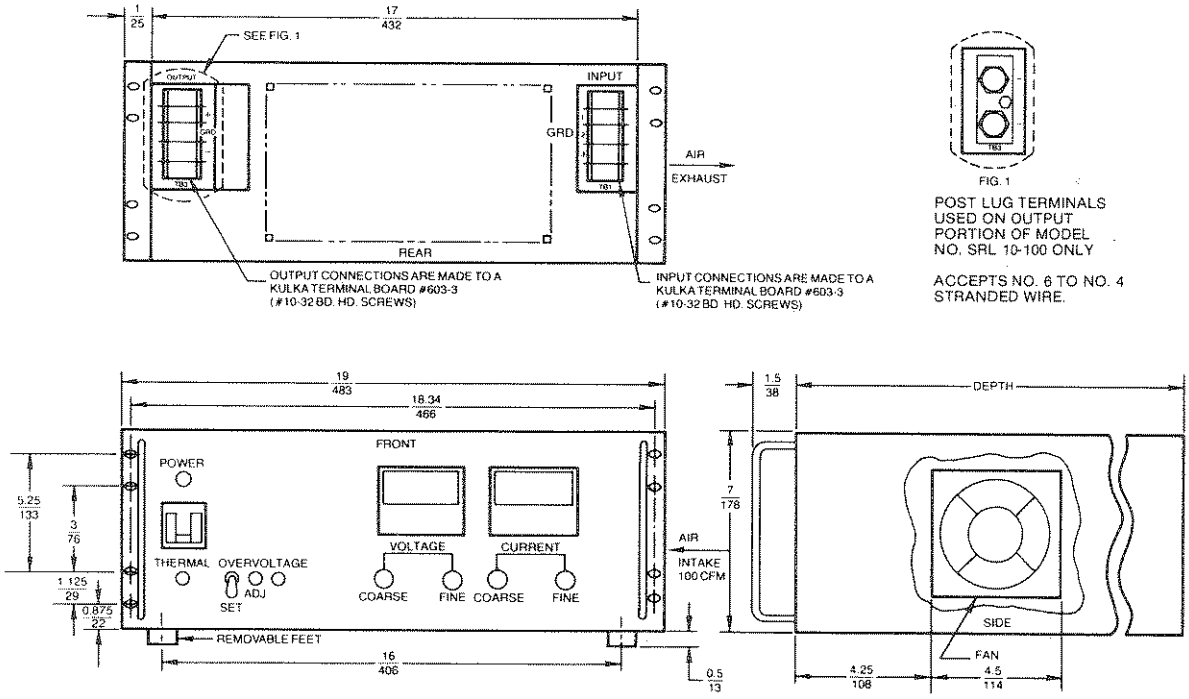


Model	Depth	Rear View	Weight lbs (kg) Net
SRL 10-25	16.2 (409)	Fig. 1	64 (29)
SRL 10-50	21 (533)	Fig. 2	81 (36)
SRL 20-25	16.2 (409)	Fig. 1	64 (29)
SRL 40-12	16.2 (409)	Fig. 1	64 (29)
SRL 40-25	21 (533)	Fig. 2	95 (43)
SRL 60-8	16.2 (409)	Fig. 1	64 (29)
SRL 60-17	21 (533)	Fig. 2	95 (43)

NOTES: ALL DIMENSIONS ARE IN INCHES / MM

Dwg NO. E585324
Rev. -

Figure 2-2 SRL Outline Drawing 5 1/4" Panel Series



Model	Depth	Weight lbs (kg) Net
SRL 10-100	23 (584)	132 (60)
SRL 20-50	21 (533)	128 (58)
SRL 40-50	21 (533)	120 (54)
SRL 60-35	21 (533)	120 (54)

NOTES: ALL DIMENSIONS ARE IN INCHES
MM

Figure 2-3 SRL Outline Drawing 7" Panel Series

SECTION 3

OPERATION

3.1 GENERAL

In this section, procedures required to convert an SRL unit to any of its various operating configurations are presented, including local and remote sensing, voltage and current mode programming, and series and parallel operation. Unit controls and indicators have been illustrated and described in section 1.

3.2 VOLTAGE MODE OPERATION

3.2.1 Local Sensing

All models in the SRL series are shipped ready for use with local sensing, i.e., sensing point is at the output terminals. If variations in load lead drops are expected to be high relative to unit's specified regulation, remote sensing should be used (paragraph 3.2.2).

To operate unit in local sensing, proceed as follows:

1. To set current limit value, short the unit output terminals. Set panel CURRENT control to zero (fully counterclockwise). Set POWER switch to ON, and use CURRENT control to adjust current limit value, not to exceed 110% of rated current.

2. Set POWER switch to OFF, remove short.

3. Apply input power, and rotate COARSE and FINE VOLTAGE controls to obtain desired output. Set POWER switch to OFF.

4. Observing polarity, run load leads to either front or rear output terminals. At rear terminals, link should be fitted between binder screw head and lead.

NOTE

Some models do not include front panel output terminals.

5. Set POWER switch to ON.

3.2.2 Remote Sensing

To adapt unit for remote sensing operation, follow procedures outlined in paragraph 3.2.1. Before setting POWER switch to ON, remove wire sense leads between terminals TB3-1 and TB2-5 and TB3-3 and TB2-6. Then connect sensing leads, observing polarity, to TB2-5 and TB2-6. Use coaxial cable or a twisted pair of wires for sensing leads and make certain that the leads are firmly connected to unit terminals and load. Current in the sensing leads is below 100 mA. In remote sensing, standard programming operation, transient response characteristics may degenerate slightly.

3.2.3 Remote Programming

In voltage mode, remote programming operation, unit output voltage is controlled by external resistance or voltage signal commands. Either type may be used.

3.2.3.1 Resistance Programming

If the output voltage is to be controlled by resistance programming, calculate the resistance required using the ratio of 200 ± 0.5 ohms per volt, that is for every volt of output desired approximately 200 ohms are required. In selecting a programming resistor, choose one with a low temperature coefficient (±20 ppm/°C) and a wattage at least twice that calculated (programming current is normally 5 mA).

Note that resistance programming may also be used to improve the unit drift characteristic. For example, if a fixed output is required, a fixed resistor may be selected. This eliminates the variable contact resistance which is inherent in any potentiometer and which contributes to the drift characteristic. If abrupt changes in output voltage are to be made by switching the programming resistance, use a make-before-break switch.

To adapt unit to resistance programming, proceed as follows:

a. Short unit output terminals with current control set to zero (CCW). Set POWER switch to ON. Use the CURRENT control to adjust current limit value.

b. Set POWER switch to OFF, remove short.

c. Rotate VOLTAGE controls fully counterclockwise.

d. Remove link between terminals TB2-3 and TB2-4, and connect programming resistor. Use twisted or shielded wire for leads.

NOTE

Operating the unit with open programming leads or links may result in either low or high output voltage.

With the programming resistor connected across terminals TB2-3 and TB2-4, the VOLTAGE control remains in the circuit. Rotation of this control will alter the programmed voltage. If this is undesirable, connect the resistor across terminals TB2-3 and TB2-6 to effect complete bypass. If step changes in output voltage are to be made by abrupt resistance alterations, use make-before-break switching.

3.2.3.2 Changing of Programming Constant

If it becomes desirable to change the programming constant, the value of R21 (programming constant resistor) may be determined as in the following example.

Example: To change the programming coefficient (Pc) from 200 ohms per volt to 1000 ohms per volt, calculate the new value of R21:

$$R21 = Vref \times Pc$$

where Vref is the voltage across C11 (approximately 9 volts). thus;

$$R21 = 9 \text{ volts} \times 1000 \text{ ohms/volt} = 9000 \text{ ohms}$$

The current through R21 is then $\frac{9 \text{ volts}}{9000 \text{ ohms}} = 1$ milliampere.

As noted before, the programming resistor should have a low temperature coefficient and a wattage rating at least twice that of the calculated rating.

To adapt unit to a different resistance programming constant, proceed as follows:

a. Rotate VOLTAGE controls fully counterclockwise.

b. Remove the link between TB2-1 and TB2-2. Install programming constant resistor R21 between TB2-1 and TB2-3 and adjust Vref until the ratio of Vref/R21 is exactly 1 milliampere, or the calculated reference current. This can be done by inserting a resistor in place of R53A (between TB2-3 and TB2-6, with TB2-3 and TB2-4 open) equal to Eout max/1mA and adjusting the voltage reference potentiometer R9 until Eout is exactly equal to Eout max.

c. Deterioration of the voltage regulation will occur as the programming constant is increased, due to the effect of the offset current, and will be proportional to the increase of R21. As an example, if the contribution due to offset current at 200 ohms per volt is 0.002%, at 1000 ohms per volt approximately 0.01% contribution to regulation might be expected.

3.2.3.3 Voltage Signal Programming

To adapt unit for voltage signal programming proceed as follows:

a. Unity Gain (1V/V) (Figure 3-1)

1) Remove the input power.

2) Remove the link between TB2-1 and TB2-2.

3) Remove the link between TB2-3 and TB2-4.

4) Connect the signal programming source between TB2-3 and TB2-6 using a series resistor Ri as shown on Figure 3-1. Select Ri based on the rated maximum voltage of the SRL and 200 ohms per volt (e.g., 60V SRL units will use Ri of 12K). Use a precision 1/2 watt resistor such as the RL 20S type. Observe the proper polarity of signal source (negative) on TB2-6.

5) With this modification, the SRL will produce a one volt output for one volt of signal. Do not exceed the rated output voltage of the SRL.

NOTE

The stability and regulation will be a function of the signal source stability. This source requires an output current rating of 5mA dc, with its output floating (ungrounded).

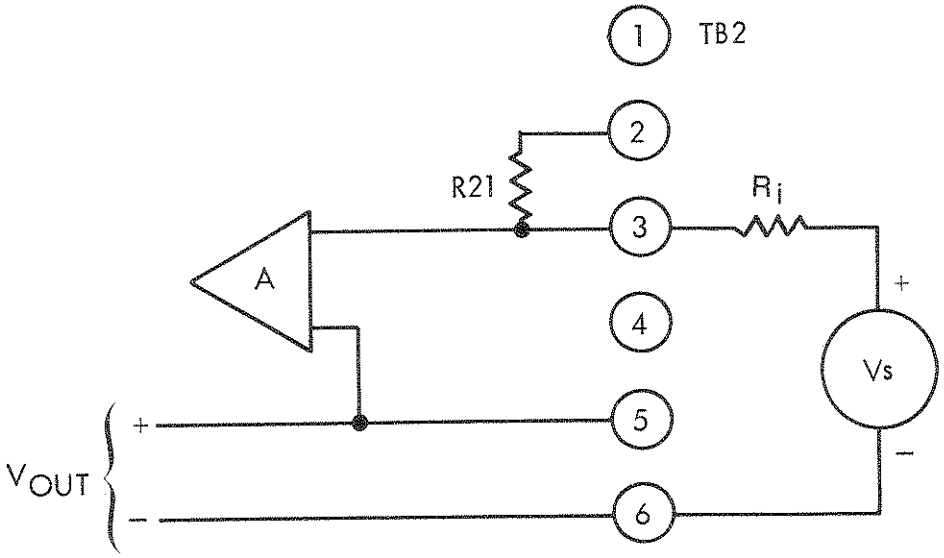


Figure 3-1 Unity Gain

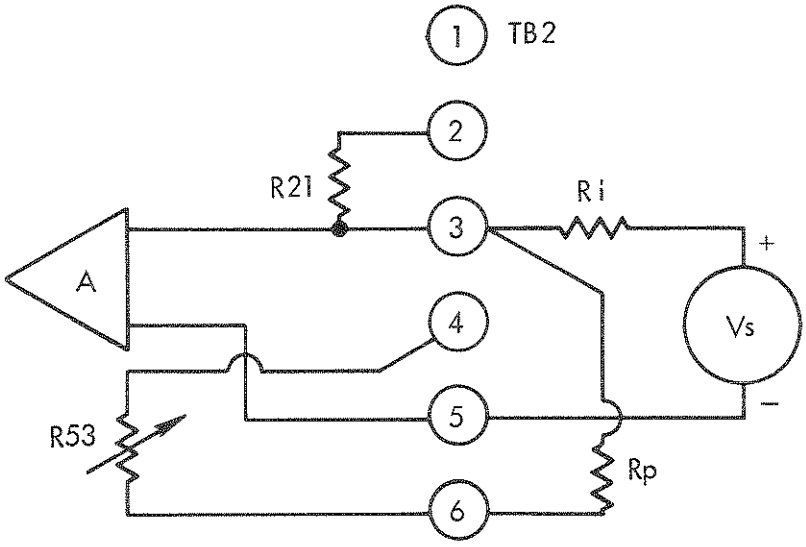


Figure 3-2 Variable Gain

b. Variable Gain (Figure 3-2)

1) Remove the link between TB2-1 and TB2-2.

2) Remove the link between TB2-3 and TB2-4.

3) Place Ri (1.78K suggested) in series with the signal source and connect as shown in Figure 3-2 between TB2-3 and TB2-5, observing the proper polarity.

4) As with the previous method of programming, stability will be a function of the signal source stability, its internal impedance, and the stability of Ri and Rp.

In this mode of operation Vo = Vs Rp/Ri assuming the effects of amplifier offset and signal source impedance are negligible. Thus the gain is determined by the ratio Rp/Ri. It is suggested that Ri be made equal to 1.78 kohm or less to minimize the effect of offset voltage. Ri and Rp should be stable resistors (10 ppm/°C or less). Note that the front panel VOLTAGE control R53 may be substituted for Rp if TB2-3 and TB2-4 are linked.

3.3 CURRENT MODE OPERATION

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

1. Rotate all front panel controls fully counterclockwise.
2. Short the output terminals.
3. Rotate FINE VOLTAGE control clockwise, and close POWER switch.
4. Turn COARSE and FINE CURRENT controls clockwise to select the desired output current.
5. Open POWER switch and remove short from output terminals.
6. Set POWER switch to ON and adjust output voltage to desired compliance setting.
7. Open POWER switch, and observing polarity, connect load to terminals TB3-1 and TB3-3. Reapply input power.

NOTE

If compliance voltage exceeds voltage control setting, crossover to voltage mode operation occurs automatically.

3.3.1 Remote Programming

In current mode, remote programming operation, the regulated output current may be controlled externally by resistance changes or voltage signals.

3.3.1.1 Resistance

For resistance programming, calculate the value of resistor required by using the ohms/ampere coefficient listed in Table 3-1.

Table 3-1 Programming Constants (Current Mode)

SRL Model	Resistive Ohms/Ampere (±10%)	Voltage Millivolts/Ampere (±10%)
10-25	40	20
30-12	80	80
20-25	40	20
40-6	150	150
40-12	80	80
60-4	250	250
60-8	125	125
10-50	20	8
10-100	10	2.5
20-50	20	8
40-25	40	20
40-50	20	8
60-17	60	40
60-35	28	15

Note: Use a resistor with a low temperature coefficient (±20 ppm/°C), and a wattage rating at least twice that of the calculated value (normal programming current is approximately 1 milliampere).

To adapt unit for current mode, resistance programming operation, proceed as follows:

a. Close POWER switch, adjust output voltage to desired compliance setting.

b. Open POWER switch and rotate CURRENT controls fully counter-clockwise.

c. Remove link between terminals TB2-7 and TB2-8, and replace with programming resistor.

CAUTION

Operating unit with open programming leads or links will result in high output current with possible crossover to voltage mode. If step changes in output current are to be made by abrupt resistance alterations, use make-before-break switching.

---

d. Run load to terminals TB3-1 and TB3-3, observing polarity.

e. Set POWER switch to ON. Unit supplies regulated programmed current to the load.

NOTE

Any rotation of the CURRENT control alters the output current. Dangerous output currents may result. The panel current knobs may be removed if desired.

3.3.1.2 Voltage Signal

To adapt an SRL unit to voltage signal programming, connect the programming device as shown in Figure 3-3 and follow the procedure listed below. This method will alleviate the possibility of damage to the equipment by inadvertent application of too high a programming voltage by presetting a current limit "threshold".

The external program power supply must have an OP-AMP output, capable of sinking 1 mA through CR1. External sense must be used as shown. Do not ground either the positive or negative terminals of the program power supply.

See Unit Specifications Table 1-3 or 1-4, CURRENT MODE AMPS/AMP heading for the program constant. (The full scale voltage varies from 250 mV to 1V depending on model.

NOTE

CR2 and CR3 are used to clamp the + program terminal from exceeding negative 1.5 volts to protect the SRL.

CAUTION

Do not program SRL current by direct connection between the program power supply and the SRL. This will defeat the SRL power limiting circuit. (See Section 4, para. 4.3).

CAUTION

Do not rotate the panel current adjust controls from the OFF position since dangerous SRL output current may result when overloaded.

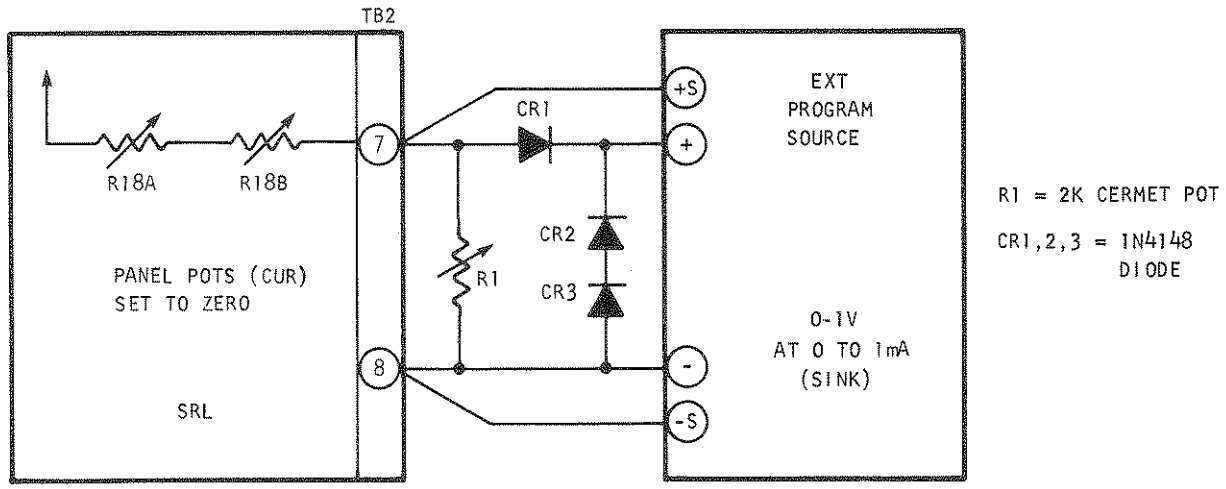


Figure 3-3 Current Programming by Voltage Signal

Procedure:

1. Set the front panel current controls (R18A and R18B) fully counter-clockwise (OFF). The control knobs should be removed to prevent accidental use.
2. With the program power supply OFF, and the (+S) lead disconnected from the program power supply, short the SRL output terminals. Set R1 trimmer at 50% rotation.
3. Turn the SRL ON. Adjust R1 trimmer for 110% of rated output current.
4. Turn the SRL OFF. Reconnect the (+S) lead to the program power supply and turn it ON. Turn the SRL ON.
5. The external program power supply must have an op-amp output, capable of sinking 1 mA through CR1. External sense must be used as shown. Do not ground either (+) or (-) terminal of external program power supply.
6. See unit specification Table 1-2 "CURRENT MODE VOLTS/AMP" for program constant. (The full scale voltage varies from 250 mV to 1V depending on model).
7. Note that overvoltage from the program power supply will not exceed the preset maximum I_{out} (as set by R1 trimmer).

3.4 SERIES OPERATION

For applications which require voltages higher than a single SRL model can provide, series operation may be utilized. The maximum rated output of any series connected system is 200 Vdc. System regulation is the sum of the regulations for all units. In SRL models, there is no need to connect reverse voltage rectifiers across the output terminals. Reverse voltage protection has been designed in.

3.4.1 Local Sensing Figure 3-4 (a)

To connect units in series with local sensing, proceed as follows:

1. Adjust the output voltage of each unit so that their sum is equal to the desired system output. Set POWER switches of each unit to OFF.

2. Disconnect links between terminals TB3-1 and TB2-5, and TB3-3 and TB2-6 of each unit.

3. Reconnect load and sensing leads as shown in figure 3-4, (a).

4. Set POWER switches to ON. The system supplies regulated voltage to the load.

3.4.2 Remote Sensing Figure 3-4 (b)

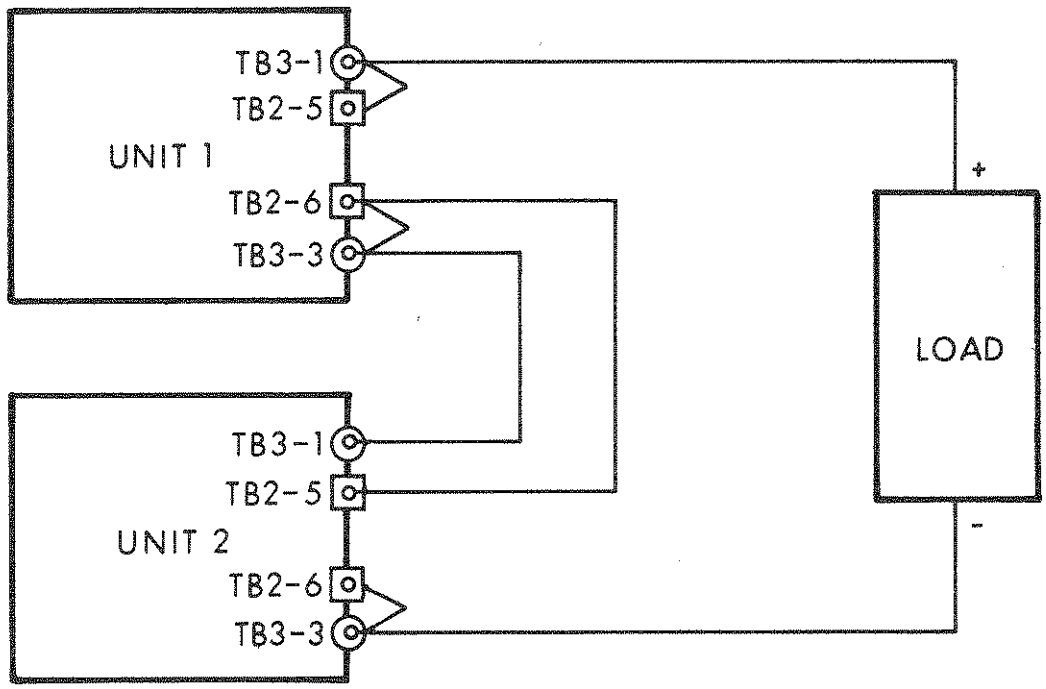
To connect units in series, remote sensing, remove leads from terminals TB2-5 and TB2-6. Observing polarity, connect coaxial cable or a twisted pair of wires from TB2-5 and TB2-6 across load as shown.

NOTE

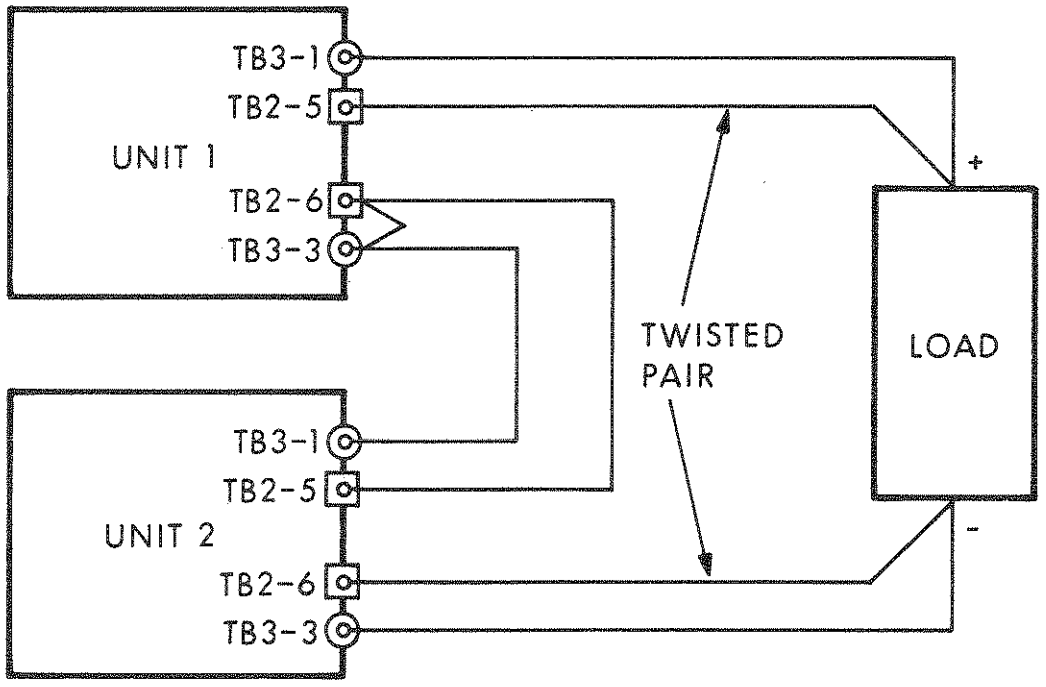
Wherever possible, use twisted or shielded leads. At load and unit terminals, place sensing leads between binder screwhead and load lead.

3.5 PARALLEL OPERATION

Parallel operation may be used to obtain currents greater than any single model can supply. Up to three units may be connected in this manner. The maximum rated output of any parallel connected system is the sum of the maximum outputs of each unit, derated to 90%.

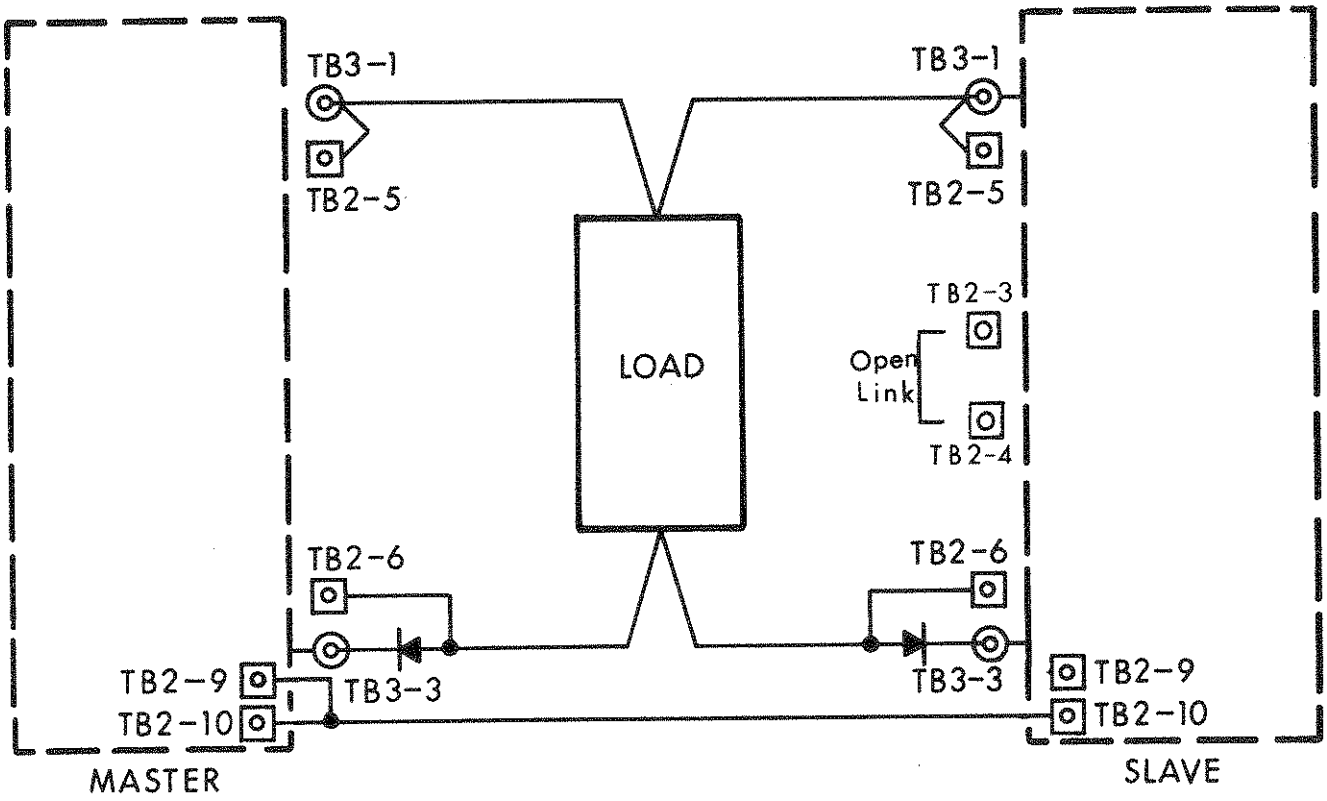


(a) Local Sensing - Series Operation

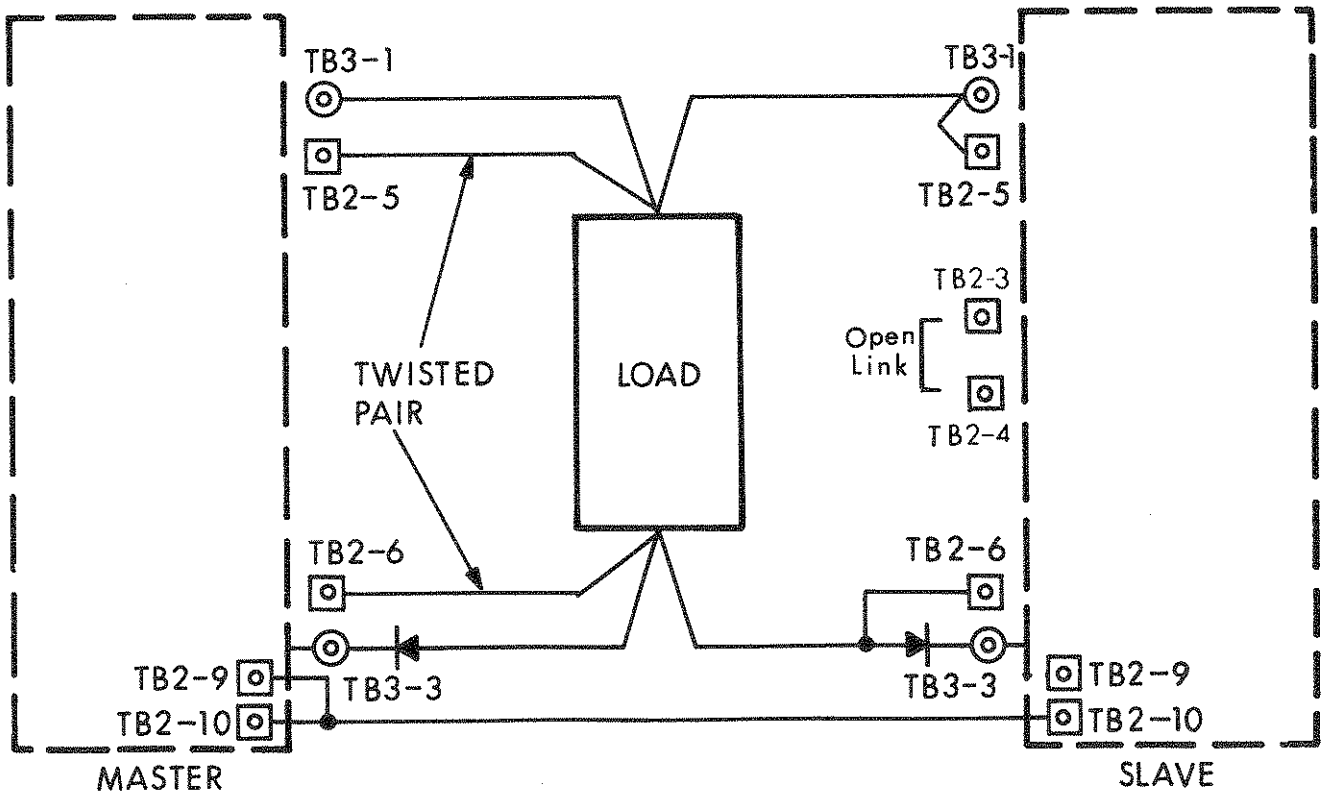


(b) Remote Sensing - Series Operation

Figure 3-4 Series Operation



(a) Local Sensing - Parallel Operation



(b) Remote Sensing - Parallel Operation

Figure 3-5 Parallel Operation

3.5.1 Local Sensing Figure 3-5 (a)

To connect additional units in parallel with local sensing, proceed as follows:

1. Apply nominal input power to MASTER unit, and adjust output to desired load voltage. Set POWER switch to OFF.

2. Short master unit output terminals and apply input power. Adjust output current to Io/X, where Io is the total system output current, and X is the number of units in the system. Set POWER switch to OFF.

3. At SLAVE units, remove links from across terminals TB2-3 and TB2-4, and TB2-9 and TB2-10. Connect a lead between TB2-10 terminals of each unit.

4. Observing polarity, run leads from the load to terminals TB3-1 and TB3-3 on each unit, with (2) diodes connected as shown in (a) of figure 3-5.

NOTE

Assure the diodes have a current capability at least equal to its associated supply. Connect anode to load in each case. A suitable heatsink is required for each diode.

5. On each unit, open lead between terminals TB2-6 and TB3-3, and connect a lead from TB2-6 to the anode of the diode.

3.5.2 Remote Sensing Figure 3-5 (b)

For remote sensing, remove existing leads from terminals TB2-5 and TB2-6. Observing polarity, connect coaxial cable or twisted pair of wires from TB2-5 and TB2-6 of master unit across load as shown.

3.5.3 Overvoltage Protection (OVP)

A special circuit in the SRL series allows the operator to set the desired overvoltage trip point without disturbing the voltage output of the supply. This feature enables the trip point to be set and verified even with the load connected. Proceed as follows:

1. Depress the OVERVOLTAGE SET toggle switch on the front panel. The panel voltmeter will then indicate the OVP trip voltage, instead of the unit output voltage.

2. Adjust the recessed overvoltage ADJ screw on the front panel until the voltmeter indicates the desired trip voltage.

3. Release the toggle switch.

Overvoltage indicator DS2 will illuminate when the OVP preset limit has been exceeded by power supply output, and remains on until the OVP circuit is reset. Resetting is accomplished by placing the unit POWER switch to OFF momentarily. To avoid nuisance tripping, it is recommended that the OVP trip point be set at least 10% above the desired output voltage, but not less than 1 volt.