SIEMENS

L-828 Constant Current Regulator Air Cooled (4, 7.5, 10, 15, 20, 25, and 30 kW/6.6 Amps)

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ETL Certified to FAA Specifications
AC 150/5345-10E

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The innovative approach

RECORD OF CHANGES

Page	Rev.	Description	Chkd	App'd
	A	Manual release		
	B	Extensively revised manual.	SP	ER
	C	Revised Table 1-6. Added Table 1-7.	SP	VP
8-11 thru 8-20	D	Deleted Figures 8-12 through 8-15. Added new Figure 8-12.	AS	VP
1-8	E	ECO 00880. Revised Table 1-7 to update input current.	MH	WT

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SAFETY NOTICE

The operating and maintenance personnel should refer to FAA Advisory Circular AC 150/5340-26 "Maintenance of Airport Visual Aid Facilities" for instructions on safety precautions. All operations on this unit shall be carried out by personnel qualified to work on high voltage equipment. Personnel must observe the safety regulations at all times. While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS

Operating and maintenance personnel must at all times observe all safety regulations. Do not change plug-in components or make adjustments inside equipment with high voltage supply on. To avoid casualties, always remove power, then discharge and ground by use of a grounding rod, prior to touching any parts.

RESUSCITATION

Operating and maintenance personnel should familiarize themselves with the technique for resuscitation found in the First Aid Instruction Manual.

GUARANTEE

ADB-ALNACO, Inc. guarantees that the L-828 Regulators described herein, when sold by ADB-ALNACO, Inc. or its approved representatives has been manufactured and will perform in accordance with the FAA specification AC 150/5345-10E, L-828, and that any defect in design, materials or workmanship which may occur during proper and normal use during a period of one (1) year from date of installation or a maximum of two (2) years from the date of shipment will be corrected by repair or replacement by ADB-ALNACO, Inc., f.o.b. factory. Such corrections shall constitute the limit of all ADB-ALNACO, Inc. liabilities for the L-828 Regulators.

SECTION 1. GENERAL INFORMATION AND REQUIREMENTS

1.1 INTRODUCTION.- The ADB-ALNACO, Inc. air-cooled L-828 Constant Current Regulators (CCRs) are designed to supply three or five precision output current levels (6.6 A maximum) to power airport series lighting circuits on runways and taxiways. The output current of the L-828 CCRs is accurately regulated within ±1% of the adjustable nominal current levels (see Table 1-1) for no load (short circuit) to full load and with input voltage variations of -5% to +10% of nominal. Output current levels are maintained even if 30% of the isolation transformers on the series circuit have open secondaries.

1.1.1 Purpose.- This instruction manual describes procedures for the installation, maintenance, operation and troubleshooting of the air-cooled L-828 Constant Current Regulators.

1.1.2 Scope.- The L-828 Constant Current Regulators described in this manual are manufactured to FAA specification AC 150/5345-10E. Operation outside the design limitations of this specification may result in degradation of performance, damage or failure of regulator components or hazardous conditions.

1.2 CONSTRUCTION.- See Figure 8-1. A painted steel-frame cabinet houses the power components (transformer and capacitors) and the control logic necessary to regulate the output current level. The control logic is contained in plug-in modules in the card rack and is divided into two separate modules: the Input Module PCB and the Current Controller PCB.

1.3 MODULES.-

1.3.1 Input Module PCB.- The Input Module Printed Circuit Board (PCB) receives:

a. The remote control signals

b. The output current

c. The 48 V dc signals.

The Input Module PCB outputs the following signals to the Current Controller:

a. DC power supply voltage

b. A signal proportional to the output current

c. A phase reference signal to control the firing of the SCRs

d. The 48 V dc for on/off control

e. A signal to set the output current according to the brightness setting.

1.3.2 Current Controller PCB.- The Current Controller PCB receives signals from the Input Module PCB and performs the following functions:

a. Produces SCR-drive signals in accordance with the signals from the Input Module PCB.

b. Detects an overcurrent, open circuit or undervoltage, and switches the constant current regulator off.

1.4 EQUIPMENT SPECIFICATION DATA.- The ADB-ALNACO, Inc. general assembly part numbers for the L-828 Constant Current Regulators are given in Table 1-2. Reference data pertinent to the equipment is listed in Table 1-3. Information on items not supplied which might be required for installation is given in Table 1-4. Equipment and accessories supplied are listed in Table 1-5.

1.5 PROTECTIVE DEVICES.- The following protective devices are provided on each regulator:

a. Output open-circuit protection

b. Output overcurrent protection

c. Input power-line undervoltage protection

d. Lightning arrestors on output terminals/bushings
Input lightning protection can be ordered as an option for 480 V ac and less input voltages.

e. Fuse protection of: AC supply voltage of the Input Module PCB, brightness control voltage for local control, and regulator control supply on primary and secondary.

1.6 REGULATION.- See Table 1-1 for output current limits. Current regulation is obtained under the following conditons:

a. Load variations of zero (short-circuit) to full load with input voltage variations of -5% to +10%, at -40°C up to +55°C (-40°F to +131°F) ambient temperature.

b. With up to 30% of the series load isolating transformers open-circuited.

1.7 PANEL AMMETER.- A true rms-reading ammeter mounted on the front of the Input Module PCB indicates the output current. The screw on the face of the ammeter is for zeroing the indicator needle.

1.8 INPUT VOLTAGE.- The power transformer for the L-828 regualtors is designed for an input voltage of either 208, 220, 240, 480 or 2400 V ac. The input voltage must be accurately determined prior to ordering the regulator as no alternate input voltage taps are available.

Table 1-1. Output Current Levels

3 STEP CCR BRIGHTNESS CONTROL SWITCH POSITION	NOMINAL RMS OUTPUT CURRENT (amperes)	OUTPUT CURRENT LIMITS (amperes)
100	6.6	6.40 - 6.70
30	5.5	5.33 - 5.67
10	4.8	4.66 - 4.94

5 STEP CCR BRIGHTNESS CONTROL SWITCH POSITION	NOMINAL RMS OUTPUT CURRENT (amperes)	OUTPUT CURRENT LIMITS (amperes)
5	6.6	6.40 - 6.70
4	5.2	5.04 - 5.36
3	4.1	3.98 - 4.22
2	3.4	3.30 - 3.50
1	2.8	2.72 - 2.88

Table 1-2. L-828 Part Numbers

L-828 Part Numbers

	Input Voltage				
	208 V	220 V	240 V	480 V	2400 V
4 kW, 6.6A	44D1301-X	44D1302-X	44D1093-X	44D1327-X	
7.5 kW, 6.6A	44D1303-X	44D1304-X	44D1094-X	44D1328-X	
10 kW, 6.6A	44D1305-X	44D1306-X	44D1095-X	44D1307-X	44D1329-X
15 kW, 6.6A	44D1308-X	44D1309-X	44D1310-X	44D1097-X	44D1195-X
20 kW, 6.6A	44D1312-X	44D1313-X	44D1096-X	44D1314-X	44D1315-X
25 kW, 6.6A	44D1317-X	44D1318-X	44D1319-X	44D1320-X	44D1321-X
30 kW, 6.6A	44D1323-X	44D1324-X	44D1325-X	44D1196-X	44D1181-X

44D1XXX-X

1 = 3-Step Standard L-828
3 = 5-Step Standard L-828
7 = 3-Step L-828 with ALCS & Scanning Monitor Interface (without Remote Box)*
8 = 5-Step L-828 with ALCS & Scanning Monitor Interface (without Remote Box)*
9 = 3-Step L-828 with ALCS & Scanning Monitor Interface (with Remote Box)**
0 = 5-Step L-828 with ALCS & Scanning Monitor Interface (with Remote Box)**

Note:

ALCS and Scanning Monitor Interface: L-828 designed for connection to the ADB Airfield Lighting Computer System and the ADB Scanning Monitor. The ADB Scanning Monitor provides state-of-the art accuracy in computer monitoring of the status of L-828 regulators and the series circuits powered by them. In addition to providing all the functional capability of an FAA L-827 airport lighting monitor, the ADB Scanning Monitor's software-controlled monitoring can be easily changed to provide additional monitoring information or updated to monitor new equipment installed on the lighting circuits. Contact ADB Sales Department for details and additional literature. See ADB Catalog Sheet #1041 for details on the ADB Airfield Lighting Computer System.

Without Remote Box:** The current and voltage transformers for ALCS/ Scanning Monitor feedback are mounted ***external to the regulator on the wall.

****With Remote Box:** The current and voltage transformers for ALCS/ Scanning Monitor feedback are installed ***inside*** the L-828 regulator.

Table 1-3. Equipment Data

Type: L-828 (air cooled) Constant Current Regulator (CCR)

Ratings: 4, 7.5, 10, 15, 20, 25 and 30 kW

Input Voltage: 208, 220, 240, 480 or 2400 V ac; single phase, 60 Hz ac.

Class: Class 1 (6.6 A maximum output current)

Style: Style 1, 3 brightness steps: 4.8 A, 5.5 A, and 6.6 A

Style 2, 5 brightness steps: 2.8 A, 3.4 A, 4.1 A, 5.2 A, and 6.6 A

Power Factor: For 4, 7.5 and 10 kW CCR, not less than 90%
For 15, 20, 25, and 30 kW CCR, not less than 95%

Efficiency: Minimum overall efficiency of not less than 90% for regulators less than 30 kW and 92% for the 30 kW CCR.

Reactive Loading: The CCRs maintain the current within the limits of Table 1-1 for all brightness steps when the load is connected via isolating transformers, and the secondaries of 30 % of these transformers become open-circuited. The load before opening the isolation transformer secondaries may be any value from half to full load. For regulators less than 10 kW loaded as specified above, the current remains below 6.8 amperes for the 100 % brightness step.

Resistive Loading: The CCRs maintain the output current within the limits of Table 1-1 while powering any load between no load (short circuit) and full load. For regulators 10 kW or larger, the regulation is maintained over the full range of environmental conditions specified below and for the input voltages specified above. For regulators less than 10 kW, the regulation is provided at nominal input voltage for all brightness steps.

Environmental Operating Conditions: Designed for indoor use only in an area with adequate ventilation for cooling the constant current regulator.

Temperature Range: -40°C to +55°C
(-40°F to +131°F)

Relative Humidity: 10 to 100%

Altitude: Sea level to 6,600 ft (2,000 m)

Table 1-3. Equipment Data (continued)

Protective Devices: Open-Circuit Protection - The primary switch is opened in less than 1 second after an open circuit occurs in the secondary. The open-circuit protective device is reset within 2 seconds after the rotary selector switch on the CCR is turned to OFF (or CCR is turned OFF while it is in REMOTE control) and reenergized, and is not tripped by switching of load circuits or other transients.

Overcurrent Protection - Regulators include an overcurrent protective device which opens the primary switch when the output current exceeds 6.6A by 5%. The device operates within 5 seconds after an overcurrent of 25%. The device is reset within 2 seconds after the regulator is turned off and reenergized. The overcurrent protection is not activated by a momentary (0.25s) overcurrent caused by switching of load circuits or other transients.

RATING & INPUT VOLTAGE	DIMENSIONS HEIGHT x WIDTH x DEPTH (inches)	WEIGHT (lbs)
4 kW (208-480 V ac)	47.5 x 23.5 x 31.5	440
7.5 kW (208-480 V ac)	47.5 x 23.5 x 31.5	490
10 kW (208-2400 V ac)	47.5 x 23.5 x 31.5	590
15 kW (208-480 V ac)	47.5 x 35.5 x 31.5	890
15 kW (2400 V ac)	47.5 x 35.5 x 40.0	1140
20 kW (208-480 V ac)	47.5 x 35.5 x 31.5	990
20 kW (2400 V ac)	47.5 x 35.5 x 40.0	1190
25 kW (208-2400 V ac)	47.5 x 35.5 x 40.0	1190
30 kW (208-2400 V ac)	47.5 x 35.5 x 40.0	1290

Table 1-4. Equipment Not Supplied But Which Might be Required*

QUANTITY	DESCRIPTION
A/R	Wire, Input Power (see Table 1-6)
A/R	Wire, Remote Control (AWG 19 min.; AWG 14 max.)
A/R	Wire, Ground (AWG 6 minimum)
A/R	Wire, Output Load (AWG 8, 5000 V ac, L-824 type)
A/R	Wire, Shorting Jumper (AWG 8 minimum)
1	Disconnect Switch or Main Circuit Breaker
A/R	Input Lightning Arrestor** (The following optional ADB-ALNACO Input Varistor Assemblies are available: #94B0011-1 for use on 480 V ac CCR, #94B0011-2 for use on 220 & 240 V ac CCRs, #94B0011-3 for use on 208 V ac CCR)
1 each	Screwdriver: BLADE WIDTH 0.1-0.14 inches (2.5-3.5 mm) 0.14-0.2 inches (3.5-5 mm) 0.16-0.24 inches (4-6 mm) 0.24-0.31 inches (6-8 mm)
1	Voltmeter (for 208-480 V ac CCRs [minimum 600 V ac scale], for 2400 V ac CCR [minimum 3000 V ac scale])
1	Voltmeter (60 V dc full scale)
1	Ammeter, true rms-reading (9 A maximum scale)
1	Ohmmeter
1	2400 V Step-down Transformer (for 2400 V ac CCRs; such as, OLSUN #9219S-25995, 2400/240 V ac, 0.5 kVA)
1	Extender Board (ADB-ALNACO #44C1123)
4	Mounting Bolts ($\frac{1}{2}$-16x1$\frac{1}{2}$ inches long) and Washers ($\frac{1}{2}$ STD) and Lockwashers

* See Table 6-2 for recommended spare parts.
** Standard 2400 V ac lighting arrestors (customer supplied) should be used external to CCR.

Table 1-5. Equipment Supplied

Quantity	Description
1	L-828 Constant Current Regulator
1	Instruction Manual

Table 1-6. Recommended Input Power Supply Wire

kW Rating	208 Vac	220 Vac	240 Vac	480 Vac	2400 Vac
4 kW	AWG 12, 600 V	AWG 12, 600 V	AWG 12, 600 V	AWG 18, 600 V	Not applicable
7.5 kW	AWG 8, 600 V	AWG 8, 600 V	AWG 10, 600 V	AWG 14, 600 V	Not applicable
10 kW	AWG 6, 600 V	AWG 6, 600 V	AWG 6, 600 V	AWG 12, 600 V	AWG 8, 5000 V
15 kW	AWG 4, 600 V	AWG 4, 600 V	AWG 4, 600 V	AWG 10, 600 V	AWG 8, 5000 V
20 kW	AWG 2, 600 V	AWG 2, 600 V	AWG 2, 600 V	AWG 6, 600 V	AWG 8, 5000 V
30 kW	AWG 1/0, 600 V	AWG 1/0, 600 V	AWG 1, 600 V	AWG 4, 600 V	AWG 8, 5000 V

NOTE: Table 1-6 refers to recommended input power supply wire (90 °C, 600 or 5000 V minimum).

NOTE: It is recommended that the circuit breaker on the input power supply lines have a rating of 125% of the CCR's input current, as given in Table 1-7, unless local codes require a different rating technique. See the CCR's nameplate for the kW rating and input voltage to determine the input current from Table 1-7. If no standard-size circuit breaker exists at the 125% value, use the next larger standard-size circuit breaker.

Table 1-7. Input Current for L-828 CCRs

Rating	208 Vac	220 Vac	240 Vac	480 Vac	2400 Vac
4 kVA	27 A	26 A	24 A	12 A	2 A
7.5 kVA	51 A	48 A	44 A	22 A	4 A
10 kVA	68 A	65 A	59 A	30 A	6 A
15 kVA	97 A	92 A	84 A	42 A	8 A
20 kVA	129 A	122 A	112 A	56 A	11 A
30 kVA	190 A	179 A	164 A	82 A	16 A

SECTION 2. THEORY OF OPERATION

2.1 POWER CIRCUIT.- A resonant network T1-C1 to T1-CX feeds the output circuit independent of the impedance of the load with a current proportional to the value of the input voltage. Control and regulation of the output current is accomplished by the SCRs Q1 and Q2 which shunt progressively a part of the resonant circuit, decreasing the output current. The components of the resonant network are designed to deliver an output current slightly higher than 6.6 A for the minimum input voltage, the SCRs being in the OFF state.

2.2 OUTPUT CURRENT MEASUREMENT.- The output current flows through the high voltage current transformer T2. The secondary of this transformer delivers a nominal current of 6.6 A to the rack where it is used on the Input Module for:

a. The true rms-reading ammeter on the Input Module to indicate output current.

b. The step-down current transformer T1 (on Input Module PCB) which supplies a reduced proportional current to the Current Controller for control of the regulator output.

2.3 REGULATION OF THE OUTPUT CURRENT.- See Figures 8-16 and 8-17.

2.3.1 DC Power Supply.- See Figure 8-17.

a. Bridge-rectifier CR1 rectifies the AC voltage from T1 (on Input Module PCB), charges C15 and C18 to +12 V dc and -12 V dc, respectively.

b. If relay K1 is energized (rotary switch S2 in position 10, 30 or 100 for 3 step CCR; in position 1, 2, ..., or 5 for a 5 step CCR; or in position REM with remote control switch set to ON) all the circuitry of the constant current regulator is supplied with DC voltage.

2.3.2 SCR Inhibit Signals.- See Figure 8-17.

a. The Input Module PCB inputs into the Current Controller PCB an AC voltage of about 26 V ac (signal PHREF) in phase with the supply voltage of the power transformer T1.

b. Integrator AR4/D outputs an AC voltage shifted in phase, filtered and lowered in level in comparison to signal PHREF.

c. Comparators AR4/B and AR4/C transform the output voltage of AR4/D into square waves such that:

1. The output of AR4/B is HIGH (about +10.5 V) as long as the output voltage of AR4/D is higher than -0.94 V.

2. The output of AR4/C is HIGH as long as the output voltage of AR4/D is lower than about +0.94 V.

2.3.3 Sawtooth Generator.- See Figure 8-17.

Capacitor C6 is slowly charged through resistor R31 and is short-circuited if Q12 is switched on. Q12 is switched on during the short period of time that both AR4/B and AR4/C are HIGH. This provides a sawtooth voltage across C6 synchronized with the AC voltage at the output of AR4/D.

2.3.4 SCR Ignition Circuit.- See Figure 8-17.

a. If there is no SCR-inhibit signal, then trigger transformer T1 or T2 has as an input a square wave generated by a push-pull transistor stage (one for each trigger transformer).

b. The voltage across resistor R14 depends on the current through the trigger transformer. As soon as this current exceeds a certain value, the schmitt-trigger AR1 commutates the push-pull stage. This means that the frequency of oscillation is determined by the saturation point of the trigger transformers.

c. To drive the gates of SCR Q1 or SCR Q2 (on SCR block):

    1. The output current of either transformer T1 or T2 is rectified.

    2. The gate current is limited by R15 or R28, respectively.

d. The SCR's ignition circuit is controlled by three signals:

    1. If the output of AR4/B is HIGH (about +10.5 V), circuitry for SCR Q1 is inhibited from oscillation.

    2. If output of AR4/C is HIGH, circuitry for SCR Q2 is inhibited from oscillation.

    3. If the output of AR2/A is HIGH, AR1 is forced HIGH, and Q5 and Q10 are shut off by Q2 and Q7. Therefore, the two SCRs and AR1 are inhibited.

2.3.5 Output Current Regulation.- See Figure 8-17.

a. A voltage of -6.2 V ± 5% provided by reference zener diode D32 (high-stability and low-temperature-coefficient type zener diode). This stabilized voltage produces signal VREF (adjustable by potentiometer

R110) which is output to the Input Module PCB which determines all the brightness levels. Signal VREF is used to adjust the maximum output current.

b. The secondary current of transformer T1 (on Input Module PCB) is rectified by diode CR2 and produces a voltage across R75 proportional to the output current.

c. A squarer composed of R68/R69/R70/R71/R72/R73/D25/D26/D27 produces a DC feedback voltage across capacitor C11 proportional to the rms value of the output current of the constant current regulator.

d. The difference between the current through R67 (produced by the voltage across C11) and the current through R66 (derived from VREF on the Input Module PCB) produces a charge (positive or negative) on capacitor C8, which causes a correction of the output voltage of integrator AR2/D.

e. The sawtooth voltage present across capacitor C6 and the output voltage of integrator AR2/D are compared by AR2/A. The output of AR2/A swings to LOW when the sawtooth voltage becomes higher than the output voltage of AR2/D, and stays LOW as long as sawtooth voltage is higher than the voltage AR2/D. This determines the conduction time of the SCRs and adjusts the constant current regulator output current until the difference between the current through R67 and R66 are equal.

f. To speed up regulation response time:

    1. When output current is higher than demanded, the output of AR2/D is held to -0.6 V minimum by diode D17.

    2. When the output current is lower than that which is demanded, the output AR2/D is held to a level slightly higher than the maximum sawtooth voltage by AR2/B (valid as long as the output current is higher than about 5.3 A when a current of 6.6 A is demanded).

    3. Diode D12 makes sure the SCRs are always conducting when switched on. This prevents overvoltage spikes from occurring across the SCRs in case the CCR is switched on when an open circuit is present on the output.

2.3.6 Switching On.- See Figure 8-17.

a. The DC voltage produced by resistor-capacitor network R101/R102/R103/R111/C17/C20 is compared with the voltage generated by zener diode D32 through resistor divider network R91/R92. The minimum supply voltage for on/off switching can be adjusted with potentiometer R111.

b. When the supply voltage is too low, the output of AR4/A will be LOW and transistor Q13 will be off. This causes integrated circuits AR3, zener diode D31, and relay K2 (on the CCR front panel) to not be supplied with -12 V dc.

c. When the supply voltage reaches a threshold (adjusted with R111), AR4/A goes HIGH causing Q13 to conduct. This causes Q11 to conduct as long as C7 is charging (less than 1 second). Q11 turns on Q14 causing relay K2 (on the CCR front panel) to switch on. If no open circuit or overcurrent exists, Q15 will conduct and Q14 will stay energized through a normally open contact of K2.

2.4 FAILURE PROTECTION.- See Figure 8-17.

a. The voltage across resistor R75 (proportional to the output current) is also used for the squarer R58/R59/R60/R61/R62/R63/D22/D23/D24 which produces a voltage across capacitor C16 proportional to the rms value of the constant current regulator output current. The voltage across C16 is used for the overcurrent and open-circuit protection.

b. Zener diode D31 (high-stability and low-temperature-coefficient zener diode) produces -6.2 V dc ± 5% voltage which is used for the overcurrent and open-circuit protection.

2.4.1 Overcurrent Protection.- See Figure 8-17.

The voltage across C16 is proportional to the rms value of the output current. If the current through R55 and R56 becomes higher than the current through R53 (adjustable by R109), the integrator AR3/A will swing to -12 V causing C12 to discharge through R79 until Q15 turns off which causes Q14 to turn off (through ARC1 to ARC2 and R49). When Q14 turns off, relay K2 (on the CCR front panel) switches off which deenergizes the regulator. Q14 stays off because the contacts of relay K2 are open. Relay K2 can only be reenergized by interrupting the supply to the PCB (such as turning the rotary switch S2 on the Input Module to OFF) causing C7 to discharge.

2.4.2 Open-circuit Protection.- See Figure 8-17.

In normal conditions the current through R83 is higher than the current through R84. With an open circuit the output current will become lower, and the current through R83 will decrease. The moment that pin 6 of AR3/B becomes less than 0 V, the output of AR3/B will go to -12 V dc causing C12 to discharge through D29/R80 until Q15 turns off which causes Q14 to turn off. When Q14 turns off, relay K2 (on the CCR front panel) switches off which deenergizes the regulator. Q14 stays off because the contacts of relay K2 are open. Relay K2 can only be reenergized by interrupting the supply to the PCB (such as turning the rotary switch S2 on the Input Module to OFF) causing C7 to discharge.

2.5 ON/OFF AND BRIGHTNESS CONTROL.- See Figure 8-16.

2.5.1 Transformers.- See Figure 8-16.

a. Current transformer T1 steps down the output current of the constant current regulator to a lower level (6.6 A becomes 55 mA).

b. Transformer T2 outputs:

1. The voltage VAC1, VAC2 and VOAC to the Current Controller PCB which is used to produce the DC power-supply voltages of +12 V dc or -12 V dc.

2. The voltage PHREF and VO which is used by the Current Controller PCB to determine the moment of SCR ignition.

3. An AC voltage rectified by CR1 to produce 48 V dc to control the regulator in local or remote. This voltage is protected by fuse F3.

2.5.2 Local Brightness Control.- See Figure 8-16.

a. When the rotary selector switch S2 is in the 10, 30 or 100 position for a 3 step CCR (1, or 2, ..., or 5 position for a 5 step CCR):

1. K1 is energized via pin 5 which closes contact RON and provides 48 V dc to the Current Controller PCB. This turns on relay K1 on the Current Controller PCB which eventually causes the CCR to be turned on.

2. 48 V dc energizes one of the brightness selection relays-K2 (via S2-9), K3 (via S2-13), K4 (via S2-17) and K5 (via S2-21). Each position except B10 (B1) selects a relay.

b. When the rotary control switch S2 is in position REMOTE, 48 V dc energizes relays K2-K5 via remote control signals which enter at P6. Local brightness control is disengaged through rotary selector switch S2.

If switch S2 is set to B10 (B1), AR1/A detects that there is no closed contact of K2, or K3, ..., or K5. This causes the output of AR1/A to go HIGH. Q1 will conduct and the output current of the regulator is determined by potentiometer R21.

The output current of the CCR is determined by the current required via signal VCON at P6-c10. The signal VREF from the Current Controller PCB produces a stable reference voltage. By changing the impedance between VCON and output AR1/B (voltage follower) the output current of the regulator is altered. The minimum impedance (across P6/c10 and P6/a10) produces the maximum output current.

2.6 MOTHER BOARD.- See Figure 8-9.

The function of the Mother Board is to:

a. Prevent wiring errors between modules

b. Provide fast connect/disconnect feature

2.7 OPTIONAL EXTENDER BOARD.-

The optional Extender Board is used to facilitate testing and temporary adjustment of PCBs. It is inserted into the Mother Board PCB assembly, and the PCB to be tested or adjusted is then inserted into the Extender Board.

2.8 120 VAC to 48 VDC INTERFACE.- See Figure 8-10.

Remote control of the CCR is accomplished by using 48 V dc signals. The 120 V ac to 48 V dc Interface PCB allows the CCR to be remotely controlled using 120 V ac signals. The 120 V ac signals are input at TB6 and energize a relay. The 48 V dc is connected to the wiper of each relay. When a relay is energized, the corresponding 48 V dc is input into the Input Module PCB through connector J4 on the Mother Board.

SECTION 3. OPERATION

3.1 CONTROL.- The rotary selector switch S2 on the front panel of the regulator is used for local control of the regulator. This control switch has either five (3 step CCR) or seven positions (5 step CCR) labeled: REM (remote), OFF, and brightness steps 1(10), 2(30), 3(100), 4, 5. For regulator operation by remote control signals, rotary selector switch S2 must be set to REM. Remote control is disengaged when switch S2 is set to any position other than REM.

3.1.1 Local Control.- See Figure 8-9.

a. Rotary selector switch (S2) positions 1 through 5 (10, 30, 100) are for local operation of the regulator. For a three-step CCR, position 10 provides an output current of 4.8 amps, position 30 gives 5.5 amps, and position 100 given an output current of 6.6 amps. For a five-step CCR, positions 1, 2, 3, 4, and 5 provide an output current of 2.8 A, 3.4 A, 4.1 A, 5.2 A, and 6.6 A, respectively. The regulator will automatically maintain the output current within ±1% of the nominal value for the brightness position selected.

b. When rotary selector switch S2 is set to the OFF position, the regulator is deenergized and can not be remotely turned on.

NOTE

Before removing any modules (such as Input Module or Current Controller) from the card rack, turn rotary selector switch S2 to the OFF position, and then turn switch S8 on the card rack to OFF.

c. When switch S2 is set to REM, operation of the regulator is by remote control signals.

3.1.2 Remote Control.- See Figure 8-9.

a. When the rotary selector switch S2 is set to position REM and remote control wiring is connected to remote control terminal block TB1 on the regulator, the output current of the regulator will correspond to the brightness setting energized by remote control signals. Remote control signals generated from a remote location have no control over the regulator when switch S2 is set to OFF.

b. When there are no remote control connections on terminal block TB1, the position REM becomes an additional OFF position, i.e. the regulator is deenergized when S2 is set to REM.

3.2 SHUTDOWN PROCEDURE.- Set rotary selector switch S2 to position OFF, and set switch S8 on Card Rack to OFF. Power to the output terminals is now off, and the regulator cannot be energized by remote control signals. Power is still

present on the input terminals. To remove input power, disengage disconnect switch or main circuit breaker.

3.3 ADJUSTMENTS.- The regulator has been adjusted at the factory to provide the nominal output current levels as given in Table 1-1. If the current level settings need to be adjusted, read the following warning statement before proceeding.

WARNING

Only personnel qualified to work on high voltage systems should attempt to make any adjustments on the constant current regulator.

Turn rotary selector switch S2 on the front panel of the regulator to position OFF, and turn switch S8 on the card rack to the OFF position before removing any modules from the card rack.

Before attempting to service regulator, remove input power by turning off disconnect switch or main circuit breaker.

If the regulator deenergizes suddenly, the output circuit could be interrupted by an overcurrent, open-circuit or undervoltage condition. Turn rotary selector switch S2 to position OFF and disconnect the input power (turn off main circuit breaker or disconnect switch) before inspecting the output circuit. Without this precaution, a dip in the power line may produce an on-cycling and reenergize the regulator, causing an output voltage of several hundreds or thousands of volts to be present. These high voltages can cause serious injury or death.

3.3.1 Output Current Adjustment.- Potentiometers are provided on the Input Module PCB and Current Controller PCB to permit adjustment of the output current levels if not within the limits defined in Table 1-1.

a. Connect a clamp-on true rms-reading instrument (such as a Beckman "Tech 360" multimeter with Model CT-231 current clamp or equivalent) around one of the output current leads.

NOTE

Because the output current waveform is not a true sine wave, the ammeter must be of the true-rms type. Field instruments such as clamp-on ammeters and Simpson voltmeters will give erroneously low readings.

b. Set switch S8 on the Card Rack to OFF, and remove the Current Controller PCB from the card rack. Insert an Extender Board into the previous location of the Current Controller PCB, and then insert the Current Controller PCB into the Extender Board.

c. Energize the regulator locally, and set the rotary selector switch S2 to the maximum brightness position 5(100).

d. Turn potentiometer R23 (for a 3-step CCR) or R25 (for a 5-step CCR) on Input Module PCB fully clockwise. See Table 3-1.

e. Adjust potentiometer R110 on the Current Controller PCB to obtain an output current of 6.6 amps. See Figure 8-17.

f. Adjust the potentiometers of the other brightness steps, if necessary, without touching R110 anymore.

Table 3-1. Output Current Adjustment Potentiometers

Rotary Switch S2 Position	Adjustment Potentiometer on Input Module PCB
1, 10	R21
2, 30	R22
3, 100	R23
4	R24
5	R25

3.3.2 Overcurrent Adjustment.- Read safety precautions in paragraph 3.3 before proceeding.

3.3.2.1 Direct Method.-

NOTE

It is a good rule to short-circuit the output terminals of the regulator with a minimum AWG 8 wire before making this adjustment.

a. Turn potentiometer R109 on Current Controller PCB fully counter-clockwise.

b. Energize regulator by engaging disconnect switch or main circuit breaker.

c. Turn rotary selector switch S2 to maximum brightness position 5(100).

d. Adjust potentiometer R110 to obtain an output current of 6.93 A measured with a precision true-rms ammeter.

e. Turn potentiometer R109 slowly clockwise until the regulator deenergizes in 3.5 seconds or less after reaching the new R109 position. Use one of the following methods in order to set R109 to the proper position:

1. Oscilloscope Method: Connect an oscilloscope across C12 on the Current Controller PCB. Short the test points TP9 and TP10 on Current Controller PCB. Rotate potentiometer R109 clockwise until the voltage waveform (voltage across C12) starts to fall on the oscilloscope screen. The voltage waveform falls when the overcurrent detection circuitry starts to operate.

2. Timing Method: Turn R109 clockwise until the regulator shuts down. Then turn R109 counter-clockwise by 1/8 of a turn and reenergize regulator. Slowly turn R109 clockwise in short intervals, waiting approximately 5 seconds to determine if the R109 setting causes the regulator to shut off. Continue with this procedure until the R109 position is reached which causes the regulator to shut off.

3. Analog Voltmeter Method: Using a voltmeter (1M-ohm minimum input) measure the voltage across C12. Short the test points TP9 and TP10 on the Current Controller PCB. Rotate potentiometer R109 clockwise while observing voltage across C12 on the voltmeter. The correct R109 position is reached when the voltage starts to drop. The overcurrent detection circuitry starts to become operational when the voltage starts to drop. Remove the short across TP9 and TP10.

f. Overcurrent Detection Check: Set rotary selector switch S2 to the OFF position and then switch from brighness step 4(30) to the maximum brightness position 5(100) to verify the delay time between switching to overcurrent and regulator turn-off is correct.

g. Readjust potentiometer R110 as described in paragraph 3.3.1.

3.3.2.2 Indirect Method.-

NOTE

It is a good rule to short-circuit the output terminals of the regulator with a minimum AWG 8 wire before making this adjustment.

a. Turn potentiometer R109 on the Current Controller PCB fully counter-clockwise.

b. Short-circuit test points TP9 and TP10 on the Current Controller PCB.

c. Energize regulator and turn rotary selector switch S2 to the maximum brightness position 5(100).

d. Turn potentiometer R109 slowly clockwise until regulator deenergizes in 1.5 seconds or less.

e. Reenergize regulator to verify the delay-time between switching to 6.6 A and turn-off of the regulator.

f. Remove short-circuit between test points.

3.3.3 Undervoltage Adjustment.- The regulator's undervoltage adjustment has been desensitized at the factory so that variations in input voltage will not deenergize the regulator. However, if it is desired that regulator shut down when the input voltage drops below a certain level, the undervoltage adjustment (potentiometer R111 on the Current Controller PCB) can be activated. Correct undervoltage adjustment requires an adjustable AC supply voltage. Typical values of supply voltage in accordance with the position of potentiometer R111 on the Current Controller PCB are:

a. If R111 is turned fully clockwise:

- Regulator deenergizes at 0.89 Vnom (Vnom = nominal input voltage)
- Regulator energizes at Vnom.

b. If R111 is turned fully counter-clockwise:

- Regulator deenergizes at 0.78 Vnom
- Regulator energizes at 0.86 Vnom.

SECTION 4. PERIODIC MAINTENANCE

4.1 GENERAL.- This section establishes the maintenance procedures required for the L-828 constant current regulator. The maintenance tasks must be performed on a recurring basis to insure optimum performance, minimize service interruptions, and avoid major breakdowns.

WARNING

Only personnel authorized to work on high voltage equipment should perform maintenance on the regulator.

Operate regulator under local control (using rotary selector switch S2) when performing maintenance tasks on the regulator. This will prevent the regulator from accidently being turned on and causing serious injury or death. Always switch S8 on Card Rack off before removing or inserting PCBs.

Deenergize regulator by turning rotary selector switch to OFF and remove input power to regulator by turning off disconnect switch or main circuit breaker before opening access door to service regulator.

4.2 PREVENTIVE MAINTENANCE.- The preventive maintenance checks for the regulator are listed in Table 4-1.

4.3 SHORT-CIRCUIT TEST.-

WARNING

Since high open-circuit voltages may result by the opening of the primary of a series lighting circuit, only personnel authorized to work on high-voltage equipment should be allowed to perform the short-circuit test.

a. Remove input power to regulator (turn off disconnect switch or main circuit breaker) and turn rotary selector switch S2 to OFF.

b. Remove leads from output terminals/bushings and using AWG #8 or larger, short output bushings.

c. Make sure the panel ammeter on the regulator is zeroed. If not, adjust screw on face cover so the needle is set to 0 amps.

d. Energize regulator and turn rotary selector switch S2 to the lowest brightness step (1) and then to the remaining brightness steps. Check the output current on the ammeter at each step. The output current should be within the tolerance given in Table 1-1.

e. If the output current is not within the limits specified in Table 1-1, check the input voltage to regulator. The supply voltage should be within -5% to +10% of the nominal input voltage given on the regulator nameplate.

f. Turn off disconnect switch or main circuit breaker to remove input power to regulator.

g. Disconnect the shorting jumper and reconnect output cables.

h. Close input power disconnect switch or main circuit breaker.

4.4 OPEN-CIRCUIT TEST.-

WARNING

Since high open-circuit voltages may result by the opening of the primary of a series lighting circuit, only personnel authorized to work on high-voltage equipment should be allowed to perform the open-circuit test.

a. Remove input power to regulator (turn off disconnect switch or main circuit breaker) and turn rotary selector switch S2 to OFF.

b. Disconnect cables from the output terminals/bushings.

c. Turn on input power to regulator.

d. Turn rotary selector switch S2 to the lowest brighness position (1). The open-circuit protective device should automatically deenergize the regulator in less than 2 seconds.

e. Turn rotary selector switch S2 to OFF. The open-circuit protective device should reset.

f. Turn rotary selector switch S2 to position 1. The regulator should turn on and then deenergize in less than 2 seconds.

g. If regulator operation is satisfactory, turn rotary selector switch to OFF, and turn off disconnect switch or main circuit breaker before reconnecting the load.

h. After load has been reconnected, turn on input power to regulator.

Table 4-1. Preventive Maintenance Tasks

INTERVAL	MAINTENANCE TASK	ACTION
Daily	Check all control equipment for proper operation	Check local and remote control (if used) on each brightness step.
Monthly	Check input voltage	If input voltage is not within -5% to +10% of the nominal value specified on the regulator nameplate, notify power company to correct voltage.
	Check and record output current on each brightness step	Use a true rms-reading instrument. Adjust current levels if out of tolerance (see Table 1-1 and Sect. 3.3.1).
Annually	Check relays, wiring and insulation	Clean dirty or slightly pitted contactor contacts. Use a fine file for surface cleaning. Replace contacts that are excessively burned or pitted. Operate the local control switch S2 to check for proper operation of relays and contactors. Make sure input and output connections are tight and that there are no damaged wires and frayed or burned insulation.
	Inspect housing for rust spots and damage	Clean and touch up rust spots with paint.
	Inspect lightning arrestor connections	Tighten any loose connections. Replace charred or burnt wiring or broken arrestors.
	Perform a short-circuit test	See paragraph 4.3.
	Perform an open-circuit test	See paragraph 4.4
Unscheduled	Check regulator load	At installation and subsequent load changes make sure that the output true rms voltage times the output true rms current does not exceed the rated load on the regulator nameplate.

SECTION 5. TROUBLESHOOTING

5.1 TROUBLESHOOTING TABLE.- The troubleshooting guide for the L-828 constant current regulator is given in Table 5-1.

WARNING

Only personnel qualified to work on high voltage systems should be permitted to troubleshoot on the regulator.

Deenergize regulator by turning rotary selector switch S2 to OFF and turn off disconnect switch or main circuit breaker. Turn switch S8 on the Card Rack off. Discharge capacitors and ground input and output terminals/bushings by use of a grounding rod, prior to touching any parts.

If regulator deenergizes suddenly, the output circuit could be interrupted by an overcurrent, open-circuit, or undervoltage condition. Before inspecting the output circuit, place rotary selector switch S2 in the OFF position and turn off disconnect switch or main circuit breaker. Without this precaution, a dip in the power line may produce an on-cycling and reenergize the regulator, resulting in an output voltage of several hundreds or thousands of volts which can cause serious injury or death.

5.2 PRELIMINARY TROUBLESHOOTING.- It is essential for rapid troubleshooting of the CCRs that at least one set of spare PCBs (Input Module and Current Controller) be available.

The following is a check list of steps to perform:

a. Visually examine all areas of the CCR. Are there any burnt or loose connections/parts?

b. Is the input voltage present and within +10 to -5% of nominal?

c. Check all fuses.

d. Are the PCBs fully pushed into the card rack?

e. Are relays on the front panel fully seated?

f. Are there any bent pins on the rear of the Input Module and Current Controller?

g. Are the wire harness connectors (J3 and J4) fully seated?

h. Have the PCBs been adjusted in accordance with the instruction manual?

i. Has the Input Module and Current Controller PCB been replaced?

j. Replace SCR Protective Network PCB.

k. If CCR works in local but not remote, check voltage on remote control lines. If 120 V ac remote control is used, visually check the Interface PCB to insure individual relay contacts are moving or "clicking." If not, check relays by swapping them. If they still don't work, check for 120 V ac at remote control terminal block (TB1).

l. Can the CCR be reenergized by turning rotary switch S2 from OFF to step B1 (B10)? If it can be, problem is due to open circuit or overcurrent.

m. Does relay K1 on front panel energize? If it does but CCR does not come on, the problem is bad contactor wiring/contactor/relay K1/ step-down transformer or incorrect input voltage.

n. Does the CCR intermittently deenergize in both local and remote? If so, replace K1/check K1 socket and wiring.

o. Short the output of the CCR with an AWG 10 wire, and turn CCR on. If the regulator operates normally, problem is load related.

p. If the CCR turns on and then shuts off after a few seconds and the ammeter on the Input Module indicates 0 amps, the problem is either an open circuit or current transformer T2 is open. T2 can be checked by comparing the primary and secondary current readings.

q. If the CCR turns on and then shuts off after a few seconds and there is a high current reading on the Input Module's ammeter, the problem is an overcurrent. Adjust the output current accordingly.

r. If CCR does not energize at all, check the Current Controller PCB's undervoltage adjustment.

5.3 FUSES.

a. Input Module Fuses F1, F2 and F3:

F1 (2A, 250 V) : Protects primary of T2 on Input Module PCB which supplies AC voltage for PHREF (SCR phase control signal) and DC power supplies on both Input Module and Current Controller (via lines VAC1 and VAC2).

F2 (2A, 250 V): Protects contactor K2 or mercury relays K2 and K6 via relay K1 pin 6 on main assembly.

F3 (0.1A, 250 V): Protects 48 V dc source (CCI)

NOTE

The 48 V dc CCI signal is not connected outside the regulator when the 120 V ac to 48 V dc PCB is used.

b. Input Power Fuses F1 and F2:

See chart for amp rating as a function input voltage and CCR kW rating

CCR Input Voltage	CCR kW Rating						
	4	7.5	10	15	20	25	30 kW
208 V ac	30A*	50A*	70A*	100A*	125A*	175A*	200A*
220 V ac	25	50	60	90	125	150	175
240 V ac	25	45	60	80	110	150	175
480 V ac	12	25	30	40	60	75	90

*Fuse F1 and F2 rating in amps, 250 V

c. Step-up/down Transformer T3 Fuses F3 and F4: Protect transformer T3 which supplies 240 V ac to Card Rack.

CCR Input Voltage	Fuse Rating F3 and F4
208 V ac	12A, 250 V
220 V ac	12A, 250 V
240 V ac	4A, 250 V
480 V ac	3A, 600 V

On 2400 V ac CCRs fuses F3 and F4 are replaced by fuses F1 and F2 with a rating of 0.63A, 4800 V

d. 120 V ac to 48 V dc Interface PCB Fuse F1: Rated at 1A, 250 V; protects 120 V ac remote control source (CCI)

NOTE: After replacement of any module, check the output current on all brightness steps and the overcurrent protection adjustment.

Table 5-1. Troubleshooting Guide

PROBLEM: REGULATOR DOES NOT TURN ON

POSSIBLE CAUSE	SOLUTION
Main power supply off	Verify presence of input voltage.
Switched off due to overcurrent	Switch regulator off in local, wait for 2 seconds and check if regulator now operates correctly.
Incorrect external wiring	If regulator works correctly in local but not in remote, check the remote control signals. Replace the Input Module if necessary.
Blown fuse	Replace any blown fuse. Check input supply voltage and insure that it is between -5% to +10% of the nominal value listed on the CCR nameplate.
Defective relay	Turn rotary selector switch S2 (on Input Module) to position B1 (B10). Check if relay K1 of the Current Controller is energizing. Check coil of main contactor K2.
Malfunction of undervoltage detection	If 48 V dc is present on Current Controller and CCR doesn't work, replace Current Controller. If 48 V dc is not present, replace Input Module.

PROBLEM: REGULATOR TURNS ON BUT DEENERGIZES SUDDENLY

CAUTION

Short the output terminals/bushings before switching the regulator on. Wire should be AWG 8 or larger.

POSSIBLE CAUSE	SOLUTION
Output circuit interrupted	Turn regulator on. If regulator works correctly, repair lighting circuit taking safety precautions into account.
Defective printed circuit board	Check regulator output current on panel ammeter. Replace Input Module and/or Current Controller if defective.
Overcurrent condition	If no overcurrent (output current higher than 6.93 A) condition exists on the maximum brightness setting, then readjust the overcurrent protection. See Sect. 3.3.2. Verify the current is within nominal range (defined in Table 1-1) at all other brightness steps. Verify the presence of voltage across R75 of Current Controller. (TP1: 0 V reference; TP8: voltage across R75; this is a rectified AC signal with a peak value of about 40 V max. at 6.6 A output current). If no voltage is present, replace Input Module. Verify SCR ignition by replacing the Current Controller. Check SCRs and wiring. Replace SCR Protective Network PCB.

Table 5-1. Troubleshooting Guide

PROBLEM: OUTPUT CURRENT IS ALWAYS 6.6 A OR MORE

CAUTION

Short the output terminals/bushings before switching the regulator on. Wire should be AWG 8 or larger.

POSSIBLE CAUSE	SOLUTION
Malfunction of output current control circuitry	If problem exists only in remote mode, check remote control signals for more than one 48 V dc (or 120 V ac) control signal on brightness control terminals. If problem occurs in remote and local mode, check the brightness step relays (K2, K3, ..., K5) on Input Module for proper operation. Measure voltage across relay coil to see if relay is energized or replace Input Module.
Overcurrent condition	See previous problem "Regulator turns on but deenergizes suddenly."

PROBLEM: OUTPUT CURRENT IS ALWAYS 4.8 A OR LESS FOR 3-STEP CCR OR 2.8 A OR LESS FOR 5-STEP CCR

POSSIBLE CAUSE	SOLUTION
Brightness relay on Input Module fails to pull in	If problem exists only in remote mode, replace Input Module. Verify existence of DC voltage on TB1 terminals B30 and B100 (or B2, B3, B4 and B5).
Defective module	If problem exists in remote and local mode, replace Input Module to see if: current transformer reacts correctly (low probable failure), or the brightness control relays K2, K3, ..., K5 work correctly.
SCRs always conducting	Verify SCR ignition by replacing Current Controller. Check SCRs and wiring for shorts in SCR circuitry. Replace SCR Protective Network PCB.
Defective resonant circuit (transformer or capacitor)	Visually inspect capacitors for damaged housing or wire connections. Visually inspect transformer for damaged coils, connections and/or wiring. To check capacitance, insure that, (a) Output terminals are shorted, (b) R75 (on Current Controller PCB) is shorted (no output current detection, and (c) C7 (on Current Controller PCB) is shorted (no open circuit or overcurrent detection). The capacitors are working properly if the output current: at V_{nom} -5% is greater than or equal to 6.9 A; at V_{nom} is greater than or equal to 7.3 A; and at V_{nom} +10% is greater than or equal to 7.9 A. V_{nom} is the nominal input voltage for the CCR.

Table 5-1. Troubleshooting Guide

PROBLEM: MORE THAN 2 SECONDS IS REQUIRED FOR CCR TO DEENERGIZE ON AN OPEN-CIRCUIT LOAD

POSSIBLE CAUSE	SOLUTION
Faulty open-circuit protection	Replace Current Controller.

PROBLEM: SHORT LAMP LIFE AND/OR HIGH OUTPUT CURRENT READING ON PANEL AMMETER

POSSIBLE CAUSE	SOLUTION
Incorrect output current adjustment	Proceed as in Section 3.3.1.
Faulty overcurrent protection	Replace Current Controller.

PROBLEM: REGULATOR DOES NOT INDICATE PROPER CURRENT

POSSIBLE CAUSE	SOLUTION
Incorrect output current adjustment	Proceed as in Section 3.3.1.
Defective module	Replace Input Module.

PROBLEM: REGULATOR OPERATES BY LOCAL CONTROL SWITCH S2, BUT DOES NOT OPERATE BY REMOTE CONTROL

POSSIBLE CAUSE	SOLUTION
Rotary switch S2 (on Input Module) not set to "REM"	Set switch S2 to "REM".
Blown fuse	Check fuse F3 on Input Module. Replace if blown.
Loose or broken remote control wires	Check connections on remote terminal block TB1. If 48 V dc remote control signal used, use a DC voltmeter (60 V dc scale) to verify correct signals are received at CCR. If 120 V ac remote control signals are used, use an AC voltmeter (300 V ac scale) to verify correct signals are received at CCR.
Incorrect wire connections	See Table 7-1 and verify wiring connections are correct.

PROBLEM: AMMETER ON CCR OSCILLATES AND A LOUD "GROWLING" NOISE IS PRESENT

POSSIBLE CAUSE	SOLUTION
Incorrect secondary connections on transformer T3 (if T3 has been replaced in the field)	Reverse the secondary connections on T3.

PROBLEM: OUTPUT CURRENT CANNOT BE ADJUSTED UP TO 6.6 A

POSSIBLE CAUSE	SOLUTION
Regulator load is too large	Check if the input current x input voltage x CCR efficiency [= .90 or .92 (for 30 kW CCR)] is larger than kW rating on CCR nameplate. If it is, either reduce the load or replace regulator with a larger kW CCR. Note: this problem can also be verified by shorting the output of the CCR and verifying output current can be adjusted correctly in each step.

6.1 PARTS LIST.- Table 6-1 provides data on all replaceable parts for each repairable or replaceable component or assembly. Table 6-2 lists recommended spare parts for the regulators.

NOTE

Substitution of electronic components may be done only if substitution is the exact physical equivalent (body or case size) and equal, or better electrical characteristics with respect to tolerance, failure rate and/or reliability.

4, 7.5 & 10 KW (208-480 VAC)

10 KW (2400 VAC)

Table 6-1. Parts List

Item # Figs. 8-1, 8-2, 8-9	Description: GENERAL ASSEMBLY 4, 7.5 and 10 kW (208-480 V AC) 10 kW (2400 V AC)	MFRS. Part No.	ADB-ALNACO Part No.
1	Power Transformer:		
	4 kW (208, 220 and 240 V ac)		35C0134
	4 kW (480 V ac)		35C0155
	7.5 kW (208, 220 and 240 V ac)		35C0135
	7.5 kW (480 V ac)		35C0156
	10 kW (208, 220 and 240 V ac)		35C0136
	10 kW (480 V ac)		35C0151
	10 kW (2400 V ac)		35C0157
2	High Voltage Terminal	P. P. #70105	49A0086
3	Current Transformer (6.6/6.6A)		35C0138
6	Input Module Assembly (3 Step)		44D1136
6	Input Module Assembly (5 Step)		44D1132
7	Current Controller		44C1134
8	Heatsink (for 4 & 7.5 kW CCR)		50B0028
8	Heatsink (for 10 kW CCR)		50B0032
9	SCR Block	Semikron SKKT 91/12D	28A0011
10	SCR Protective Network PCB		44B1171
11	Capacitor, 26 μF, 525 V ac		20A0019
13	Interface PCB Assembly (3 Step)		44B1235-1
13	Interface PCB Assembly (5 Step)		44B1235-2
14	Relay, DPDT, 24 V ac	Potter & Brumfield #KUP11D15-24	53A0173
17	Varistor	Siemens S10VB32K750	32A0025
		GE #V7510A40	
21	Transformer (208, 220, 240 V ac)		35C0207
22	Transformer (480/240 V ac)		35C0150
23	Transformer (2400/240 V ac)	Olsun #10018	35C0146
27	Fuse, 4A, 250 V	Buss #MDA 4	47A0073
28	Fuseblock	Buss S-8202-1	47A0061
30	Fuse, 3A, 600 V	Gould #ATM1-3	47A0084
31	Fuse Holder, 30A	Gould #30322	49A0084
32	Fuse, 1A, 2400 V	Buss #JCW1E	47A0088
33	Fuse Holder Assembly		44C1217
34	Contactor [for 4 kW (208, 220, 240, 480 V ac; 7.5 and 10 kW (480 V ac)]	Telemechanique #LC1-D163	53A0178
34	Contactor [for 7.5 kW and 10 kW (208, 220, 240 V ac)]	Telemechanique #LC1-D503	53A0179
(see Fig. 8-4 for Item #26 below, Contactor Assembly 44C1410-1)			
26	Contactor Assembly (for 10 kW, 2400 V ac)		44C1410-1
26a	Contactor	MSI #100NO-220AH2 or MDI #SP-1034-220A	53A0250
26b	Thermostat	Therm-O-Disc #37T21, Style #29753	54A0007
26c	Strip Heater, 240 Vac, 150 W	Chromalox #129322	85A0054
26d	Varistor, 275 Vac, 360 joules	G.E. V271DA40	32A0032

Table 6-1. Parts List

Item # Figs. 8-1, 8-2, 8-9	Description: GENERAL ASSEMBLY 4, 7.5 and 10 kW (208-480 V AC) 10 kW (2400 V AC)	MFRS. Part No.	ADB-ALNACO Part No.
35	Fuse, 25A, 250 V (4 kW, 220 & 240 V ac CCRs)	Buss #LPN-RK-25	47A0069
35	Fuse, 30A, 250 V (4 kW, 208 V ac CCRs)	Buss #LPN-RK-30	47A0092
35	Fuse, 45A, 250 V (7.5 kW, 240 V ac CCRs)	Buss #LPN-RK-45	47A0070
35	Fuse, 50A, 250 V (7.5 kW, 208 & 220 V ac CCRs)	Buss #LPN-RK-50	47A0093
35	Fuse, 60A, 250 V (10 kW, 220 & 240 V ac CCRs)	Buss #LPN-RK-60	47A0071
36	Fuse Holder:		
	30A (for 4 kW, 208, 220, 240 V ac)	Gould #20357R	72A0091
	60A (for 7.5 kW, 208, 220, 240 V ac; and 10 kW, 220, 240 V ac)	Gould #20657R	72A0098
37	Fuse, 12A, 600 V (4 kW, 480 V ac CCRs)	Buss #LPS-RK-12	47A0090
37	Fuse, 25A, 600 V (7.5 kW, 480 V ac CCRs)	Buss #LPS-RK-25	47A0091
37	Fuse, 30A, 600 V (10 kW, 480 V ac CCRs)	Buss #LPS-RK-30	47A0085
37	Fuse, 70A, 250 V (10 kW, 208 V ac CCRs)	Buss #LPN-RK-70	47A0094
38	Fuse Holder:		
	30A, 600 V (for 4, 7.5 & 10 kW, 480 V ac)	Buss #1B0031, 600 V, 1/10 -30 A	49A0081
	100A, 250 V (for 10 kW, 208 V ac)	Buss #1B0017, 250 V, 61 - 100 A	49A0091

4, 7.5 & 10 KW (208-480 VAC)

Item # Figs. 8-1, 8-3, 8-4, 8-9	Description: GENERAL ASSEMBLY 15 and 20 kW (208-480 V AC)	MFRS. Part No.	ADB-ALNACO Part No.
1	Power Transformer, 15 kW (208, 220 & 240 V ac)		35C0159
1	Power Transformer, 15 kW (480 V ac)		35C0152
1	Power Transformer, 20 kW (208, 220 & 240 V ac)		35C0137
1	Power Transformer, 20 kW (480 V ac)		35C0153
3	Current Transformer (6.6/6.6 A)		35C0138
6	Input Module Assembly (3 Step)		44D1130
6	Input Module Assembly (5 Step)		44D1132
7	Current Controller		44C1134
8	Relay, DPDT, 24 V ac	Potter & Brumfield #KUP11D15-24	53A0173
9	Interface PCB Assembly (3 Step)		44B1235-1
9	Interface PCB Assembly (5 Step)		44B1235-2
12	Transformer (208, 220, 240 V ac)		35C0207
13	Transformer (480/240 V ac)		35C0150
17	Fuse, 4A, 250 V	Buss #MDA 4	47A0073
18	Fuseblock	Buss S-8202-1	47A0061
20	Fuse, 3A, 600 V	Gould #ATM1-3	47A0084
21	Fuse Holder, 30A	Gould #30322	49A0084
22	Contactor, 15 kW	Telemechanique #LC1-FF43	53A0180
23	Contactor, 20 kW	Telemechanique #LC1-D503P	53A0179
24	Heatsink (180 mm)		50B0030
25	SCR Block	Semikron SKKT 91/12D	28A0011
26	SCR Protective Network PCB		44B1171
27	Fuse, 80A, 250 V (15 kW, 240 V ac CCRs)	Buss #LPN-RK-80	47A0096
27	Fuse, 90A, 250 V (15 kW, 220 V ac CCRs)	Buss #LPN-RK-90	47A0083
27	Fuse, 100A, 250 V (15 kW, 208 V ac CCRs)	Buss #LPN-RK-100	47A0098
27	Fuse, 110A, 250 V (20 kW, 240 V ac CCRs)	Buss #LPN-RK-110	47A0099
27	Fuse, 125A, 250 V (20 kW, 208 & 220 V ac CCRs)	Buss #LPN-RK-125	47A0072
27	Fuse, 40A, 600 V (15 kW, 480 V ac CCRs)	Buss #LPS-RK-40	47A0086
27	Fuse, 60A, 600 V (20 kW, 480 V ac CCRs)	Buss #LPS-RK-60	47A0087
28	Fuse Block:		
	100A, 250 V (for 15 kW, 208, 220, 240 V ac)	Buss #1B0017, 250 V, 61 - 100 A	49A0091
	200A, 250 V (for 20 kW, 208, 220, 240 V ac)	Buss #1B0019	72A0099
	60A, 600 V (for 15 kW & 20 kW, 480 V ac)	Buss #1B0034, 600 V, 31 - 60 A	49A0082
30	Lightning Arrestor	GE #9L24FTB011AC (or Westinghouse HX06000H21)	32A0024
31	Capacitor, 26 µF, 525 V ac		20A0019

10 KW (2400 VAC)

15 & 20 KW (208-480 VAC)

Table 6-1. Parts List

Item # Figs. 8-1, 8-3, 8-4, 8-9	Description: GENERAL ASSEMBLY 15 and 20 kW (2400 V AC) 25 and 30 kW (208-2400 V AC)	MFRS. Part No.	ADB-ALNACO Part No.
1	Power Transformer, 15 kW (2400 V ac)		35C0148
1	Power Transformer, 20 kW (2400 V ac)		35C0161
1	Power Transformer, 25 kW (208, 220 & 240 V ac)		35C0163
1	Power Transformer, 25 kW (480 V ac)		35C0164
1	Power Transformer, 25 kW (2400 V ac)		35C0165
1	Power Transformer, 30 kW (208, 220 & 240 V ac)		35C0167
1	Power Transformer, 30 kW (480 V ac)		35C0149
1	Power Transformer, 30 kW (2400 V ac)		35C0145
3	Current Transformer (6.6/6.6 A)		35C0138
6	Input Module Assembly (5 Step)		44D1132
7	Current Controller		44C1134
8	Interface PCB Assembly (5 Step)		44B1235-2
9	Relay, DPDT, 24 V ac	Potter & Brumfield #KUP11D15-24	53A0173
12	Transformer (208, 220, 240 V ac)		35C0207
13	Transformer (480/240 V ac)		35C0150
14	Transformer (2400/240 V ac)	Olsun #10018	35C0146
18	Fuse, 4A, 250 V [25 & 30 kW (208-240 V ac) CCRs]	Buss #MDA 4	47A0073
19	Fuseblock	Buss S-8202-1	47A0061
21	Fuse, 3A, 600 V [25 & 30 kW (480 V ac) CCRs]	Gould #ATM1-3	47A0084
22	Fuse Holder, 30A (for 25 & 30 kW, 480 V ac)	Gould #30322	49A0084
23	Fuse, 1A, 2400 V [25 & 30 kW (2400 V ac) CCRs]	Buss #JCW1E	47A0088
24	Fuse Holder Assembly (2400 Vac CCRs)		44C1217
25	Contactor [25 & 30 kW (208-240 V ac) CCRs]	Telemechanique #LC1-FG43	53A0192
25	Contactor [25 & 30 kW (480 V ac) CCRs]	Telemechanique #LC1-FF43	53A0180
26	Contactor Assembly [15, 20, 30 kW (2400 V ac) CCRs]		44C1410-1
26a	Contactor	MSI #100NO-220AH2 or MDI #SP-1034-220A	53A0250
26b	Thermostat	Therm-O-Disc #37T21, Style #29753	54A0007
26c	Strip Heater, 240 Vac, 150 W	Chromalox #129322	85A0054
26d	Varistor, 275 Vac, 360 joules	G.E. V271DA40	32A0032
27	Heatsink (180 mm)[15 & 20 kW (2400 V ac) CCRs]		50B0030
27	Heatsink (300 mm)[25 & 30 kW (208-2400 V ac) CCRs]		50B0027
28	SCR Protective Network PCB		44B1171
29	SCR Block [for 15 & 20 kW (2400 V ac) CCRs]	Semikron SKKT 91/12D	28A0011
30	SCR Block [for 25 & 30 kW (208-2400 V ac) CCRs]	Semikron SKKT 161-12 (or	28A0012
32	Terminal, H.V. (15, 20, 30 kW (2400 V ac)]	P.P. #70105	48A0086
33	Fuse, 75A, 600 V (for 25 kW 480 V ac CCRs)	Buss #LPS-RK-75	47A0095
33	Fuse, 90A, 600 V (for 30 kW, 480 V ac CCRs)	Buss #LPS-RK-90	47A0097
33	Fuse, 150A, 250 V (25 kW, 220 & 240 V ac CCRs)	Buss #LPN-RK-150	47A0100
33	Fuse, 175A, 250 V (25 kW, 208 V ac CCRs and 30 kW, 220 & 240 V ac CCRs)	Buss #LPN-RK-175	47A0101
33	Fuse, 200A, 250 V (30 kW, 208 V ac CCRs)	Buss #LPN-RK-200	47A0102
34	Fuse Block, 100A, 600 V (for 480 V ac CCRs)	Buss #1B0040	49A0085
35	Lightning Arrestor	GE #9L24FTB011AC (or Westinghouse HX06000H21)	32A0024
36	Capacitor, 26 μF, 525 V ac		20A0019

Item # Fig. 8-5	Description: INPUT MODULE ASSEMBLY	MFRS. PART NO.	ADB-ALNACO Part No.
2	Ammeter		52A0099
5	Fuse, 2A, 250 V, S.B.	Buss #MDA2	47A0049
7	Fuse, .1A, 250 V, S.B.	Buss #MDL1/10	47A0068
13	3-Step Input Module PCB Assembly (PCB only, no bracket)		44D1131
	3-Step Input Module PCB Assembly (complete)		44D1130
	5-Step Input Module PCB Assembly (PCB only, no bracket)		44D1133
	5-Step Input Module PCB Assembly (complete)		44D1132

Item # Fig. 8-10	Description: 120 V AC to 48 V DC INTERFACE ASSEMBLY	MFRS. Part No.	ADB-ALNACO Part No.
4	Transformer (240/120 V ac)	TRIAD-UTRAD #FS 120-300	35A0220
8	Fuse, 1A, 250 V, Slow Blow	Littelfuse #326001	47A0017
15	Relay, DPDT, 10A	Potter & Brumfield #K10P11A15-120 VAC	53A0183
17	Varistor	GE MOVII #V130LA2	32A0013

	Description: Optional Equipment	MFRS. Part No.	ADB-ALNACO Part No.
	Extender Board Assembly (optional)		44C1123

4-10 KW (208-480 VAC)
10 KW (2400 VAC)
15 & 20 KW (208-480 VAC)
25 & 30 KW (208-2400 VAC)
15 & 20 KW (2400 VAC)

Table 6-2. Recommended Spare Parts

4, 7.5 and 10 kW (208-480 V AC) CCRs and 10 kW (2400 V AC) CCRs:	Part No.
Current Controller	44C1134
Fuse, 0.1A, 250 V, Slow Blow	47A0068
Fuse, 1A, 250 V, Slow Blow	47A0017
Fuse, 1A, 2400 V	47A0088
Fuse, 2A, 250 V, Slow Blow	47A0049
Fuse, 3A, 600 V	47A0084
Fuse, 4A, 250 V	47A0073
Fuse, 12A, 600 V (4 kW, 480 V ac CCRs)	47A0090
Fuse, 25A, 600 V (7.5 kW, 480 V ac CCRs)	47A0091
Fuse, 25A, 250 V (4 kW, 220 & 240 V ac CCRs)	47A0069
Fuse, 30A, 600 V (10 kW, 480 V ac CCRs)	47A0085
Fuse, 30A, 250 V (4 kW, 208 V ac CCRs)	47A0092
Fuse, 45A, 250 V (7.5 kW, 240 V ac CCRs)	47A0070
Fuse, 50A, 250 V (7.5 kW, 208 & 220 V ac CCRs)	47A0093
Fuse, 60A, 250 V (10 kW, 220 & 240 V ac CCRs)	47A0071
Fuse, 70A, 250 V (10 kW, 208 V ac CCRs)	47A0094
Input Module Assembly (3 Step CCR)	44D1130
Input Module Assembly (5 Step CCR)	44D1132
Relay, DPDT, 10A	53A0183
Relay, DPDT, 24 V ac	53A0173
SCR Block	28A0011
SCR Protective Network PCB	44B1171
Transformer (240/120 V ac)	35A0220

15 and 20 kW (208-480 V AC) CCRs:	Part No.
Current Controller	44C1134
Fuse, 0.1A, 250 V, Slow Blow	47A0068
Fuse, 1A, 250 V, Slow Blow	47A0017
Fuse, 2A, 250 V, Slow Blow	47A0049
Fuse, 3A, 600 V	47A0084
Fuse, 4A, 250 V	47A0073
Fuse, 40A, 600 V (15 kW, 480 V ac CCRs)	47A0086
Fuse, 60A, 600 V (20 kW, 480 V ac CCRs)	47A0087
Fuse, 80A, 250 V (15 kW, 240 V ac CCRs)	47A0096
Fuse, 90A, 250 V (15 kW, 220 V ac CCRs)	47A0083
Fuse, 100A, 250 V (15 kW, 208 V ac CCRs)	47A0098
Fuse, 110A, 250 V (20 kW, 240 V ac CCRs)	47A0099
Fuse, 125A, 250 V (20 kW, 208 & 220 V ac CCRs)	47A0072
Input Module Assembly (3 Step)	44D1130
Input Module Assembly (5 Step)	44D1132
Interface PCB Assembly (3 Step)	44B1235-1
Interface PCB Assembly (5 Step)	44B1235-2
Relay, DPDT, 24 V ac	53A0173
Relay, DPDT, 10A	53A0183
SCR Block	28A0011
SCR Protective Network PCB	44B1171
Transformer (240/120 V ac)	35A0220

15 and 20 kW (2400 V AC) CCRs and 25 and 30 kW (208-2400 V AC) CCRs:	Part No.
Current Controller	44C1134
Fuse, 0.1A, 250 V, Slow Blow	47A0068
Fuse, 1A, 250 V, Slow Blow	47A0017
Fuse, 1A, 2400 V [25 & 30 kW (2400 V ac) CCRs]	47A0088
Fuse, 2A, 250 V, Slow Blow	47A0049
Fuse, 3A, 600 V [25 & 30 kW (480 V ac) CCRs]	47A0084
Fuse, 4A, 250 V [25 & 30 kW (208-240 V ac) CCRs]	47A0073
Fuse, 75A, 600 V (for 25 kW 480 V ac CCRs)	47A0095
Fuse, 90A, 600 V (for 30 kW, 480 V ac CCRs)	47A0097
Fuse, 150A, 250 V (25 kW, 220 & 240 V ac CCRs)	47A0100
Fuse, 175A, 250 V (25 kW, 208 V ac CCRs and 30 kW, 220 & 240 V ac CCRs)	47A0101
Fuse, 200A, 250 V (30 kW, 208 V ac CCRs)	47A0102
Input Module Assembly (5 Step)	44D1132
Interface PCB Assembly (5 Step)	44B1235-2
Relay, DPDT, 10A	53A0183
Relay, DPDT, 24 V ac	53A0173
SCR Protective Network PCB	44B1171
SCR Block [for 15 & 20 kW (2400 V ac) CCRs]	28A0011
SCR Block [for 25 & 30 kW (208-2400 V ac) CCRs]	28A0012
Transformer, (240/120 V ac)	35A0220

SECTION 7. INSTALLATION

7.1 INTRODUCTION.- This section provides instructions for the installation of the L-828 constant current regulator. Refer to the airport project plans and specifications for the specific installation instructions.

7.2 UNPACKING.- Unpack crate upon receipt and examine regulator to insure that no damage has occurred during shipment. Note any exterior damage to crate which might lead to detection of equipment damage. When handling the regulator, care should be taken to maintain the unit in an upright position.

7.2.1 Damage.- If damage to any equipment is noted, a claim form should be filed with the carrier immediately. Inspection of equipment by the carrier may be necessary.

7.3 INSTALLATION.- The regulator can be lifted using a forklift (remove the two lower vent screens on the bottom of the regulator) or with a portable hoist (using the two 3/4-inch I.D. eyebolts on top of cabinet). Place regulator inside a well ventilated room with sufficient clearance for personnel to inspect and maintain the unit.

NOTE

Remove internal shipping strap from power transformer prior to installation. See Fig. 8-1.

7.3.1 Shipping Strap Removal.- A metal shipping strap has been installed inside the regulator cabinet to the top of the power transformer to restrain the transformer from movement during shipment. The strap is clearly marked with a label "Shipping Strap" and must be removed prior to the connection of the input power supply lines. Since the rear panel of the regulator cabinet must be opened to gain access to the shipping strap, it is best removed prior to the placement of the regulator in its final operating location. If the shipping strap is not removed, the regulator will not operate properly since the transformer must be free to vibrate. After removal of the strap, visually inspect the interior of the cabinet to make sure no parts are loose or damaged.

7.4 WIRING CONNECTIONS AND STARTUP.-

WARNING

Installation and operation of the CCR should be performed by personnel qualified to work on high-voltage equipment. The high voltage involved with the unit makes it potentially dangerous and may be lethal if contacted by operating personnel.

1. Verify the input supply voltage corresponds to the voltage rating on regulator nameplate.

2. Make sure the front-panel rotary selector switch S2 is set to the OFF position. Also insure that the card rack switch S8 is set to the OFF position.

3. Ground the regulator by making an adequate ground wire (AWG 6 or larger) connection to the external ground lug on the regulator.

4. An appropriate disconnect-type cutout or circuit breaker shall be provided outside the regulator for the input power supply lines.

5. Short-circuit the output terminals TB2-1, TB2-2/bushings E1, E2 using AWG 8 minimum wire to avoid lamp destruction in case of excessive current output.

6. Install appropriate lightning arrestors on the input power supply lines as close as possible to the CCR input fuse block (F1, F2) or terminal block TB3, whichever is present.

7. Connect the power supply lines (see Table 1-6 for recommended input wire) from the disconnect switch or main circuit breaker to the CCR input fuse block (F1, F2) or terminal block TB3. Tighten all connections.

8. Energize regulator (engage main circuit breaker or disconnect switch). Turn switch S8 on the card rack to position ON, and turn rotary selector switch S2 on the front panel to all brightness steps, and verify current values on the panel ammeter correspond to those in Table 1-1 for each brightness step.

9. Deenergize regulator (disengage main circuit breaker or disconnect switch), and turn rotary selector switch S2 and switch S8 to the OFF position.

10. Connect remote control lines, if required, to remote control terminal block TB1 (use AWG 19, 300 V wire or larger) as indicated in Table 7-1 for 48 V dc control signals and Table 7-2 for 120 V ac signals. See Figure 8-19 for remote control and alarm connections.

WARNING

Do not connect an external 120 V ac power source to CCI on a 120 V ac to 48 V dc Interface PCB.

NOTE

Tables 7-1 and 7-2 give the necessary connections for remote control. Terminal B1(B10) does not need to be wired. Brightness step B1(B10) occurs when the regulator is switched on.

Table 7-1. Remote Control Connections

Terminal Block TB1 Label	Function
N	Remote Control Common
CCI	Remote Control Power
CC	On Command Voltage (from remote control)
B(10), B(30), B(100) B1, B2, B3, B4, B5	Brightness Control

Table 7-2. Remote 120 V ac Control Connections

Remote Intensity Step	Connect CCI to
3 STEP CCR	
LOW (4.8 A)	CC
MEDIUM (5.5 A)	CC, B30
HIGH (6.6 A)	CC, B100
OFF	Nothing
5 STEP CCR	
2.8 A	CC
3.4 A	CC, B2
4.1 A	CC, B3
5.2 A	CC, B4
6.6 A	CC, B5
OFF	Nothing

11. Make sure wiring connections are tight and no wires are shorting across each other.

CAUTION

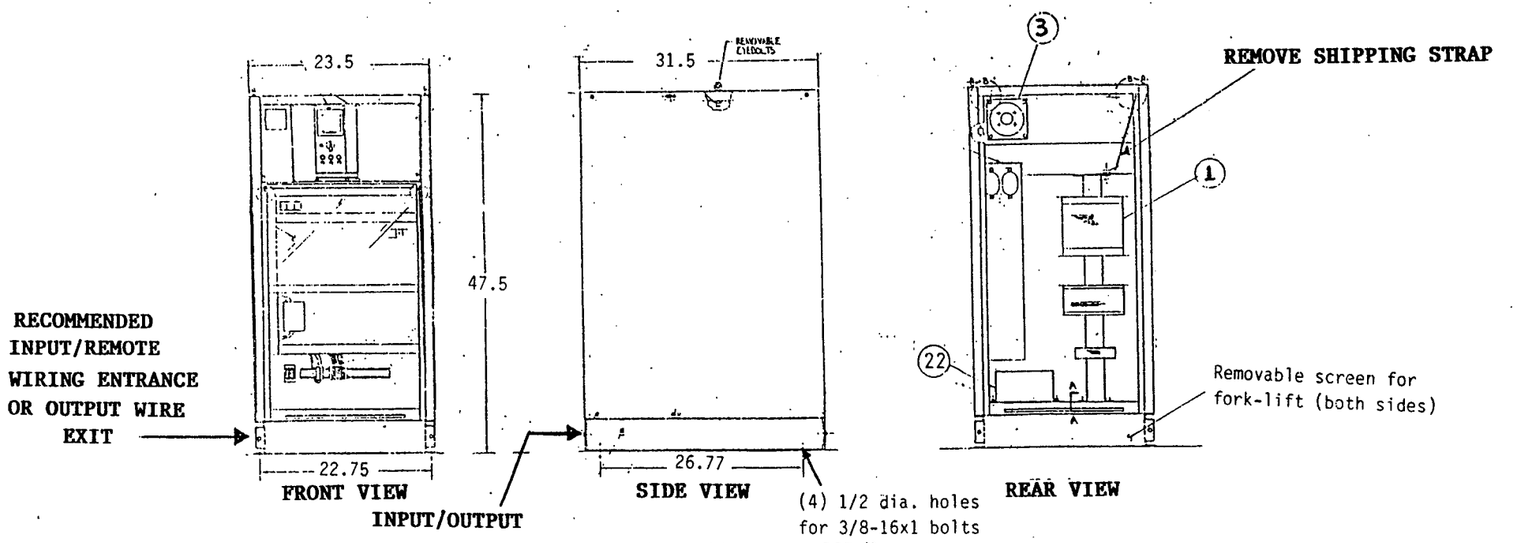
Incorrect wiring can damage the regulator.
Double check all connections.

12. Energize regulator and set rotary selector switch to the REM position. Operate the CCR by remote control, and verify correct current levels are obtained on all brightness steps.

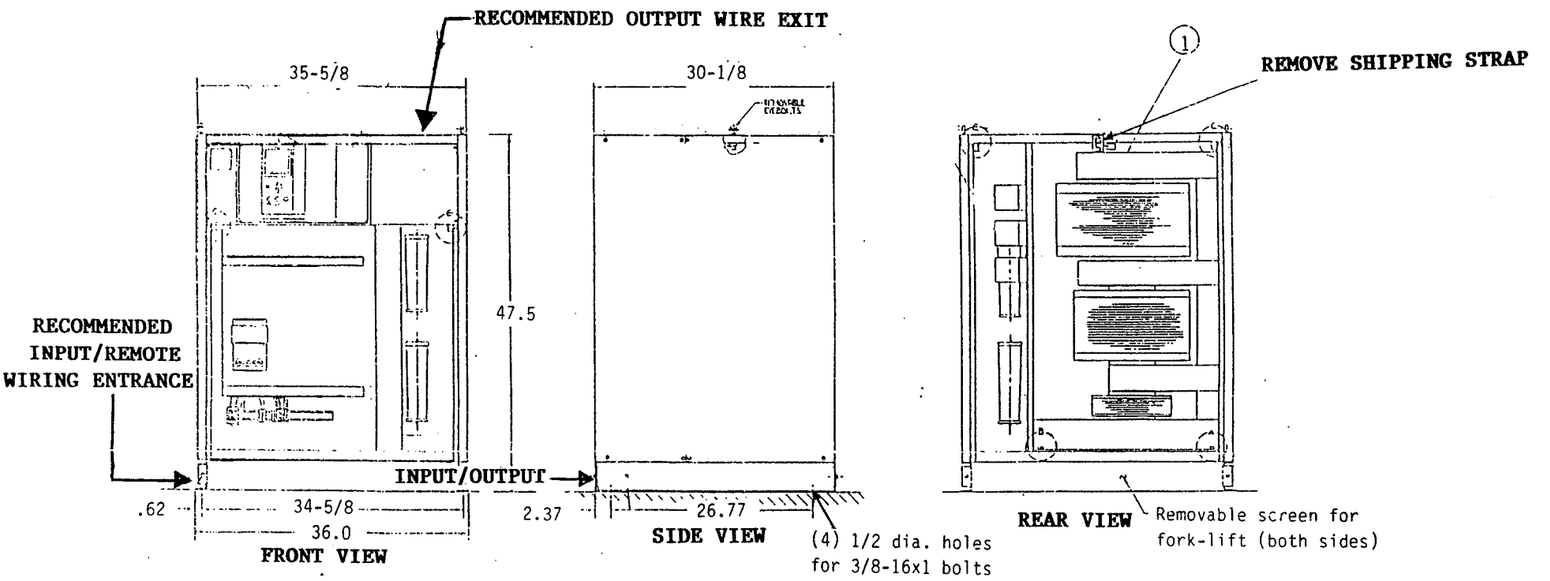
13. Turn rotary selector switch S2 to OFF and deenergize regulator (disengage disconnect switch or main circuit breaker). Remove short-circuit link from output terminals TB2-1, TB2-2/bushings E1 and E2. Remove short-circuit link form output terminals/bushings.

14. Connect the 6.6 amp series lighting circuit to the output terminals/bushings. Tighten all connections.

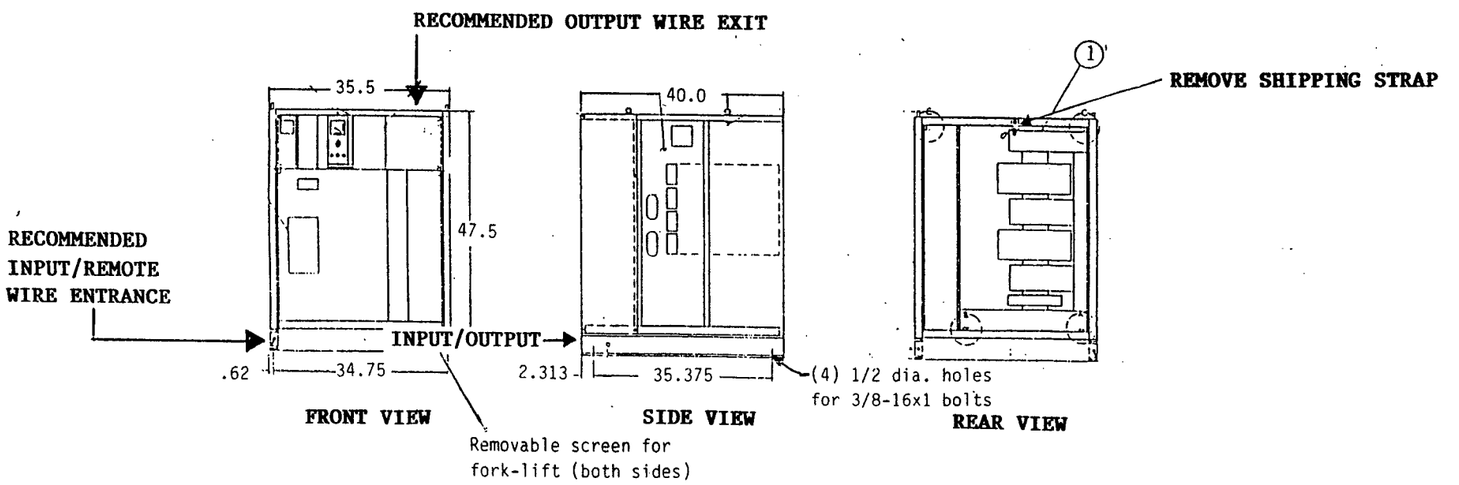
15. Check if the input current x input voltage x CCR efficiency [= .90 or .92 (for 30 kW CCR)] is larger than kW rating on CCR nameplate. If it is, either reduce the load or replace regulator with a larger kW CCR.



4 kW (208-480 V ac CCRs)
7.5 kW (208-480 V ac CCRs)
10 kW (208-2400 V ac CCRs)



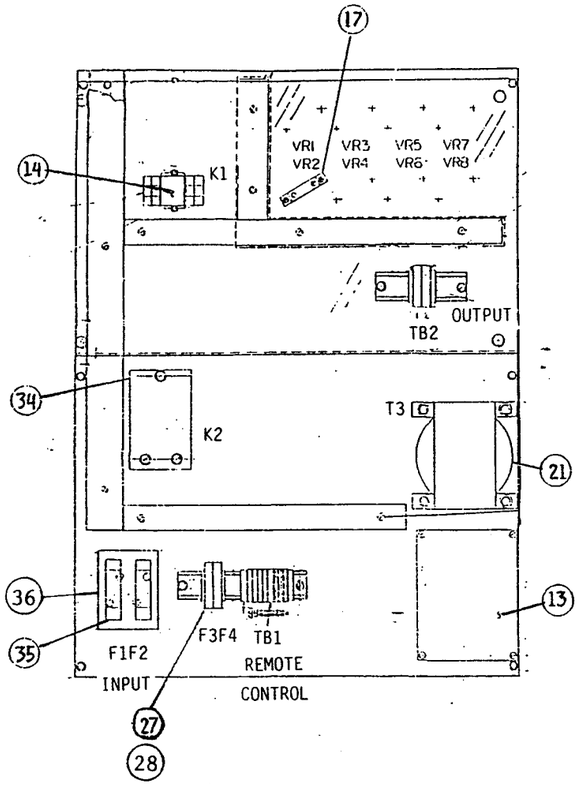
15 kW (208-480 V ac CCRs)
20 kW (208-480 V ac CCRs)

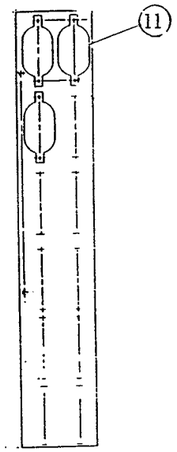


15 kW (2400 V ac CCRs)
20 kW (2400 V ac CCRs)
25 kW (208-2400 V ac CCRs)
30 kW (208-2400 V ac CCRs)

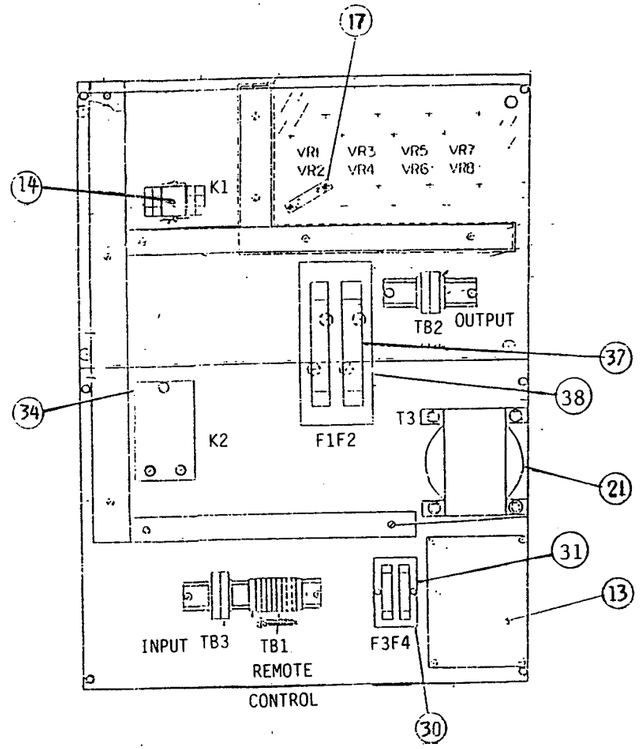
FIGURE 8-1. FINAL ASSEMBLY

4-30 KW (208-2400 VAC)

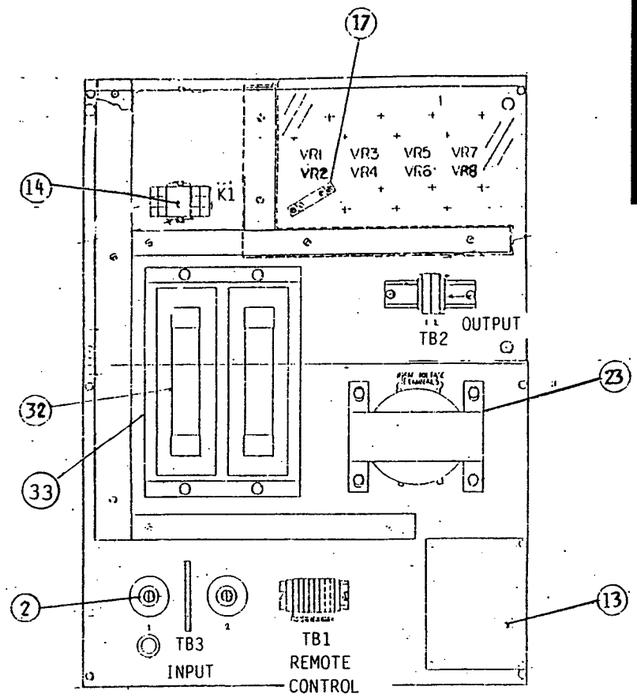




4 kW (208-240 V ac CCRs)
7.5 kW (208-240 V ac CCRs)
10 kW (208-240 V ac CCRs)

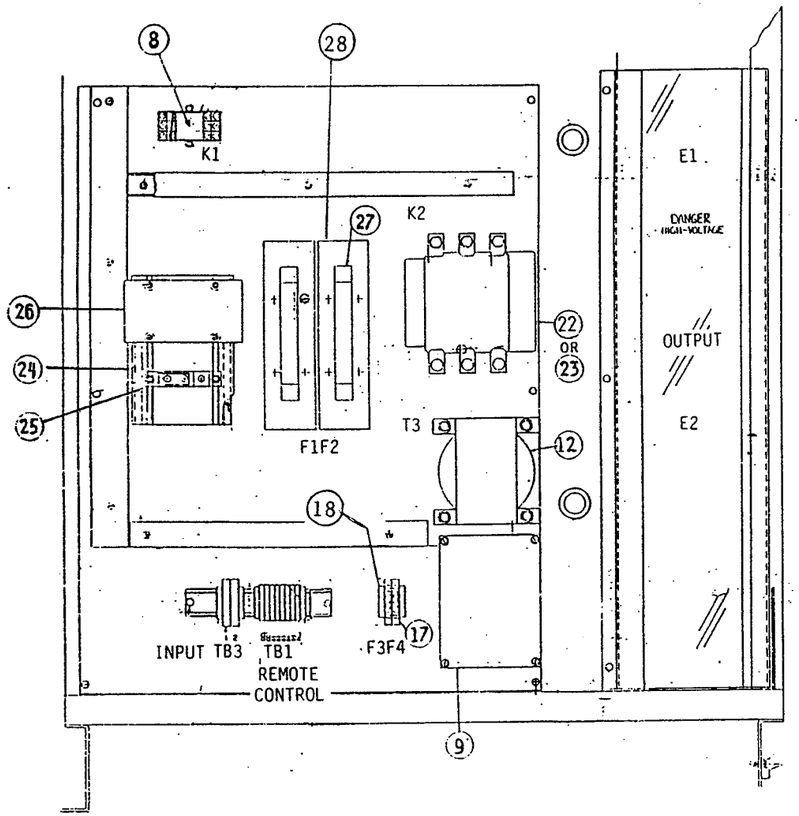


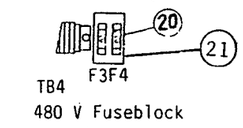
4 kW (480 V ac CCRs)
7.5 kW (480 V ac CCRs)
10 kW (480 V ac CCRs)



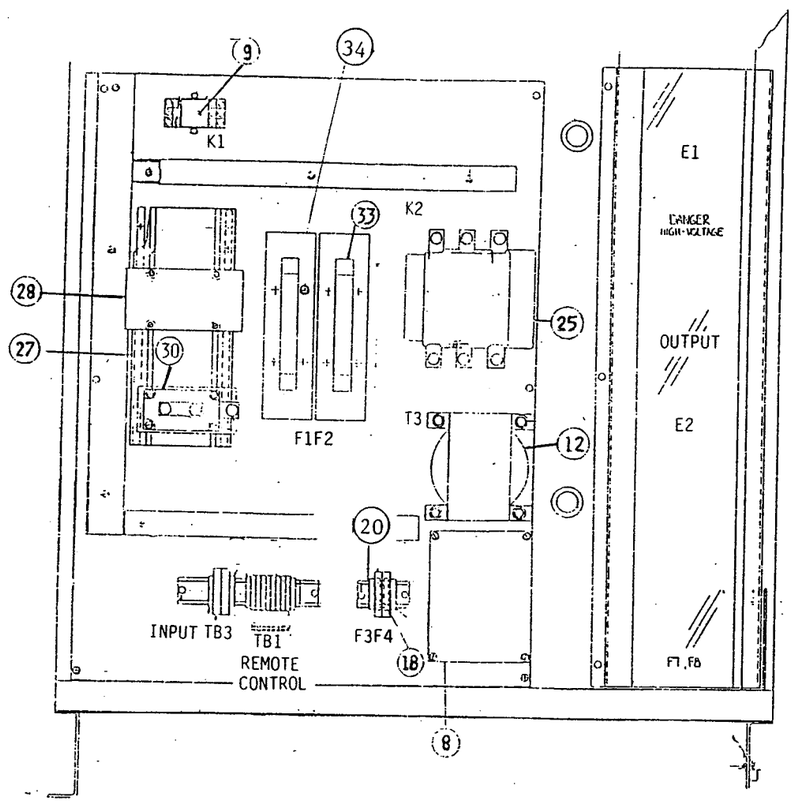
10 kW (2400 V ac CCRs)

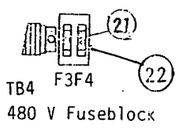
FIGURE 8-2. COMPONENT PLATE ASSEMBLY FOR 4-10 kW CCRs



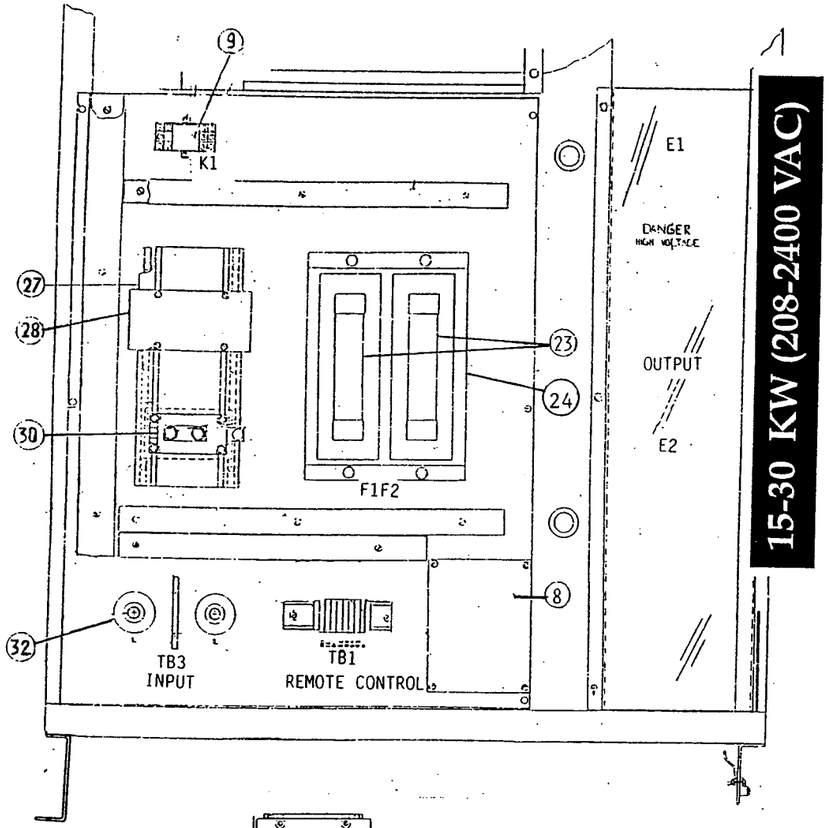


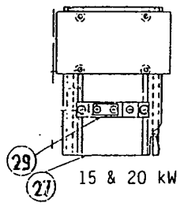
15 kW (208-480 V ac CCRs)
20 kW (208-480 V ac CCRs)





25 kW (208-480 V ac CCRs)
30 kW (208-480 V ac CCRs)

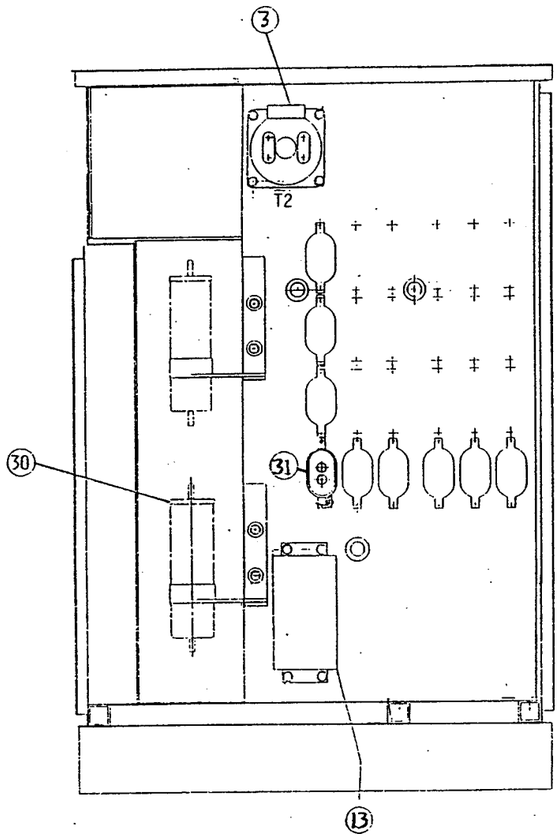




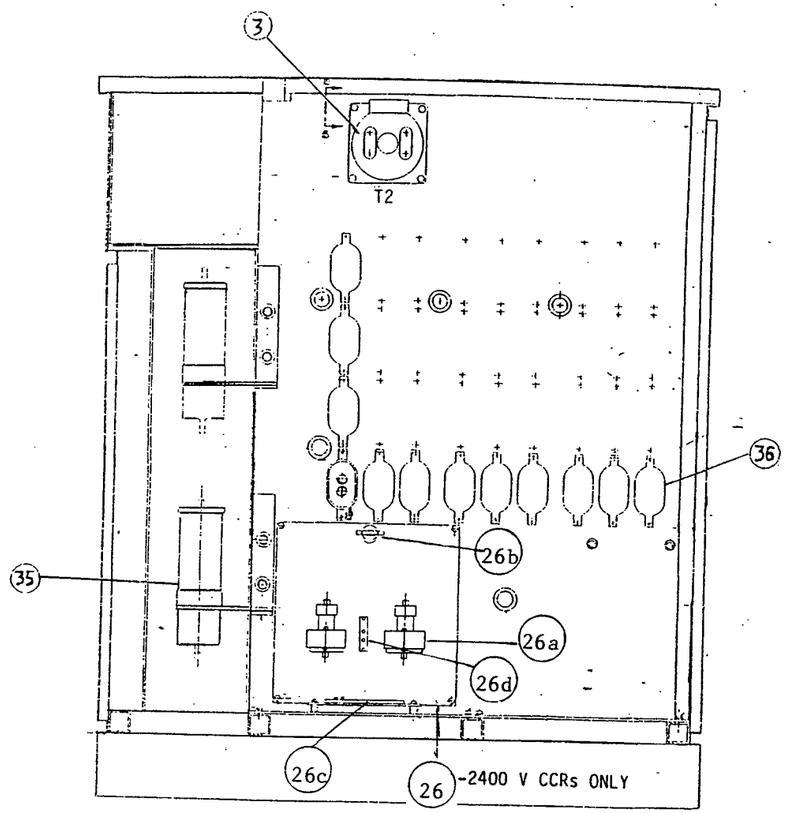
15, 20, 25, 30 kW (2400 V ac CCRs)

15-30 KW (208-2400 VAC)

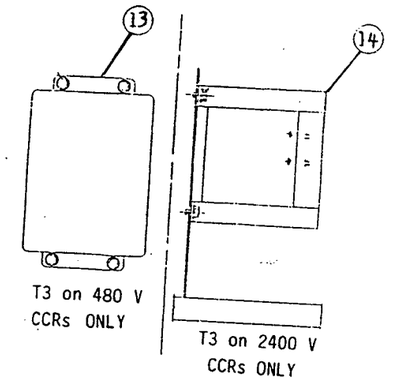
FIGURE 8-3. COMPONENT PLATE ASSEMBLY FOR 15-30 kW CCRs



15 kW (208-480 V ac CCRs)
20 kW (208-480 V ac CCRs)

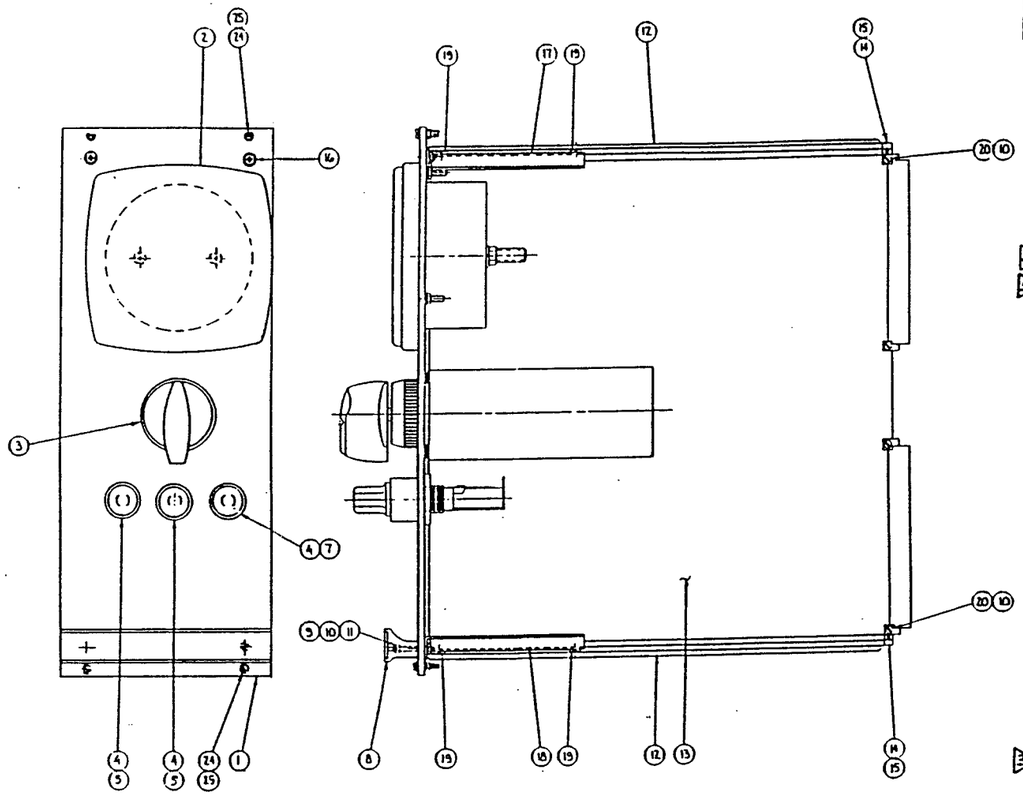


15 and 20 kW (2400 V ac CCRs)
25 and 30 kW (208-2400 V ac CCRs)



15-30 KW (208-2400 VAC)

FIGURE 8-4. CAPACITOR PLATE ASSEMBLY



ITEM NO	PART NO	PART NAME / DESCRIPTION
1	60C0517	PLATE, FRONT
2	52A0099	AMMETER
3	46B0021	SWITCH
3	46B0020	SWITCH
4	49A0040	FUSEHOLDER
5	47A0049	FUSE, 2A, 250V S.B.
7	47A0068	FUSE, 0.1A, 250V S.B.
8	63A0431-2	HANDLE
9	64A0231-6	SCREW, RD HD/PHILLIPS
10	66A0079-12	LOCKWASHER, SPLIT M2.5
11	65A0149-12	NUT, HEX M2.5
12	63A0384	GUIDE, P.C.B. 220MM
13	44D1131	INPUT MODULE P.C.B. ASSY
13	44D1133	INPUT MODULE P.C.B. ASSY
14	61B0135	FIXATION P.C.B.
15	64A0231-12	SCREW, RD. HD/PHILLIPS M2.5×12
16	64A0235-12	SCREW, C'SK/PHILLIPS. M2.5×12
17	60C0502-1	REINFORCEMENT, UPPER
18	60C0502-2	REINFORCEMENT, LOWER
19	64A0233-4	SCREW PAN HD/SL. M2.5×4
20	64A0233-10	SCREW, PAN HD/SL., M2.5×10
22	70A0150	TERMINAL RING
24	63A0403	INSERT, PLASTIC
25	64A0234-12	SCREW, CAPTIVE M2.5×12
26	72A0019	TERMINAL, FORK

DO NOT SCALE DRAWING

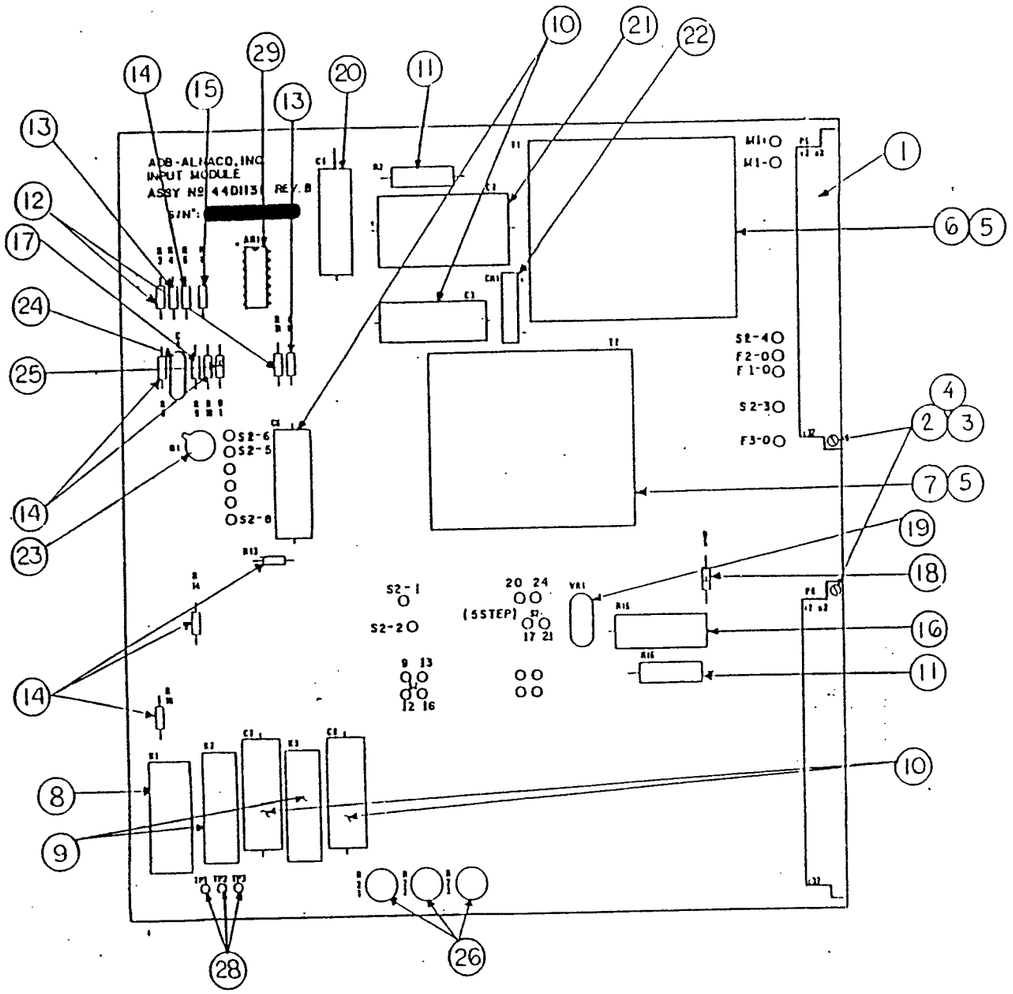
ADB ALNACO — ADB-ALNACO, INC. P.O. BOX 30829 877 GAHANNA PARKWAY COLUMBUS, OHIO 43230

PART NAME: INPUT MODULE ASSY 3 STEP G.6A
DRAWING NO. 4.4.D.1.1.30. . REV. A

PART NAME: INPUT MODULE ASSY 5 STEP G.6A
DRAWING NO. 4.4.D.1.1.32. . REV. A

FIGURE 8-5. Input Module Assembly (3 and 5 Step)

4-30 KW (208-2400 VAC)



ITEM	PART NO.	DESCRIPTION	QTY.
1	70A0271	Connector, Male/32C./Din	2
2	64A0233-10	Screw, Pan Hd./Slotted M2.5x10	2
3	66A0079-12	Lockwasher, M2.5 Split	2
4	65A0149-12	Nut, Hex M2.5	2
5	64A0236-10	Screw, Self-Tapping #4-24x10	4
6	35C0128	Transformer, Current 6.6A/55mA	1
7	35C0133	Transformer, Power Supply	1
8	53A0175	Relay, DPDT, Coil, 48 VDC, CONTACT 5A	1
9	53A0177	Relay, Reed, SPST,Coil,24Vdc,CON. .75A	2
10	23A0065	Capacitor, 6.8uF, 100V, ±10%	4
11	15A0063	Resistor, 2.2k ohm, 4W, ±1%	2
12	02A1001-01F	Resistor, 1k ohm, 1/2W, ±1%	2
13	11A0136	Resistor, 392 ohm, 1/4W, ±2%	2
14	01A1002-05F	Resistor, 10k ohm, 1/4W, ±5%	6
15	01A4703-05C	Resistor, 470k ohm, 1/4W, ±5%	1
16	15A0062	Resistor, 15 ohm, 4W, ±1%	1
17	01A2202-05C	Resistor, 22k ohm, 1/4W, ±5%	1
18	27A0048	Diode	1
19	32A0019	Varistor	1
20	22A0050	Capacitor, 68uF, 60V	1
21	22A0051	Capacitor, 1000uF, 63V	1
22	27A0047	Diode, Bridge Rectifier	1
23	29A0034	Transistor	1
24	23A0061	Capacitor, 0.1uF, 100V, ±10%	1
25	27A0008	Diode, Switching	1
26	18A0030	Potentiometer, 5k ohm, 1W, ±5%	3
28	66A0047	Test Point	3
29	37A0005	Integrated Circuit, OP-Amp, Dual	1

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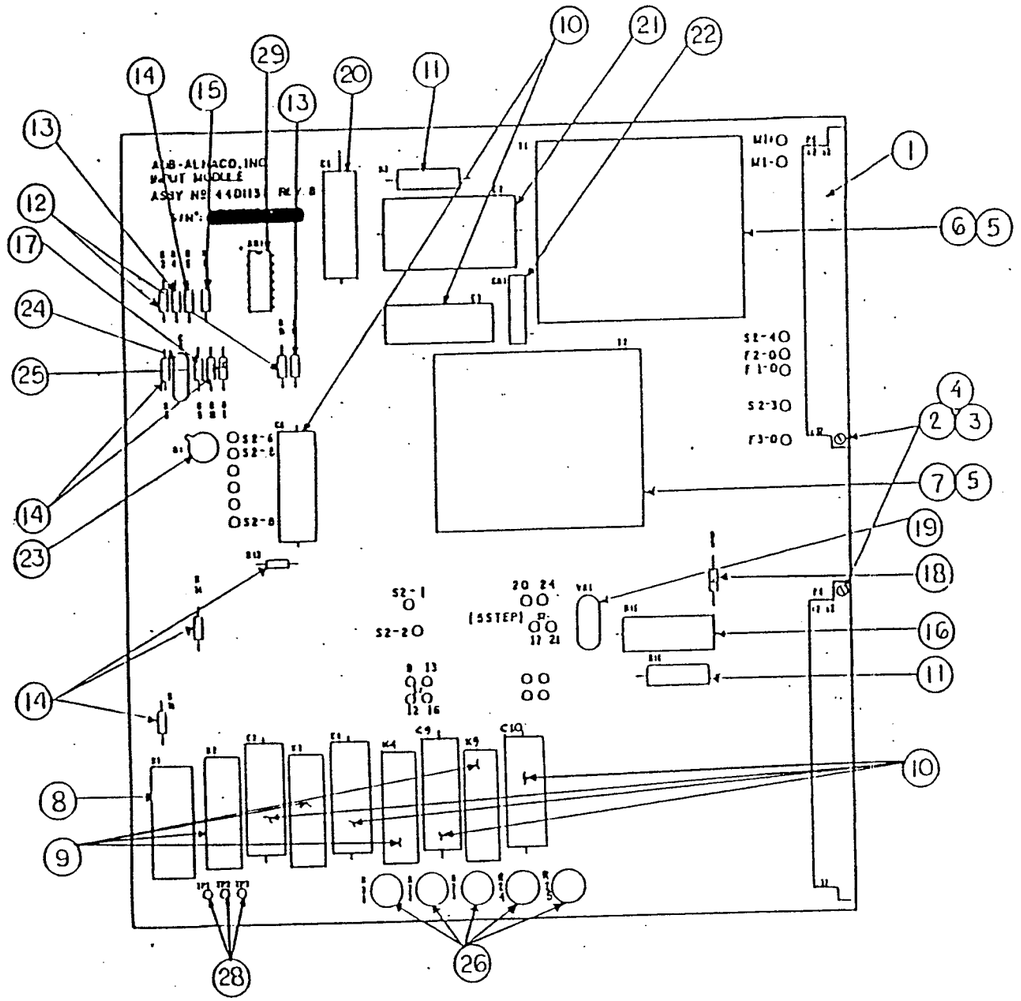
ADB ALNACO — ADB-ALNACO, INC. P.O. BOX 30920 977 GAHANNA PARKWAY COLUMBUS OHIO 43230

PART NAME: INPUT MODULE PCB ASSY 3 STEP, 6.6A

RAW STOCK NO	MAT'L	
NEXT ASSEM	CHKD BY	DATE
SCALE:	DRAWN BY	DATE
DRAWING NO: 4.4.D.1.1.3.L.		REV

4-30 KW (208-2400 VAC)

FIGURE 8-6. 3 Step Input Module PCB Assembly



ITEM	PART NO	DESCRIPTION	QTY
1	70A0271	CONNECTOR, MALE/32C./DIN	2
2	64A0233-10	SCREW, PAN HD./SLOTTED M2.5x10	2
3	66A0079-12	LOCKWASHER, M2.5 SPLIT	2
4	65A0149-12	NUT, HEX M2.5	2
5	64A0236-10	SCREW, SELF-TAPPING #4-24x10	4
6	35C0128	TRANSFORMER, CURRENT 6.6A/55mA	1
7	35C0133	TRANSFORMER, POWER SUPPLY	1
8	53A0175	RELAY, DPDT, COIL, 48 VDC, CONTACT 5A	1
9	53A0177	RELAY, REED, SPST, COIL, 24VDC, CON, .75A	4
10	23A0065	CAPACITOR, 6.8μF, 100V, ±10%	6
11	15A0063	RESISTOR, 2.2K OHM, 4W, ±1%	2
12	02A1001-01F	RESISTOR, 1K OHM, 1/2W, ±1%	2
13	11A0136	RESISTOR, 392 OHM, 1/4W, ±2%	2
14	01A1002-05F	RESISTOR, 10K OHM, 1/4W, ±5%	6
15	01A4703-05C	RESISTOR, 470K OHM, 1/4W, ±5%	1
16	15A0062	RESISTOR, 15 OHM, 4W, ±1%	1
17	01A2202-05C	RESISTOR, 22K OHM, 1/4W, ±5%	1
18	27A0048	DIODE	1
19	32A0019	VARISTOR	1
20	22A0050	CAPACITOR, 68μF, 60V	1
21	22A0051	CAPACITOR, 1000μF, 63V	1
22	27A0047	DIODE, BRIDGE RECTIFIER	1
23	29A0034	TRANSISTOR	1
24	23A0061	CAPACITOR, 0.1μF, 100V, ±10%	1
25	27A0008	DIODE, SWITCHING	1
26	18A0030	POTENTIOMETER, 5K OHM, 1W, ±5%	5
28	66A0047	TEST POINT	3
29	37A0005	INTEGRATED CIRCUIT, OP-AMP, DUAL	1

DO NOT SCALE DRAWING

ADB ALNACO

ADB ALNACO, INC.
P.O. BOX 30829
877 GAHANNA PARKWAY
COLUMBUS OHIO 43230

PART NAME: INPUT MODULE PCB ASSY, 5 STEP, 6.6A

RAW STOCK NO | MATL

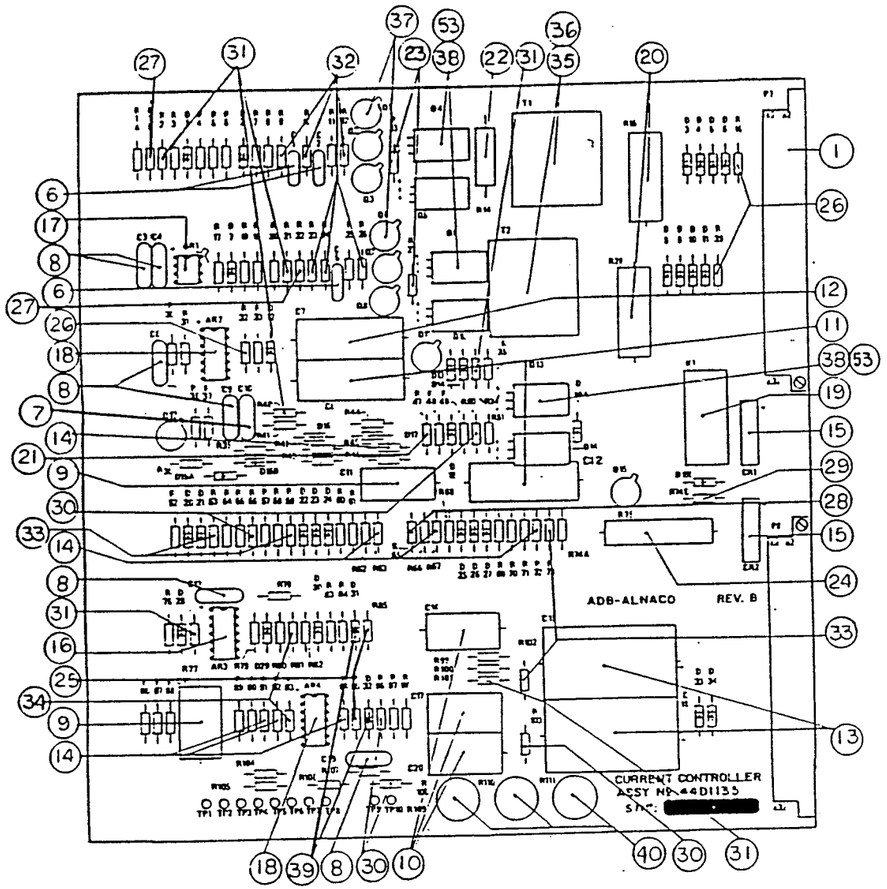
NEXT ASSEM | CHKD BY | DATE

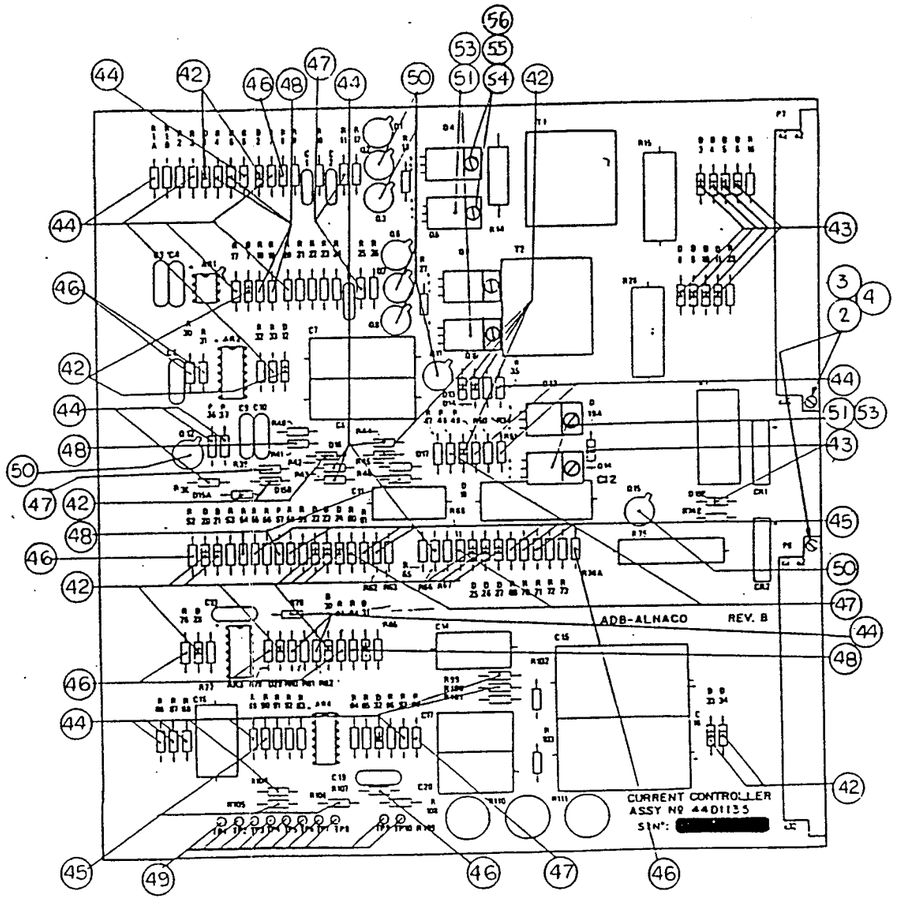
SCALE | DRAWN BY | DATE

DRAWING NO: 4.4.D.1.1.3.3. | REV: A

4-30 KW (208-2400 VAC)

FIGURE 8-7. 5 Step Input Module PCB Assembly





ITEM NO	PART NO	PART NAME / DESCRIPTION	QTY
1	70A0271	CONNECTOR, MALE/32C./DIN	2
2	64A0233-10	SCREW, PAN HD./SLOTTED M2.5x10	2
3	66A0079-12	LOCKWASHER, M2.5 SPLIT	2
4	65A0149-12	NUT, HEX M2.5	2
5	29A0038	TRANSISTOR	1
6	22A0037	CAPACITOR, 22pF, 500V, ±10%	3
7	23A0060	CAPACITOR, 0.022µF, 250V, ±10%	1
8	23A0061	CAPACITOR, 0.1µF, 100V, ±10%	6
9	23A0062	CAPACITOR, 0.22µF, 100V, ±10%	2
10	23A0063	CAPACITOR, 1µF, 100V, ±10%	3
11	23A0064	CAPACITOR, 4.7µF, 100V, ±10%	2
12	23A0065	CAPACITOR, 6.8µF, 100V, ±10%	1
13	22A0052	CAPACITOR, 2200µF, 40V	2
14	11A0141	RESISTOR, 47.5K OHM, 1/4W, ±1%	7
15	27A0047	DIODE, BRIDGE RECTIFIER	2
16	37A0005	INTEGRATED CIRCUIT, OP-AMP, DUAL	1
17	37A0006	INTEGRATED CIRCUIT	1
18	37A0007	INTEGRATED CIRCUIT	2
19	53A0175	RELAY DPDT, COIL, 48 VDC, CONTACT 5A	1
20	15A0062	RESISTOR, 15 OHM, 4W, ±1%	2
21	01A4703-05C	RESISTOR, 470K OHM, 1/4W, ±5%	1
22	13A0025	RESISTOR, 1 OHM, 1 W, ±5%	1
23	02A1000-05C	RESISTOR, 100 OHM, 1/2W, 5%	2
24	15A0064	RESISTOR, 470 OHM, 5W	1
25	11A0137	RESISTOR, 681 OHM, 1/4W, ±1%	2
26	02A1001-05C	RESISTOR, 1K OHM, 1/2W, ±5%	3
27	01A3301-05C	RESISTOR, 3.3K OHM, 1/4W, ±5%	2
28	01A1501-05F	RESISTOR, 1.5K OHM, 1/4W, ±5%	1
29	11A0138	RESISTOR, 4.75K OHM, 1/4W, ±1%	1
30	01A1502-05F	RESISTOR, 15K OHM, 1/4W, ±5%	5
31	11A0139	RESISTOR, 22.1K OHM, 1/4W, ±1%	6
32	01A3302-05C	RESISTOR, 33K OHM, 1/4W, ±5%	6
33	11A0140	RESISTOR, 27.4K OHM, 1/4W, ±1%	4
34	01A1004-05C	RESISTOR, 1M OHM, 1/4W, ±5%	2
35	35C0124	TRANSFORMER, TRIGGER	2
36	64A0236-10	SCREW, SELF-TAPPING, #4-24x10	4
37	29A0035	TRANSISTOR	2
38	29A0036	TRANSISTOR	3
39	27A0049	DIODE, ZENER, 6.2V, REFERENCE	2
40	18A0030	RESISTOR, VARIABLE, 5K OHM, 1W, ±5%	3
42	27A0008-1	DIODE, SWITCHING	24
43	27A0048	DIODE	10
44	01A1002-05F	RESISTOR, 10K OHM, 1/4W, ±5%	28
45	11A0142	RESISTOR, 56.2K OHM, 1/4W, ±1%	10
46	01A1003-05F	RESISTOR, 100K OHM, 1/4W, ±5%	9
47	01A1503-01F	RESISTOR, 150K OHM, 1/4W, ±1%	7
48	01A3323-05F	RESISTOR, 332K OHM, 1/4W, ±5%	9
49	66A0099	TEST POINT	10
50	29A0034	TRANSISTOR	7
51	29A0037	TRANSISTOR	2
53	29A0053	INSULATOR	6
54	64A0198-4	SCREW, PAN HD. 6-32 x ¼	6
55	66A0093-4	LOCKWASHER, #6 EXT. TH.	6
56	65A0015-11	NUT HEX 6-32	6

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ADB ALNACO
ADB-ALNACO, INC.
PO BOX 30829
977 GAHANNA PARKWAY
COLUMBUS, OHIO 43230

FIGURE 8-8 .
Current Controller PCB Assembly

NEXT ASSEM.	CHKD BY	DATE
SCALE:	DRAWN BY	DATE
DRAWING NO. 44D1135.		REV

4-30 KW (208-2400 VAC)

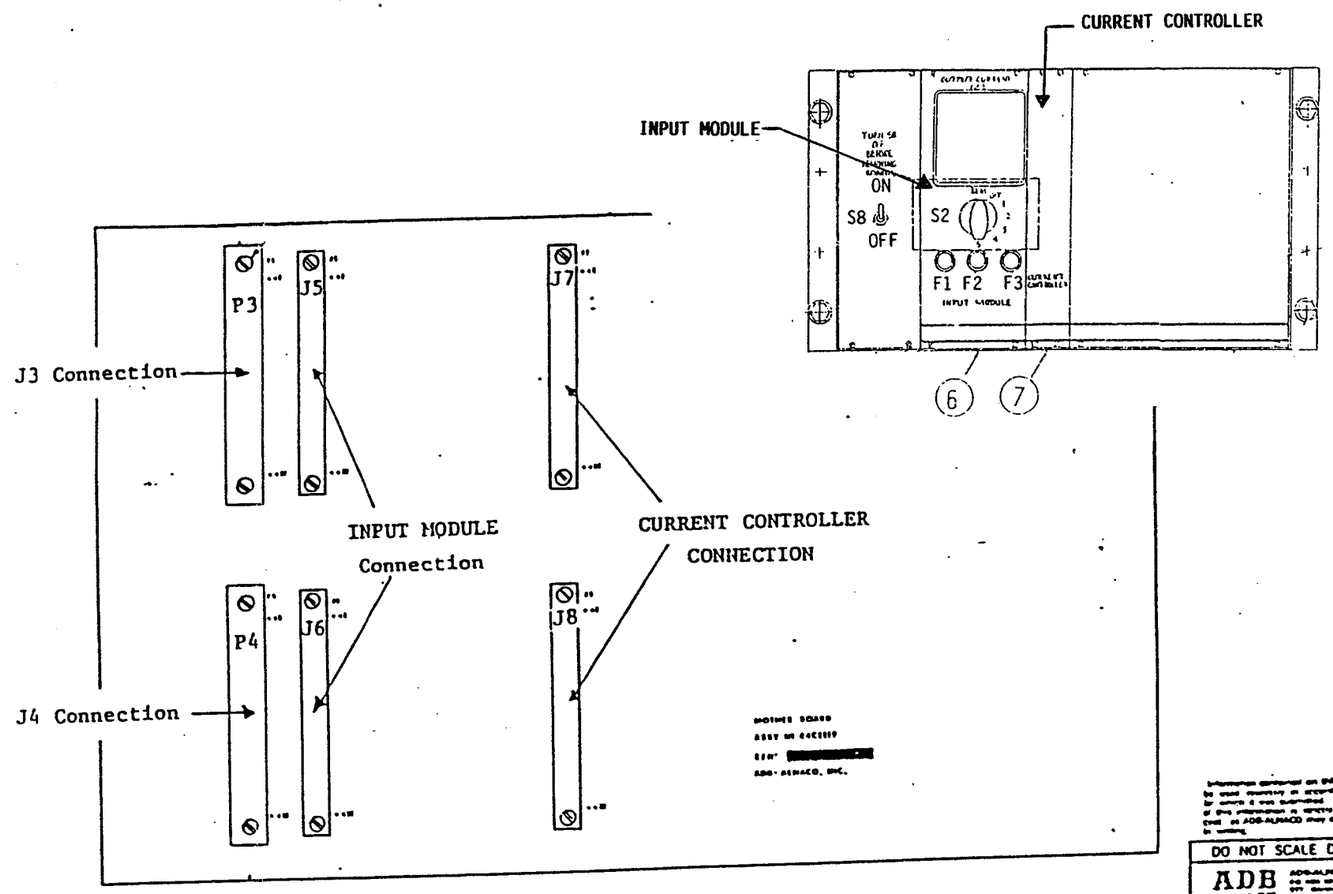


FIGURE 8-9. Mother Board PCB Assembly

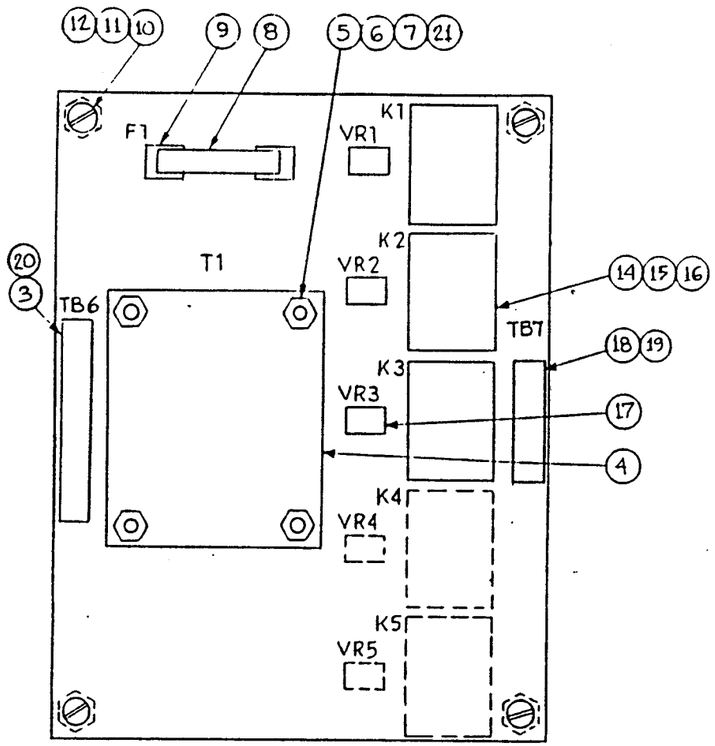
DO NOT SCALE DRAWING

ADB ALNACO

MOTHERBOARD PCB ASSY

4.4.C.1.1.3-6. A

4-30 KW (208-2400 VAC)



ITEM NO.	PART NO.	PART NAME / DESCRIPTION	QTY
3	72A0116-2	CONNECTOR	1
4	35A0220	TRANSFORMER	1
5	64A0194-20	SCREW, RD HD #6-32 x 1 1/2	4
6	66A0026-11	LOCKWASHER, SPLIT #6	4
7	65A0015-11	NUT, HEX #6-32	4
8	47A0017	FUSE	1
9	47A0067	FUSE CLIP	2
10	64A0177-8	SCREW, PAN HD #10-32 x 1/2	4
11	66A0057-10	STAND OFF, 3/8 HEX x 5/8 LG	4
12	66A0038-5	LOCKWASHER INT.TH. 10	4
14	49A0066	SOCKET RELAY	SEE TABLE
15	53A0183	RELAY	
16	61A0131	SPRING, RELAY, HOLD-DOWN	
17	32A0013	VARISTOR	
18	72A0116-3	CONNECTOR	1
19	72A0117-3	PLUG, P.C. CONNECTOR	1
20	72A0117-2	PLUG, P.C. CONNECTOR	1
21	66A0055-8	SPACER, #6, 1/2 LG	4

BOARDTHICKNESS	PCB ASSY NO.	ITEM 14	15	16	17
3 STEP	44B1735-1	3	3	3	3
5 STEP	44B1735-2	5	5	5	5

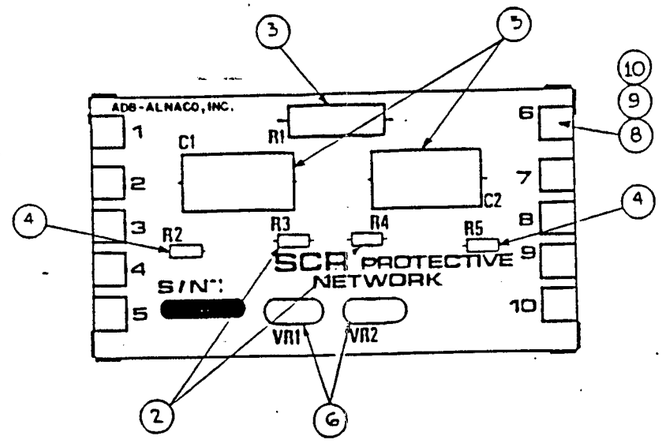
DO NOT SCALE DRAWING

ADB ALNACO — ADB-ALNACO, INC. P.O. BOX 30829 977 GAHANNA PARKWAY COLUMBUS OHIO 43230

PART NAME: INTERFACE PCB ASSY, 120 VAC, 3 STEP OR 5 STEP L828/829

DRAWING NO. .4.4.B.1.2.3.5.-X REV E

FIGURE 8-10. 120 V ac to 48 V dc Interface



ITEM NO	PART NO.	PART NAME / DESCRIPTION	QTY
2	02A1004-01F	RESISTOR, 1H Ohm, 1/2W, (R3,R4)	2
3	15A0065	RESISTOR, 680 Ohm, 7W, (R1)	1
4	02A1001-01F	RESISTOR, 1K Ohm, 1/2W, (R2,R5)	2
5	23A0066	CAPACITOR, 0.15 mF, 250V ac (C1,C2)	2
6	32A0021	VARISTOR (VR1, VR2)	2
8	70A0301	TERMINAL, MALE TAB	10
9	65A0043-2	POP-RIVET, 1/8 DIA.	10

1. ASSEMBLY SHOWN FROM COMPONENT SIDE.

DO NOT SCALE DRAWING

ADB ALNACO — ADB-ALNACO, INC. P.O. BOX 30829 977 GAHANNA PARKWAY COLUMBUS OHIO 43230

PART NAME: SCR PROTECTIVE NETWORK ASSY

RAW STOCK NO. | MAT'L:

NEXT ASSEM. | CHKD BY | DATE

SCALE: | DRAWN BY: | DATE

DRAWING NO. .4.4.B.1.1.7.1. REV A

FIGURE 8-11. SCR Protective Network Assembly

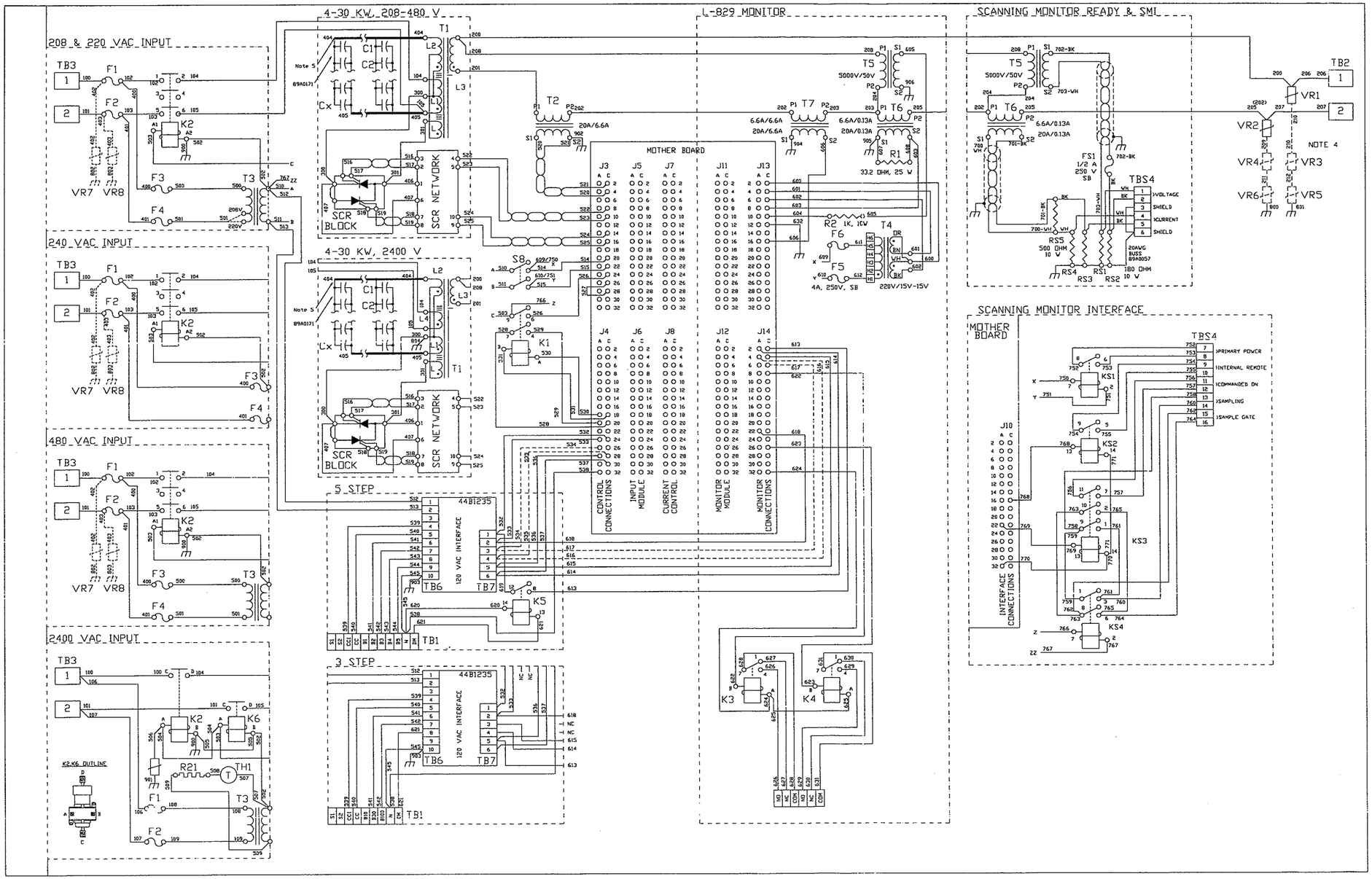
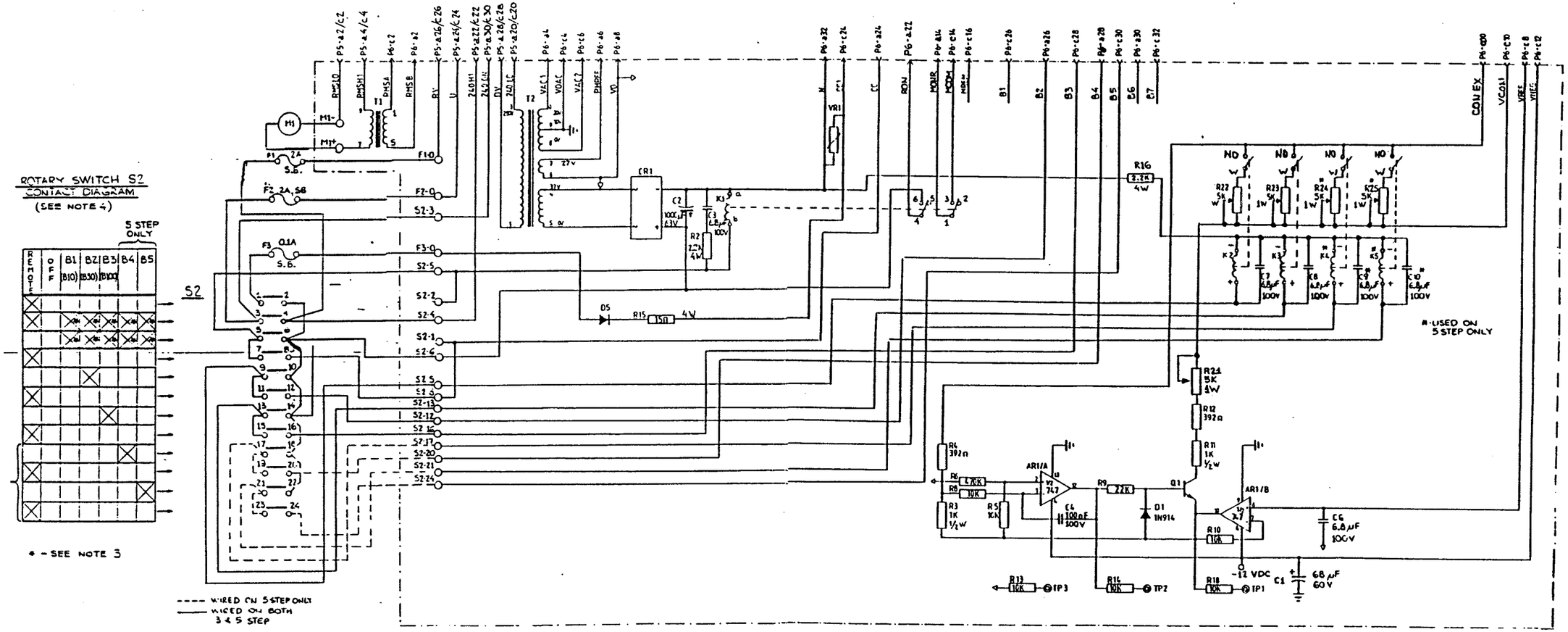
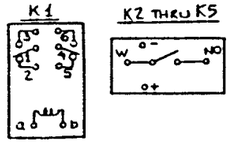


Figure 8-12. 4-30 kW Wiring Schematic (208, 220, 480 Vac)



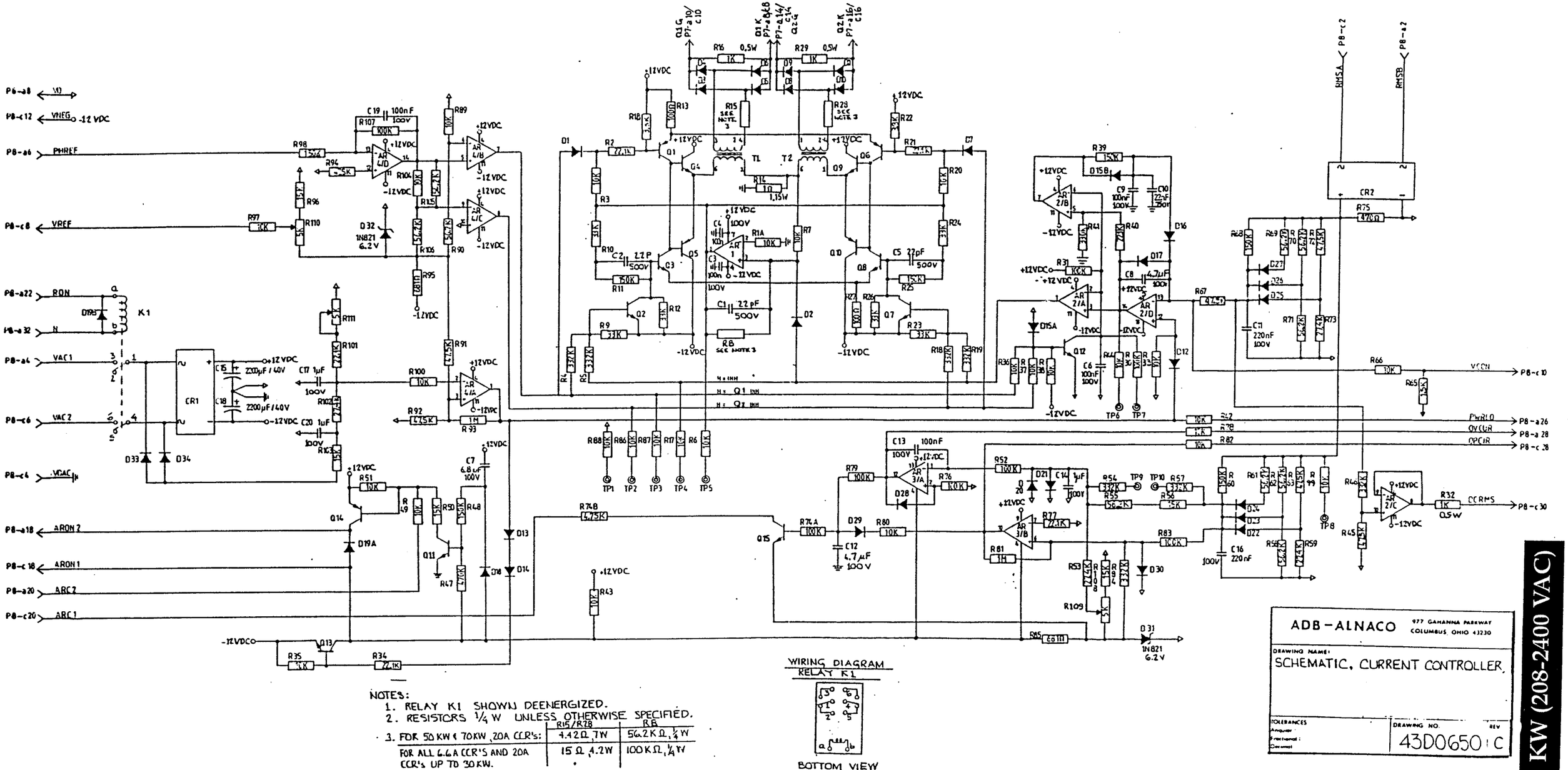
RELAY
WIRING DIAGRAMS
(BOTTOM VIEW)



NOTES :

1. RELAYS SHOWN DEENERGIZED.
2. USED ON 5 STEP ONLY : K4, K5, R24, R25, C9, C10 AND CONTACTS 17-24 ON ROTARY SWITCH S2.
3. DENOTES MAKE - BEFORE - BREAK CONTACT (SHORTING).
4. ROTARY SWITCH S2 HAS 7 POSITIONS. AN "X" IN THE COLUMN DIRECTLY ACROSS FROM CONTACT DETERMINES THE POSITION A CONTACT IS SHORTED. FOR EXAMPLE, A SHORT OCCURS BETWEEN PINS 9 AND 10 WHEN THE ROTARY SWITCH IS IN POSITION "B2."
5. WIRES FROM FRONT PANEL TO PCB ARE AWG 20, 1000 V.
6. RESISTORS 1/4 W UNLESS OTHERWISE SPECIFIED.

FIGURE 8-13. Input Module Schematic



NOTES:
1. RELAY K1 SHOWN DEENERGIZED.
2. RESISTORS 1/4 W UNLESS OTHERWISE SPECIFIED.
3. FOR 50 KW & 70KW, 20A CCR's:

	R15/R28	R8
	4.42Ω, 7W	56.2KΩ, 1/4 W
FOR ALL 6.6A CCR'S AND 20A CCR's UP TO 30 KW.	15Ω, 4.2W	100KΩ, 1/4 W

WIRING DIAGRAM
RELAY K1

BOTTOM VIEW

ADB-ALNACO	977 GAHANNA PARKWAY COLUMBUS, OHIO 43230
DRAWING NAME:	SCHEMATIC, CURRENT CONTROLLER.
TOLERANCES	DRAWING NO. 43D0650 REV C

4-30 KW (208-2400 VAC)

FIGURE 8-14. CURRENT CONTROLLER SCHEMATIC

P3 / P4 INPUT / OUTPUT SIGNALS

SIGNAL NAME	DESCRIPTION
RMSLO	SEC. OF CURR. TRNSFR. 6.6/6.6A OR 20/6.6A EARTH CONNECTED.
RMSHI	SEC. OF CURR. TRNSFR. 6.6/6.6A OR 20/6.6A
SCRxK	SCR x CATHODE
SCRxG	SCR x GATE
240LO	240V IN PHASE WITH REGULATOR SUPPLY
240HI	240V IN PHASE WITH REGULATOR SUPPLY
U'	240V AFTER FUSE F2
RV	240V AFTER FUSE F1
DV	RV AFTER EXTERNAL STRAP
240 ON	240V AFTER LOCAL/REMOTE SWITCH
240 SP	240V SPARE
ARON 1	CONTROL VOLTAGE FOR COIL OF KON
ARON 2	" " " " " "
ARC 1	FIRST NORMAL OPEN CONTACT OF KON
ARC 2	" " " " " "
CCI	POWER SUPPLY FOR REMOTE CONTROL SOURCED BY INPUT MODULE
CC	REGULATOR ON REQUEST
Bx	BRIGHTNESS x REQUEST
N	COMMON FOR REMOTE CONTROL

INTERNAL SIGNALS

SIGNAL NAME	DESCRIPTION
RMSA	SEL. OF CURR. XMER 6,6/0,055A
RMSB	" " " "
VOAC	0 VOLT AC FROM INPUT MODULE
VAC1	AC VOLTAGE " "
VAC2	" " "
PHREF	PHASE REFERENCE VOLTAGE FROM INPUT MODULE
VREF	OUTPUT CURRENT REFERENCE VOLTAGE (6,6A)
VO	0 VOLT REFERENCE LINE
VCON	OUTPUT CURRENT CONTROL VOLTAGE
CONEX	6,6A OR 20A REQUEST IF CONNECTED TO VREF
VNEG	NEGATIVE SUPPLY VOLTAGE FROM CURRENT CONTROLLER
RON	48V SIGNAL FOR ON/OFF CONTROL
PELI	PREVENTS E.L - INDICATION IN CASE OF PWRLO, OPCIR OR OVCUR

P13 / P14 INPUT / OUTPUT SIGNALS

SIGNAL NAME	DESCRIPTION
0 VAC	LOGIC ZERO VOLT
15 VAC 1 15 VAC 2	POWER SUPPLY: 15 VAC WITH RESPECT TO 0 VAC POWER SUPPLY: 15 VAC WITH RESPECT 0 VAC AND OPPOSITE PHASE WITH RESPECT TO 15 VAC 1
IOUT VOUT	OUTPUT CURRENT MEASUREMENT OUTPUT VOLTAGE MEASUREMENT
OV I.V.	COMMON OF VOUT, VOT, IOUT MEASUREMENT CONNECTED TO GND. AND LOGIC ZERO VOLT
VOT	SEC. VOLTAGE OF OPEN CIRCUITED TRANSFORMER T6
240 LO 240 HI U' RV DV 240 ON 240 SP	240V IN PHASE WITH REGULATOR SUPPLY 240V IN PHASE WITH REGULATOR SUPPLY 240V AFTER FUSE F2 240V AFTER FUSE F1 RV AFTER EXTERNAL STRAP 240V AFTER LOCAL/REMOTE SWITCH 240V SPARE
RCS-DM RCS-B5 RCS-B4 RCS-B3 RCS-B2 RCS-COM2 WRBL	MONITOR REM. CONTROL SIGNAL - DEGRADED MODE CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP 5 CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP 4 CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP 3 CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP 2 CCR REM. CONTROL SIGNAL - COMMON FOR RCS-REML RELAY CONTROL SIGNAL - NUMBER OF "LAMPS OUT" IS REACHED
FAULT A/ FAULT B/ FAULT C/ FAULT D/ FAULT E/	L = LOSS OF INPUT POWER TO THE REGULATOR L = OVERCURRENT OR OPEN CIRCUIT OF CCR L = EXCESSIVE VA - DROP IN LOOP L = INCORRECT OUTPUT CURRENT OF CCR L = EXCESSIVE NUMBER OF LAMP FAILURES IN LOOP
OVL/	L = OUTPUT CURRENT BELOW MINIMUM LEVEL AND OUTPUT VOLTAGE ABOVE NOMINAL LEVEL AT BRIGHTNESS STEP 5
RCS-REML	CCR REM. CONTROL SIGNAL - REMOTE/LOCAL SWITCH
RCS-B(X)	CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP (X)
RCS-CC	CCR REM. CONTROL SIGNAL - ON SIGNAL
RCS-B(Y)	CCR REM. CONTROL SIGNAL - BRIGHTNESS STEP (Y)
ARCL	RELAY CONTROL SIGNAL (ALARM)
VRED	INPUT POWER SUPPLY AFTER RECTIFIER
RCS-COM1	CCR REM. CONTROL SIGNAL: COMMON FOR RCS-B(X) AND RCS-CC
MCOM	MONITORING = COMMON
MONR	MONITORING = ON REQUEST
MREM	MONITORING = CCR REMOTELY CONTROLLED

■ SIGNAL SOURCE
⊠ CONNECTION POINT: SIGNAL USED
× " " : SIGNAL CONTINUING

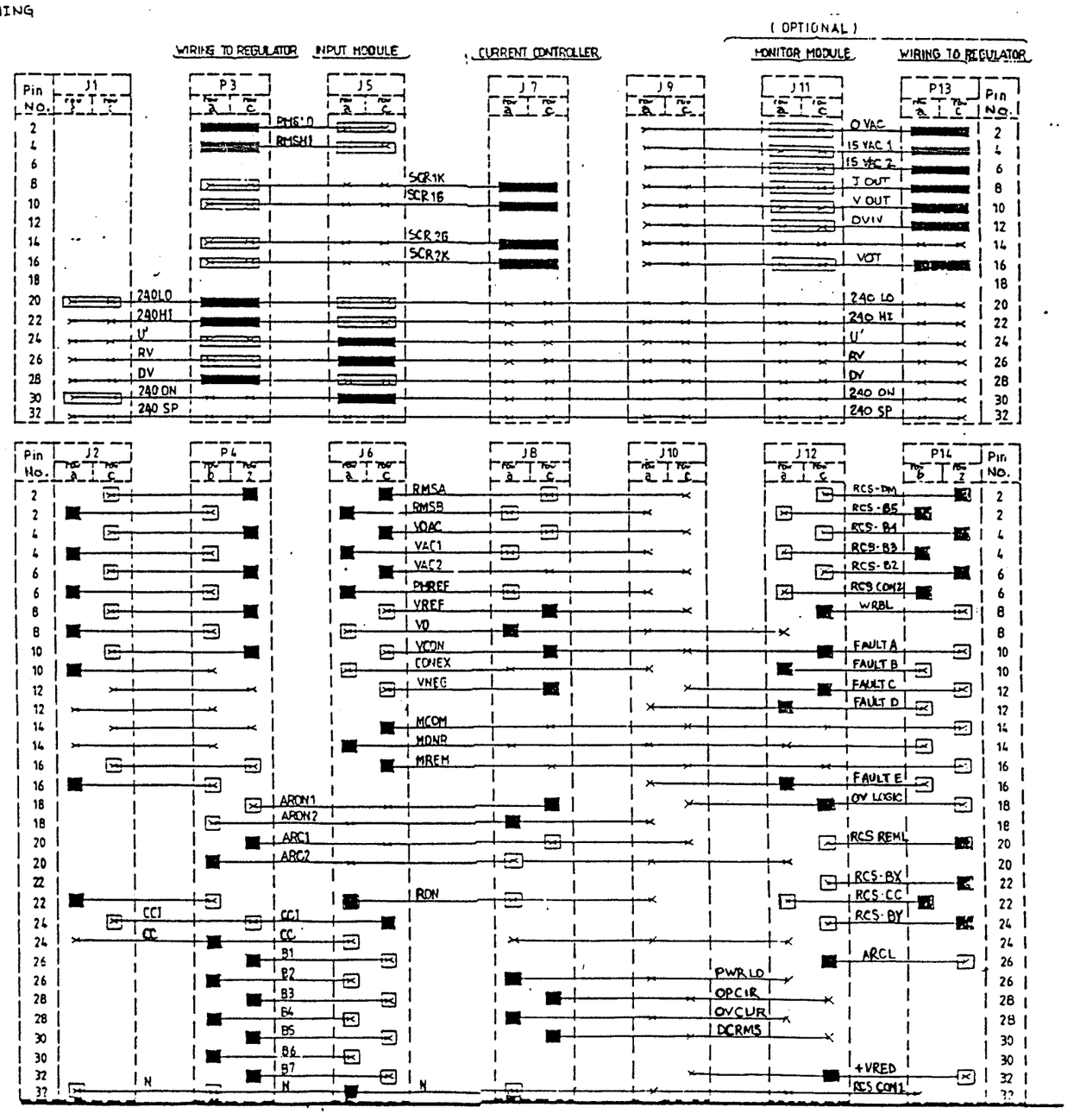
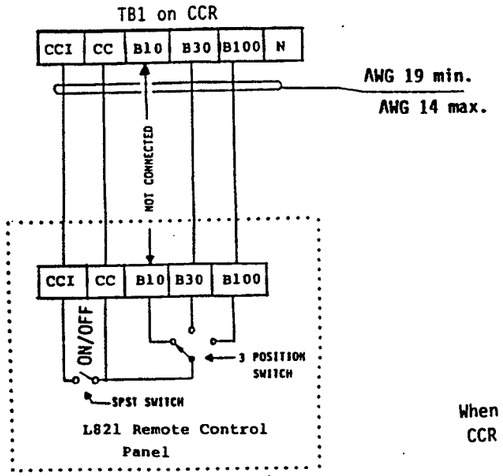
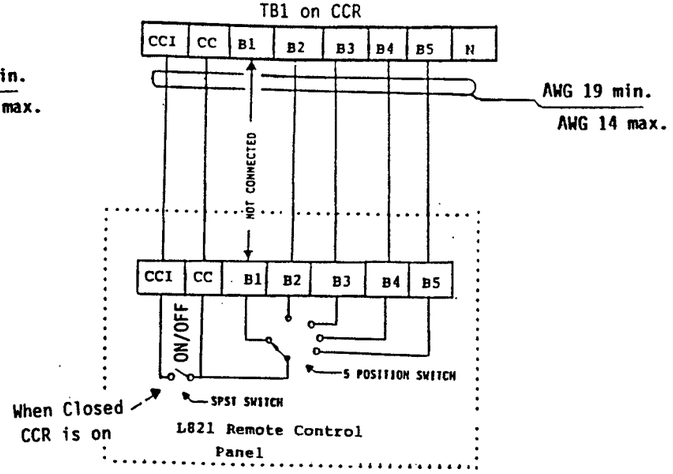


FIGURE 8-15. MOTHER BOARD

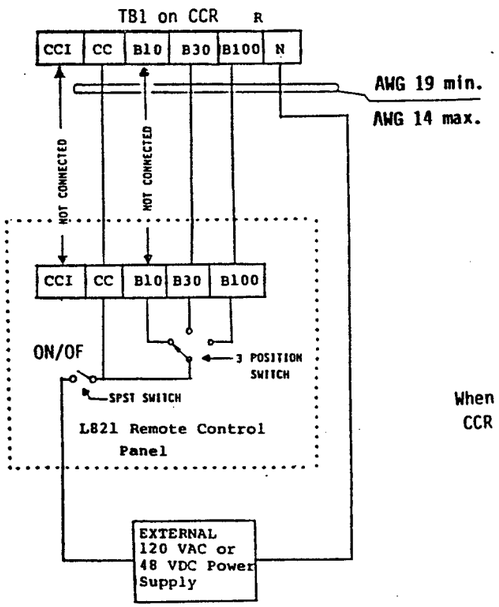
(A)



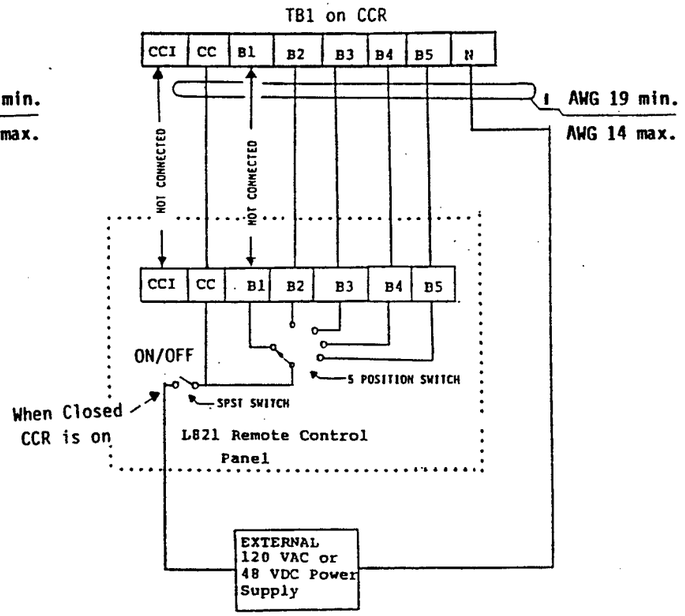
(B)



(C)



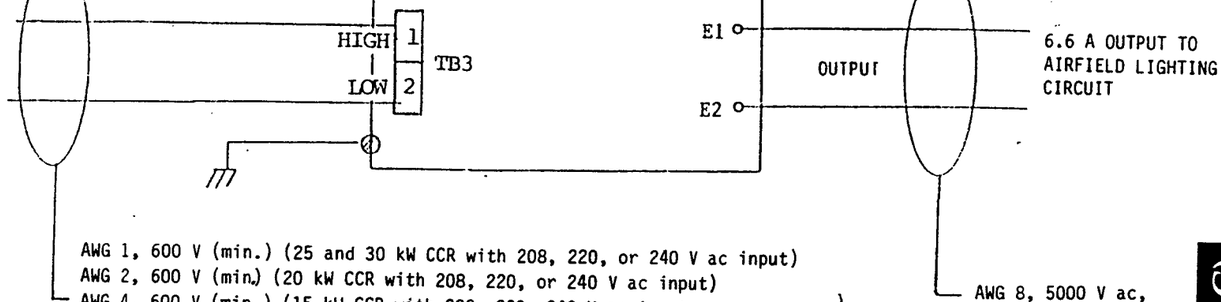
(D)



(A) Remote 3 step control using internal 48 V dc or 120 V ac CCR power supply.
(B) Remote 5 step control using internal 48 V dc or 120 V ac CCR power supply.
(C) Remote 3 step control using external 48 V dc or 120 V ac power supply.
(D) Remote 5 step control using external 48 V dc or 120 V ac power supply.

INPUT/OUTPUT WIRING

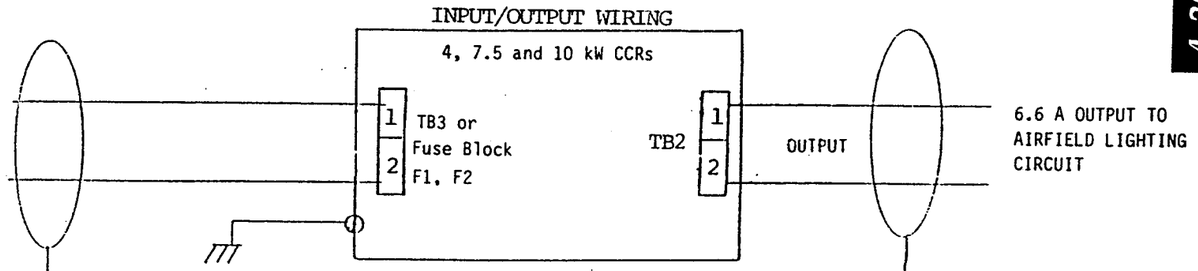
15, 20, 25 and 30 kW CCRs



AWG 1, 600 V (min.) (25 and 30 kW CCR with 208, 220, or 240 V ac input)
AWG 2, 600 V (min.) (20 kW CCR with 208, 220, or 240 V ac input)
AWG 4, 600 V (min.) (15 kW CCR with 208, 220, 240 V ac input, 30 kW CCR with 480 V ac input)
AWG 6, 600 V (min.) (20 and 25 kW CCR with 480 V ac input)
AWG 8, 5000 V (min.) (15 to 30 kW CCRs with 2400 V ac input)
AWG 10, 600 V (min.) (15 kW CCR with 480 V ac input)

INPUT/OUTPUT WIRING

4, 7.5 and 10 kW CCRs



AWG 6, 600 V (min.) (10 kW CCR with 208, 220, 240 V ac input)
AWG 8, 5000 V (min.) (10 kW CCR with 2400 V ac input)
AWG 8, 600 V (min.) (7.5 kW CCR with 208 or 220 V ac input)
AWG 10, 600 V (min.) (7.5 kW CCR with 240 V ac input)
AWG 12, 600 V (min.) (4 kW CCR with 208 or 220 V ac input)
AWG 14, 600 V (min.) (4 kW CCR with 240 V ac input or 7.5 kW CCR with 480 V ac input)
AWG 18, 600 V (min.) (4 kW CCR with 480 V ac input)

FIGURE 8-16. EXTERNAL WIRING/REMOTE CONTROL CONNECTIONS