



MACC MANUAL

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SOLID STATE CONVERTER



PEC MACC DC Power Supply

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It must be understood that these instructions cannot cover all details or variations on equipment, nor provide for every possible contingency in connection with installation operation or maintenance. When the rectifier is installed, it will require little attention.

Should further information be desired or particular problems arise which are not covered herein, please contact:

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1. INTRODUCTION

1.1 Scope

This manual describes the PEC Solid State Converter, MACC and provides information for its installation, operation and maintenance.

1.2 General Description of the MACC

The PEC MACC is an air cooled, DC power supply designed to give a specified output voltage and current to cover a wide range of applications. Its overall size and weight saves valuable floor space.

1.2.1 Power Conversion System

The power conversion section of the PEC MACC is completely solid state employing silicon controlled rectifiers (SCR's) as the voltage and current controlling elements and parallel sets of silicon diodes as the rectifying elements. See **Figure 1**. The primary of the main transformer is connected in a solid delta with the SCR's connected in inverse parallel sets in the line. The secondary connection is a six phase, single way.

1.2.2 Cooling System

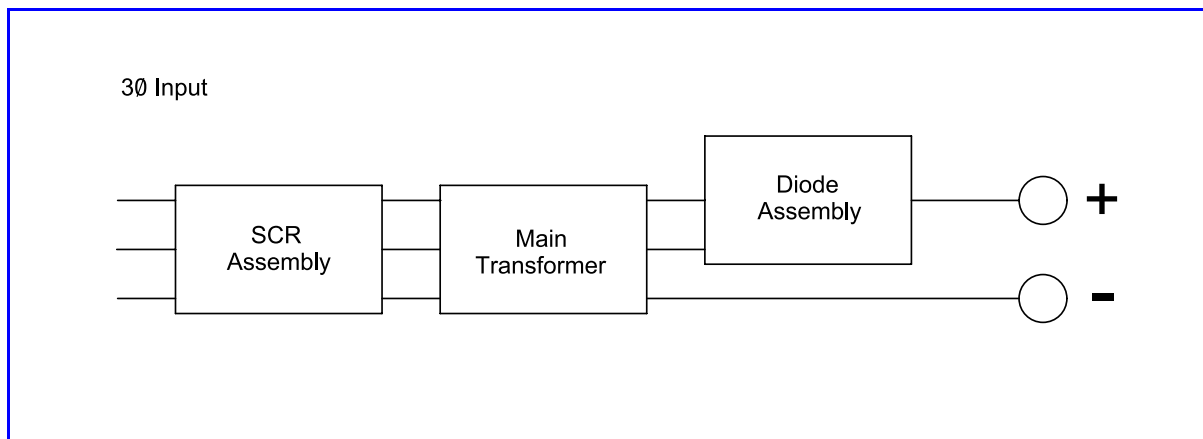


Figure 1 *Power Conversion System Block Diagram*

The Udylite MACC utilizes air cooling to maintain proper operating temperature. See **Figure 2**. Water connections are not required.

1.2.3 Control System

Input power is applied to the PEC MACC through power contacts, usually a magnetic starter, and the output power is controlled by a completely solid state control board to maintain the output at a preset value. A unique peak limit circuit offers overload protection within a half cycle of fault current for either external or internal faults. See **Figure 3**.

2. INSTALLATION

2.1 Inspection and Storage

As all units are shipped F.O.B., our plant, it is suggested that the shipping containers be removed and the converter inspected for possible damage during shipment. If any damage is found, the purchaser must handle the claim, and the carrier contacted immediately. The udyllite service department should be notified if the nature of the damage is such that operation of the converter has been impaired.

Inspection of the interior of the converter and the control panel can be done by removing the front and rear. The panels can be taken off by loosening and removing the retaining screws and lifting the panels, swinging the lower portion over the bottom retainer.

All connections between the magnetic starter, fuses, SCR assembly, main transformer, diodes and DC bus should be checked in case excessive vibration during shipment resulted in loosening them.

If it is necessary to store the unit for a period of time before it is installed, be sure to place the converter in a clean, dry area. To prevent excessive dust from accumulating on the unit, it is advisable to protect the converter by placing it in the original shipping container.

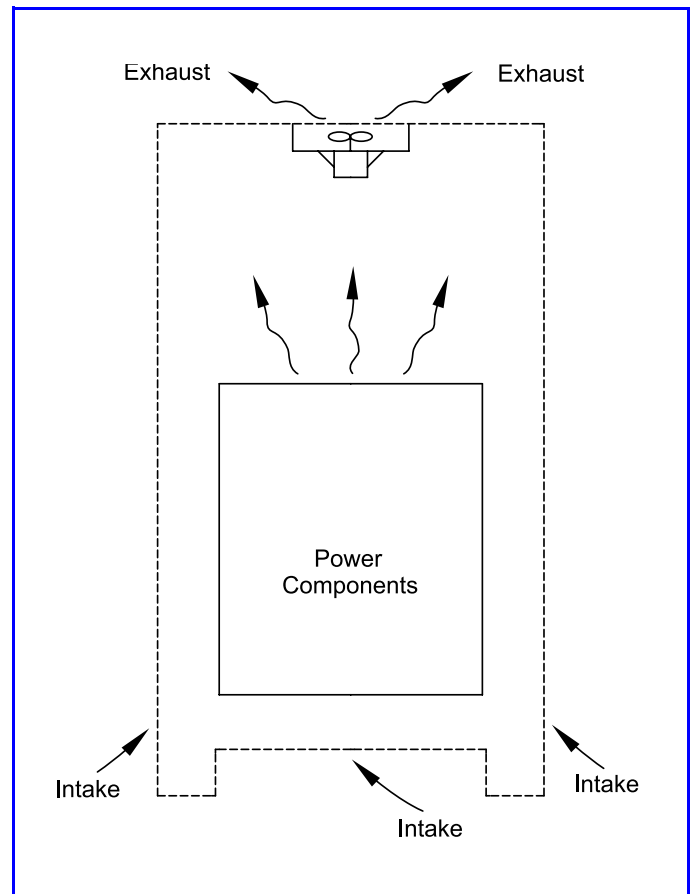


Figure 2 *Cooling System*

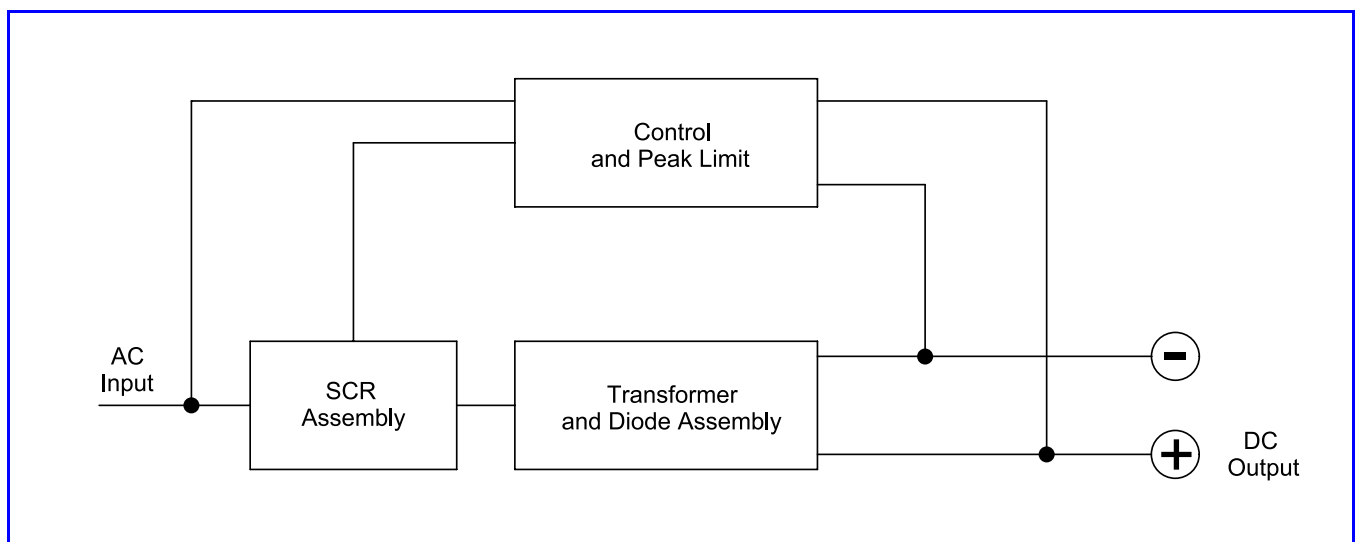


Figure 3 *Control System Block Diagram*

2.2 Handling the MACC

The MACC unit must be handled at all times with the same care that would be given any piece of precision electrical equipment.

Care must be exercised in lifting the converter. Weight distribution varies depending on the size of the cabinet. Cabinets can be lifted by means of a fork-lift truck of the proper size.

2.3 Cabinet Size, Weight, and Input KVA

Output Amp/Volt	Cabinet Size	Weight in Lbs. (Approximate)	Input KVA
500/6	See Figure 4-A	635	5
9		685	7
12		705	8.5
18		745	12
24		795	15.5
750/6	See Figure 4-A	695	7.5
9		720	10.5
12		755	12.5
18		845	18
24		945	23.5
1000/6	See Figure 4-A	720	10
9		785	14
12		820	17
18		955	24
24		1095	31
1500/6	See Figure 4-B	850	13.5
9		950	19
12		1030	24
18		1220	36
24		1500	47

Table 1 *Cabinet Size and Weight Comparison to Input*

2.4 Location

Proper location of the MACC unit will extend its operating life. Normal precautions should be taken to protect the unit from corrosive conditions and improper ventilation. Sufficient clearance (12" minimum) must be allowed at the front, rear and sides for maintenance and air flow.

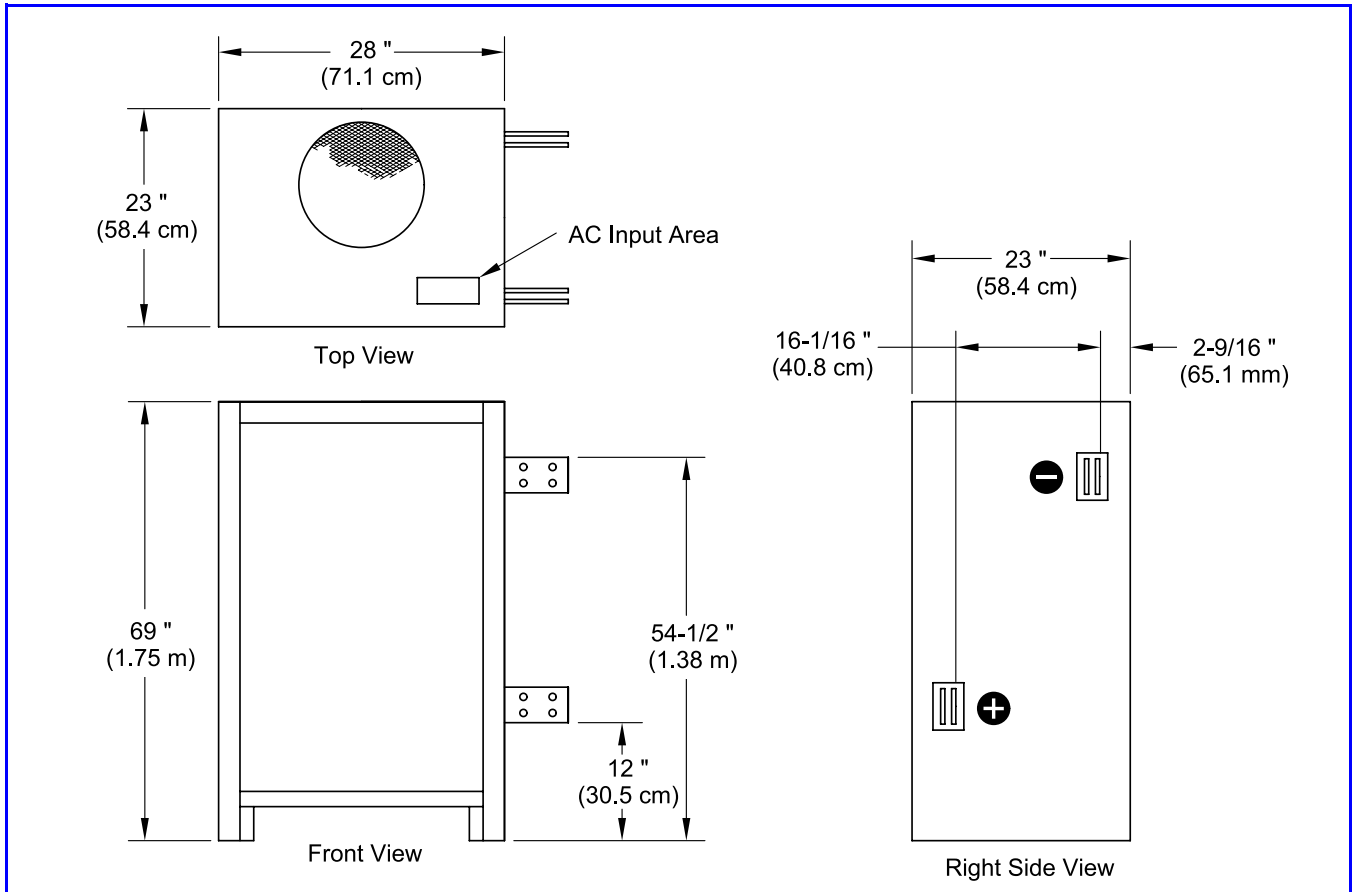


Figure 4-A Cabinet Size for 500 to 1000 Volt Output Model

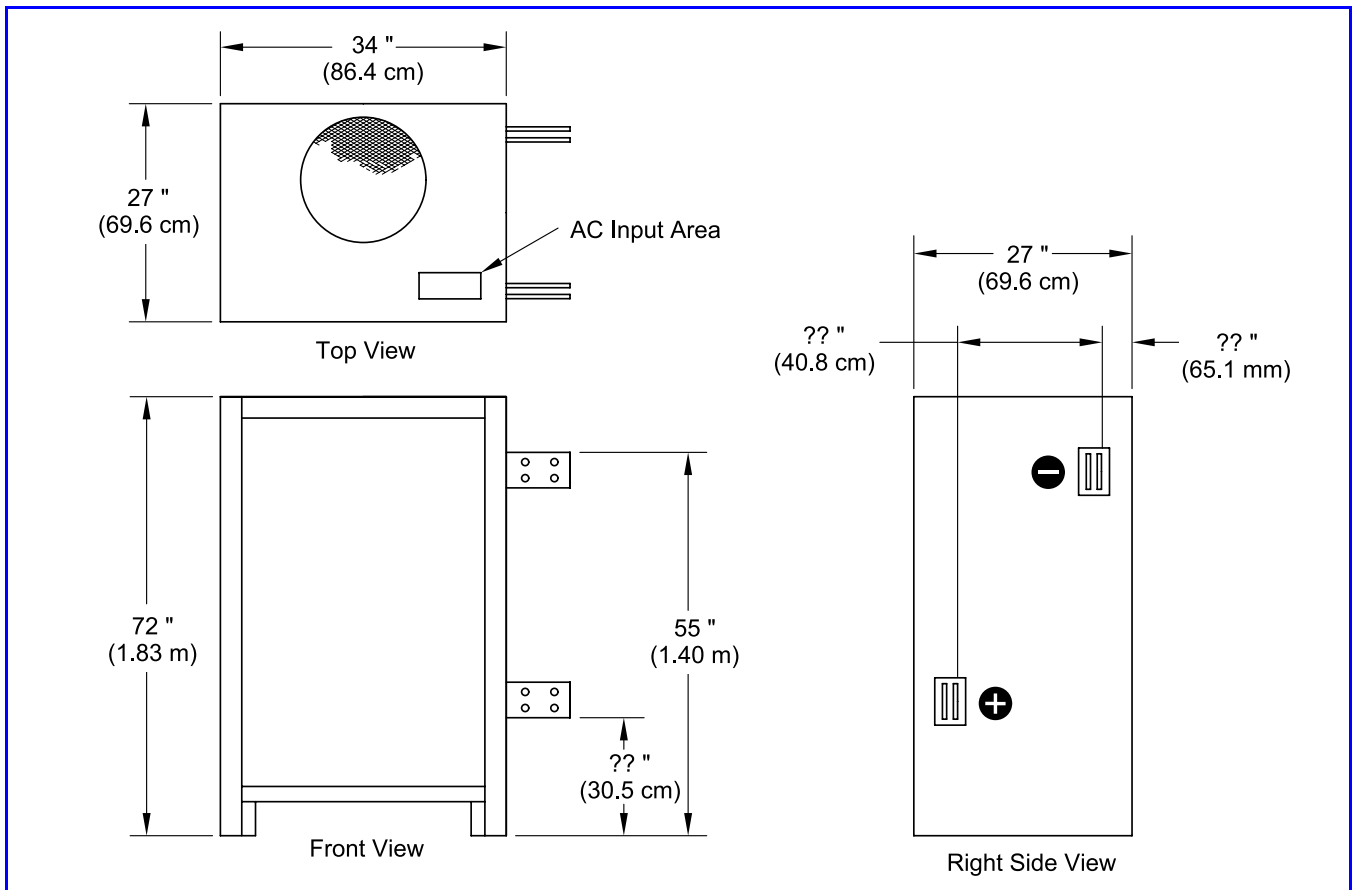


Figure 4-B Cabinet Size for 1500 Volt Output Model

2.4.1 Air Cooled Converter

Convection or forced air is used to cool the power components of the converter. Ambient temperature should not be allowed to exceed 105 ° F (40 ° C). In general, do not locate the converter:

- a) Close to heat generating equipment such as heaters or boilers.
- b) Where subject to splashing or dripping.
- c) Next to a wall or area preventing full air intake or exhaust.
- d) In areas where intake suction may pull in excessive dust, moisture or corrosive fumes.
- e) Where a combustible atmosphere exists.

Air intake is at the bottom, front and rear of the converter and air exhaust is at the top.

2.5 Electrical

Check the converter data plate to be sure that the rated input voltage and frequency match the available power supply. If the supply voltage or frequency differ from the rated input voltage or frequency, the PEC office should be contacted to advise the necessary changes before the unit can be operated. The converter should not be connected under any circumstances to a source which does not match the data plate rating without the approval of Udyllite.

CAUTION

The input wiring and installation should conform to the National Electrical Code, and or local codes as required.

2.5.1 A.C. Input Connection

The primary input connections can be made through the top of the unit. Connections for the control wiring can also be made through the top of the unit at the terminal strip located on the starter control panel.

$$\text{A.C. Input Current} = \frac{\text{KVA} \times 1000}{\text{A.C. Input Voltage} \times \sqrt{3}}$$

Connect properly sized wire cable to the magnetic starter located on the starter control panel as shown in **Figure 5**.

NOTE: A grounding lug is provided. Proper grounding is required for control operation.

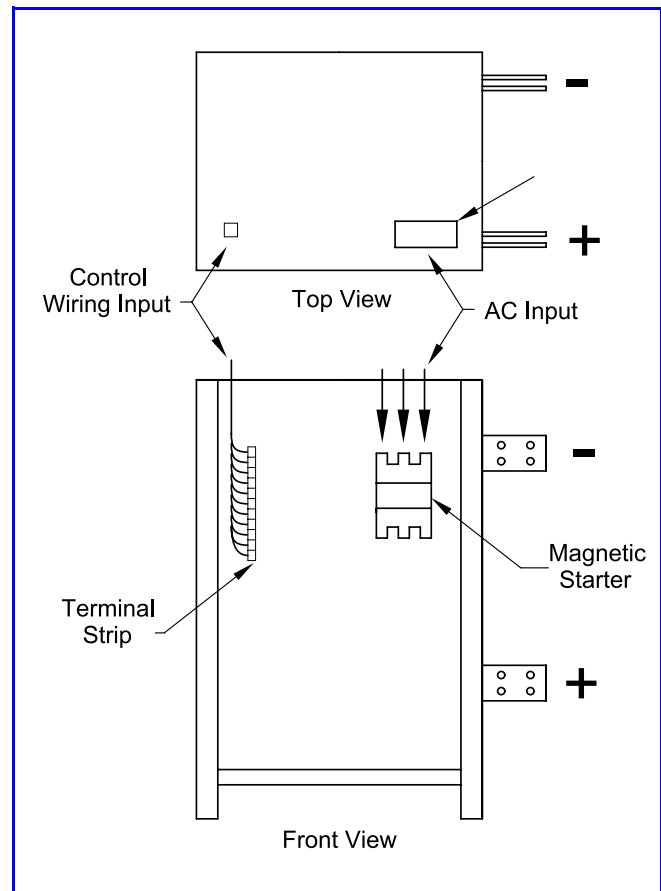


Figure 5 Cabinet Input Connection

2.5.2 DC Output Connections

The DC terminal assembly is 1/4-inch x 4-inch copper bus bar, punched with a standard four hole pattern. See **Figure 6**.

Additional bus required for the tank connection may be aluminum or copper. If aluminum, the bus should be plated at the connection ends to decrease contact resistance. A joint compound should be used before bolting the bus bars together. Belleville washers should be used at the bolted connections of aluminum bus to prevent loosening of the bus connections due to terminal cycling. See **Figure 7**.

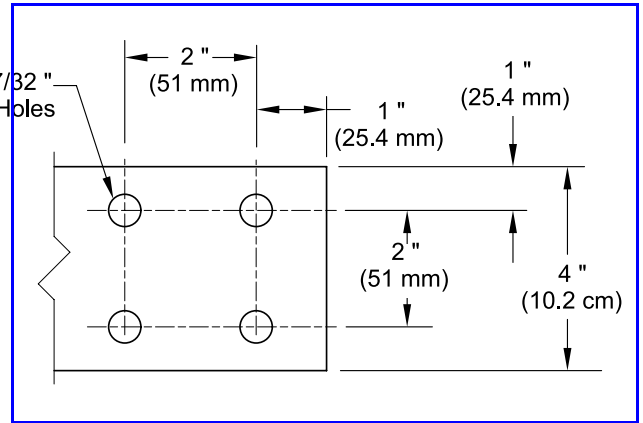


Figure 6 DC Terminal Assembly

2.5.3 Connections for Remote Control Converter

The indicating and controlling elements for the remote controlled units are mounted in a Nema 12 enclosure. The enclosure should be mounted close to the operator's normal position.

Connections from the converter are made to a terminal strip mounted on sub-panel inside the enclosure. See **Figure 8**. The wiring diagram included with each converter shows the number of wires required to connect the converter and control unit together.

It is good practice to include a spare wire or two for future requirements.

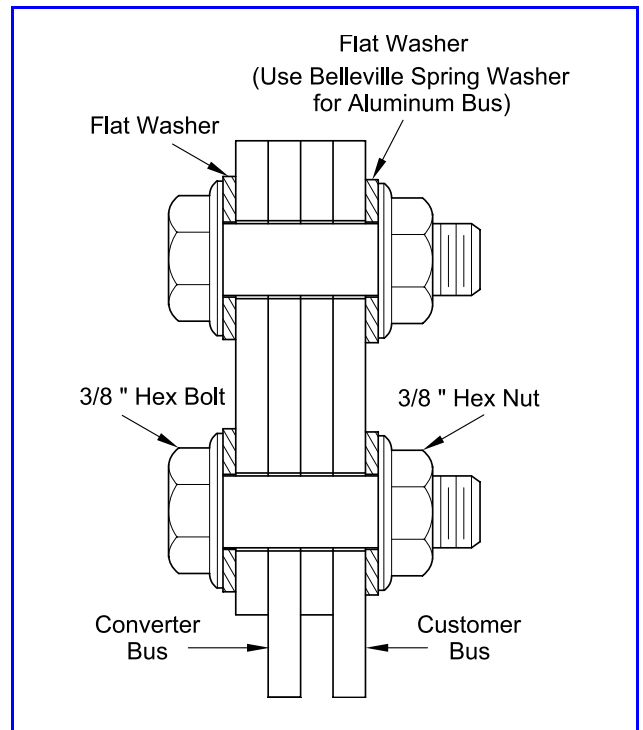


Figure 7 Customer Bus Connection

The ammeter leads should be sized according to **Table 2**.

Wire Size	Length of Lead Run	
	Feet	Meters
No. 14	0 - 15	0 - 4.5
No. 12	16 - 25	4.8 - 7.5
No. 10	26 - 40	7.2 - 12
No. 8	41 - 60	12.3 - 18.2
No. 6	61 - 100	18.5 - 30.5

Table 2 Ammeter Lead Lengths Comparison to Wire Size

NOTE: A grounding lug is provided. Proper grounding is required for control operation.

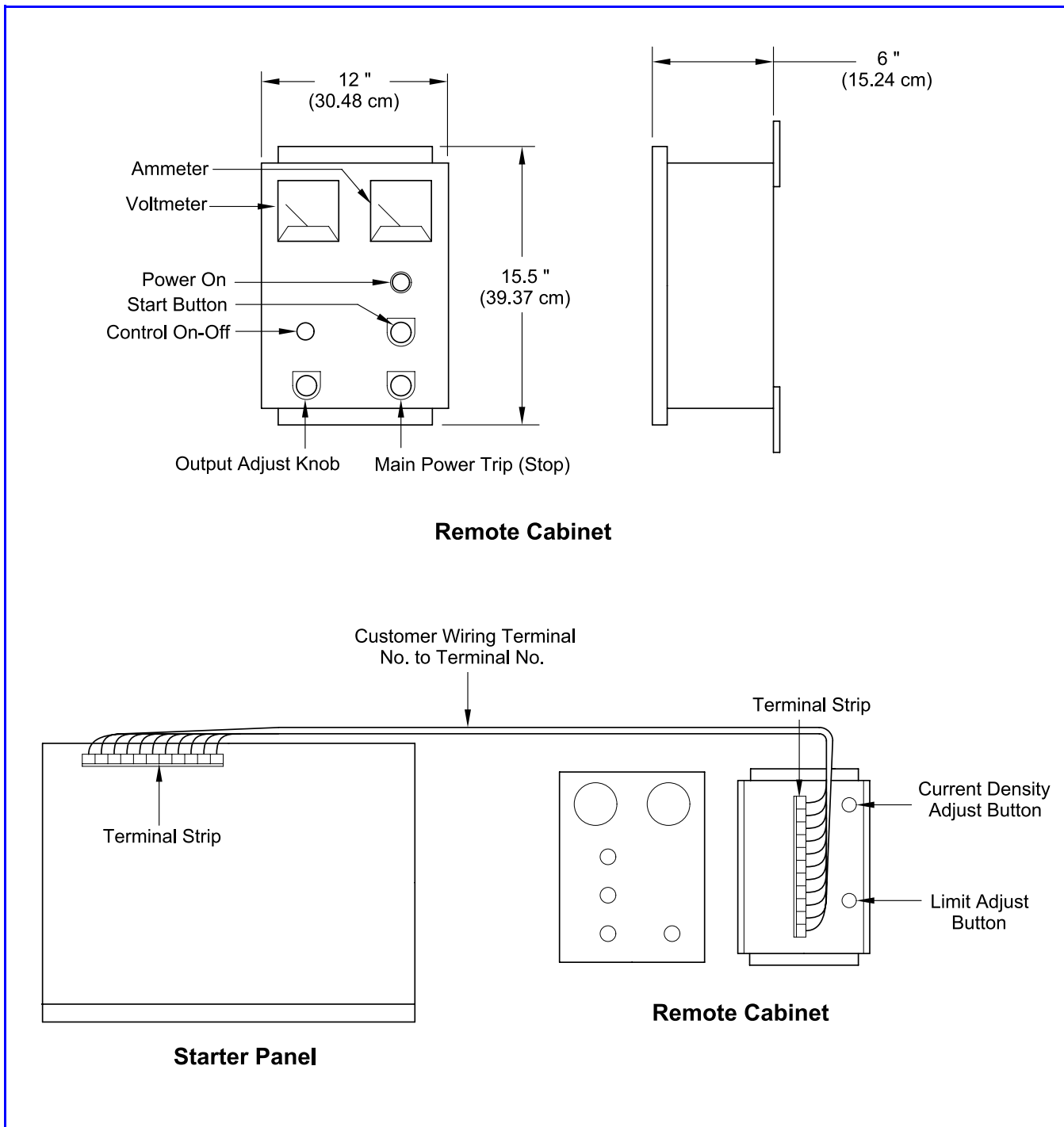


Figure 8 *Remote Control Converter Interconnection*

CAUTION

The input wiring and installation should conform to the National Electrical Code, and or local codes as required.

3. OPERATION

3.1 Component Operation

3.1.1 Magnetic Starter

Three phase input power is applied to the converter through the magnetic starter. It also provides protection in the event of a major component failure or line fault. The power contacts are actuated by energizing a magnetic coil. A normally-open contact on the main starter, or contactor, is used to apply power to the magnetic coil, holding the power contacts in until the coil is de-energized and the power contacts open, removing the converter from the power line. See **Figure 9**.

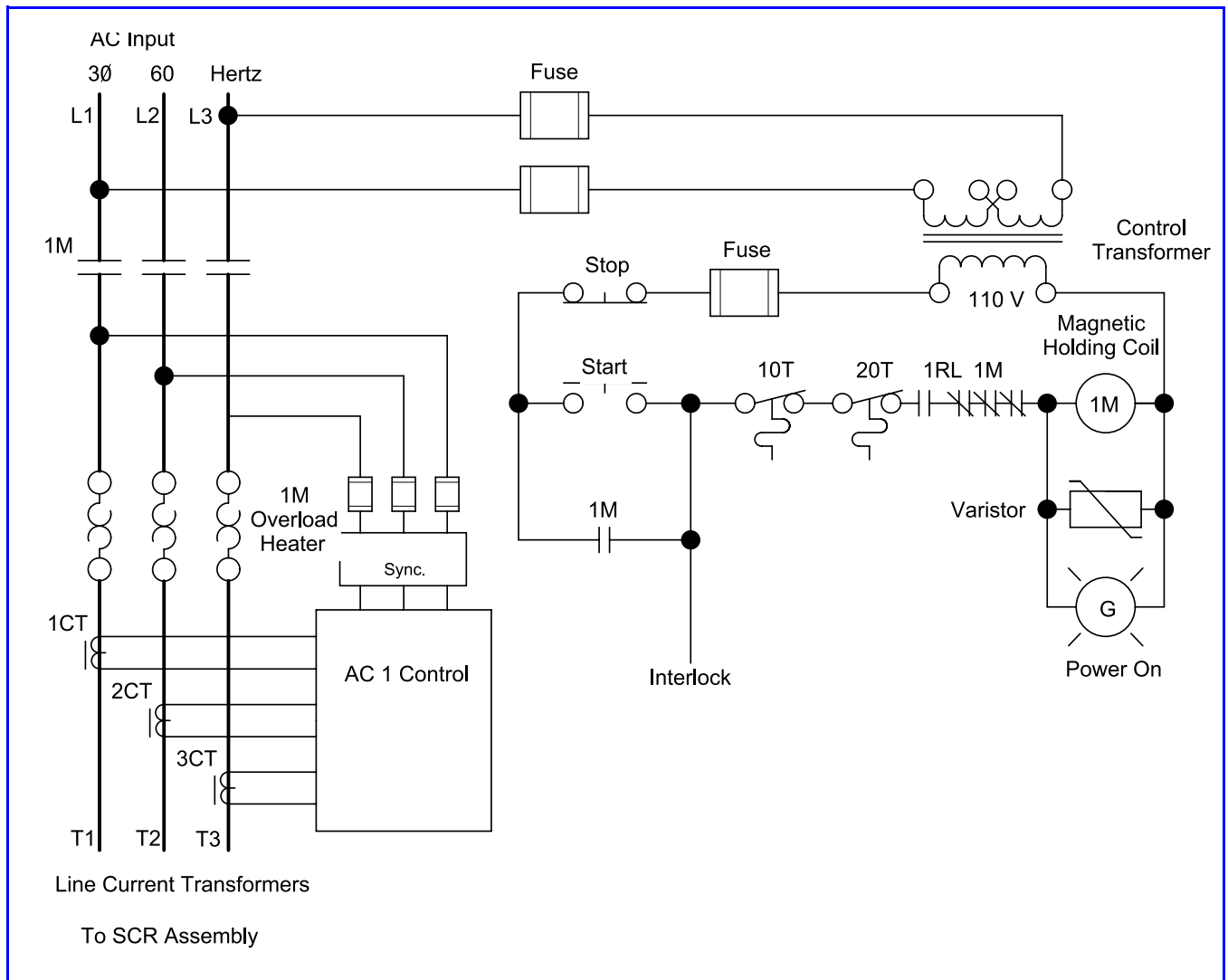


Figure 9 Converter Wiring Diagram

3.1.2 Line Current Transformers

As part of the peak limit circuit, the line current transformers (1,2,3 CT) continuously monitor the input line current while the converter is operating.

3.1.3 Silicon Controlled Rectifier

The silicon controlled rectifier (SCR) is a regenerative semiconductor switch. See **Figure 10**. It is a silicon diode with a third element, a gate, which controls the flow of current through the SCR. The gate determines the point in each half cycle when the SCR will "fire" or start to conduct.

Without a gate signal, the SCR blocks the flow of current in both directions. Not until a signal is applied to the gate does the SCR behave like a diode.

SCR firing is accomplished by introducing a DC voltage between the gate and the cathode. Conduction through the SCR starts within microseconds after voltage is applied between gate and cathode. When sufficient current has started to flow through the SCR, it "latches" into conduction until the current falls below the value of holding current at the end of that half cycle. Holding current is the current necessary to keep the SCR latched in conduction. When the SCR stops conducting, it returns to the blocking state and will not turn again until the gate is "pulsed" and the anode is positive with the respect to the cathode.

Figure 11 shows two SCR's connected in a back-to-back arrangement. SCR1 will conduct current when T1 is positive with respect to T2. SCR2 will conduct current in the opposite direction when T2 is positive with respect to T1. Assuming that voltage is applied between gate and cathode at midpoint in each half cycle, 90° of conduction angle can be obtained for each SCR resulting in a current flow through the load as shown in **Figure 12**. Therefore, it is possible by introducing gate-cathode voltage at other times during the half cycle to control the time the SCR's are "on" in each half cycle and vary the load current.

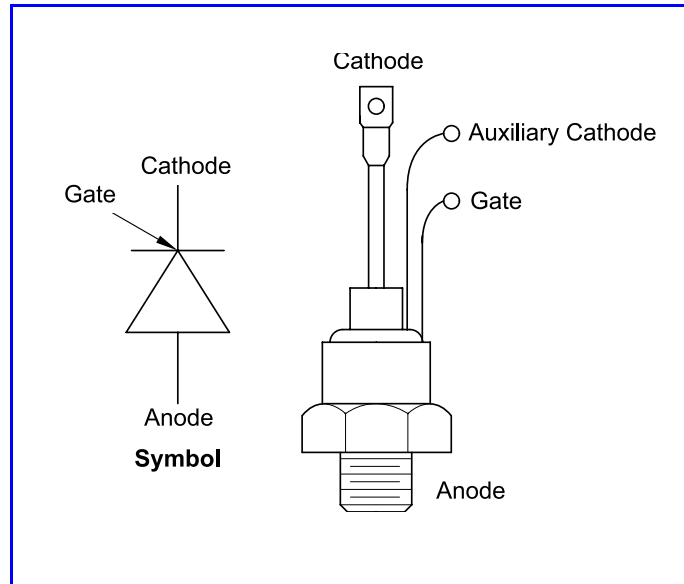


Figure 10 Silicon Controlled Rectifier (SCR)

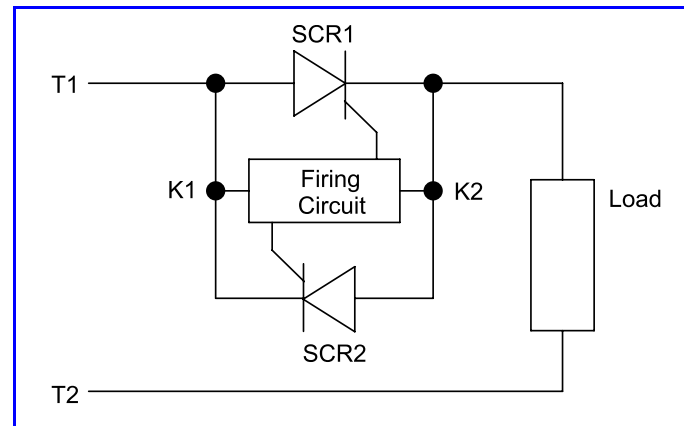


Figure 11 Two SCR's in Back-to-Back Arrangement

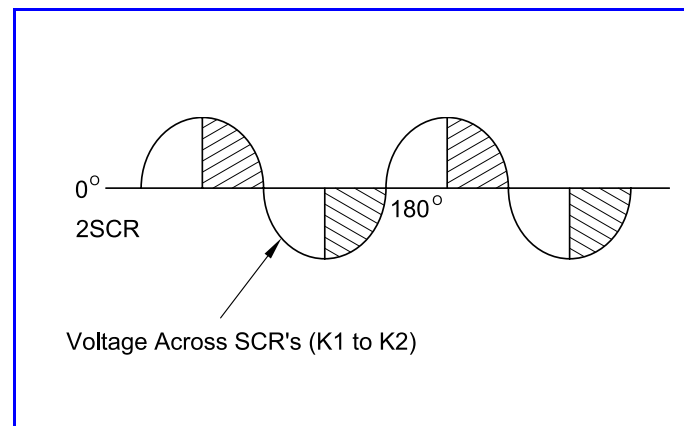


Figure 12 SCR Current Flow (90° Phase Angle)

In the MACC the SCR's are connected in the back-to-back arrangement and placed in the line. The transformer primary is connected in a solid delta. See **Figure 13**.

The DV/DT and pulse transformer boards provide both the controlling gate-cathode pulses for varying the converter output, and DV/DT protection for the SCR from line voltage transients.

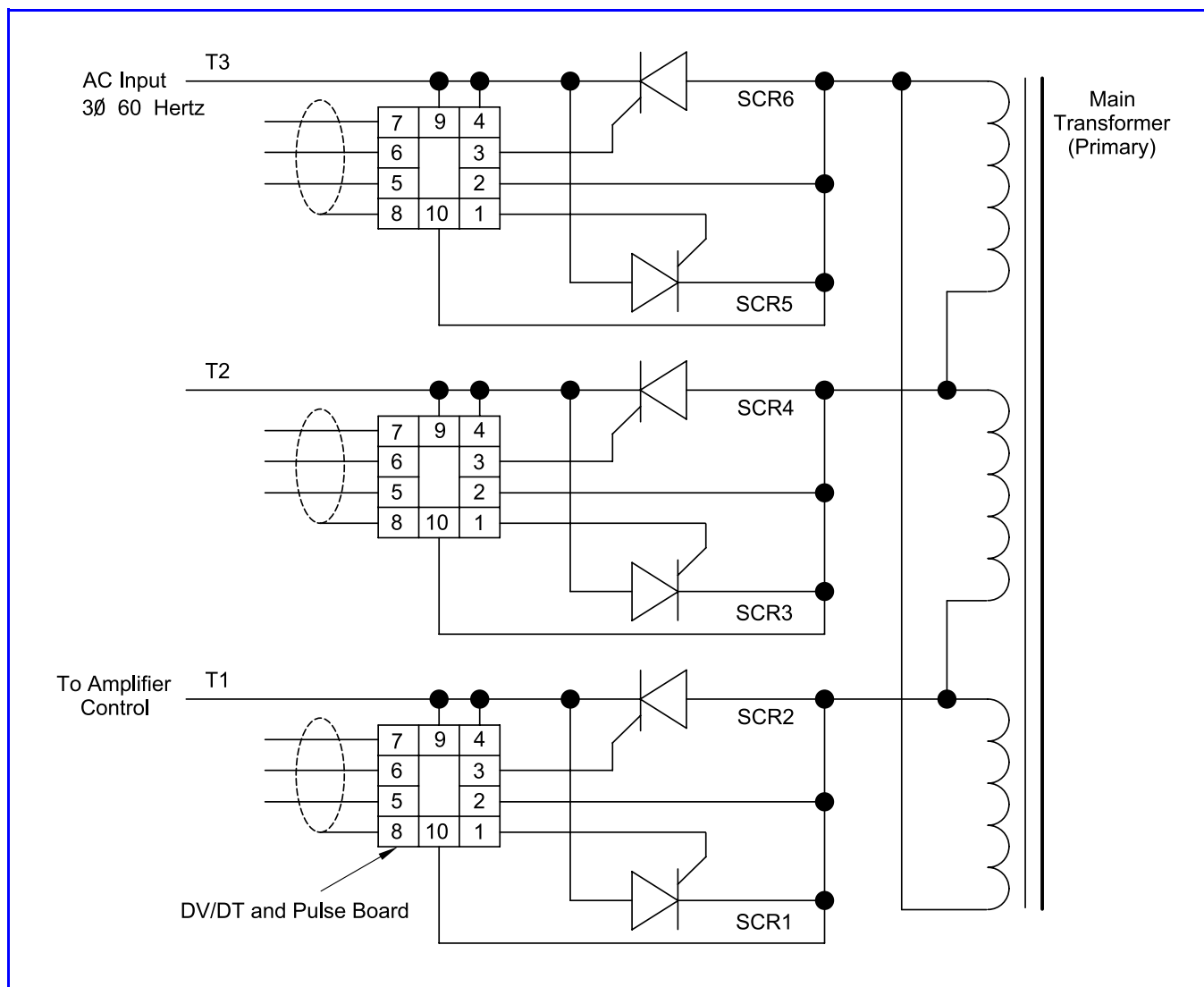


Figure 13 *DV/DT and Pulse Transformer Boards*

3.1.4 Main Transformer

The main transformer converts the high voltage, low current input from the controlling SCR's into a low voltage, high current output to the diode assembly. The main transformer is designed specifically for each particular MACC rating.

3.1.5 Diode Assembly

The diode assembly of the converter is completely solid state employing parallel sets of silicon diodes as the rectifying elements. See **Figure 14**. A six-phase single way rectifier connection is employed.

The shunt provides the current feedback for the control and also the signal for the indicating ammeter. The DC voltage output provides the voltage feedback for the control.

3.1.6 Control Transformer

Steps down the primary line voltage to 110 Volts for use in the control circuit.

3.1.7 Protective Devices

These devices provide protection for the converter.

A. Main Line Overload

A thermal type relay which opens when excessive current is drawn from the main line by the converter. A normally-closed contact in series with the starter or contactor magnetic coil will open, de-energize the coil and drop the converter off the line. The relay contacts must reset before the converter can be re-started. A starter will have the thermal overload relays integral to the starter while a contactor will use current transformers and separate overload relays.

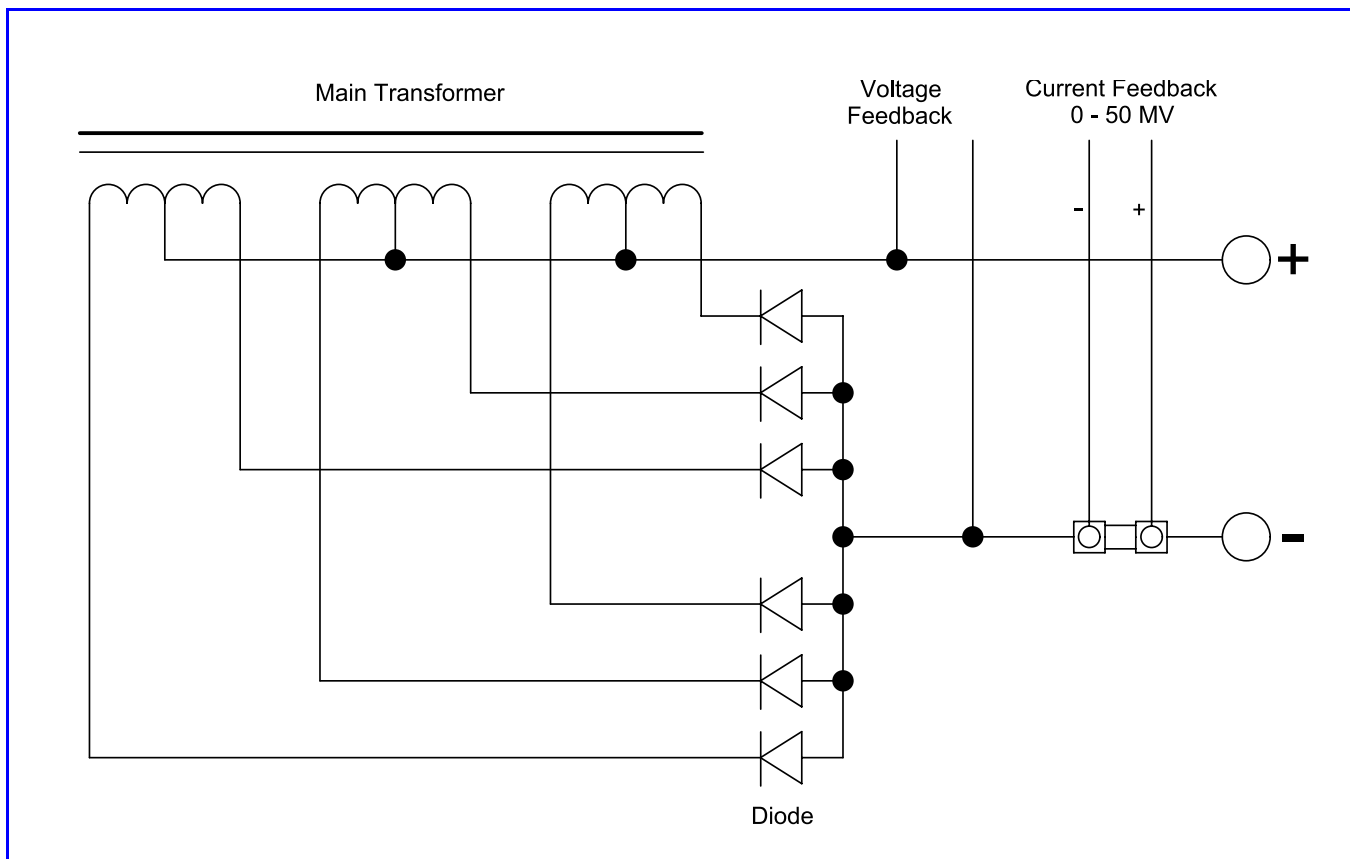


Figure 14 *Diode Assembly*

B. Peak Limit Control

In the event of excessive instantaneous line current due to either an internal or external fault, the current is electronically interrupted after a single half cycle (worst case) of fault current. The control will then automatically "ease" the converter back on while continuing to monitor the line current. The control will limit the peak input current to a safe preset level and after 5 seconds, if the fault is not cleared, will turn the converter off. In case of a short on the output of the converter, the normal current limit control will take over and maintain the converter average output current at rated value.

C. Thermal Overload

Normally-closed thermal overload are used in the converter. Mounted on the diode heat sink they will open and shut the converter off if the stud temperature is excessive (approximately 230 ° F).

3.2 Cooling System

The MACC converter is air cooled, requiring very little maintenance.

The air enters the cabinet through a screened opening in the bottom. The heated air generated from the power components rises and exits through the top of the cabinet. It is important therefore, to keep a minimum clearance of 12" between walls, etc.

Air at ambient or room temperature is used as the cooling medium. Therefore, the ambient air temperature should not exceed 104 ° F (40° C) for proper operation of the converter.

3.2.1 Control Operation

A. AC1 Control Board

Continuously monitors the current transformer (1,2,3 CT) output while the converter is operating. In the event of an external or internal fault, the peak limit circuitry will shut the converter off. The board also accepts the feedback signals from the DC bus and shunt to provide reference levels to control the converter output. By controlling the firing of the line SCR's, the control board varies the converter output voltage and current. Using the feedback signals, the converter output can be controlled and held constant at: voltage with current limiting, average current density with current limiting or current with voltage limiting. The board provides the references controlling voltage and accepts the control input from the potentiometers.

3.2.2 Control Function

A. Automatic Voltage Control with Current Limiting

The function of this control is to maintain the converter output voltage at a value preset by the operator's control knob. The preset value of output voltage will be held constant within $\pm 1\%$ of the converter's full rated output voltage over a range of 10% to 100% of output current under varying load conditions. For example, with a 1000 Amp @ 12 Volt unit, the output voltage will be held constant ± 0.12 Volts over range of operation from 10 Amp to 1000 Amp. The voltage will remain constant throughout the operational cycle and will eliminate the costly burning or over-plating which can result from widely varying load voltages.

Protection of the converter from DC overloads is provided for by the automatic current limiting.

Any decrease in load resistance above the converter current rating will result in a decrease of output voltage and the converter output current will be limited at its maximum rated current. See **Figure 15**.

In chrome plating and related processes where a current interruption by a DC overload device can result in costly stripping and replating, the current limiting feature automatically prevents the overload from damaging the converter while maintaining continuous operation at reduced output voltage.

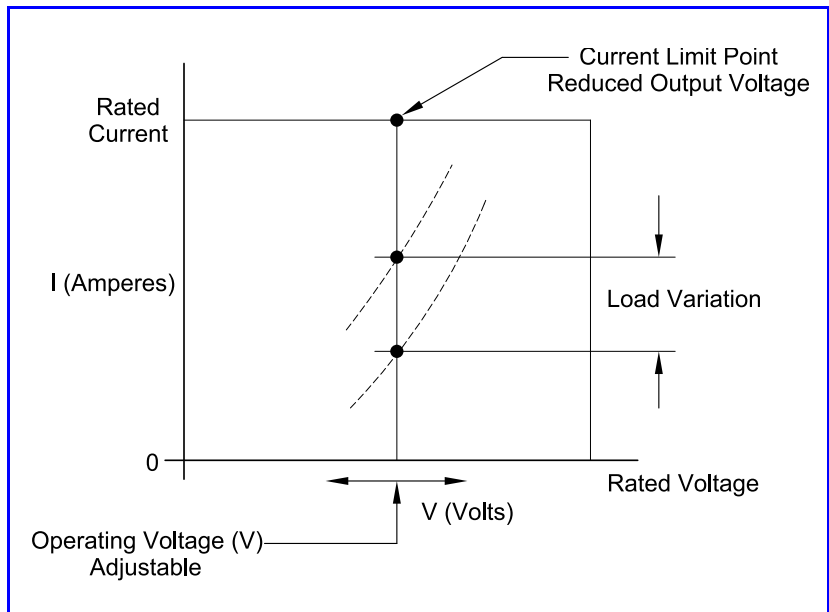


Figure 15 *Automatic Voltage Control with Current Limiting*

B. Automatic Average Current Density Control with Current Limiting

The need for average current density control is due to the fact that the current in a plating system does not increase in direct proportion as the plating area is increased, even though the plating voltage is held constant. It is necessary to increase the voltage as work area is added in order to maintain the proper average current density.

The automatic average current density control increases the converter's output voltage as a greater amount of bus current is sensed. This is done by converting a current signal to a proportional voltage and adding it to the basic operating voltage. A current limiting feature automatically prevents an overload from damaging the converter while maintaining continuous operation at reduced voltage. See **Figure 16**.

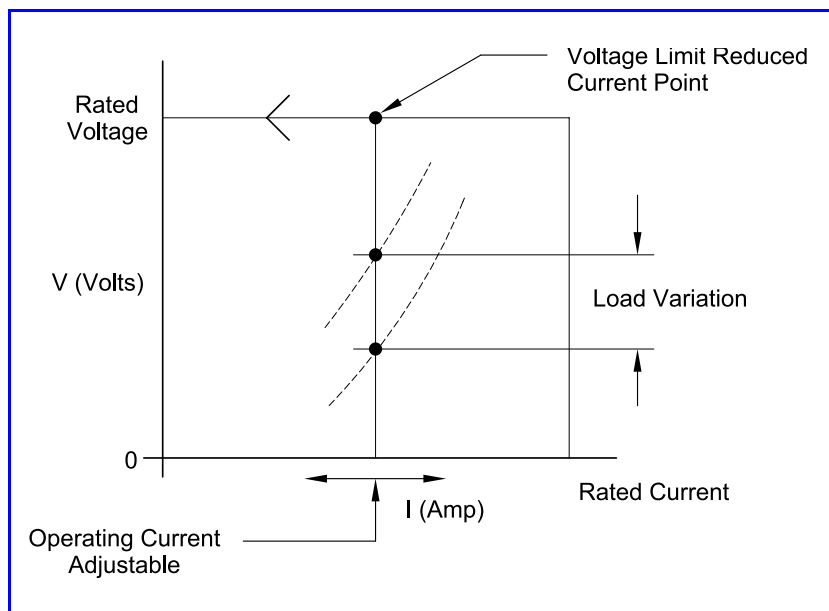


Figure 16 *Automatic Current Density Control with Current/Limiting*

This control will maintain the converter output current at a value preset by the operator's control knob. A preset value of output current will be held constant within + 1% of the converter's full rated current value over a range of 10% to 100% of output voltage under varying load conditions during operation.

For example, the output of a 1000 Amp @ 12 Volt converter will be held constant ± 10 Amp from 1.2 Volts to 12 Volts. The voltage limit control is designed to reduce load burning due to overvoltage and prevent power interruption to the load. Any increase in load resistance will result in a decrease of output current and the converter will be limited at its rated voltage output.

This automatic current control can be used in operations such as hard chrome where thickness must be accurately controlled. It can eliminate costly grinding and stripping operations. An automatic current control can be used in any type of operation where variations in solution, temperature, thickness and contact area will adversely affect the work being done.

3.3 Converter Operation

3.3.1 Turn-On Procedure

1. Make sure all open panels are closed before the converter is energized.
2. Close the main disconnect (customer).
3. Turn the "output adjust" knob completely counterclockwise.
4. Switch the "control on-off" switch to the "off" position.
5. Press the "start" button to energize the converter.
6. See **Section 3.3.2, 3.3.3, or 3.3.4** for particular operation required by the application.

3.3.2 Automatic Voltage with Current Limit Operation Adjustment Procedure

All converters are shipped in the voltage mode of control unless otherwise specified at time of order.

- A. The "current density adjust" pot must be turned completely counterclockwise for automatic voltage operation. This pot is located on the front panel of integral control units or inside the remote cabinet for remote control units. To adjust, remove the locknut and turn the pot with a screwdriver completely counterclockwise, then replace and tighten the locknut.
- B. The "limit adjust" pot should be turned completely clockwise. At this setting the converter current output will be limited at its full rated value. If a lower current limit point is desired, then turn the pot counterclockwise to the desired setting. For example, setting the pot at midpoint will limit the current to approximately half the rated output current. This pot is located on the front panel of integral control units, or inside the remote cabinet for remote control units. To adjust, remove the locknut, turn the pot to desired setting with a screwdriver, then replace and tighten the locknut.
- C. Turn the "output adjust" knob completely counterclockwise.
- D. Energize the converter as outlined in **Section 3.3.1**.
- E. Switch the "control on-off" to the "on" position.
- F. Adjust the "output adjust" knob to the desired voltage level. The converter will hold the desired voltage level constant for varying load conditions.

NOTE: Desired voltage level setting must be between 10% to 100% of the full rated output voltage of the converter.

3.3.3 Automatic Average Current Density Control with Current Limit Adjustment Procedure

All converters are shipped in the voltage mode of control unless otherwise specified at the time of order. The automatic average current density control must be used with the voltage mode of control for proper operation.

1. Turn the "current density adjust" pot completely counterclockwise. This pot is located on the front panel of integral control units or inside the remote cabinet for remote control units. To adjust, remove the locknut and turn the pot with a screwdriver completely counterclockwise. Do not replace the locknut until the remainder of the adjustment is complete.
2. Turn the "limit adjust" pot completely clockwise. This pot is located on the front panel of integral control units or inside the remote cabinet of remote control units. To adjust, remove the locknut, turn the pot with a screwdriver, replace and tighten the locknut.
3. Turn the "output adjust" knob completely counterclockwise.
4. Energize the converter as outlined in **Section 3.3.1**.
5. Switch the "control on-off" to the "on" position.
6. With the smallest anticipated work load in the tank, turn the "output adjust" knob clockwise to produce the desired current output for that work load.
7. Increase the work load in the tank to the maximum expected load. Although the current has increased, the total current will be less than desired for that load.
8. Turn the "current density adjust" knob clockwise until the proper current is reached.
9. Repeat steps 6, 7 and 8 to minimize the current difference from small to larger loads.
10. Replace and tighten locknut on "current density adjust" pot

NOTE: This control works well for repeated loads of the same type. A change in size and shape of the work load may require readjustment of the pot settings.

3.3.4 Automatic Current Control with Voltage Limit Adjustment Procedure

All converters are shipped in the voltage mode of control unless otherwise specified at the time of order. Refer to **Section 3.3.5** for instruction to change from voltage mode to current mode of control.

- A. The "current density adjust" pot must be turned completely counterclockwise for automatic current operation. This pot is located on the front panel of integral control units or inside the remote cabinet for remote control units. To adjust, remove the locknut and turn the pot with a screwdriver completely counterclockwise, then replace and tighten the locknut.
- B. The "limit adjust" pot should be turned completely clockwise. At this setting the converter voltage output will be limited at its full rated value. If a lower voltage limit point is desired, turn the pot counterclockwise to the desired setting. For example, setting the pot at midpoint will limit the voltage to approximately half the rated output voltage. This pot is located on the front panel of integral control units or inside the remote cabinet for remote control units. To adjust, remove the locknut, turn the pot to the desired setting with a screwdriver, then replace and tighten the locknut.

- C. Turn the "output adjust" knob completely counterclockwise
- D. Energize the converter as outlined in **Section 3.3.1**.
- E. Switch the "control on-off" to the "on" position
- F. Adjust the "output adjust" knob to the desired current level. The converter will hold the desired current level constant for varying load conditions.

NOTE: The converter will hold the desired current level for an operating range from 10% to 100% of the converter's full rated output voltage.

3.3.5 Conversion to Current Mode of Control

The conversion from voltage mode to current mode of control is easily accomplished.

1. Open front panel of converter (see **Section 2.1**) and locate the upper terminal strip mounted on the control panel
2. Locate Terminals No. 21 and No. 20 on the terminal strip. See **Figure 17**.
3. Remove wire No. 21 from Terminal No.21 and wire No.20 from terminal No.20.
4. Connect wire No. 21 to Terminal No. 20 and wire No. 20 to Terminal No. 21. See **Figure 18**.
5. Reverse steps 3 and 4 for conversion back to voltage mode of control.

3.3.6 Turn-Off Procedure

The MACC may be shut off by two methods:

1. For operation without interrupting the starter or contactor, switch the "control on-off" switch to the "off" position. This stops the firing pulses to the line SCR's and shuts off the converter. This switch allows complete control of the converter from the control panel without having to de-energize the starter or contactor.
2. Depress the "stop" button. This will interrupt the magnetic coil of the starter, or contactor, and remove the converter from the line.

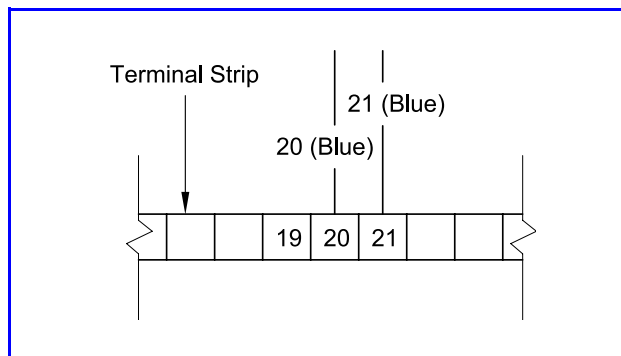


Figure 17 *Wiring Connection for Current Mode of Operation*

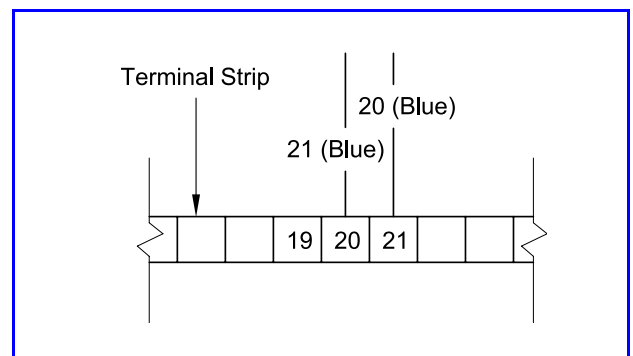


Figure 18 *Wiring Connection for Voltage Mode of Operation*

4. MAINTENANCE

The PEC MACC solid state converter has been designed for minimum maintenance. A regular schedule of periodic checks should be set up to keep the converter in peak operating condition. All components requiring normal maintenance are easily accessible from the front and rear of the converter.

4.1 Cabinet

Very little, if any, maintenance is required on the cabinet. All panels should be kept securely fastened. Corrosive deposits should not be allowed to build up on the cabinet.

4.2 Connections

The power and control wiring and bus connections should be checked at regular intervals for tightness and the presence of high resistance film build-up. Loose joints or connections cause localized overheating leading to rapid breakdown of equipment. Loose bus connections should be taken apart, cleaned, coated with a thermal compound and bolted together again.

4.3 Control Connections

A starter panel mounted in the converter contains the electronic control board. Connections between the control board and the converter are made by quick connect terminals and plugs.

P1 - Gray Shielded Cable (SCR Connections)

P2 - Yellow (Current Transformer)

Check these connections periodically for loose connections, tighten if necessary.

4.4 Control Checkpoints

The control terminal strip provides a checkpoint on the proper operation of the converter and control board. See **Table 3**. Refer to the circuit diagram for appropriate terminal number to identify the wire number.

Terminal No.	Function
16, 18, or 19	Voltage signal terminals accepts DC voltage output signal of the converter.
9	Lockout terminal (Special Application Only)
10 and 11	Current signal terminals- accepts a 0 to 50 millivolt DC voltage proportional to the converter output, from the shunt.
21	Average current density input terminal from pot.
15	Output adjust input. Accepts 0 to 5 DC reference voltage from controlling pot to the trigger/ amplifier board which controls the converter output. Measure between terminal #15 (+) and terminal #22 (-).
14	Limit adjust input. Accepts 0 to 5 DC reference voltages from limiting pot to the trigger/ amplifier board which limits the converter output. Measure between terminal #14 (+) and terminal #22 (-).
20	Reference output. Provides ?weel? regulated 5 Volt DC for use with controlling and limiting pots. Measure between terminal #20 and terminals #22 (-)
21	Common. Provides common tie point for measuring controlling and reference voltages.

Table 3 Terminal Number and Function Comparison

4.5 Cooling

Keep air passages in heat sinks and transformer free of dust build up and corrosive deposits.

4.5.1 Power Components

All accumulated dust, dirt, and particles of foreign matter should be removed at each periodic inspection. A soft bristled brush should be used to clean off the power heatsinks, SCR's diodes and main transformer. The residue can be picked up with a vacuum cleaner.

4.5.2 Replacement of Diodes and Thyristors (SCR's)

All diodes and thyristors are accessible from the rear of the converter. The stud devices are mounted in self-locking heatsinks so it is only necessary to loosen and remove the stud nut to remove the device.

Each defective device must be replaced by the same device. In replacing any defective device, a good thermal compound (Wakefield Type 120) must be used. The stud nut must be installed with a torque wrench. See **Table 4** for values.

Device	Part Number	Torque in Inch-Pounds
Diode	BN-8--Series CR-38148 (3/4-inch Stud)	275 - 325
Thyristor (SCR)	CR-38119	130 - 150
	CR-38120	
	CR-38109	
	CR-38103	
	CR-38110	250 - 300
	CR-38104	
	CR-38105	
	CR-38106	

Table 4 Diode and Thyristor Torque Values

A. Method of Checking Diodes

Any good quality ohmmeter can be used to check if a diode is open or short circuited. The diode to be checked must be removed from the circuit. A good diode will read a resistance in both directions, forward (15-50 Ohms) and reverse (100k-10m Ohms). An open diode will indicate infinite resistance in both directions. A short circuited diode will have a zero resistance in both directions. The resistance reading value of a good diode may vary from one diode to another. This variance is no indication of the quality of the diode.

B. Method of Checking Thyristors (SCRs)

In-Circuit Check

1. Disconnect the power supply to the converter.

2. Build test fixture as illustrated in **Figure 19**.

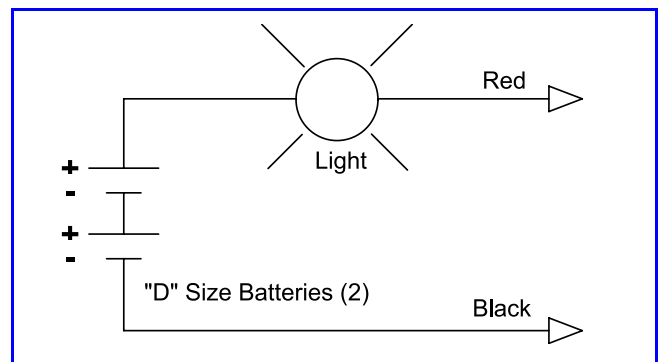


Figure 19 Checking SCR on Test Fixture

3. Identify SCR terminals. See **Figure 20**.

4. Place the red lead and black lead in circuit back-to-back across the SCR combination as shown in **Figure 21**. This tests SCR1.

NOTE: No light should register. If the light comes on, one of the two SCR's is shorted.

5. If the light does not come on, momentarily short the gate lead of SCR1 to the anode stud of SCR1 and remove. The light should come on, and in many cases stay on. If the light comes on, the SCR is good.

6. Reverse the leads as noted below in order to test SCR2. See **Figure 22**.

NOTE: No light should register. If the light comes on, one of the two SCR's is shorted.

7. If the light does not come on, momentarily short the gate lead of SCR2 to the anode stud of SCR2. The light should come on and in many cases stay on. If the light comes on, the SCR is good.

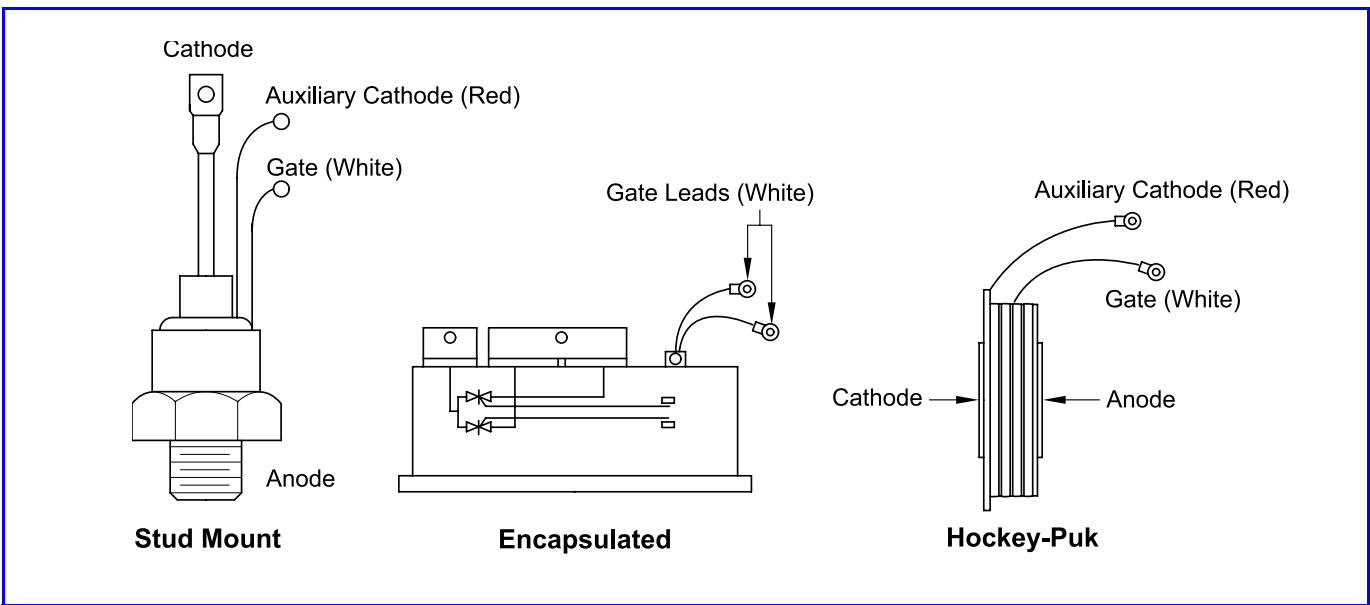


Figure 20 SCR Terminal Identification

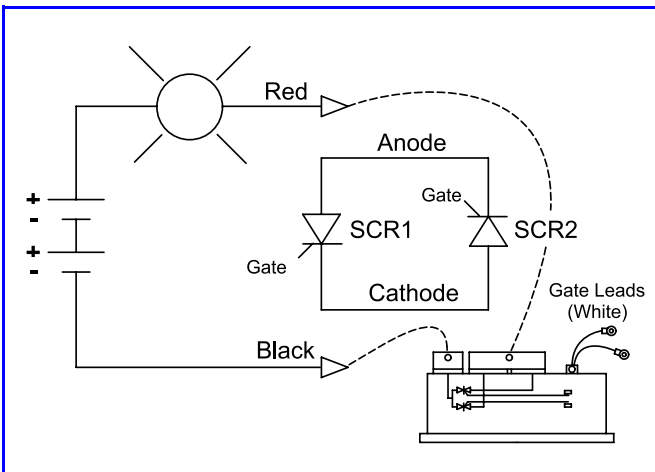


Figure 21 Testing SCR1

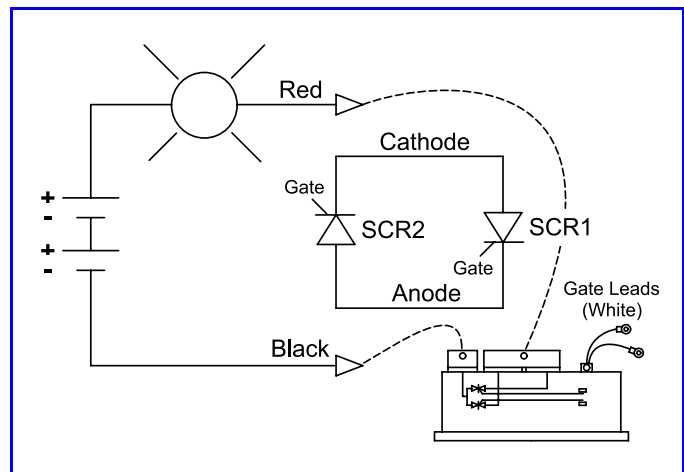


Figure 22 Testing SCR2

4.6 AC1 Electronic Control Board (McTrigger)

This board has a 7 segment display continuously showing the operating status of the control. A list of possible display characters and their meanings is shown in **Table 5**.

Character (Numeral)	Meaning
A	Synchronization signal missing
B	Synchronization signal missing
	Lockout. Terminal 9 shorted to common
	Line frequency out-of-range
	Peak limit trip
0	Circuit operating, amplifier calling for lower output. Pulses shut off
1 - 9	High-phase angle fully advanced, but control amplifier not satisfied. Relative indication of degree of phase advance, roughly 20 for each unit.
	Random flashing pattern, no output. Probable wrong relationship between A and B sync signals. Possibly due to no ground on Y of AC source, or lack of cabinet ground.

Table 5 *AC1 Electronic Control Board Operating Status Characters*

4.7 Troubleshooting

The MACC converter is designed for ease of troubleshooting. Control checkpoints are brought out to the main terminal strip.

Power checkpoints are readily accessible in the main cabinet at the starter panel. Maintenance personnel should have a basic knowledge of electricity and be acquainted with the electrical diagrams and physical location of components within the converter. Equipment required to troubleshoot the MACC unit:

- A. VOM- Multimeter- (Triplett 630-PLK or equivalent)
- B. Clamp-on ammeter- (Amprobe RS-3 or equivalent)
- C. Continuity light

Optional equipment to minimize downtime and useful in locating a problem.

- D. Spare Parts. See **Section 5**.
- E. Oscilloscope

CAUTION

There are dangerously high voltages present within the power supply enclosure. The SCR assembly has up to 480 Volts present on the heat sink. Extreme caution should be used in this area of the cabinet. Under no circumstances should any person reach within the enclosure for the purpose of servicing the equipment within the immediate presence or assistance of another person capable of rendering aid.

Troubleshooting Chart

Problem	Probable Causes
General	
Converter does not start	<ol style="list-style-type: none"> 1. Main switch not closed 2. Line fuse open 3. Loose connection at push-button 4. Open overload device 5. Open starter coil 6. Control circuit fuse open
Converter starts but drops out when start button is released	<ol style="list-style-type: none"> 1. Defective holding contact on 1M or IRL
Converter starts but drops out after 3-5 seconds	<ol style="list-style-type: none"> 1. Defective diode 2. Defective SCR 3. Defective control board
Converter shuts off after a period of operation at or near full load	<ol style="list-style-type: none"> 1. Ambient temperature too high 2. Build up of dirt and/or foreign material on diode heatsinks 3. Defective thermal overload 4. Defective diodes 5. Defective A.C. overload 6. Operating unit over rated output
Converter shuts off intermittently	<ol style="list-style-type: none"> 1. Loose connections in holding circuit 2. Operating unit over rated output
Converter Output	
No output	<ol style="list-style-type: none"> 1. Meter connections loose or broken 2. Defective meter(s) 3. 3T supply transformer leads or 3FU fuses open 4. All diodes open 5. Open control potentiometer 6. System not grounded properly 7. Defective control board 8. Control switch in Off position or open
Output with little or no control	<ol style="list-style-type: none"> 1. Two or more shorted SCR's 2. Feedback connections loose or broken 3. Defective control board 4. Loss of voltage feedback
Over sensitivity of output adjust potentiometer	<ol style="list-style-type: none"> 1. Feedback connections loose or broken 2. Defective control potentiometer 3. Insufficient load in current mode-of-operation
Oscillation of the ammeter or voltmeter sometimes accompanied by violent vibration of bussing	<ol style="list-style-type: none"> 1. Loose or broken feedback connections 2. Defective SCR's 3. Defective diodes 4. Defective control board

5. REPLACEMENT PARTS

When ordering replacement parts, give the model number and serial number of the unit as shown on the data nameplate, a description of the parts and the quantity desired. If further information is desired, contact your PEC salesman, the service department, or write to:

Process Electronics Corporation.

100 Brickyard Road
 Mount Holly, North Carolina 28120
 704-827-9019 or 1-800-421-9107 (Outside North Carolina)

5.1 Parts List

The parts list includes the major items for all standard converter sizes. A particular item should be double-checked with its description before ordering by part number for replacement.

Component	Part Number (Udylite)	Part Number (PEC)
DV/DT and Pulse Board	R-34242	
Belectronic Control Board	R-34240	
Control Transformer 230/460 Volt, 250 VA	BR-40192-4	
Control Transformer 115/25 Volt stepdown	AR-48122	
Control Switch (Toggle, 15 W)	AR-40244	
Current Transformer (1, 2, 3 CT) [small]	BR-40309	
Potentiometer (1 P)	AR-40623	
Potentiometer (2, 3 P)	AR-40336	
Power Diode	CR-38148	
Starter (Size 00) *	AR-40688-01	
Starter (Size 0) *	AR-40688-02	
Starter (Size 1) *	AR-40688-03	
Starter (Size 2) *	AR-40688-04	
Starter (Size 3) *	AR-40688-05	
Starter (Size 200) *	AR-40616	
Starter (Size 400) *	AR-40687	
Starter (Size 6) *	AR-40972	
Thermal Overload (10 T)		AR-40732
Thermal overload (20 T)		AR-40497
Thyristor (SCR)- 63 Amp. 600 Volt		CR-38119
Thyristor, 63 Amp 1200 Volt		CR-38120
Thyristor, 110 Amp 600 Volt		CR-38109
Thyristor, 110 Amp 1200 Volt		CR-38103
Thyristor, 235 Amp 600 Volt		CR-38110
Thyristor, 235 Amp 1200 Volt		CR-38104
Ammeter (Specify current when ordering)		BR-40277
Voltmeter- 15 Volt		BR-40278-1
Voltmeter- 30 Volt		BR-40278-2
Fuse (1,3 FU)		AR-40327-1
Fuse (2 FU)		FG-00205
Encapsulated Thyristor Assembly (60 Amp)		AR-45282-01
Encapsulated Thyristor Assembly (90 Amp)		AR-45282-03
* Starters are Series 41 Only		

