OPERATING INSTRUCTIONS
and
TROUBLESHOOTING GUIDE
for

PS^2L

PROGRAMMABLE SOLID STATE LOAD
MODELS PS^2L — 500
and
PS^2L — 1000

Acme Electric †
Power Products

Cuba, New York 14727 • (716) 968-2400
Fax: (716) 968-3948
Telex: 532493 Acme Elec Cuba

Power Conversion Equipment
For Electric & Electrical Systems

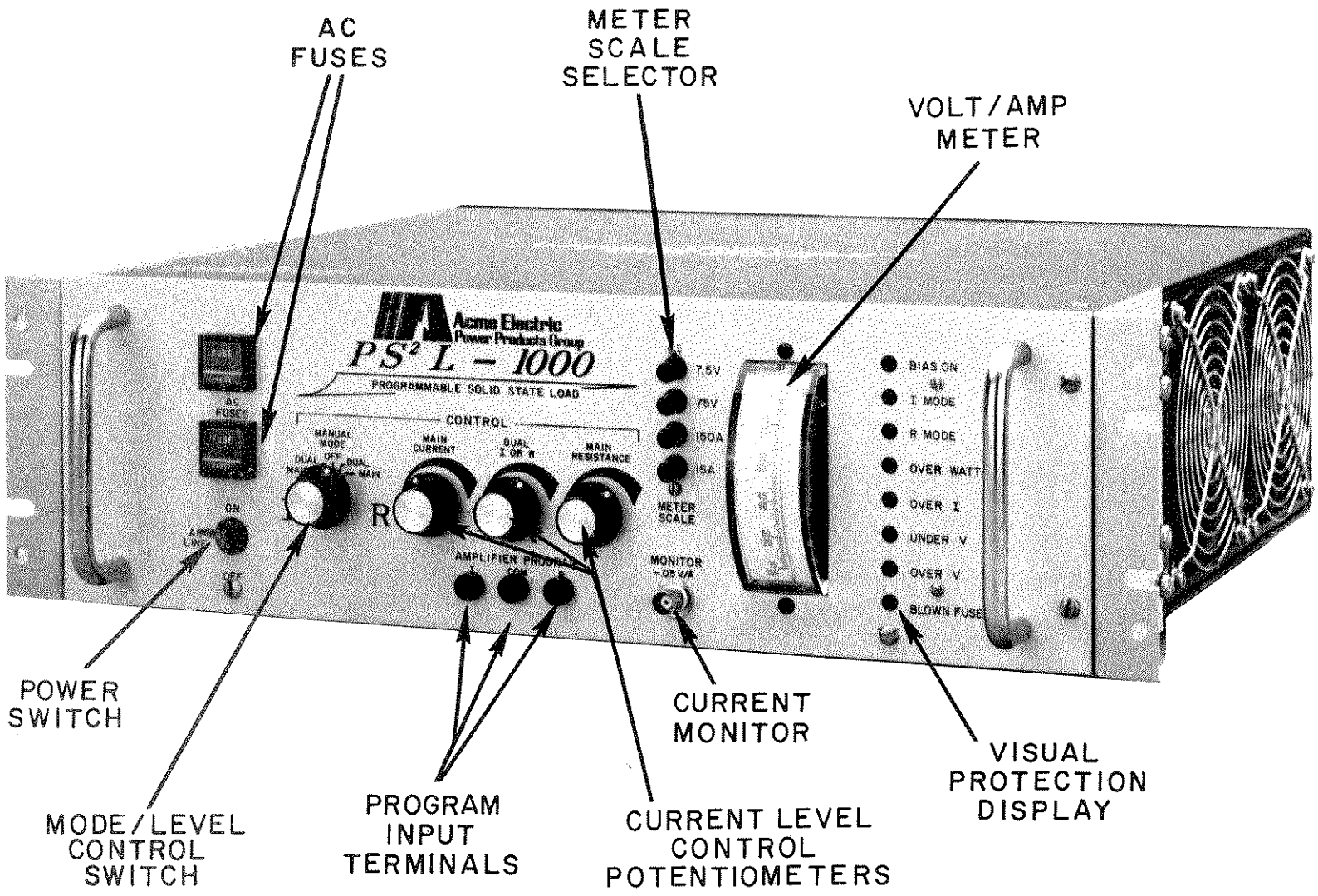
Introduction

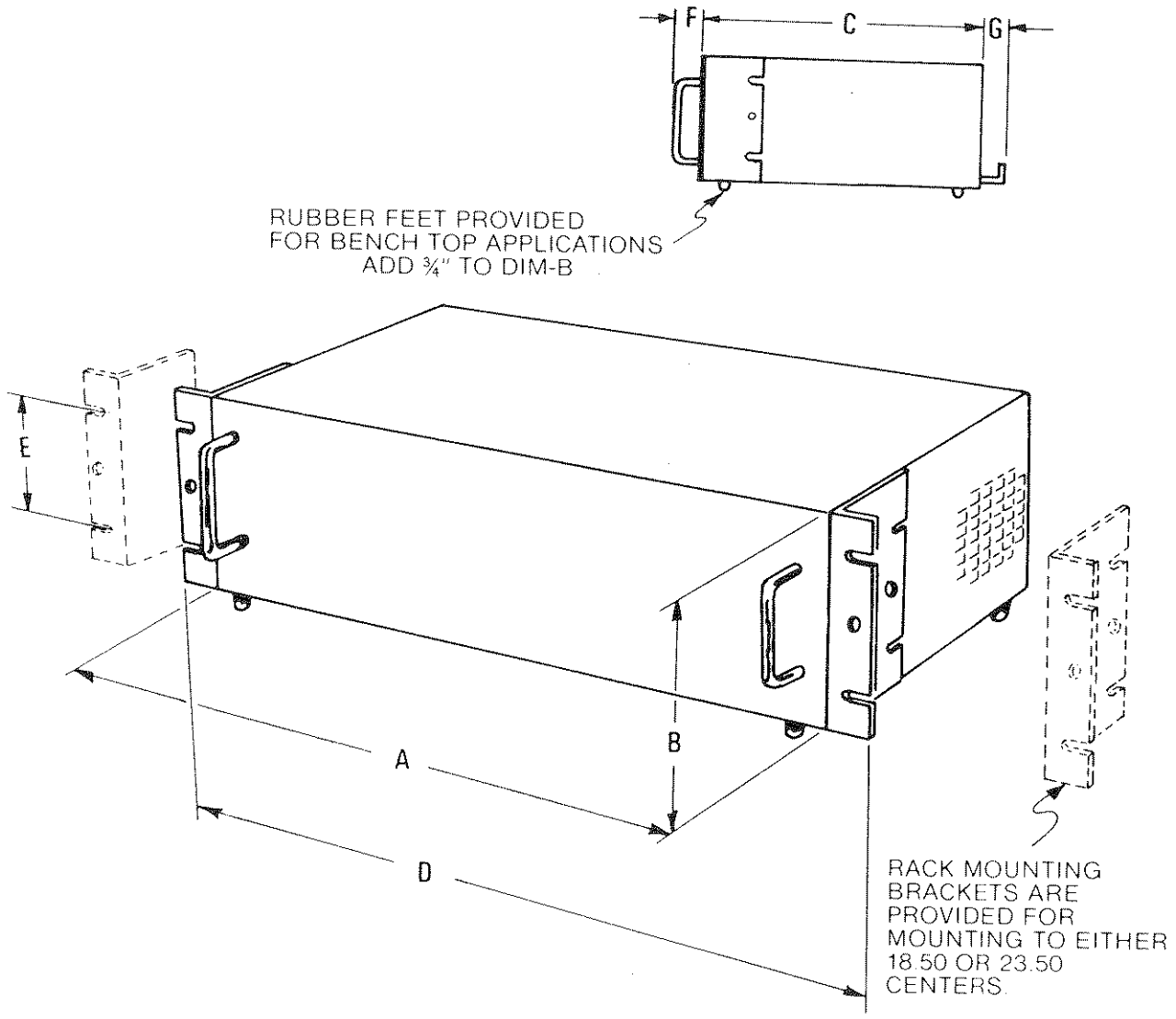
The PS²L-500 and PS²L-1000 are single level, direct current load units employing NPN silicon transistors as shunting load elements.

The shunt element is controlled by a constant current amplifier and a constant resistance amplifier operating in parallel with the amplifier having the higher output voltage predominating.

Each of the two amplifiers is controlled by comparison of the actual load current signal to the associated amplifier reference and adjustment potentiometer.

The current through the shunt element is also sensed, amplified and applied to an ammeter and BNC current monitor to provide direct visual and electrical indication of load current.


AC FUSES
METER SCALE SELECTOR
VOLT/AMP METER
POWER SWITCH
MODE/LEVEL CONTROL SWITCH
PROGRAM INPUT TERMINALS
CURRENT LEVEL CONTROL POTENTIOMETERS
CURRENT MONITOR
VISUAL PROTECTION DISPLAY
Acme Electric
Power Products Group
PS²L – 1000
PROGRAMMABLE SOLID STATE LOAD
CONTROL
MANUAL MODE
MAIN CURRENT
DUAL I OR R
MAIN RESISTANCE
AMPLIFIER PROGRAM
METER SCALE
MONITOR
7.5V
75V
150A
15A
BIAS ON
I MODE
R MODE
OVER WATT
OVER I
UNDER V
OVER V
BLOWN FUSE
ON
OFF



Model	Dim-A	Dim-B	Dim-C	Dim-D		Dim-E	Dim-F	Dim-G	Load Capacity
PS²L-500	17.00	5.25	10.81	19.00	24.00	2.25	1.38	.63	500 Watts
PS²L-1000	17.00	5.25	14.00	19.00	24.00	2.25	1.38	.63	1000 Watts

Contents

Characteristics

GENERAL

The PS²L-500 and PS²L-1000 provide DC loading capabilities, both static and dynamic, for an infinite number of voltage-current combinations, both as constant current and constant resistance. In addition, two levels of either current or resistance are available without continual manual readjustment.

For dynamic loading, these solid state loads are provided with a program input for external connection of a signal generator. Dynamic current changes can be monitored directly on the PS²L without use of an external shunt.

The PS²L units provide a meter that functions both as a dual scale voltmeter and a dual scale current meter for direct visual readings. Also provided on the front panel is a LED display to indicate which of two operational modes is controlling the load current and any protective shutdown mode which may occur.

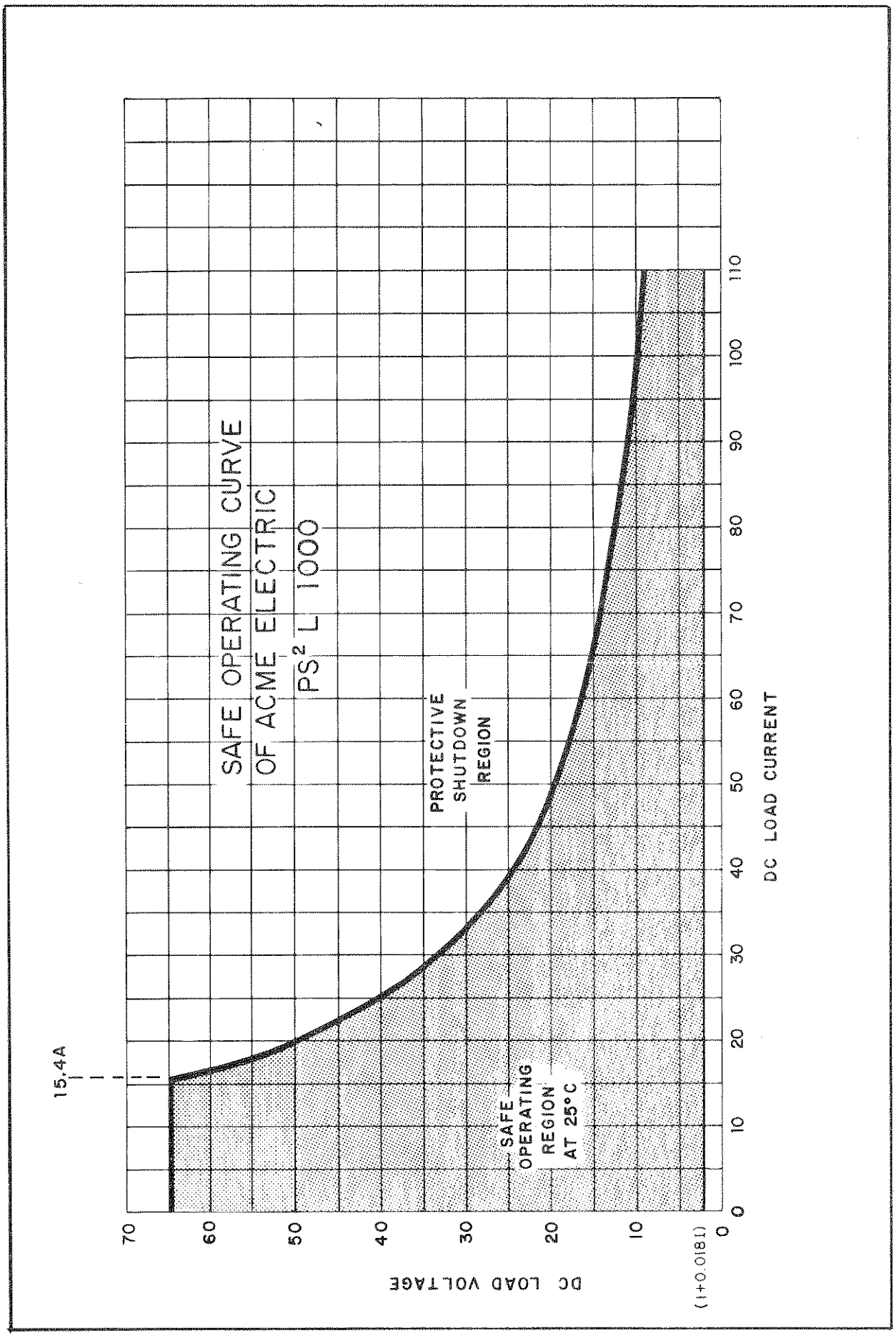
The PS²L units are set at the factory for 115 Volts AC operation. The unit can easily be converted to 230 Volts AC operation by removing the top cover of the unit, changing a voltage selection plug, and changing the primary fuse type and value.

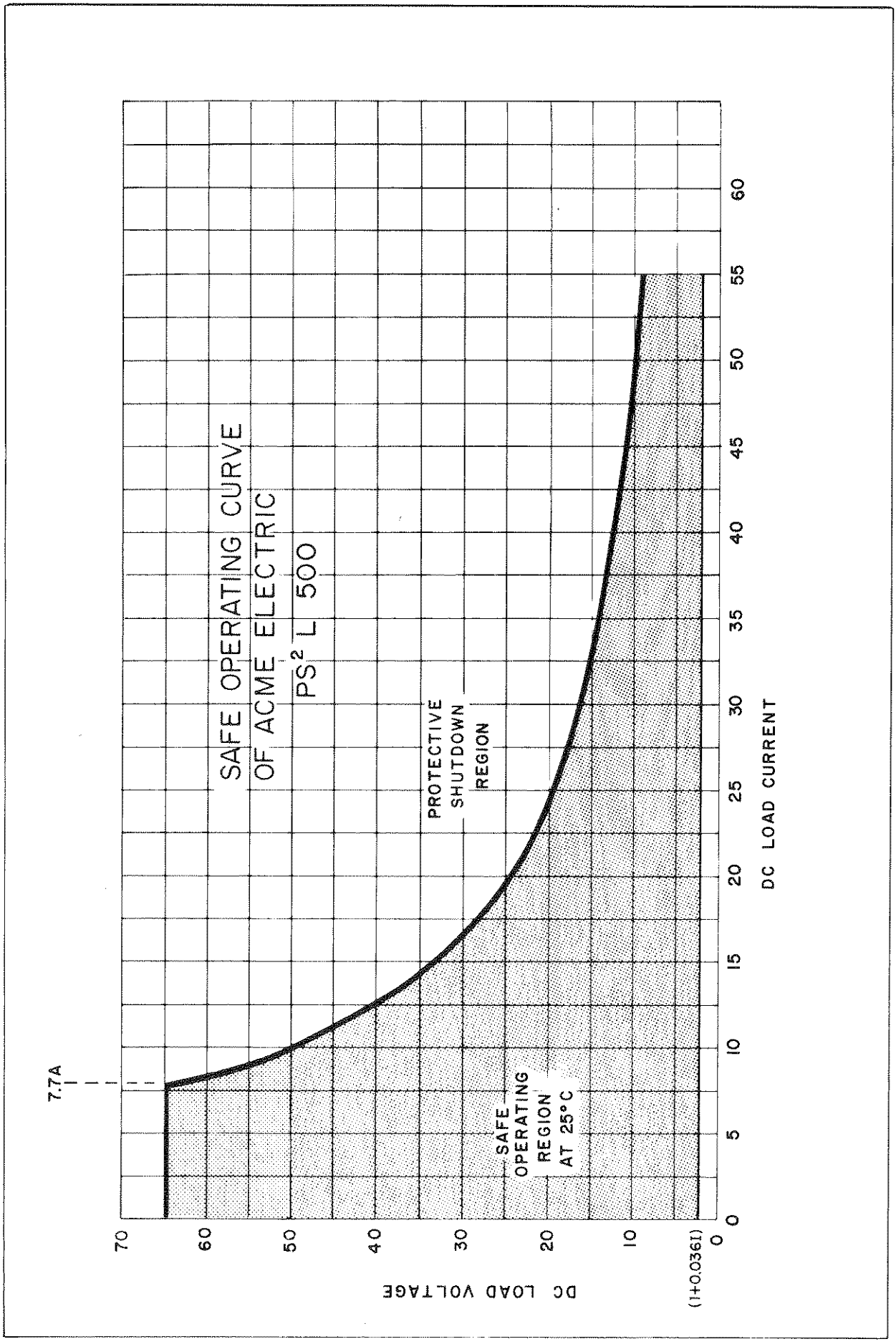
ELECTRICAL CHARACTERISTICS

	PS²L-500	PS²L-1000
Operating Ambient	0° C - 55° C	0° C - 55° C
Input Voltage Requirements	115/230 VAC ±10%	115/230 VAC ±10%
Input Frequency Range	47-63 Hz	47-63 Hz
Maximum Input Current	1 Amp	1 Amp
Input Fuse Rating @ 115 VAC	2 Amp Type MDX	2 Amp Type MDX
@ 230 VAC	1 Amp Type MDL	1 Amp Type MDL
Maximum Loading Power @ 25°C	500 Watts	1000 Watts
Maximum Loading Voltage	60 VDC	60 VDC
Maximum Loading Current	55 ADC	110 ADC
Minimum Loading Voltage	(1+0.036I) VDC	(1+0.018I) VDC
Overvoltage Crowbar Point	70 VDC-78 VDC	70 VDC-78 VDC
Typical Constant Resistance Range	.036 - 2000	.018 - 2000
Typical Program Input Impedance	50 K	50 K
Programming Input Volt Requirement	2V/10 Amp load	1V/10 Amp load
Typical Current Monitor Output	-100MV/Amp load	-50MV/Amp load
Typical Square Wave Response Time (constant current mode)	60 µ sec for 50 Amp step	80 µ sec for 100 Amp step
Typical Regulation (constant current, constant resistance)	1%	1%

VENTILATION

The PS²L units are forced air cooled. A minimum of 3" unobstructed clearance on both ends of the load is recommended for adequate ventilation. Exhaust air should not be allowed to recirculate. A thermal cutout protects the PS²L from overheating.


SAFE OPERATING CURVE
OF ACME ELECTRIC
PS² L 1000
PROTECTIVE
SHUTDOWN
REGION
SAFE
OPERATING
REGION
AT 25°C
15.4A
DC LOAD VOLTAGE
DC LOAD CURRENT
0
10
20
30
40
50
60
70
80
90
100
110
(1+0.0181)


SAFE OPERATING CURVE
OF ACME ELECTRIC
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PROTECTIVE
SHUTDOWN
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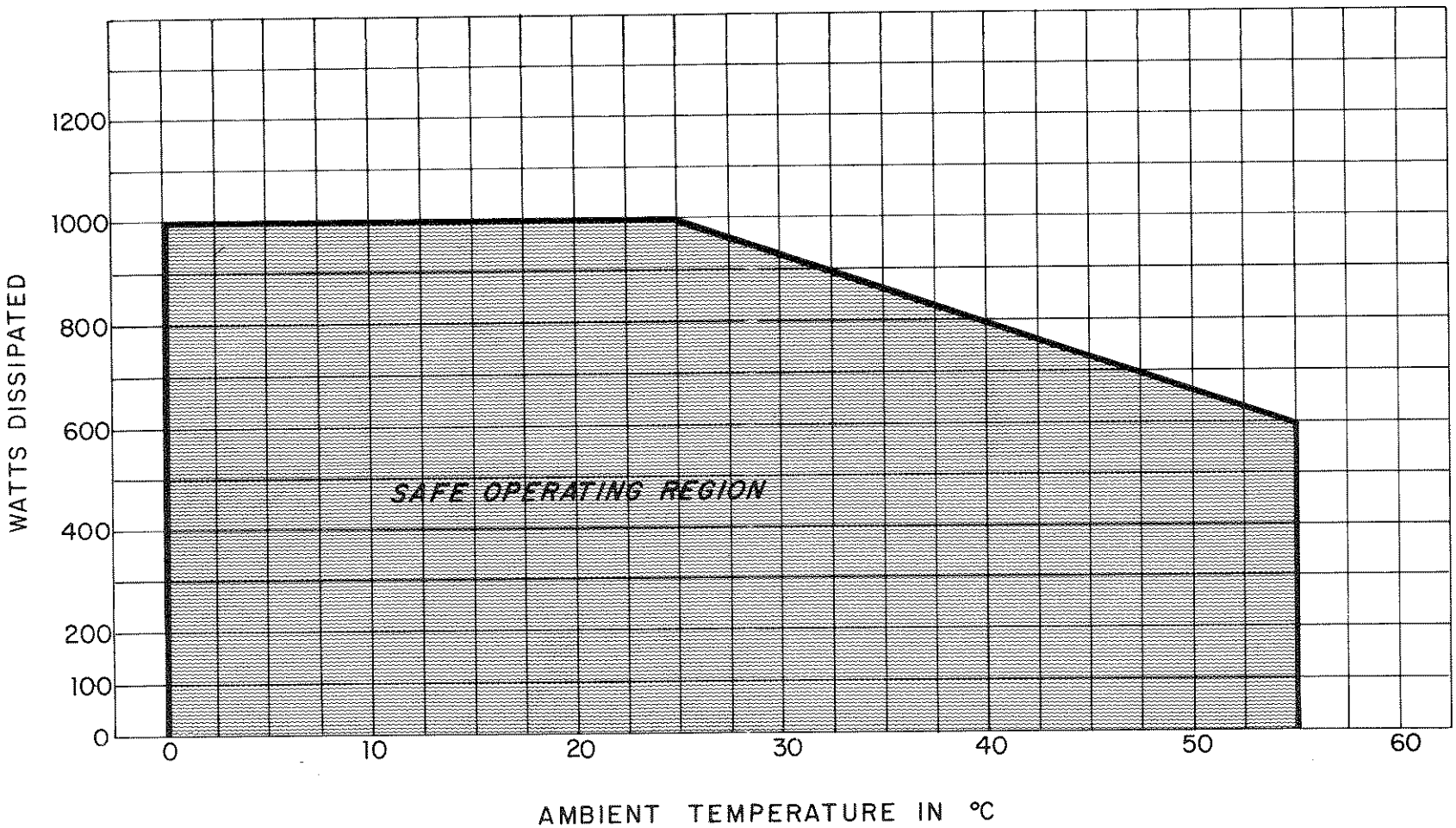
SAFE
OPERATING
REGION
AT 25°C
7.7A
DC LOAD VOLTAGE
DC LOAD CURRENT
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
55
60
(1+0.0361)

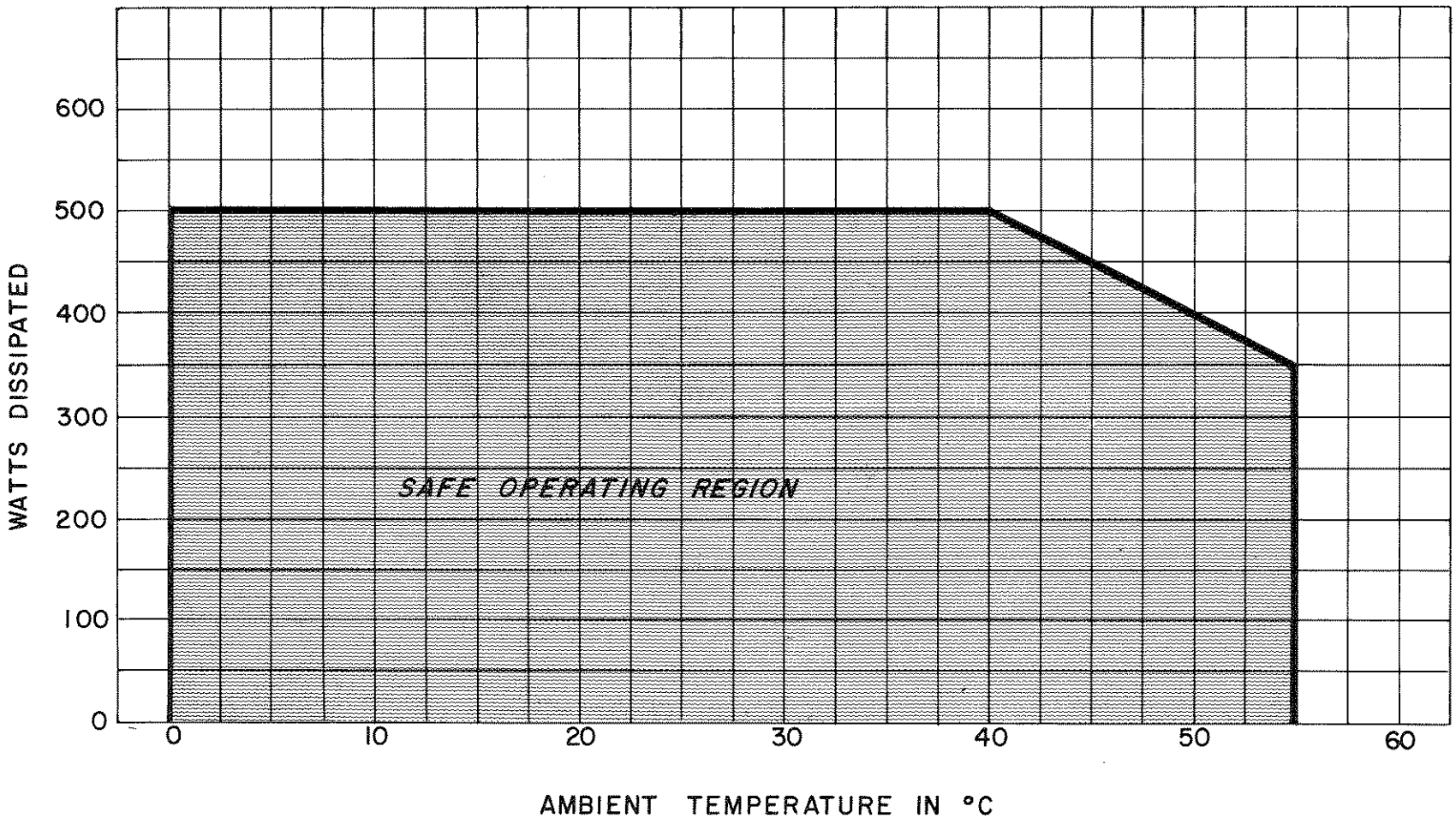
LOAD POWER DISSIPATION VS. AMBIENT TEMPERATURE

ACME ELECTRIC CORP.
PS^2 L – 1000



LOAD POWER DISSIPATION VS. AMBIENT TEMPERATURE

ACME ELECTRIC CORP.
PS^2 L – 500



Operating Instructions

COOLING

Internally mounted fans maintain a proper operating temperature in the PS²L-500 and PS²L-1000 by circulating air over the shunting load elements. Therefore, the load must be placed so that the air intake and exhaust are free from obstruction. If the case temperature of the load transistors should rise too high, a thermal switch will disconnect the shunt element drive current and keep it disconnected until the temperature drops to a proper level.

PRIMARY POWER REQUIREMENTS

The PS²L-500 and PS²L-1000 will operate at a line voltage between 103 Volts AC and 127 Volts AC, and also between 206 Volts AC and 254 Volts AC within a 47 Hz to 63 Hz frequency range.

115 VAC Operation

The PS²L units are shipped from the factory connected for 115 Volt AC operation and fused with a 2 Amp MDX slo-blo type fuse, F3. For 115 Volt AC operation, fuse F4 is not connected, and a MDL 1 Amp fuse is provided.

230 VAC Operation

To convert to 230 Volt AC operation, disconnect the unit from all power sources and remove the top cover. Connect P1 to J5 (indicated on underside of cover) mounted on the power transformer and change fuse F3 on the front panel to 1.0 Amp MDL slo-blo type. CAUTION: For 230 Volt AC operation, F4 is connected into the primary low side of the power supply and carries full line current - it is not a spare.

If the PS²L is to operate on 230 Volt AC, the plug on the line cord should be removed and replaced with a standard 230 Volt AC plug.

LOAD CONNECTION

The positive current source of the test unit should be directly connected to the positive loading bus on the rear of the PS²L, and the negative current return should be connected to the negative loading bus on the rear of the PS²L. If the PS²L is to be dynamically loaded, the leads connecting to the unit should be twisted to minimize inductive di/dt voltage transients on the load terminals. Voltage transients at the load connections may cause the PS²L to exceed the safe operating limits and protective shutdown by undervoltage or overvoltage crowbar will occur.

SETTING CONSTANT CURRENT LEVELS

Turn the PS²L on. Set the manual mode switch to constant current "Main." Turn the constant current and dual level adjust pot fully CCW and the constant resistance pot fully CW. Turn on the power supply under test. At this point the PS²L is at no load condition. Turn the constant current adjust CW until the desired current level is obtained. If it is desired to switch to a second current level, set the manual mode switch to the "dual" position and adjust the "dual" level pot CW to the desired second current level. The manual mode switch will now allow selection between either preset current condition. (Refer to page 20).

SETTING CONSTANT RESISTANCE LEVELS

Turn on the PS²L, set the manual mode switch to constant resistance main, turn the current resistance and the "dual" level pot fully CCW and constant current pot fully CW. Apply DC voltage to the PS²L. In this condition the PS²L is at maximum resistance. Adjust the constant resistance pot CW until the desired resistance level is present. If it is desired to switch to a second resistance level, set the manual mode switch to the constant resistance "dual" position and adjust the "dual" level pot CW to the desired second resistance level. The mode switch will now allow selection between either preset resistance.

SETTING CONSTANT RESISTANCE TO ACT AS A LIMIT FOR CONSTANT CURRENT MODE

Adjust the constant current level to the maximum current load desired under any condition as outlined previously. Adjust the constant resistance pot CCW until the current level starts to decrease. In this state of operation the constant current level can be adjusted up to, but never over, the set resistance current level. The crossover point will be indicated on the front panel by the resistance mode indicating light coming on and the current mode light going out.

SETTING CONSTANT CURRENT TO ACT AS A LIMIT FOR CONSTANT RESISTANCE MODE

Adjust the constant resistance level to the maximum current desired under any condition as outlined previously. Adjust the constant current pot CCW until the current just starts to decrease. in this state of operation the resistance can be adjusted down to, but never under, the preset constant current level limiting the current. The crossover point will be indicated on the front panel by the constant resistance light going out and the constant current light turning on.

DYNAMIC LOADING - OPERATION AND PROGRAMMING

Before programming the solid state load, care should be taken in connection of grounds.

CAUTION: THE NEGATIVE LOAD BUS, THE NEGATIVE PROGRAM INPUT, AND THE CURRENT MONITOR GROUNDS ARE MUTUALLY COMMON AND ARE ISOLATED FROM CHASSIS GROUND.

Determining the Program Input Requirements

The PS²L is designed with a program input section that requires a D.C. voltage potential to produce a current change through the load. The following input D.C. signal amplitudes are required:

PS²L-1000	0.1 VDC/1 Amp (or 10 VDC to produce a 100A change)
PS²L-500	0.2 VDC/1 Amp (or 10 VDC to produce a 50A change)

For programs using high frequency signals it should be noted the program terminals have a D.C. input impedance of 50 K, attenuated by a R-C filter. The 3 db crossover occurs at approximately 8 KHz.

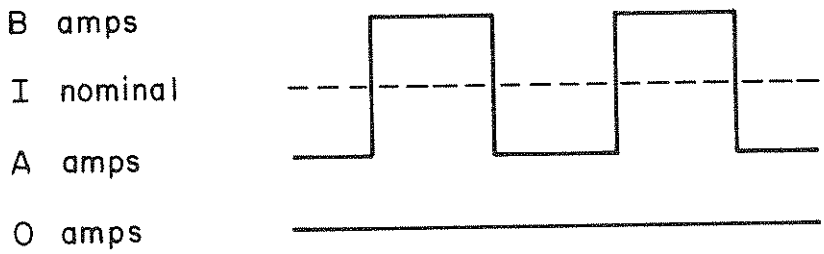
There are also two basic requirements that must be determined before any programmed input is made. These conditions apply for programming in either constant current or constant resistance modes.

Condition I

If the intended program source is of a ± voltage, such as a signal generator, then the constant current/resistance "main" adjust pot must be adjusted to produce the nominal value of the D.C. current change.

For example: If a peak to peak square wave pulse is desired between load level "A" and load level "B", the constant current/resistance "main" adjust pot must be set such that the nominal current will be:

$$\frac{\text{"A"} + \text{"B"}}{2}$$



Condition II

If the source is a positive voltage pulse only, then the constant current/resistance "main" adjust pot must be adjusted to the "A" level only.

Monitoring the Programmed Input Signal

For either constant current or constant resistance programs the dynamic current pulse can be monitored directly from the PS²L without the use of an external shunt. The waveform can be monitored at the BNC connector labeled "Current Monitor" with a D.C. coupled scope. This waveform will be inverted and has a negative value as described below:

PS²L-1000 - 50 MV/1 Amp

PS²L-500 -100 MV/1 Amp

See "Current Monitor" section on page 17 for additional information for observing steady state functions.

Programming Constant Current

Initial Conditions

A. Turn the PS²L on.
B. Select "constant current main."
C. Set constant current "main" adjust pot fully CCW.
D. Set "dual" adjust pot fully CCW.
E. Set constant resistance "main" adjust pot fully CW.
F. Connect signal generator or dynamic program to "constant current" program input and adjust to minimum amplitude.
G. Turn on power source to be loaded.

Operational Example

1. Adjust the current level of the PS²L, with the constant current "main" adjust pot, to the appropriate current level as outlined above under Condition I or II.

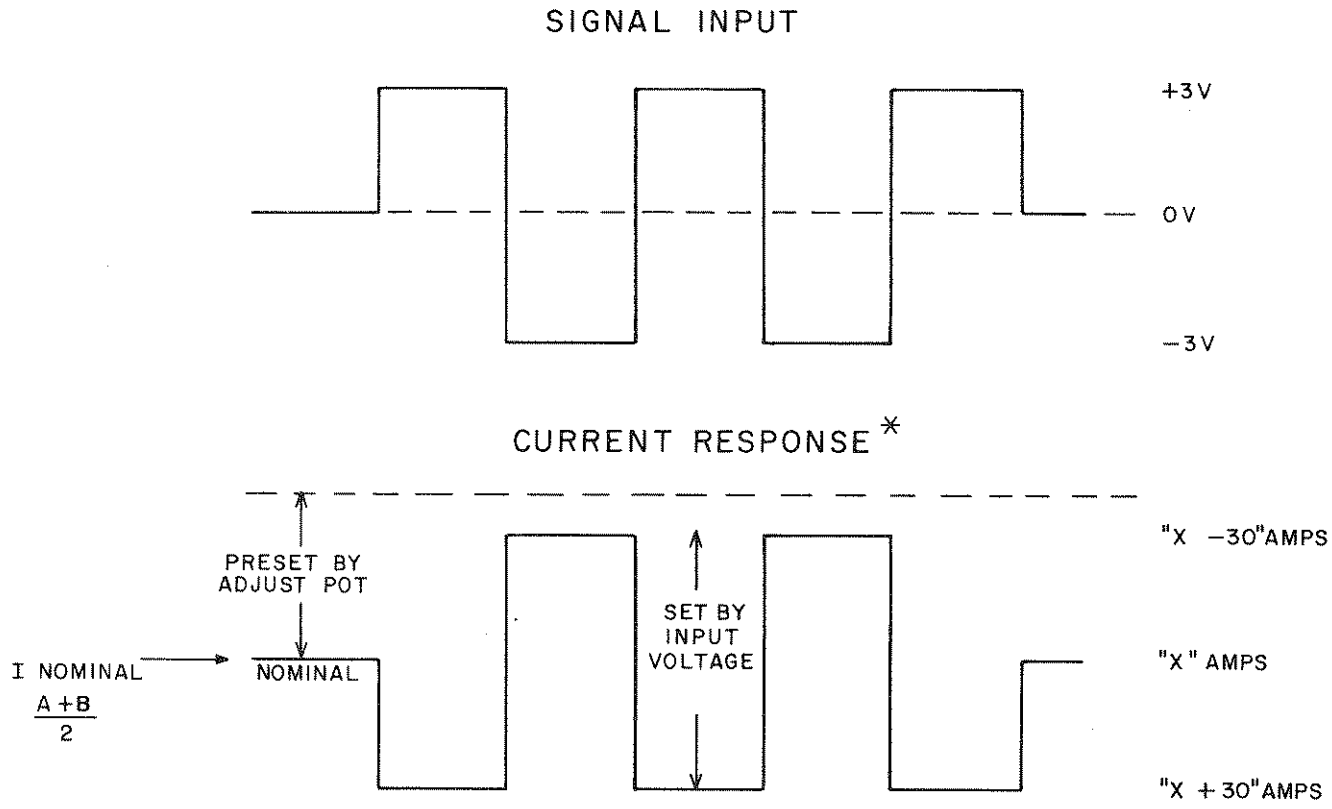
2. Predetermine the program input voltage amplitude by the following method:
   Program Input Volts = (B Amps-A Amps)(.1V/A) PS²L-1000
   (B Amps-A Amps)(.2V/A) PS²L-500

   Example:

   If a 10 amp to 70 amp (PS²L-1000 only, due to current rating) pulse is desired and a plus/minus pulse generator is to be used, the nominal constant current level (I nom) should be set at

$$X = \frac{70 + 10}{2} = 40 \text{ Amps}$$

DYNAMIC LOAD RESPONSE TO SIGNAL INPUT



NOTE: "X +30" MUST NOT EXCEED MAXIMUM RATED LOAD CURRENT
"X −30" MUST BE GREATER THAN 0 AMPS

* AS OBSERVED ON BNC CONNECTOR

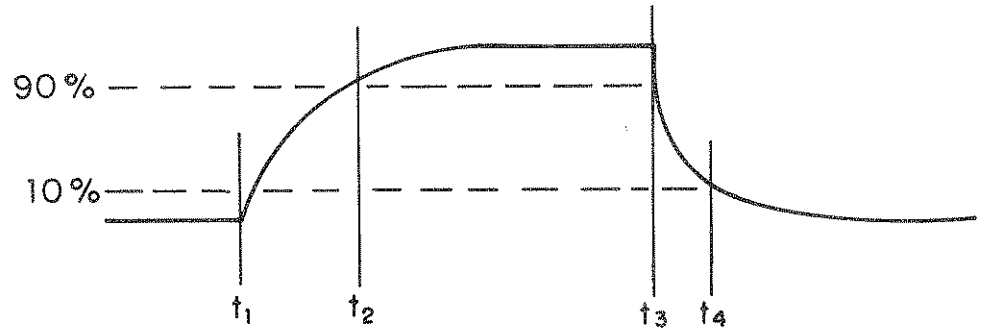
The program input volts (peak to peak) would be:

Input volts = (70A-10A)(.1V/A) = 6Vp-p

or + 3V/-3V for ± 30 amps modulated on the 40 amp nominal. By varying the nominal current "X", the 60 amps pulse will be maintained, but the "A" "B" points will vary. In the figure above the current response is inverted from the signal input to match the output from the current monitor. A positive signal input voltage will actually give a positive current pulse, but the signal seen at the current monitor is inverted.

If the PS²L is overdriven or underdriven in load current, the load will not operate properly and a distorted waveform will be present. When operating in the programmed constant current mode, the constant resistance mode can still act as a limit.

The dynamic response of the PS²L current input has been compensated to minimize overshoot and undershoot while switching full rated current and to eliminate any underdamped response to a current load step. The transition rise time on a 0 ADC to 55 ADC load step on the PS²L-500 is typically 60 μ sec (t_1 to t_2). The fall time on a 55 ADC to 0 ADC load step on the PS²L-500 is also typically 60 μ sec (t_3 to t_4).



The PS²L-1000 transition rise and fall time for a 0 ADC and 100 ADC are typically 80 μ sec.

Programming Constant Resistance

Initial Conditions

A. Turn the PS²L on.
B. Select "constant resistance."
C. Set constant resistance "main" adjust pot fully CCW.
D. Set "dual" pot fully CCW.
E. Set constant current "main" adjust pot fully CW.
F. Connect the signal generator or dynamic program to "constant resistance" program input and adjust to minimum amplitude.
G. Turn on power source to be loaded.

Operational Example

1. Adjust the current level of the PS²L, with the constant current "main" adjust pot, to the appropriate current level as outlined above under Condition I or II.

Example:

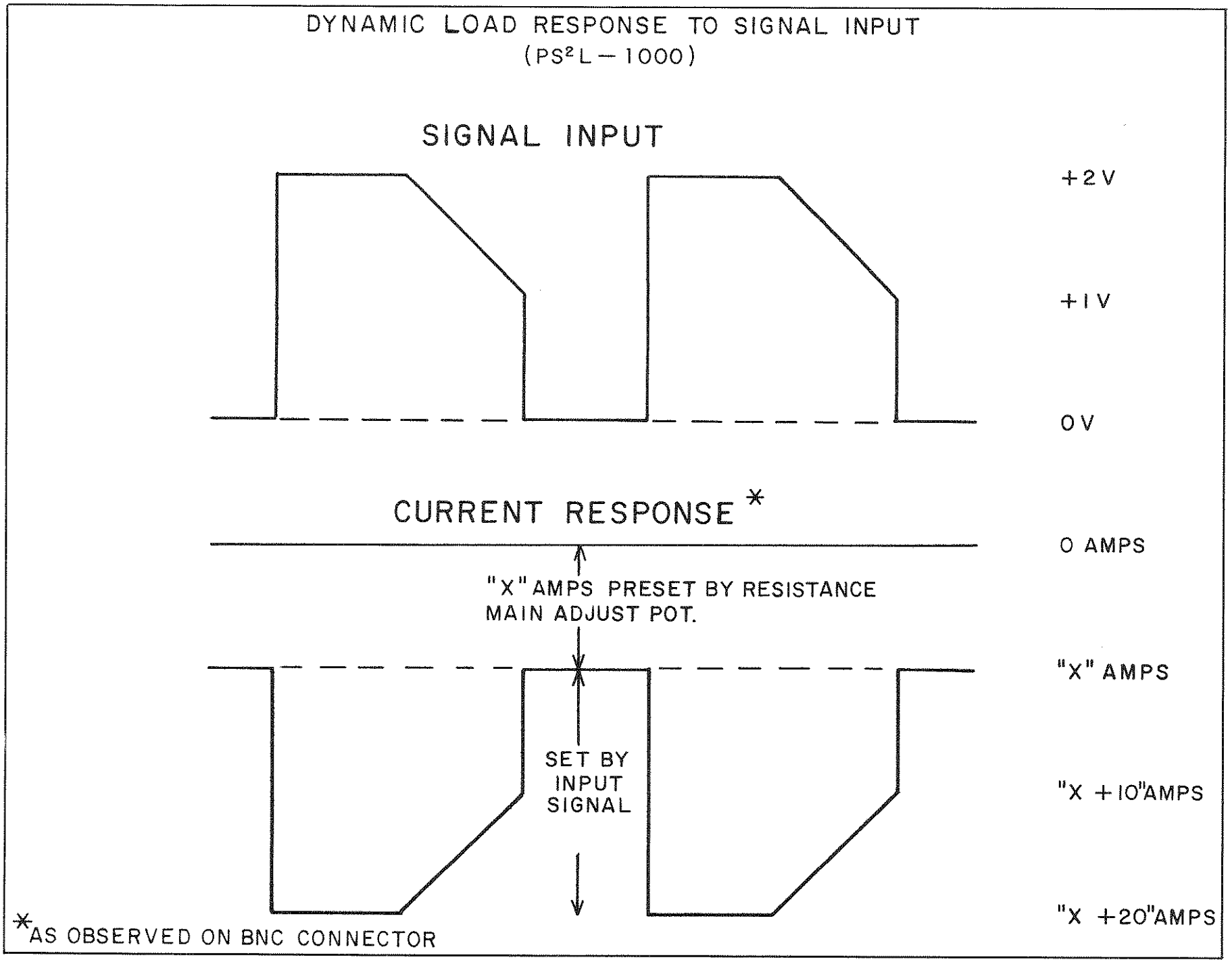
If a 10 VDC power supply is being tested and a 10 amp to 30 amp constant resistance pulse is desired (see figure on page 13) and a positive voltage pulse generator is to be used, the current level "x" (I) should be set at I minimum or 10 amps D.C.

The program input volts (peak to peak) would be:

Input volts = (30-10)(.1V/A) = 2Vp-p (PS²L-1000)

Input volts = (30-10)(.2V/A) = 4Vp-p (PS²L-500)

DYNAMIC LOAD RESPONSE TO SIGNAL INPUT
(PS²L – 1000)

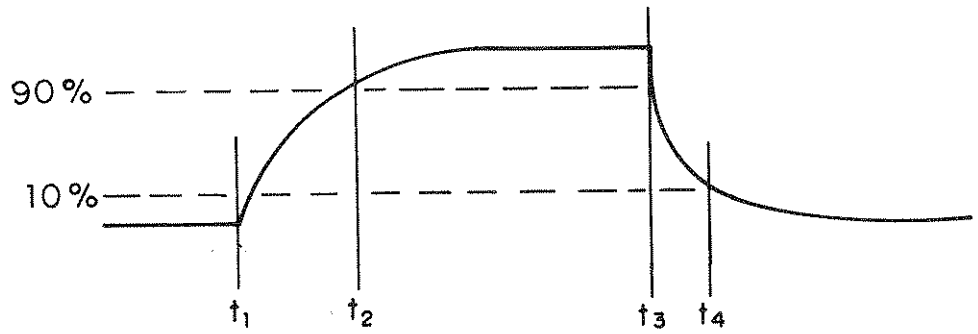


By varying the minimum current "x", the 20 amps pulse will be maintained but the "A" and "B" points will vary. In figure on page 15 the current response is inverted from the signal input to match the output from the current monitor. A positive signal input voltage will actually give a positive current pulse, but the signal seen at the current monitor is inverted.

If the PS²L is overdriven or underdriven in load current, the load will not operate properly and a distorted waveform will be present. When operating in the programmed constant resistance mode, the constant current mode can still act as a limit.

It should be noted here that programming in the constant resistance mode with a voltage generator does not switch between two levels of resistance but switches a constant current level modulated on a constant resistance level. In the above example, with a 2Vp-p program input signal, a 20 amp pulse is generated regardless of the output voltage; however, the "x" current level will change proportionally with the load voltage.

The dynamic response of the PS²L resistance program has been compensated to minimize overshoot and undershoot while switching full rated current and to eliminate any underdamped response to a current load step. The transition rise time on a 0 ADC to 55 ADC load step on the PS²L-500 is typically 100 sec (t_1 to t_2). The fall time on a 55 ADC to 0 ADC load step on the PS²L-500 is also typically 100 μ sec (t_3 to t_4).



The PS²L-1000 transition rise and fall time for 0 ADC and 100 ADC are typically 120 sec.

PROTECTIVE CIRCUITRY

The PS²L is protected against the following:

1. Reverse polarity hookup
2. Overvoltage
3. Undervoltage
4. Overcurrent
5. Overwatts
6. Primary faults (fuse)

The PS²L is internally protected against reverse polarity hookup by a reverse diode and against overvoltage conditions by a SCR crowbar. Both of these conditions are protected by the

clearing of a fuse when the condition of fault occurs. The type of fuse and respective value for each unit is as follows:

PS²L-1000	Chase-Shawmut A13X130	130 Amp
PS²L-500	Chase-Shawmut A13X70	70 Amp

CAUTION: If the unit being tested does not have the capability of clearing the fuses provided in the PS²L in the event of reverse polarity hookup or overvoltage condition, the PS²L must be externally fused with an appropriate device, or damage to the PS²L and/or supply under test may occur. This fuse should be of the current limiting, fast blowing time type fuse with an I^2T rating less than 4000 at times greater than or equal to 1.5 milliseconds.

The PS²L is not thermally designed to carry continuous current in either mode of failure.

In the event of an overvoltage condition, the PS²L will short the (+) load bus to the (—) bus through a SCR and an indicator light on the front panel will turn on, indicating the crowbar condition. The indicator light will stay on ultil primary power to the PS²L is removed, and the output buses will remain shorted until load power on the buses is removed.

The PS²L will internally sense conditions of overcurrent, overwatts, undervoltage, and blown power fuse and give a visual indication of each on the front panel. In the case of overcurrent and overwatts, the load is protected by current limiting circuitry.

CURRENT MONITOR

The BNC connector on the front panel of the PS²L is the output of a 741C operational amplifier that senses the load current and can be calibrated to within ± ½% over the full current range of the PS²L. The amp/volt meter on the front panel is a 2% meter that can read two current ranges and two voltage ranges. The current meter is driven by the above 741C amplifier, and the meter can be compensated by an internal adjustment for calibration.

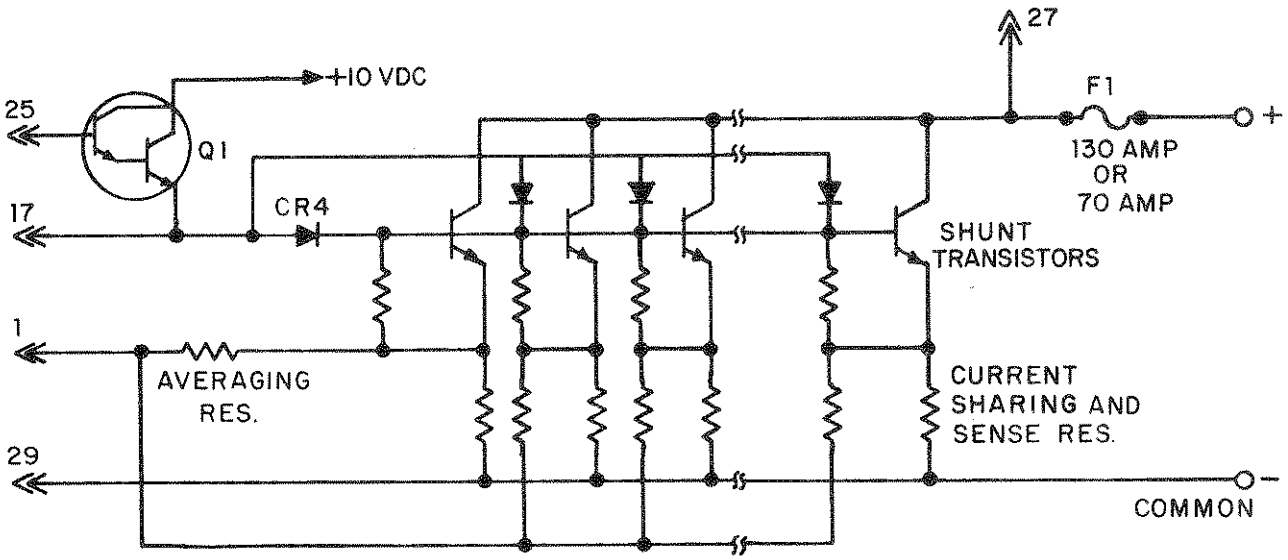
For steady state operation the BNC monitor signal can be read with a high impedance digital voltmeter for accurate readings or a scope can be used for dynamic load situations. If more precise measurements are desired, a calibrated shunt should be connected externally to the PS²L and monitored with a digital voltmeter or scope.

See "Dynamic Loading" page 11 for information on using current monitor to observe "dynamic loading" conditions.

Circuit Description

SHUNT ELEMENT AND CURRENT SENSE

The shunt element consists of paralleled NPN (Acme Electric P/N A-7-67703) power transistors (34 parallel in PS²L-1000 and 17 parallel in PS²L-500) rated at 80 VDC and one power darlington Q1 connected as a driver to the shunting transistors. The shunt transistors are forced to share load current by the sense resistors (R2-R35) rated 0.2 5W, which also compensate for gain differences in the shunting transistors.



The current allowed to pass through the load transistors induces a voltage drop across the sense resistors. The IxR drops across each of these resistors are summed together through averaging resistors (R42-R75) into the current sense input of the regulating feedback loop.

Current amplifier (A102) is a 741C operational amplifier which converts the current sense input signal from the sense resistors to a negative voltage signal proportional to the load current. The current control signal level from A102 can be adjusted by use of pot R140. For calibration procedure see page 23. This control voltage is set at -5.00 VDC at 100 amps or -50 mv/amp for the 1000 watt PS²L and serves several functions: (1) level indicator for current regulator circuit, (2) current level indicator for the power limit circuitry, (3) drive signal for the two current scales on the panel meter, and (4) source for the current monitor signal.

The current monitor is connected to the current amplifier output through a 10 K resistor (R134) to protect against accidental shorting of the BNC connector. When connected to a high impedance scope, a dynamic load can be observed without an external shunt and connection of a digital voltmeter will allow accurate steady state current monitoring.

The dual scale panel meter on the PS²L offers two current metering scales, selectable by SW3, both driven by the current control signal from A102. The higher current scale can be calibrated by potentiometer R135 and the lower scale by R137. For calibration procedure see page 23.

CONSTANT CURRENT CIRCUITRY

The constant current mode employs one-half of a NE5558V dual operational amplifier (A101b) to compare the current control signal from A102 with a reference signal and drive the

control transistor Q110 accordingly. The reference signal is composed of a steady state signal and, if programming, a dynamic signal modulated on the steady state signal.

The steady state reference is a temperature compensated 1N936 zener diode supplied by a constant current source. The current adjust potentiometer on the front panel acts as a voltage divider across the reference zener to supply an adjustable positive D.C. voltage into the inverting input of the current amplifier. The program reference is supplied by an external source applied to the program input terminals on the front of the PS²L. The program signal has a D.C. input impedance of 50 K and has a R-C filter which attenuates the program signal at higher frequencies. The 3 db crossover occurs at approximately 8 KHz.

The reference signal produces a positive voltage at the inverting input of the constant current amplifier, and the current amplifier A102 provides a negative voltage proportional to the load current at the inverting input of A101. The net unbalance of both signals produces the "constant current control signal."

CONSTANT RESISTANCE CIRCUITRY

The constant resistance mode employs the other half of A101 (A101a) to compare the current control signal from A102 to a reference signal and drive the control transistor Q110 accordingly. The reference signal is composed of a steady state signal and, if programming, a dynamic signal modulated on the D.C. signal. The steady state reference is obtained from the constant resistance potentiometer on the front of the PS²L connected as a divider across the load terminal voltage. This pot provides an adjustable positive D.C. voltage into the inverting input of the resistance amplifier. The program reference is supplied by an external source applied to the program input terminals on the front of the PS²L.

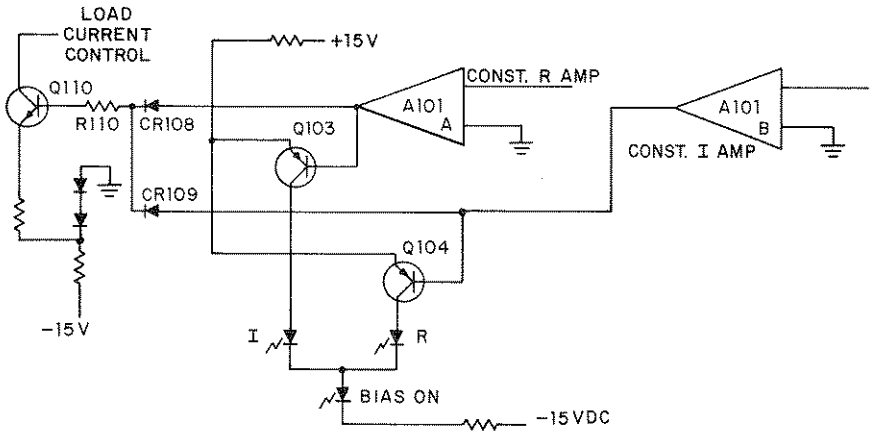
The program signal has a D.C. input impedance of 50 KΩ and has a R-C filter which attenuates the program reference at high frequencies. The 3 db crossover occurs at approximately 8 KHz.

The reference signal produces a positive voltage at the inverting input of the constant resistance amplifier, and the current amplifier A102 provides a negative voltage proportional to the load current at the inverting input of A101a. The net imbalance of both signals produces the "constant resistance control signal."

CONTROL ELEMENT

The constant current control signal and the constant resistance control signal are operating in parallel, with the outputs tied together through two diodes CR108 and CR109. If the output of either amplifier is positive, the diode on its output will be forward biased and will supply base current drive to transistor Q110, thereby turning it on. If either amplifier output is negative, its output diode will be reverse biased and no base drive will be supplied to Q110. This configuration provides for the more positive output of the two control amplifiers to control the current in Q110.

The current and the resistance control amplifier outputs also function as the control for the "bias on," "constant I" mode and "constant R" mode indicating LED's. If the PS²L is operating in the constant resistance mode, the output of the constant resistance amplifier will be positive, forward biasing CR108 and Q110. The constant current amplifier output will, therefore, be more negative and thus sink current from the base of PNP transistor Q104 which in turn passes current through the "constant R" LED and the "bias on" LED. When operating in the constant current mode, the constant resistance amplifier output is low, sinking current from the base of PNP transistor Q103 which passes current through the "constant I" LED and the "bias on" LED.



Transistors Q101 and Q102 (silicon PNP) form two constant current sources. Q101 supplies a constant current to reference zener diode CR117 and the constant adjustment dividers. Transistor Q102 supplies a constant current base drive into darlington transistor Q1 which amplifies the base current drive to the bank of shunting transistors.

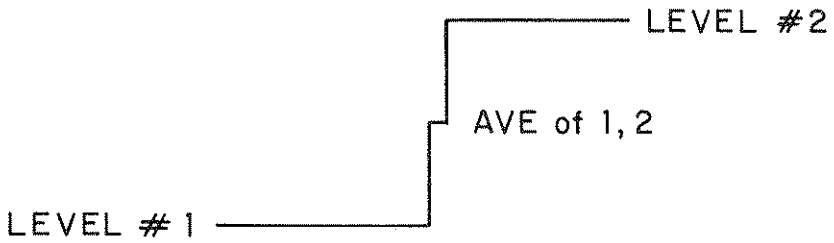
By supplying base current to Q110, the amount of base drive delivered to darlington transistor Q1, by transistor Q102, can be varied to control the amount of load current in the PS²L.

MANUAL MODE SELECTOR

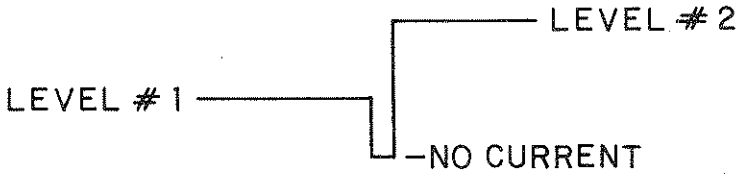
The manual mode selector switch provides switching between the two basic modes of operation, constant current or constant resistance. This switch also provides the capability of operation between two levels of either constant current or constant resistance.

The switch is a 3 pole, 5 position shorting type which controls the voltage reference applied across the "dual" level adjustment pot, R37. While in constant current mode, the voltage of reference zener CR117 is applied across the "dual" level pot. While in constant resistance mode, the "dual" level pot is placed directly across the load voltage.

Due to the fact that the switch is a shorting type, when switching between two current levels, whether constant I or constant R, a momentary current is selected where the average of level 1 and level 2 is obtained:



If the switch were non-shorting, there would be a momentary break in the current switching:



The duration of the interim switch period under normal conditions is negligible.

PROTECTION CIRCUITRY

Any overpower, overcurrent or undervoltage condition will be indicated by the appropriate LED on the front panel of the PS²L.

The current passing through the LED supplies base drive to transistor Q111 which limits drive current to the input of the constant current amplifier and the constant resistance amplifier, thereby limiting power dissipation in the load and signaling a problem to the operator. As soon as the faulty condition is corrected, the load will return to normal operation. These three LED's each have a zener diode in parallel (CR124, CR125, CR126) to insure operation of the protection circuitry in the event of a LED failure.

Overcurrent

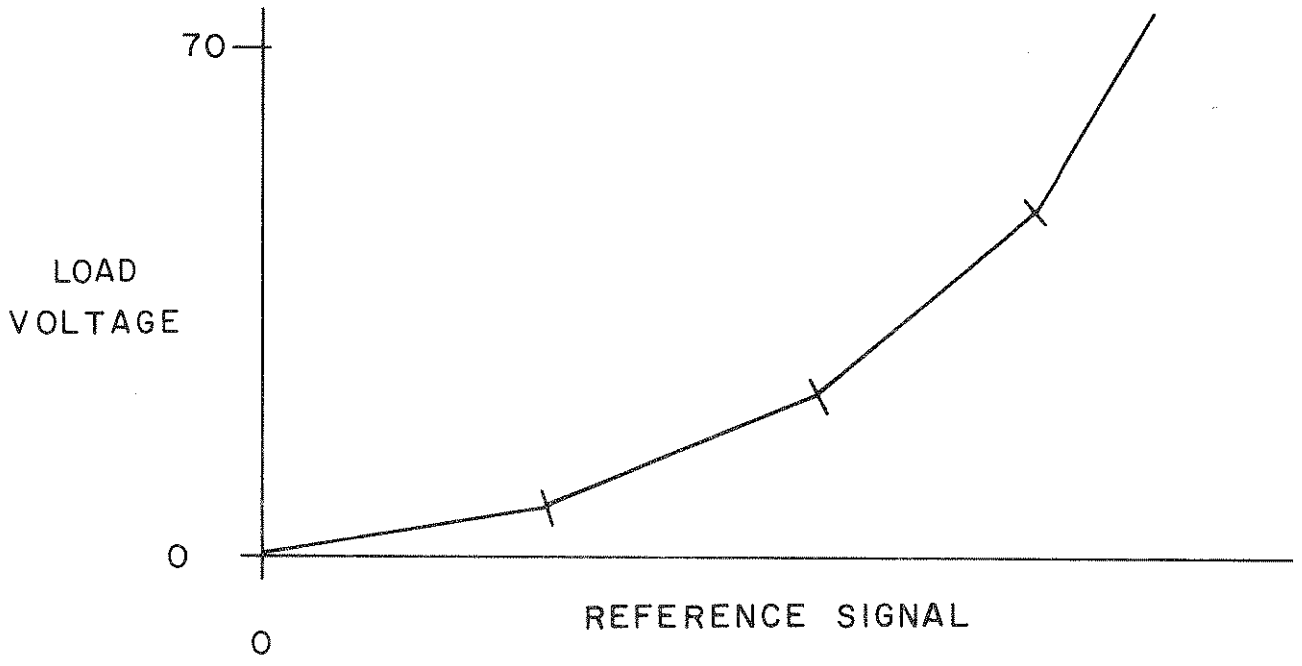
The current level is sensed at the output of the current amplifier A102 and the signal is compared with the zener voltage on CR123. An overcurrent condition will turn on Q107, supplying base drive to Q111 through LED 5, thus activating the protection circuit.

Undervoltage

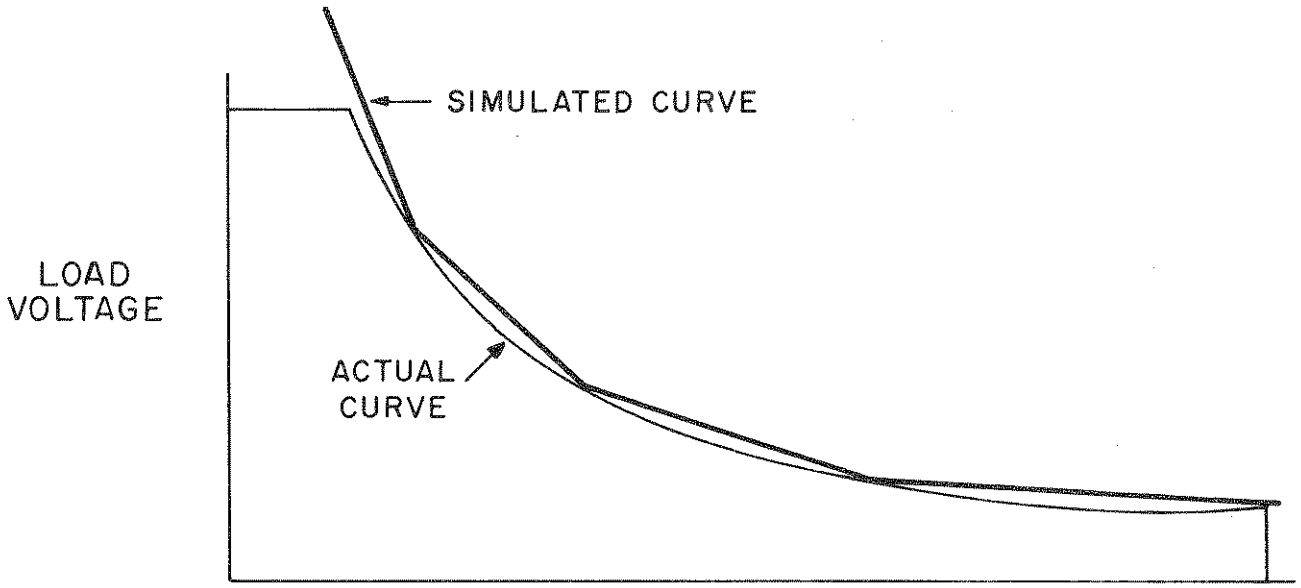
The base-collector voltage of the shunting transistors is sensed, and when the load voltage (collector voltage) decreases to a point near saturation, Q105 senses the undervoltage and supplies base drive to Q111 through LED 6.

Overwatts

The load voltage is sensed by a resistor-diode divider that generates a four linear segment voltage sense point on the base of Q112:



This non-linear voltage signal and the linear negative current reference signal are combined to yield a simulated power curve:



When excess power is attempted, both Q112 and Q106 turn on, supplying base drive to Q111 through LED 4.

Overvoltage

The PS²L is also protected against overvoltage conditions. The output voltage is sensed and compared against zener voltage of CR 122, turning on Q108, Q113 and Q109. Q109 supplies a gate pulse to the power crowbar SCR1 which shorts the load terminals through fuse F1. Q109 also supplies a gate pulse to SCR201 on PC3 which pulls current through LED 7 and latches in this condition with the overvoltage indicator on. Input power to the PS²L must be interrupted for several seconds before the overvoltage indicator will go out and reset. Here again it should be noted that in the event of overvoltage and the power crowbar activates, load power must be disconnected by fusing from the PS²L or damage may result to the PS²L and/or the unit under test. For more information on proper fusing see page 5.

Blown Fuse

The power fuse (F1) drop is sensed by Q201 on PC3 and in the event the fuse should open, LED 8 will light up indicating the failure - as long as a load voltage is applied to the load terminals.

Reverse Polarity

Reverse polarity hookup protection is achieved by reverse diode CR1 protected by fuse F1. CR1 is not thermally sinked to carry reverse current continuously. For more information on proper fusing see page 5.

POWER SUPPLY

Base drive power for the load transistors and bias voltages for the amplifiers are furnished by transformer T1 through full wave bridge rectifier CRB1. The primary is a series/parallel configuration rated to operate from 115 VAC or 230 VAC. Two full wave secondary windings supply nominal D.C. voltages of +10 VDC and ±15 VDC.

The +10 VDC level is rated for 6 amps continuous current and supplies base drive capability for the power load transistors. The +10 VDC transformer secondary windings feeds full wave bridge rectifier CRB1 incorporating a C-L-C filter for ripple reduction. Fuse F2 protects the winding from short circuit conditions or component failure.

The operational amplifiers are based from two 15V zener regulators. The voltages are obtained by a full wave-center tapped bridge rectifier circuit (CR101-CR104 on PC1) and capacitive filter (C101 and C102). The 15 VDC supplies not only act as a bias for the 741 amplifiers, but as a regulated power source for the constant current reference zener CR117 and for the power protection circuitry.

ADJUSTMENT PROCEDURE FOR CALIBRATION

1. Set manual mode switch to "off" position.
2. With no voltage on PS²L load terminals, turn PS²L on.
3. Connect digital voltmeter to "monitor" output and adjust R146 on PC1 to set voltage reading to 0.000 volts ±.0001 (turn CCW to make more positive).
4. Adjust the meter on the PS²L to "zero."
5. Connect a low voltage source capable of supplying full load current through a calibration shunt.
6. Set the manual mode selector to constant current (main or dual) and adjust the monitor voltage to -1.0000 ± .0003 volts (with constant current control pot).
7. Adjust R140 on PC1 to give 10.00 amps on the PS²L-500 or 20.00 amps on the PS²L-1000 (on calibration shunt). Adjust CCW to increase load current.
8. Readjust the constant current control pot to give -.7500 volts on the monitor. Set the meter scale selector on the front of the PS²L to 7.5 amps on the PS²L-500 or 15 amps on the PS²L-1000. Adjust pot R137 on PC1 to yield full scale meter deflection. Adjust CCW to increase current reading.
9. Readjust the constant current control pot to give -5.000 volts on the monitor. Set the meter scale selector in the front of PS²L to 75 amps on the PS²L-500 or 150 amps on the PS²L-1000. Adjust pot R135 on PC1 to a meter reading of 50 amps on the PS²L-500 or 100 amps on the PS²L-1000. Adjust CCW to decrease current reading.

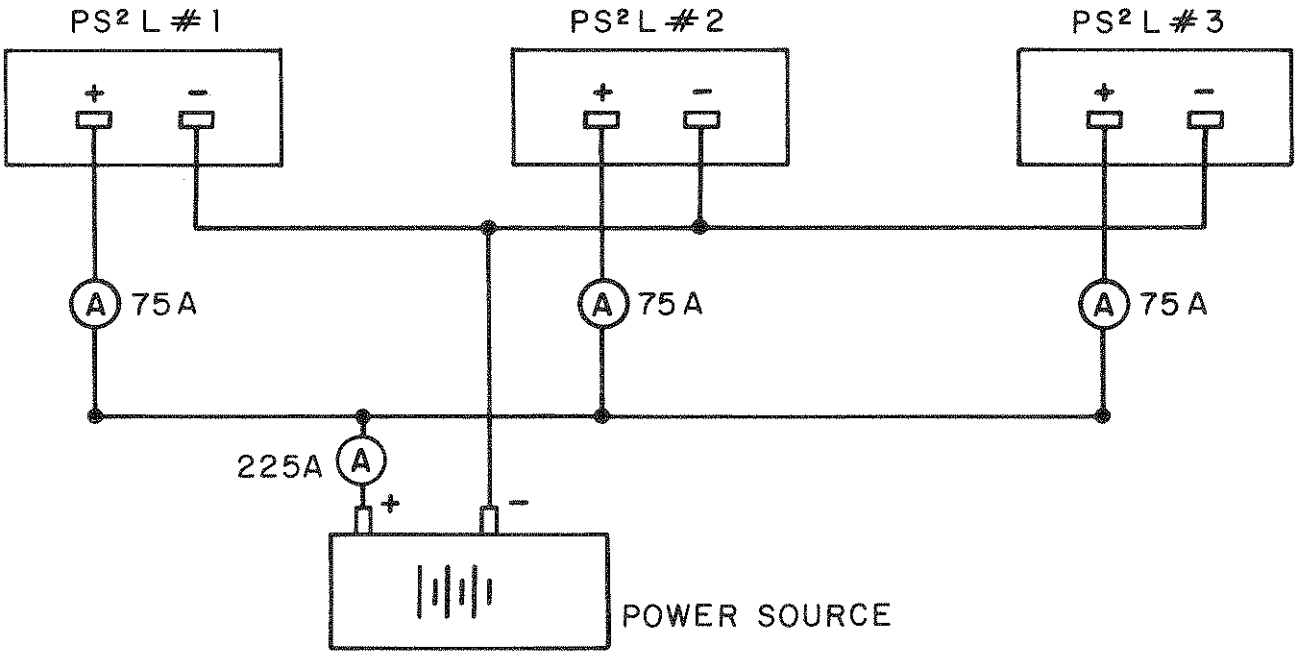
Trouble Shooting Guide

CHARACTERISTICS	POSSIBLE PROBLEM AREA
1. Fan not operating. No "bias on."	1a. Unit not plugged in. b. Primary fuse F4 or F3, opened. c. Power switch not on.
2. Voltage present but no current.	2a. Adjust pot of mode not being used is fully CCW. b. Load fuse, F1, is opened. c. Thermal switch has opened.
3. Unit current limits below power curve and overwatts light is not on.	3a. Adjust pot of mode not in use is not fully CW.
4. Load fuse, F1, opens.	4a. Voltage or spike in excess of 60 VDC is present and overvoltage crowbars. b. PS^2L is connected in reverse polarity.
5. F1 opens - overvoltage condition not present and controls are fully CCW.	5a. Shunt transistor shorted collector to emitter. b. Q1 driver shorted collector to emitter. c. Control transistor, Q110, on PC card opened.
6. Will not load (no current).	6a. Q110 on PC card shorted. b. Q110 driver opened up. c. Q102 on PC card opened.
7. Overvoltage tripping on dynamic loading.	7a. Load connection lead lengths excessive, causing inductive "kick."

Application Notes

1. Parallel application of PS²L to increase current capability.

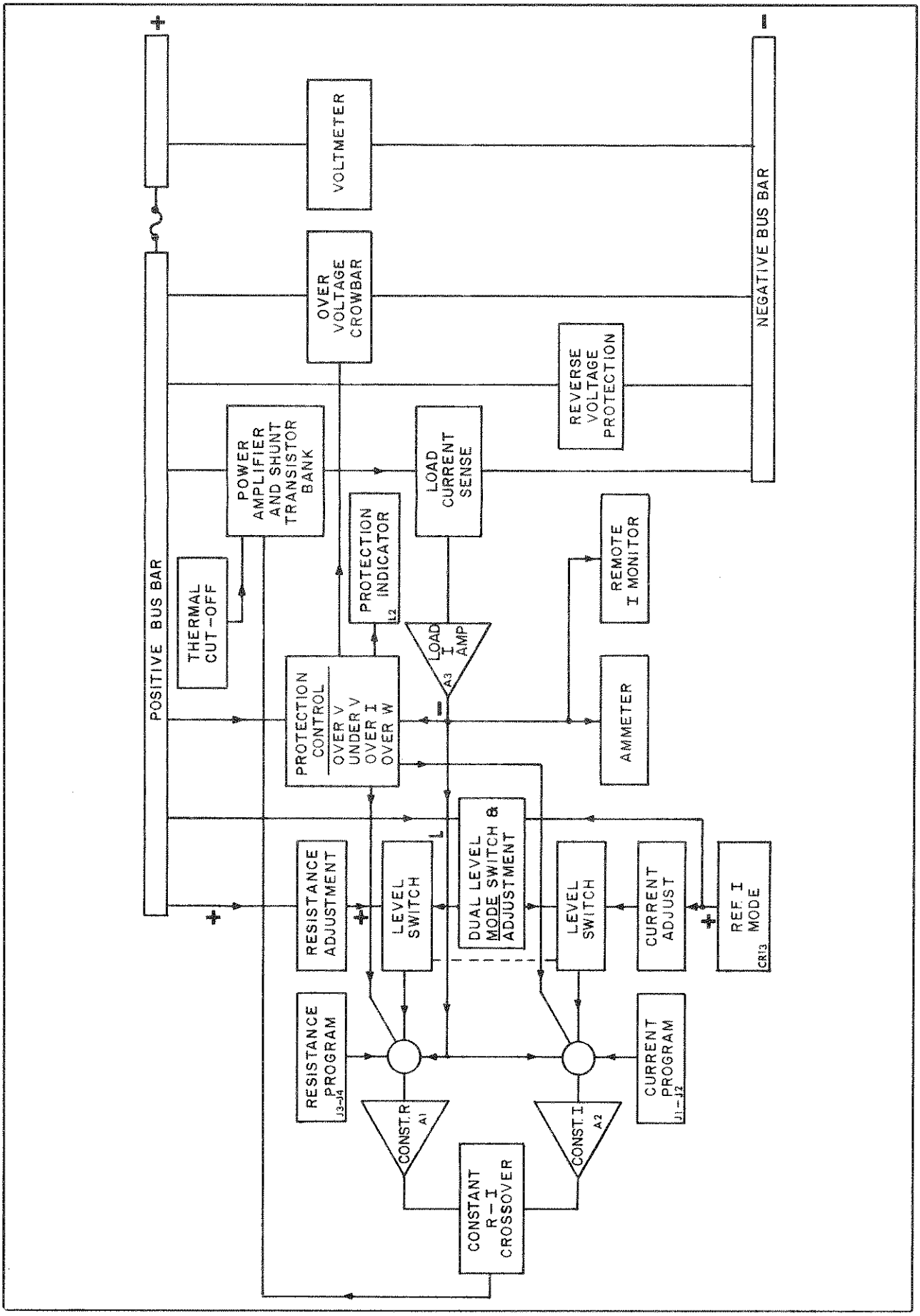
   In the most basic sense, the PS²L is a resistive device with the special ability of maintaining a constant current through itself by automatically varying its resistance. The PS²L can be be paralleled with another PS²L or with a resistance as long as voltage and wattage limits are considered.

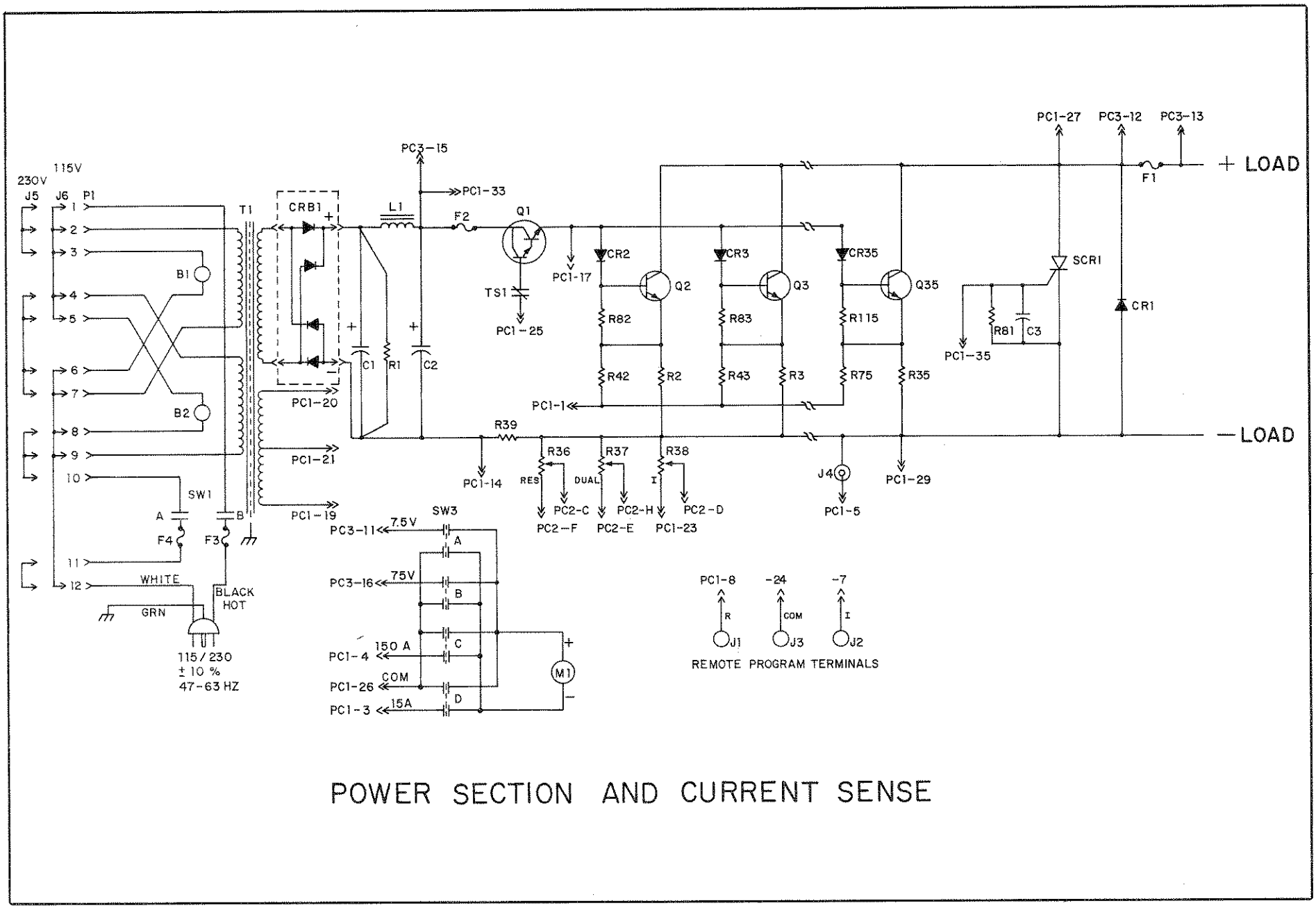


Example 1. It is desired to check the regulation of the above power source at conditions of full load and 10% of full load.

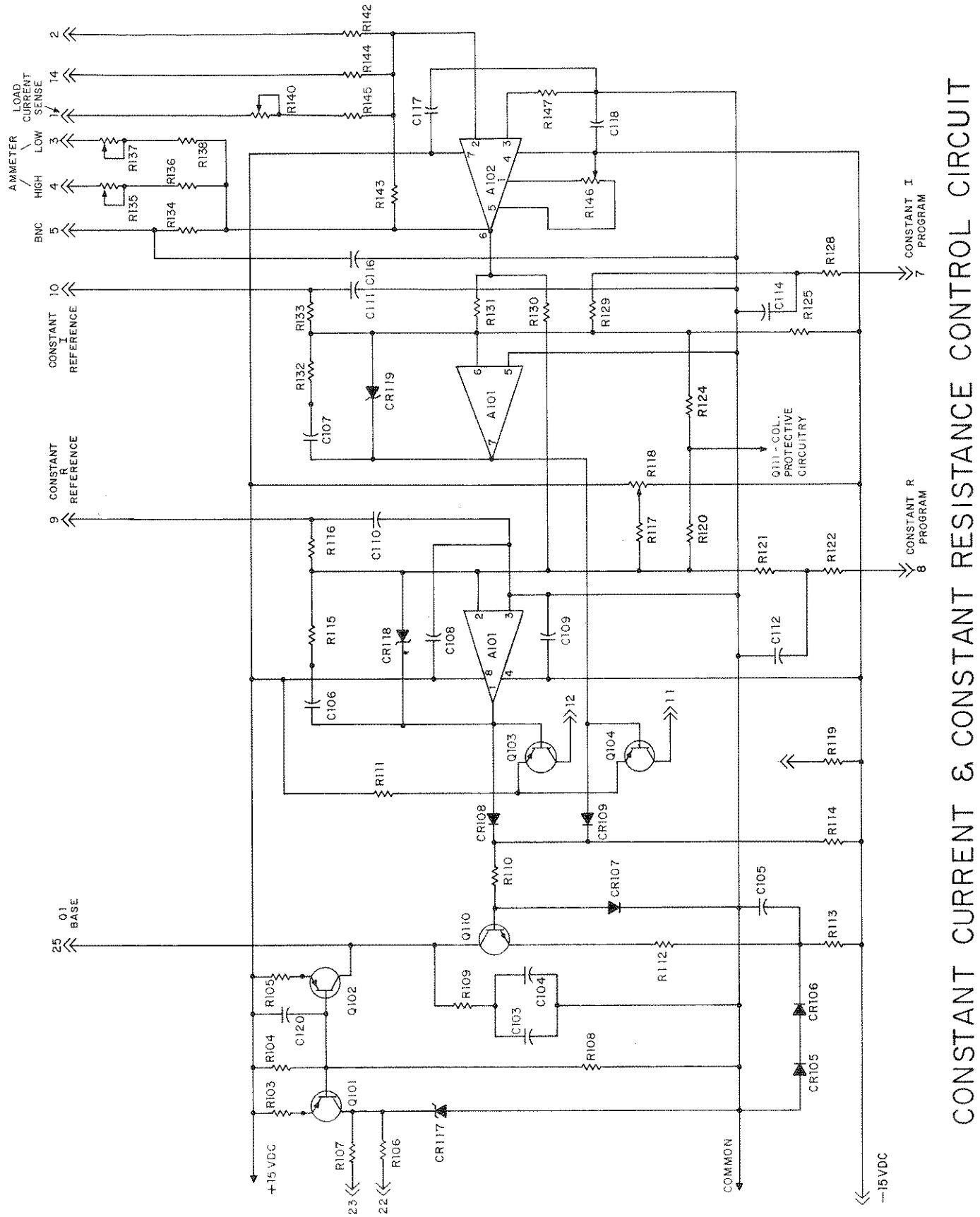
The power source is 5 VDC.
Maximum current drain is 225 amps.
Minimum current drain is 22.5 amps.

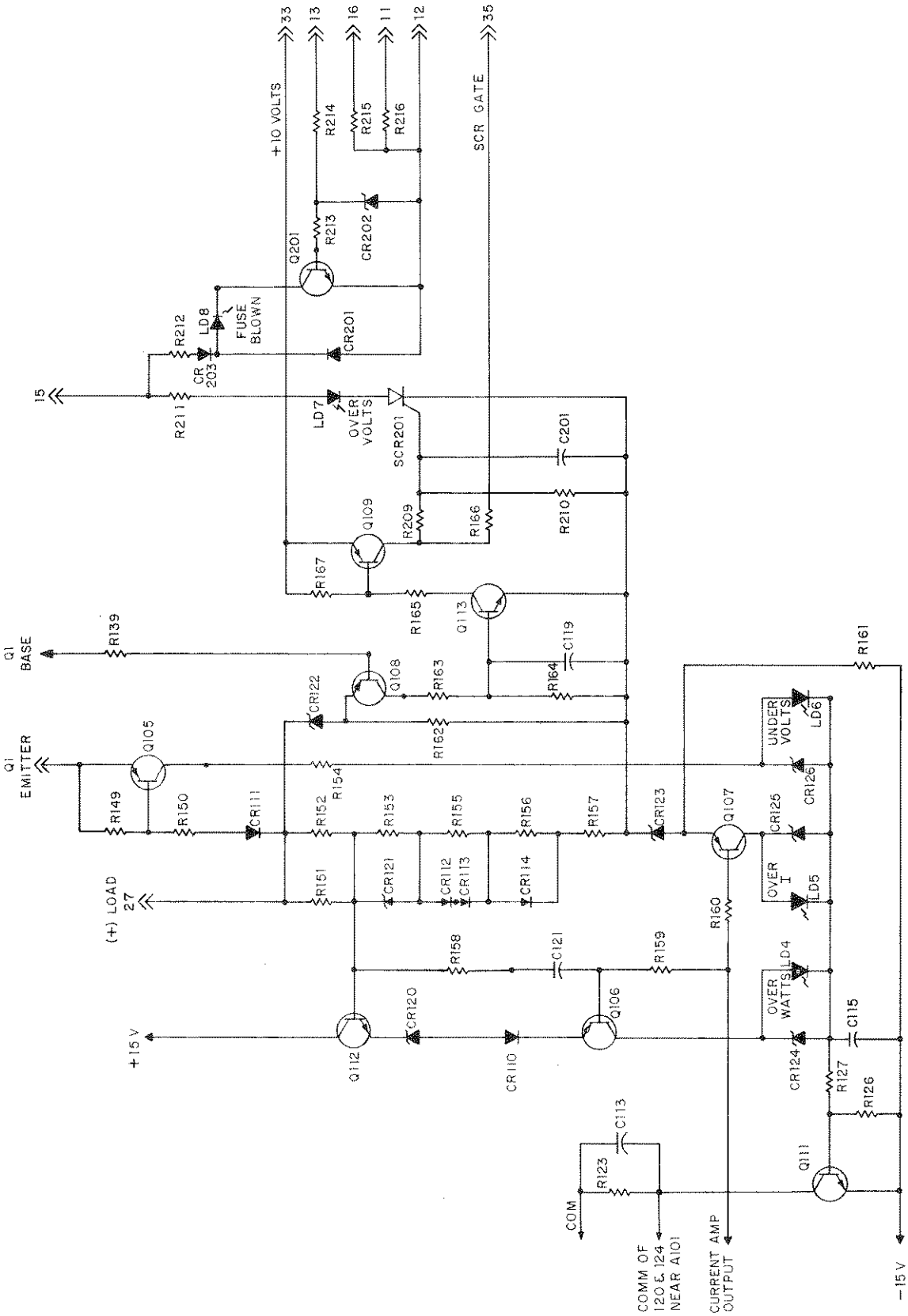
Three PS²L-1000 load units are connected in parallel and the current through each is set for 75 amperes in the resistance mode. This meets the full load condition of 225 amps. Unit No. 1 is then set for the condition of 22.5 amps by using the "dual" pot and turning the units No. 2 and No. 3 "off."


+
POSITIVE BUS BAR
VOLTMETER
OVER VOLTAGE CROWBAR
REVERSE VOLTAGE PROTECTION
NEGATIVE BUS BAR
POWER AMPLIFIER AND SHUNT TRANSISTOR BANK
LOAD CURRENT SENSE
THERMAL CUT-OFF
PROTECTION INDICATOR
L2
REMOTE I MONITOR
LOAD I AMP
A3
PROTECTION CONTROL
OVER V
UNDER V
OVER I
OVER W
AMMETER
RESISTANCE ADJUSTMENT
LEVEL SWITCH
DUAL LEVEL MODE SWITCH & ADJUSTMENT
LEVEL SWITCH
CURRENT ADJUST
REF I MODE
CR13
RESISTANCE PROGRAM
J3-J4
CONST.R
A1
CONST.I
A2
CURRENT PROGRAM
J1-J2
CONSTANT R-I CROSSOVER



POWER SECTION AND CURRENT SENSE


CONSTANT CURRENT & CONSTANT RESISTANCE CONTROL CIRCUIT
AMMETER
LOAD CURRENT SENSE
HIGH
LOW
BNC
CONSTANT I REFERENCE
CONSTANT R REFERENCE
CONSTANT I PROGRAM
CONSTANT R PROGRAM
Q1 BASE
Q111 - COL. PROTECTIVE CIRCUITRY
+15 VDC
-15VDC
COMMON
A101
A102
Q101
Q102
Q103
Q104
Q110
CR117
R107
R106
23
22



PROTECTION CIRCUITRY

ACME ELECTRIC CORPORATION
Cuba, New York

A-113643

SPARE PARTS LIST
MAIN BILL

ACME NO. PL-70662
PS^2L-500

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
F1	Fuse A13X70	Chase-Shawmut	A-1-49631	1	
F2	Fuse AGC 3A	Bussmann	A-9-27241	1	
F3	Fuse MDX 2 Amps	Bussmann	A-10-46600	1	
F4	Fuse MDL 1 Amp	Bussmann	A-13-28348	1	
T1	Transformer T-74102	Acme Electric Corporation		1	
L1	Choke T-1-72970	Acme Electric Corporation		1	
B1	Fan	Pamotor 4500C	A-105302	1	
TS1	SQ Series 2450-42	Texas Institutes	A-3-76812	1	
C1	Cap 23900 µf 20 VDC	Gen.Elec. 86F100 Series	A-32-74243	1	
C2	Cap 10800 mfd 20V	Gen.Elec. 86F100 Series	A-30-74243	1	
CR1	Diode 1N3288A	Westinghouse	A-9-61907-03	1	
CR2- CR18	Diode 1N5393	Westinghouse	A-2-82573	17	
	Asm Rectifier	Edal	A-1-108835	1	
Q1	Transistor 2N6383	R.C.A.	A-1-12665	1	
Q2-Q18	Transistor 1561-0804	R.C.A.	A-8-67703	17	
SCR1	SCR 251B	General Electric	A-3-61770	1	
R1	Res. 1W 470 Ohm	Allen-Bradley	A4-71-1100425	1	

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R2-R18	Res. .4Ω 10W	Lectrohm	A-7-1103001	17	
R36-R38	Pot. 10K 10 Turn	Beckman	A-7-112714	3	
R39	Res. 10W .10 Ohm	Tepro-Bradohm	A-15-92732	1	
R42-R58	Res. .5W 1K	Allen-Bradley	A1-02-1100315	17	
R81	Res. 15W 100 Ohm	Allen-Bradley	A1-01-1100315	1	
R82-R98	Res. .5W 150 Ohm	Allen-Bradley	A1-51-1100315	17	
SW1	SW	Cutler-Hammer	A-1-112611	1	
SW2	SW5 Pos. 3 Pole	RCL #13-ECM-5	A-1-112728	1	
SW3	SW	UID #5L04-3Z2N-53B1	A-1-112612	1	
M1	Meter	Weston	A-1490501	1	

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SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
Q101-104, 106-108	Transistor 2N 4248	Fairchild	A-1-83242	7	
Q109	Transistor 2N4037	R.C.A.	A-2-82196	1	
Q110-113	Transistor 2N 5135	Fairchild	A-1-83243	4	
Q105	Transistor 2N 527	General Electric	A-4-46857	1	
Q114	Transistor 2N 3903	Fairchild	A-1-80269	1	
A101	IC N5558V	Signetics	A-110953	1	
A102	IC 741C	R.C.A.	A-96040	1	
CR101-109, 111-113	Diode IN 5393	Westinghouse	A-2-82573	12	
CR 110	Diode 1N 5392	Westinghouse	A-1-82573	1	
CR115,116	Diode 1N 4744A	Westinghouse	A-6-82999	2	
CR117	Diode 1N 936	Motorola	A-4-59072	1	
CR118,119,121	Diode 1N753A	Motorola	A-16-50538	2	
CR120	Diode 1N255A	Motorola	A-20-50538		
CR122	Diode 1N4760A	Westinghouse	A-15-82999	1	
CR123	Diode 1N751A	Motorola	A-12-50538	1	
CR124-126	Diode 1N748A	Motorola	A-6-50538	3	
C101-102	Cap 300µf 50 VDC	Sprague	A-41-104963	2	
C103	Cap. 100V .15MF	Cornell Dubilier	A-14-61854	1	

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SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
C105	Cap. 148 MFD 10 VDC	Sprague	A-2-104963	1	
C106	Cap. .022 µf 100V	Cornell Dubilier	A-9-61854	1	
C107	Cap. 100V .22 MFD	Cornell Dubilier	A-15-61854	1	
C108 C109,117,118	Cap. .05 MFD 100 VDC	Sprague	A-5-88012	4	
C110, 111	Cap. .001 µf 1K VDC	Sprague	A-1-71984	2	
C112,114	Cap. .0033 100 VDC	Cornell Dubilier	A-4-61854	2	
C113,115,119,121	Cap. 2 MFD 50 V	Sprague	A-2-51996	4	
C116	Cap. .001µf 100V	Cornell Dubilier	A-1-61854	1	
C120	Cap. 800 MFD 15 VDC	Sprague	A-14-104963	1	
R101, 102	Res. 2W 330 Ohms	Allen-Bradley	A3-31-1100525	2	
R103	Res. .25W 301 Ohms	Corning	A-30-94562-10	1	
R104,165	Res. .5W 3.3K Ohm	Allen Bradley	A3-32-1100315	2	
R105,127,163, R141,164,167	Res. .5W 330 Ohms	Allen Bradley	A3-31-1100315	6	
R106, 107	Res. .25W 11K Ohm	Corning	A-11-94562-02	2	
R108, 162	Res. .5W 12K Ohm	Allen Bradley	A1-23-1100315	2	
R109	Res. .5W 330 Ohm	Allen Bradley	A3-30-1100315	1	

A-113643

SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R110	Res. .5W 2.2K Ohm	Allen Bradley	A2-22-1100315	1	
R111, 119	Res. .5W 2.7K Ohm	Allen Bradley	A2-72-1100315	1	
R112	Res. .5W 56 Ohm	Allen Bradley	A5-60-1100315	1	
R113, 116, 133, 149, 158, 159, 160	Res. .5W 1K Ohm	Allen Bradley	A1-02-1100315	7	
R114	Res. .5W 15K Ohm	Allen Bradley	A1-53-1100315	1	
R115, 154	Res. .5W 1.5K Ohm	Allen Bradley	A1-52-1100315	2	
R117, 125	Res. .5W 22M Ohm	Allen Bradley	A2-26-1100315	2	
R118	Pot. 5W 10K	CTS #360S	A-8-93415	1	
R120, 124	Res. .5W 22K Ohms	Allen Bradley	A2-23-1100315	2	
R121	Res. .25W 6.81K Ohm	Corning	A-68-94562-11	1	
R122, 128	Res. .25W 44.2K Ohm	Corning	A-44-94562-22	2	
R123	Res. .5W 6.8K Ohm	Allen Bradley	A6-82-1100315	1	
R126	Res. .5W 160 Ohm	Allen Bradley	A1-61-1100315	1	
R129	Res. .25W 5.62K Ohm	Corning	A-56-94562-21	2	
R130, 131	Res. .25W 24.9K Ohm	Corning	A-24-94562-92	2	
R132	Res. .5W 4.7K Ohm	Allen Bradley	A4-72-1100315	1	
R134	Res. .5W 10K Ohm	Allen Bradley	A1-03-1100315	3	

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R135	Pot. .5W 500 Ohm	CTS #360S	A-4-93415	1	
R136	Res. .25W 7.15K Ohm	Corning	A-71-94562-51	1	
R137	Pot. .5W 50 Ohm	CTS #360S	A-1-93415	1	
R138	Res. .25W 681 Ohms	Corning	A-68-94562-10	1	
R140	Pot. .75W 1K Ohm	Beckman #79PR	A-7-81756	1	
R142	Res. 125W 165K Ohm	Corning	A-10-94562-53	1	
R143,144	Res. .25W 56.2K Ohm	Corning	A-56-94562-22	1	
R145	Res. .25W 12.7K Ohm	Corning	A-12-94562-72	1	
R146	Res. 10K 79PR Pot	Beckman #79PR	A-10-81756	1	
R148	Res. .5W 15M Ohm	Allen Bradley	A7-55-1100315	1	
R150, 139	Res. .5W 100 Ohm	Allen Bradley	A1-01-1100315	2	
R151, 152	Res. .25W 6490 Ohm	Corning	A-64-94562-91	2	
R153	Res. .25W 1.74K Ohm	Corning	A-17-94562-41	1	
R155	Res. .25W 121 Ohm	Corning	A-12-94562-10	1	
R156	Res. .25W 59 Ohm	Corning	A-59-94562-R0	1	
R157	Res. .25W 13.3 Ohm	Corning	A-13-94562-R3	1	
R161	Res. .5W 560 Ohm	Allen Bradley	A5-61-1100315	1	

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SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R166	Res. .5W 51Ohm	Allen Bradley	A5-10-1100315	1	
R146	Pot. 10K 79PR	Beckman #79PR	A-10-81756	1	
R147	Res. .25W 9.09 K Ohm	Corning	A-90-94562-91	1	
R168	Res. .5W 12 K Ohm	Allen Bradley	A1-23-1100315	1	
	PC Card	Acme Electric Corporation	A-109719	1	

ACME ELECTRIC CORPORATION
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A-113642

SPARE PARTS LIST
PC 2 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R201, 202 208	Res. .5W 8.25 K Ohm	Corning	A-82-85016-51	3	
R203-206	Res. .25W 100K Ohm	Corning	A-10-94562-04	4	
R207	Res. .25W 10 Ohm	Corning	A-10-94562-R0	1	
	PC Card	Acme Electric Corporation	A-109736	1	

ACME ELECTRIC CORPORATION
Cuba, New York

A-113643

SPARE PARTS LIST
PC 3 ASM.

ACME NO. PL-70662

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R209	Res. .5W 220 Ohm	Allen Bradley	A2-21-1100315	1	
R210	Res. .5W 470 Ohm	Allen Bradley	A4-71-1100315	1	
R211, 212	Res. .5W 1.8K Ohm	Allen Bradley	A1-82-1100315	2	
R213	Res. .5W 5.1K Ohm	Allen Bradley	A5-12-1100315	1	
R214	Res. .5W 2.7K Ohm	Allen Bradley	A2-72-1100315	1	
R215	Res. .25W 75K Ohm	Corning	A-75-94562-02	1	
R216	Res. .25W 7.5K Ohm	Corning	A-75-94562-01	1	
LD 1-8	Diode Light Emit	OPCOA #LSM-3L	A-112741	8	
SCR 201	Diode C6F	General Electric	A-2-71320	1	
CR201,203	Diode 1N 5393	Westinghouse Power Components	A-2-82573	2	
CR202	Diode 1N746A	Texas Instrument, Motorola Central - Hoffman	A-2-50538	1	
Q201	Transistor 2N 5135	Fairchild	A-1-83243	1	
C201	Cap. .01 MFD 100 VDC	Sprague	A-2-88012	1	
	PC Card	Acme Electric Corporation	A-109718	1	

ACME ELECTRIC CORPORATION
Cuba, New York

A-113642

SPARE PARTS LIST
MAIN BILL

ACME NO. PL-70643

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
F1	Fuse A13X 130	Chase-Shawmut	A-9-49631	1	
F2	Fuse AGC 6	Bussman	A-2-23108	1	
F3	Fuse MDX 2 Amps	Bussman	A-10-46600	1	
F4	Fuse MDL 1 Amp	Bussman	A-13-28348	1	
T1	Transformer T-74102	Acme Electric Corporation	T-74102	1	
L1	Choke T-72970	Acme Electric Corporation	T-72976	1	
B1 + B2	Fan	Pamotor 4500C	A-105302	2	
TS1	SW Series 2450-42	Texas Instruments	A-3-76812	1	
C1	Cap. 23900 µf 20 VDC	Sprague, GE 86F100 Series Mallory, Sangamo	A-32-74243	1	
C2	Cap. 10800 MFD 20V	Sprague, GE 86F100 Series Mallory, Sangamo	A-30-74243	1	
CR1	Diode 1N3288A	Westinghouse	A-9-61907-03	1	
CR2-CR35	Diode 1N 5393	Westinghouse Power Components	A-2-82573	34	
CRB1	ASM. Rectifier	Tung-Sol EDAL	A-1-108835	1	
Q1	Transistor 2N 6383	RCA	A-1-12665	1	
Q2-Q35	Transistor 1561-0804	RCA Westinghouse	A-8-67703	34	
SCR1	SCR 251 B	General Electric	A-3-61770	1	
R1	Res. 1W 470 Ohm	Allen Bradley	A4-71-1100425	1	

ACME ELECTRIC CORPORATION
Cuba, New York

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SPARE PARTS LIST
MAIN BILL

ACME NO. PL-70643

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R2-R35	Res. 10W .4 Ohm	Lectrohm	A-7-1103001	34	
R36-R38	Pot. 10K 10 Turn	Beckman	A-7-112714	3	
R39	Res. 10W .05 Ohm	Tepro. TRW. Bradford Components	A-5-92732	1	
R-42-R75	Res. 5W 1K	Allen Bradley	A1-02-1100315	34	
R81	Res. .5W 100 Ohm	Allen Bradley	A1-01-1100315	1	
R-82-R115	Res. .5W 150 Ohm	Allen-Bradley	A1-51-1100315	34	
SW1	SW	Cutler Hammer	A-1-112611	1	
SW2	SW 5 Pos. 3 Pole	RCL #13ESM-5	A-1-112728	1	
SW3	Switch	UID #5L04-3Z2N-5331	A-1-112612	1	
M1	Meter	Weston	A-1490501	1	

ACME ELECTRIC CORPORATION
Cuba, New York

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SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70643

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
Q101-104,106-108	Transistor 2N 4248	Fairchild	A-1-83242	7	
Q109	Transistor 2N 4037	RCA	A-2-82196	1	
Q110-113	Transistor 2N 5135	Fairchild	A-1-83243	4	
Q105	Transistor 2N 527	General Electric	A-4-46857	1	
Q114	Transistor 2N3903	Fairchild	A-1-80269	1	
A101	IC N5558V	Signetics	A-110953	1	
A102	IC 741C	RCA	A-96040	1	
CR101-109, 111-113	Diode 1N5393	Westinghouse	A-2-82573	12	
CR110	Diode 1N 5392	Westinghouse	A-1-82573	1	
CR115, 116	Diode 1N4744A	Westinghouse	A-6-82999	2	
CR117	Diode 1N 936	Motorola	A-4-59072	1	
CR118, 119,121	Diode 1N753A	Motorola	A-16-50538	3	
CR120	Diode 1N255A	Motorola	A-20-50538	1	
CR122	Diode 1N4760A	Westinghouse	A-15-82999	1	
CR123	Diode 1N751A	Motorola	A-12-50538	1	
CR124 -126	Diode 1N748A	Motorola	A-6-50538	3	
CR127	Diode 1N759A	Motorola	A-2-50538	1	

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SPARE PARTS LIST
PC 1 ASM.

ACME NO. PL-70643

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
C101, 102	Cap. 300 µf 50VDC	Sprague	A-41-104963	2	
C103	Cap. 100V 15 MF	Cornell Dubilier	A-14-61854	1	
C105	Cap. 148 MFD 10 VDC	Sprague	A-2-104963	1	
C106	Cap. .022 µf 100V	Cornell Dubilier	A-9-61854	1	
C107	Cap. 100V .22MFD	Cornell Dubilier	A-15-61854	1	
C108, 109, 117, 118	Cap. .05 MFD 100 VDC	Sprague	A-5-88012	4	
C110, 111	Cap. .001µf 1K VDC	Sprague	A-1-71984	2	
C112, 114	Cap. .0033 100 VDC	Cornell Dubilier	A-4-61854	2	
C113, 115, 119, 121	Cap. 2 MFD 50 V	Sprague	A-2-51996	4	
C116	Cap. .001 µf 100V	Cornell Dubilier	A-1-61854	1	
C120	Cap. 800 MFD 15 VDC	Sprague	A-14-104963	1	
R101, 102	Res. 2W 330 Ohm	Allen Bradley	A3-31-1100525	2	
R103	Res. .25W 301 Ohm	Corning	A-30-94562-10	1	
R104, 165	Res. .5W 3.3K Ohm	Allen Bradley	A3-32-1100315	2	
R105, 127,141, R164,167,163	Res. .5W 330 Ohms	Allen Bradley	A3-31-1100315	6	
R106, 107	Res. .25W 11K Ohm	Corning	A-11-94562-02	2	
R108, 162	Res. .5W 12K Ohm	Allen Bradley	A1-23-1100315	2	

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R109	Res. 15W 33 Ohm	Allen Bradley	A3-30-1100315	1	
R110	Res. .5W 2.2K Ohm	Allen Bradley	A1-22-1100315	1	
R111, 119	Res. .5W 2.7K Ohm	Allen Bradley	A2-72-1100315	2	
R112	Res. .5W 56 Ohm	Allen Bradley	A5-60-1100315	1	
R113, 116, 149, 158, 159, 160	Res. .5W 1K Ohm	Allen Bradley	A1-02-1100315	7	
R114	Res. .5W 15K Ohm	Allen Bradley	A1-53-1100315	1	
R115, 154	Res. .5W 1.5K Ohm	Allen Bradley	A1-52-1100315	2	
R117, 125	Res. .5W 22 M Ohm	Allen Bradley	A2-26-1100315	2	
R118	Pot. .5W 10K	CTS #360S	A-8-93415	1	
R120, 124	Res. .5W 22K Ohm	Allen Bradley	A2-23-1100315	2	
R121	Res. .25W 6.81k Ohm	Corning	A-68-94562-11	1	
R122, 128	Res. .25W 44.2K Ohm	Corning	A-44-94562-22	2	
R123	Res. .5W 6.8K Ohm	Allen Bradley	A6-82-1100315	1	
R126	Res. .5W 680 Ohm	Allen Bradley	A6-81-1100315	1	
R129	Res. .25W 5.62K Ohm	Corning	A-56-94562-21	1	
R130, 131	Res. 125W 24.9K Ohm	Corning	A-24-94562-92	2	
R132	Res. .5W 4.7K Ohm	Allen Bradley	A4-72-1100315	1	

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R134	Res. .5W 10K Ohm	Allen Bradley	A1-03-1100315	2	
R135	Pot. .5W 500 Ohm	CTS # 360S	A-4-93415	1	
R136	Res. .25W 7.15K Ohm	Corning	A-71-94562-51	1	
R137	Pot. .5W 50 Ohm	CTS #360S	A-1-93415	1	
R138	Res. .25W 681 Ohm	Corning	A-68-94562-10	1	
R140	Pot. .75W 1K Ohm	Beckman #79PR	A-7-81756	1	
R142	Res. .25W 105K Ohm	Corning	A-10-94562-53	1	
R143, 144	Res. .25W 56.2K Ohm	Corning	A-56-94562-22	1	
R145	Res. .25W 12.7K Ohm	Corning	A-12-94562-72	1	
R148	Res. .5W 15M Ohm	Allen Bradley	A1-56-1100315	1	
R150, 139	Res. .5W 100 Ohm	Allen Bradley	A1-01-1100315	2	
R151, 152	Res. 1W 6.49K Ohm	Corning	A-64-87215-91	2	
R153	Res. .25W 1.74K Ohm	Corning	A-17-94562-41	1	
R155	Res. .25W 121 Ohm	Corning	A-12-94562-10	1	
R156	Res. .25W 59 Ohm	Corning	A-59-94562-R0	1	
R157	Res. .25W 13.3 Ohm	Corning	A-13-94562-R3	1	
R161	Res. .5W 560 Ohm	Allen Bradley	A5-61-1100315	1	

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R166	Res. .5W 51 Ohm	Allen Bradley	A5-10-1100315	1	
R146	Pot. 10K 79PR	Beckman #79PR	A-10-81756	1	
R147	Res. .25W 9.09 K Ohm	Corning	A-90-94562-91	1	
R168	Res. .5W 12K Ohm	Allen Bradley	A1-23-1100315	1	
	PC Card	Acme Electric Corporation	A-109719	1	

REF. DES.	DESCRIPTION AND RATING	MANUFACTURER AND NUMBER	ACME NUMBER	QTY.
R201, 202 208	Res. .5W 8.25 K Ohm	Corning	A-82-85016-51	3
R203-206	Res. .25W 100 K Ohm	Corning	A-10-94562-04	4
R207	Res. .25W 10 Ohm	Corning	A-10-94562-R0	1
	PC CARD	Acme Electric Corporation	A-109736	1

ACME ELECTRIC CORPORATION
Cuba, New York

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SPARE PARTS LIST
PC 3 ASM.

ACME NO. PL-70643

Ref. Des.	Description and Rating	Manufacturer and No.	Acme No.	Qty.	Cost
R209	Res. .5W 220 Ohm	Allen Bradley	A2-21-1100315	1	
R210	Res. .5W 470 Ohm	Allen Bradley	A4-71-1100315	1	
R211, 212	Res. .5W 1.8K Ohm	Allen Bradley	A1-82-1100315	2	
R213	Res. .5W 5.1K Ohm	Allen Bradley	A5-12-1100315	1	
R214	Res. .5W 2.7K Ohm	Allen Bradley	A2-72-1100315	1	
R215	Res. .25W 75K Ohm	Corning	A-75-94562-02	1	
R216	Res. .25W 7.5K Ohm	Corning	A-75-94562-01	1	
LD1-8	Diode Light Emit	OPCOA # LSM-3L	A-112741	8	
SCR 201	Diode C6F	General Electric	A-2-71320	1	
CR201, 203	Diode 1N5393	Westinghouse Power Components	A-2-82573	2	
CR 202	Diode 1N746A	Central-Hoffman Texas Instruments, Motorola	A-2-50538	1	
Q201	TSTR 2N 5135	Fairchild	A-1-83243	1	
C201	Cap. .01 MFD 100 VDC	Sprague	A-2-88012	1	
	PC Card	Acme Electric Corporation	A-109718	1	