# SABER
# DC 3412
DC 3412
DC 3412
DC 3412

*Installation • Operation • Maintenance*

*DC Drives*

*Technical Manual TM 3412*

MagneTek Drives & Systems

NOTICE

This equipment is **exempted** from FCC regulations.

See 47CFR15.801.

# CAUTION

NEVER CONNECT CAPACITORS ACROSS THE INVERTER OUTPUT AND MOTOR. UPON APPLICATION OF POWER, THE INVERTER INITIALLY SEES THE CAPACITORS AS A SHORT CIRCUIT, HIGH CURRENTS RESULT AND EQUIPMENT WILL BE DAMAGED.

IF REQUIRED, POWER FACTOR CORRECTION CAPACITOR NETWORKS MAY BE CONNECTED ACROSS THE INPUT POWER SOURCE ONLY AFTER CONSULTING LOUIS ALLIS.

IMPROPER USE OF POWER FACTOR CORRECTION CAPACITOR NETWORKS WILL DAMAGE EQUIPMENT.

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# PRECAUTIONARY STATEMENTS

In addition to notes, the following types of precautionary statements appear in this manual.

| | | |
|---|---|---|
| IMPORTANT | - | A statement of conditions which should be observed during drive system setup or operation to ensure dependable service. |
| CAUTION | - | A statement of conditions which must be observed to prevent undesired equipment faults or degraded system performance. |
| WARNING | - | A statement of conditions which MUST BE OBSERVED to prevent personal injury or serious equipment damage. |

# SECTION 1. INTRODUCTION

## 1.1 PURPOSE AND FUNCTION OF DRIVE SYSTEM

The Saber 3412, 12SCR drive system consists of a Power Conversion Unit (PCU), a DC motor and operator's controls. The purpose of the system is to provide controlled rotational energy to drive the customer's machinery.

## 1.2 DESCRIPTION OF PCU AND COMPONENT LOCATION

The PCU is designed to control a DC motor over a wide and infinitely adjustable speed range from zero to rated RPM. It is fully regenerative and is capable of four quadrant operation. That is, it can transfer power from the AC lines to the motor load and cause rotation in both the forward and reverse directions. It can also transfer power from the motor to the AC line to impede rotation.

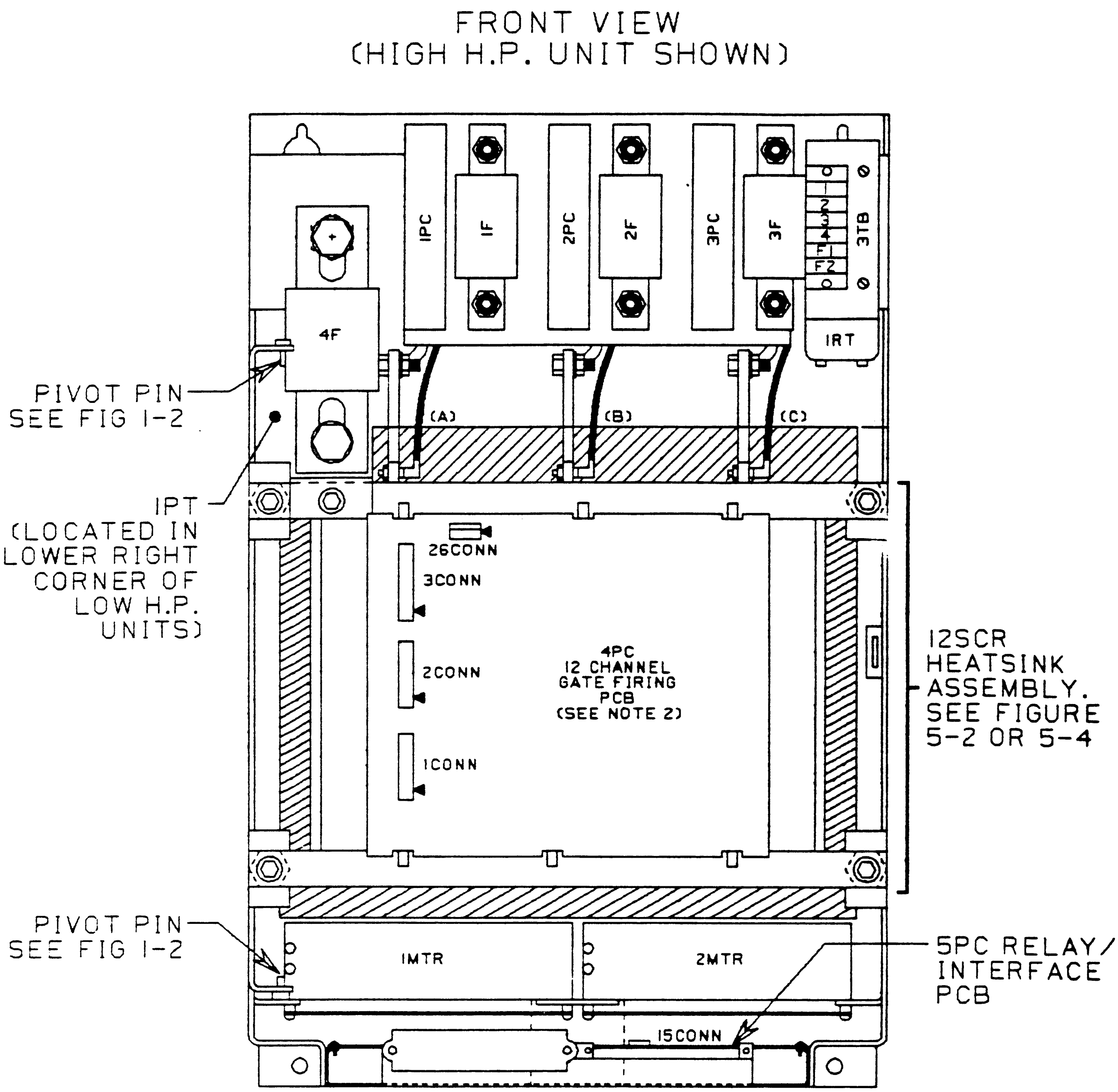
The major portion of the PCU is the Power Cube (Figure 1-1), which includes a 12SCR rectifier bridge section, a Gate Firing printed circuit board (PCB), an Analog Regulator Assembly, and a power supply control transformer (1PT).

### 1.2.1 Rectifier Bridge

The Rectifier Bridge section includes the 12SCR bridge heat sink assembly, 12 Channel Gate Firing PCB 4PC, Relay/Interface PCB 5PC, heat sink cooling fan(s), the current transformer assembly, line fuses 1-3F, and DC bus fuse 4F. The current transformer assembly includes Snubber PCBs 1-3PC, line chokes 1-3SX, current transformers 1-3CT and field rectifier 1RT. The bridge heat sink assembly contains twelve silicon controlled rectifiers (SCRs), heat sink mounted and connected to form two 3-phase full-wave bridges (forward and reverse).

### 1.2.2 Analog Regulator Assembly

The Analog Regulator Assembly components, mounted on the PCU door (swing-out panel), consist of the following: Power Supply PCB 6PC, Regulator PCB 7PC, Adjustment PCB 8PC and the 12SCR Controller PCB. See Figure 1-2 for component locations.




NOTES:

1) POWER CUBE COVER AND ANALOG REGULATOR ASSEMBLY (FIG 1-2) REMOVED.

2) MOUNTED INSIDE LEFT WALL OF LOW H.P. UNITS.

**Figure 1-1. PCU Component Location**

TD.1.3S.FIG1.1

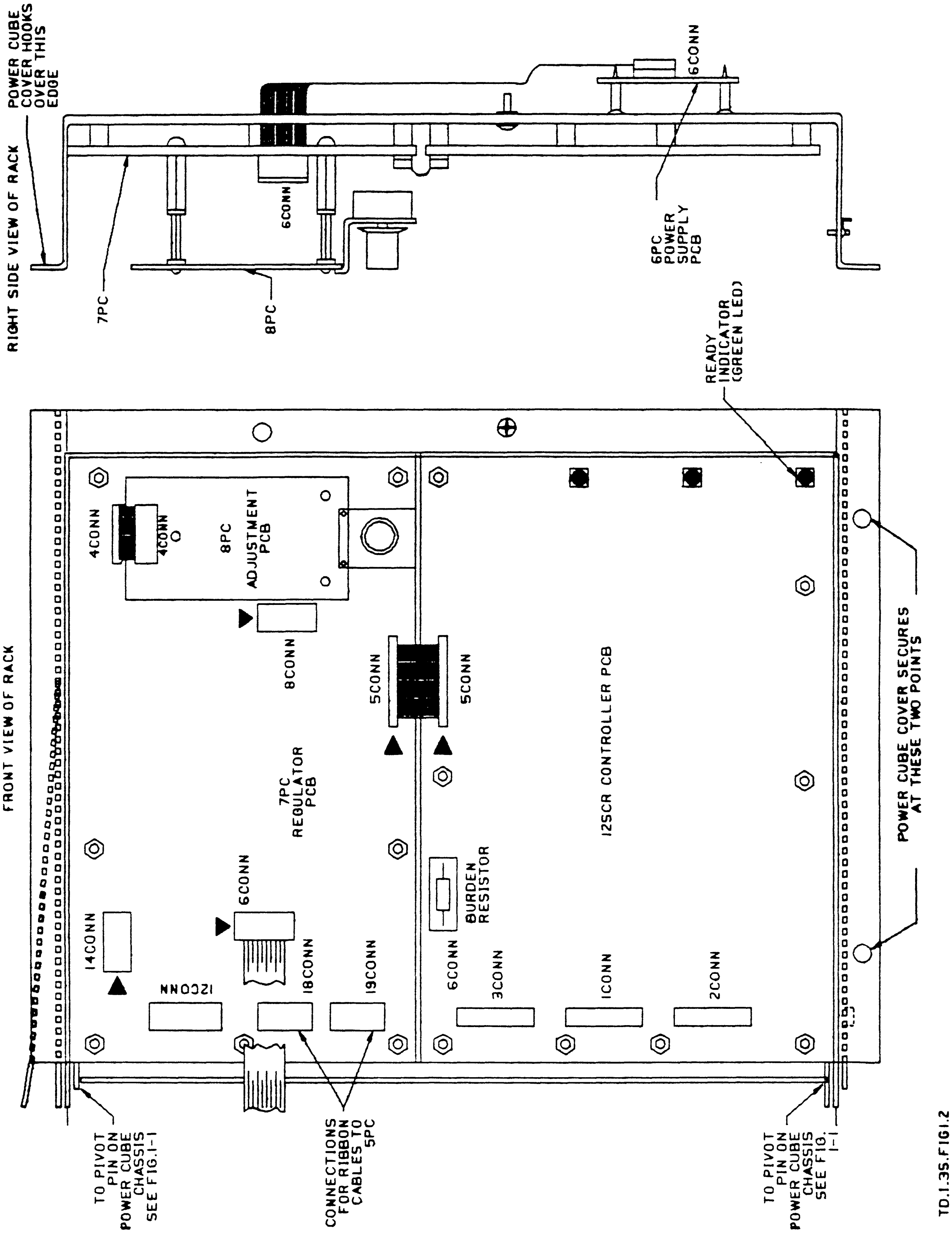



Figure 1-2. Analog Regulator Assembly

### 1.2.3 Protective Circuitry

The PCU contains the following circuits which protect the drive system, power lines and personnel:

A. Power line fuses.

B. Motor overload (thermoguard) relay.

C. Overcurrent Trip.

D. Electronic thermal overload relay.

E. Instantaneous Static Trip (IST).

F. Isolation of control circuitry.

G. Phase insensitive.

H. Phase loss shutdown.

I. Undervoltage shutdown.

J. Transient suppression.

K. Current limit.

### 1.2.4 Overload Protection (Burden Resistor Selection)

In addition to the DC motor thermoguard, which should always be used, an electronic thermal overload is provided to protect against overloads in excess of 115% ±6% of motor rating (see motor nameplate for rating), not exceeding the Controller rating.

**CAUTION**

FOR ELECTRONIC OVERLOAD PROTECTION TO FUNCTION PROPERLY, THE BURDEN RESISTOR MUST BE PROPERLY SELECTED FOR MAXIMUM EXPECTED FULL LOAD.

A custom designed drive unit is shipped with a factory installed burden resistor (located on 6CONN of the 12SCR Controller PCB) sized for the expected full load current. If the drive is a standard unit, the customer must select and install the proper burden resistor for actual motor nameplate full load current. A kit of resistors, along with a 02Y00025 instruction sheet explaining resistor selection, is contained in a plastic bag shipped with the drive unit.

This overload will allow 150% of motor rating for overone (1) minute and 200% for over ten (10) seconds. See Figure 1-3 for actual trip time vs. percent overload. Tripping of this overload will cause the OVERLOAD lamp to illuminate and the Run circuit to de-energize; the drive will come to a stop. The drive cannot be restarted until the RESET push button is pressed. If automatic reset is desired (motor can be restarted approximately one (1) minute after shutdown), switch 13SS (4) must be set to the ON position. NOTE: If drive shutdown is NOT desired, clip open jumper J11 on the Regulator PCB.

**WARNING**

USER DOES THIS AT THE RISK OF DECREASED DRIVE PROTECTION AND VOIDING WARRANTY. LOW LINE TRIP, AUX TRIP, AND OVERLOAD TRIP WILL NO LONGER SHUT DOWN THE DRIVE. THE IST WILL STILL SHUT DOWN THE DRIVE.

IST will cause the drive to come to a stop and illuminate the IST LED when the drive unit experiences overloads in excess of 310% of motor rating.

THIS OVERLOAD CANNOT BE BYPASSED. Resetting of this trip is accomplished by pressing the RESET push button, 11PB, on the Adjustment PCB.

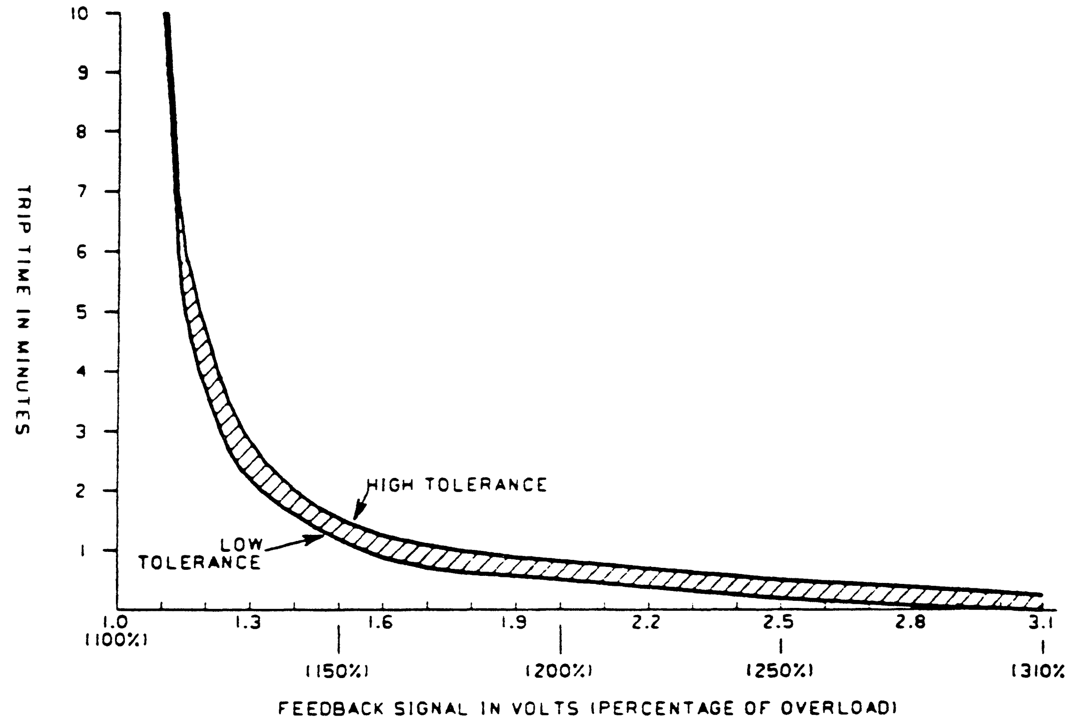



Figure 1-3. Electronic Overload Trip Curve

## 1.3 PERFORMANCE AND AMBIENT SPECIFICATIONS

The following specifications apply:

A. Input Voltage:

Low Voltage Unit -
230VAC -5%, +10%; 60HZ ±1%, 3Ø

High Voltage Unit -
460VAC -5%, +10%; 60HZ ±2%, 3Ø

Control Power -
115VAC -5%, +10%; 50/60HZ ±2%, 1Ø; 350 VA min.

B. Speed Range:
As specified for application

C. Adjustable Current Limit:
80 to 150%

D. Overload for one minute:
150% rated full load

E. Speed Regulation:
As specified for application

F. Service Factor: 1.0

G. Ambient Temperature: 10 to 40°C.

H. Maximum Operating Altitude:
3300 ft. above sea level.

## 1.4 STANDARD MODIFICATIONS

Standard plug-in modifications available for the Saber 3412 DC drive are listed in Table 1.1. These modifications enable the basic controller to perform a variety of control and operational functions. Contact the nearest Louis Allis District Office for ordering information.

Installation instructions are provided later in this instruction manual, as well as included with each modification kit.

## 1.5 CONTROLLER IDENTIFICATION

Two methods have been established for identifying the Controller with various modifications.

METHOD 1

The 53SM model number stamped on the Controller nameplate accurately depicts the Controller and any modifications installed at the time of manufacture. Write this number in the applicable blocks below.

5 3 S M _ _ _ _ - _ _ _ _

1 2 3 4   5 6 7 8

If a modification kit is installed by the customer, refer to the modification instruction sheet to identify which block designator must be changed to reflect the added modification. The accuracy of this number is an asset when contacting Louis Allis.

Table 1.1 Standard Modifications

| DESCRIPTION | DESIG-NATOR | PART NUMBER | |
|---|---|---|---|
| | | PCB | HARNESS & HARDWARE |
| TEST METER | 14PC | 46S02272-0010 | 46S02280-0070 |
| S-CURVE | 11PC | 46S02271-0020 | 46S02280-0041 |
| VOLT/CURRENT FOLLOWER | 9PC | 46S02269-0010 | 46S02280-0120 |
| AUTO/MANUAL | 16PC | 46S02276-0010 | 46S02280-0050 |
| SPEED REGULATOR WITH TACHOMETER FEEDBACK | 12PC | 46S02268-0030 | 46S02280-0030 |
| THREAD | 17PC | 46S02275-0010 | 46S02280-0051 |
| CONTROLLED STOP | 15PC | 46S02277-0010 | 46S02280-0060 |
| TACH DAMPING (See Note 1) | 13PC | 46S02273-0020 | 46S02280-0042 |

1 Used with Speed Regulator, when required. Not to be used separately.

METHOD 2

If the Controller is specially engineered, a serial number is assigned at the factory and stamped on the Controller nameplate. Fill in the space below:

SERIAL NUMBER ______________________

DATE INSTALLED ______________________

This serial number is an asset when contacting Louis Allis.

## 1.6 PRE-INSTALLATION CONSIDERATIONS

### 1.6.1 Receipt of Shipment

All equipment is tested against defect at Louis Allis Drives & Systems. Any damages or shortages evident when the equipment is received must be reported immediately to the commercial carrier who transported the equipment. Assistance, if required, is available from the nearest Louis Allis District Office. Always refer to the Louis Allis order number, equipment description, and serial number when contacting Louis Allis Drives & Systems.

### 1.6.2 Unpacking Instructions

Remove the protective shipping material from around the equipment. Remove all packing material. Unbolt the equipment from its crate. Inspect for loose wiring. Make sure that all contact wedges and other shipping devices have been removed.

## 1.7 TOOLS AND TEST EQUIPMENT

Tools and test equipment required for servicing are as follows:

A. Oscilloscope, Dual Trace, Differential Pre-amp (Tektronix 545A or equivalent).

B. Probes, X10 (all voltages except armature), and X100 (armature voltage checks).

C. Multimeter (Simpson 260 or equivalent).

D. Tachometer, Hand Held (Mod. 455, James G. Biddle Co. or equivalent).

E. Soldering Iron, 42 Watt (maximum).

F. Socket Wrench Set 1/4" to 1".

G. Box Wrench Set 3/8" to 1".

H. Allen Wrench 3/8".

I. Screw Driver Set, Standard Blade and Phillips.

J. Torque Wrench, 100 In. Pounds.

K. Metric Socket for M5, 8mm hex head nut.

## 1.8 PACKING INSTRUCTIONS FOR RESHIPMENT OR STORAGE

For long periods of storage, equipment should be covered to prevent corrosion and should be placed in a clean, dry location. If possible, equipment should be stored in its original crating. Periodic inspection should be made to ensure that the equipment is dry and that no condensation has accumulated. The equipment warranty does not cover damage due to improper storage.

When packing a PCU for reshipment, remove all plug-in components such as sealed relays and printed circuit boards which would be susceptible to shaking loose during transportation. These items should be packed in a small corrugated carton individually protected with soft wrapping material and the carton secured in the shipping crate.

A PCU should be bolted in a crate which provides at least 2 inches clearance. The PCU should then be wrapped in polyethylene and covered with wax impregnated double walled #350 corrugation and crated. Assistance, if required, is available from the nearest Louis Allis District Office.

# SECTION 2. INSTALLATION AND START UP

## 2.1 PHYSICAL INSTALLATION

The PCU is air cooled. The lowest HP rated units are cooled by convection; all other units are equipped with a fan to ensure adequate air flow. Select a site for installing the PCU which is clean and well ventilated; maintenance will be minimized if the PCU is located in a clean atmosphere.

The standard PCU is designed for vertical (wall) mounting. Attach the PCU to a wall, cabinet panel or other vertical structure using the bolt holes provided at the back of the PCU. Ensure that the unit is level.

## 2.2 ELECTRICAL HOOK UP

Refer to the equipment Interconnection Diagram for detailed wiring information. Ensure that wire size and disconnect devices conform to the installation contractor's drawings and to all applicable codes. Observe the following:

A. In long cable runs, take care to prevent excessive voltage drop.

B. Separate the leads used for speed reference, feedback, and other low level signals from those used for the motor armature, field and AC power.

C. Connect all shields on shielded wire to system common (not ground) on one end only. Twisted shielded pair wire should be used for long runs.

## 2.3 START UP PROCEDURE

This procedure contains instructions for starting up and checking out the PCU following installation.

### 2.3.1 Prepower Check

Perform the following checks before applying AC input power to prevent damage to the PCU.

A. Inspect all equipment for signs of damage, loose connections or other defects.

B. Ensure the power line voltage and frequency are correct for the drive system. Input power specifications are contained on the PCU nameplate or drive system schematic diagram.

C. Remove all shipping devices and relay wedges. Manually operate all contactors and relays to ensure they move freely.

D. Ensure that all electrical connections are secure.

E. Ensure that all transformers are connected for proper voltage according to the drive system schematic.

### 2.3.2 Initial Start Up

The drive system is started by applying AC input power to the PCU. Observe green READY LED on 12SCR Controller PCB when power is initially applied. Refer to Figure 1-2 for location of LED. The LED should light brightly for 5 to 15 seconds and then dim. If LED does not light, check for proper voltage between input power lines or for blown fuse.

On PCUs with an AC blower motor (power bridge fan), check that blower rotates in the correct direction when power is applied.

Since each PCU is thoroughly tested and adjusted for proper performance before it is shipped from the factory, additional adjustments are normally not required after installation. However, in some cases damage during shipment or inadvertent tampering with the potentiometers may necessitate installation adjustments. Adjustment procedures are contained in Section 4 of this manual. Before making any adjustments, carefully study the contents of this manual.

# SECTION 3. FUNCTIONAL DESCRIPTION

## 3.1 PCU BLOCK DIAGRAM DESCRIPTION

Refer to Figure 3-1 for a block diagram of the PCU.

Input power is applied to the forward and reverse SCR bridges through the AC fuses (which protect the rectifiers), and the current transformers (which provide a current feedback for use by the 12SCR Controller PCB current regulator). The input power is also applied to the Line Voltage Divider (located on Gate Firing PCB) which provides line voltage magnitude and synchronization information to circuits on the 12SCR Controller PCB. The line sync circuits provide a synchronization signal to the timing generator integrated circuits. The voltage regulator controls armature voltage based on a reference received from the Regulator PCB. The overcurrent trip circuit initiates an instantaneous static trip (TRIP) signal in the event of output overcurrent. The forward and reverse SCR gating controls generate the firing pulses which are transmitted by the Gate Firing PCB to the SCR bridge. The bridge output is an adjustable DC voltage, which is applied across the motor armature.

## 3.2 12SCR BRIDGE DESCRIPTION

The 12SCR bridge performs two major functions:

1. It converts AC voltage to DC voltage by rectification of the three-phase AC waveform due to its ability to conduct current in a controllable direction.

2. It varies the amplitude of the DC voltage, due to its ability to be turned on (fired) by an externally generated pulse.

Figure 3-2 is a simplified diagram of the SCR bridge. The SCRs with the suffix "F" provide positive current in the direction shown as FORWARD in the diagram. These SCRs are used in the first and fourth quadrants of operation, as shown in Figure 3-3. The SCRs with the suffix "R" provide current in the REVERSE direction, and are used in the second and third quadrants of operation.

It is inherent to the operation of an SCR that it will conduct current only when a forward bias voltage is applied (positive anode with respect to cathode) and once fired, it will continue in the conductive state until the forward current through it goes to zero. In the Figure 3-2 bridge configuration, the SCR bias voltages result from the three-phase input voltages and the motor counter EMF. An SCR may be made to conduct any time it is forward biased by application of a gate signal. The earlier in the forward bias period that the gate signal is applied, the larger the resulting output voltage will be. SCR commutation (turn off) will begin when the conducting phase voltage and the counter EMF are equal, and will be completed when the current through the inductive motor armature is driven to zero, or when the next SCR takes over conduction of continuous armature current.

To simplify the concepts of bridge operation, consider the phase A voltage with respect to phase C (Figure 3-2). 1SCRF and 2SCRF can conduct forward current through the motor when the phase A voltage is positive with respect to the motor counter EMF (both voltages referenced with respect to phase C). If the counter EMF is positive with respect to motor terminal A2 (which is tied to phase C when 2SCRF is conducting), then first quadrant operation results. If the counter EMF is negative with respect to A2, then second quadrant operation results. Still considering the phase A with respect to phase C voltage, it is seen that 4SCRR and 5SCRR can conduct reverse current through the motor when the phase A voltage is negative with respect to the counter EMF. If the counter EMF is positive with respect to

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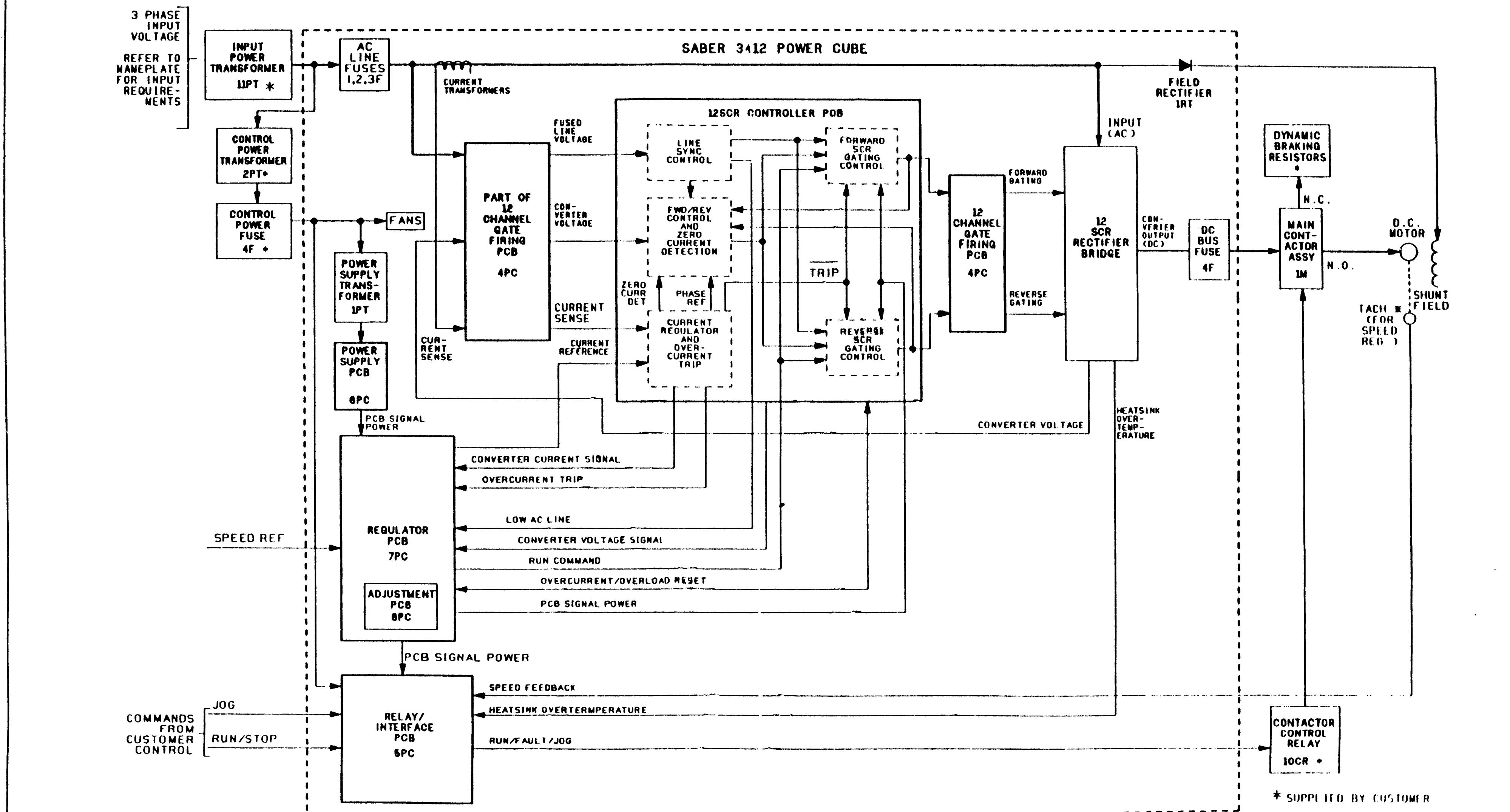
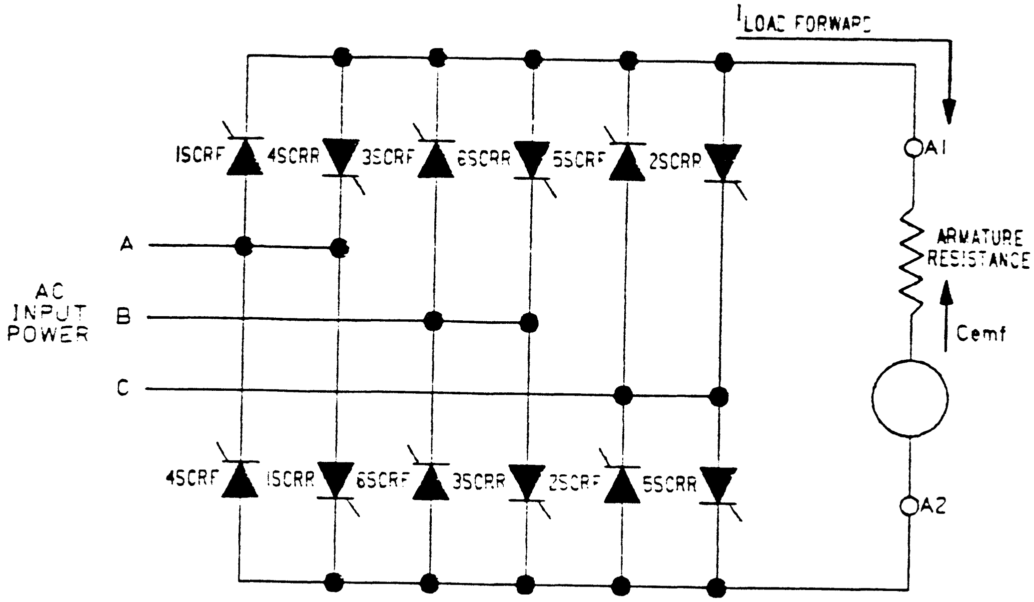



* SUPPLIED BY CUSTOMER

FIGURE 3-1.
DRIVE SYSTEM
BLOCK DIAGRAM




TD.3412.FIG.3.2

Figure 3-2. Simplified 12SCR Power Circuit

FORWARD CURRENT

SECOND QUADRANT

The PCU provides energy from the motor to the AC line to control an overhauling load in the reverse direction.

FIRST QUADRANT

The PCU supplies energy from the AC line to the motor to drive the load in the forward direction.

Reverse Rotation — — — — Forward Rotation

THIRD QUADRANT

The PCU supplies energy from the AC line to the motor to drive the load in the reverse direction.

FOURTH QUADRANT

The PCU provides energy from the motor to the AC line to control an overhauling load in the forward direction

REVERSE CURRENT

Figure 3-3. Four-Quadrant Representation

A2, fourth quadrant operation results. It should be noted that counter EMF polarity depends only on direction of rotation.

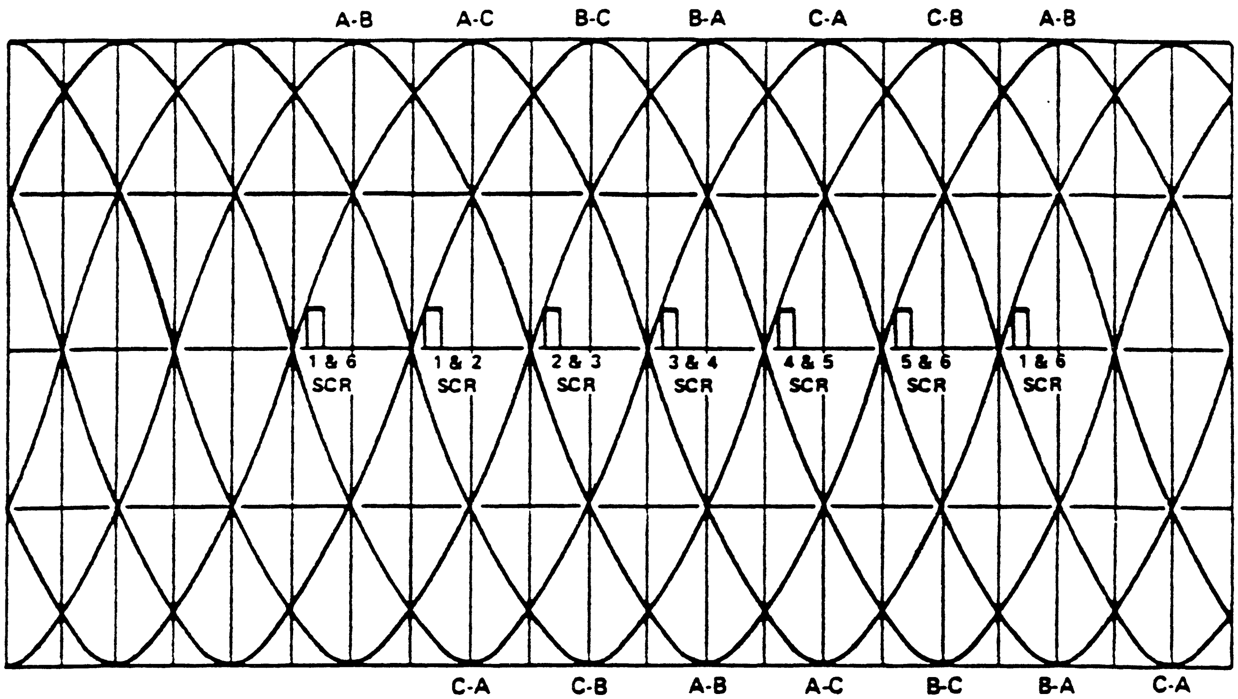
Table 3-1 shows the firing sequence for the forward and reverse SCRs. The conduction interval is 60 electrical degrees for each pair of SCRs during continuous current operation (i.e., the bridge output current does not go to zero between successive firings).

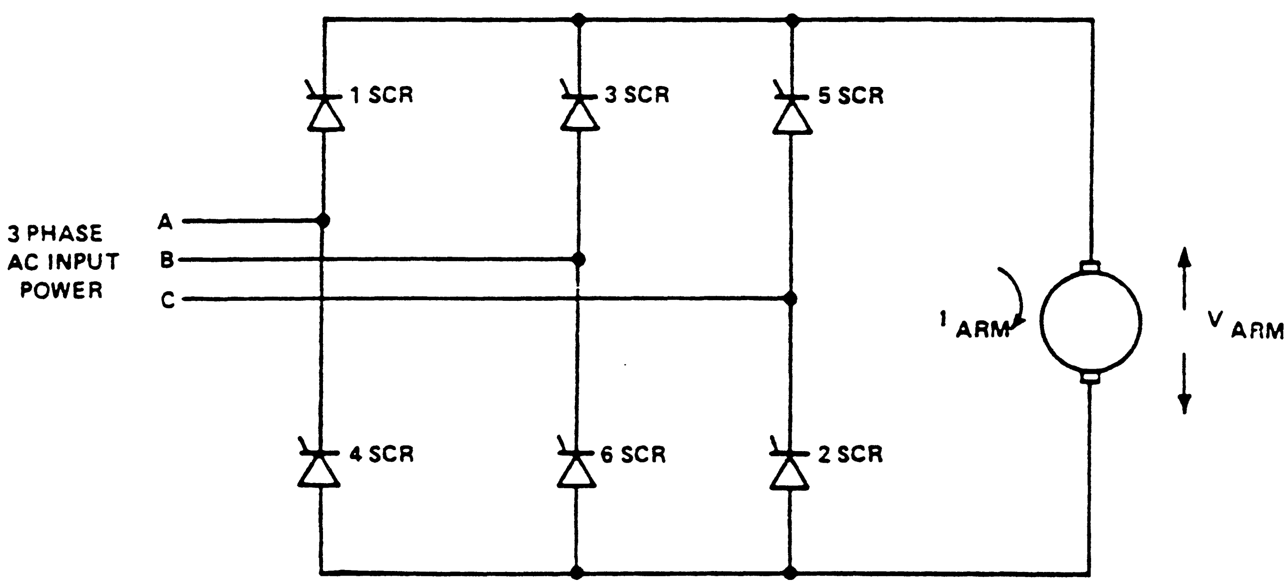
The three phase AC line voltage and the forward portion of the three-phase bridge are shown in Figure 3-4. The timing of gating pulses to achieve maximum output voltage is also shown. The SCRs in both bridges cannot be permitted to fire at the same time. If 1SCRF and 2SCRR or 6SCRR were fired at the same time, a line-to-line short circuit would occur, causing a high current that would result in a static shutdown or opening of the AC fuses. Logic circuits prevent the SCRs in one bridge from being fired while current is still flowing in the other bridge.

Table 3-1. SCR Firing Sequence

| MOST POSITIVE PHASE | MOST NEGATIVE PHASE | FORWARD SCR FIRING | REVERSE SCR FIRING |
|---|---|---|---|
| A | B | 1SCRF & 6SCRF | 1SCRR & 6SCRR |
| A | C | 1SCRF & 2SCRF | 1SCRR & 2SCRR |
| B | C | 3SCRF & 2SCRF | 3SCRR & 2SCRR |
| B | A | 3SCRF & 4SCRF | 3SCRR & 4SCRR |
| C | A | 5SCRF & 4SCRF | 5SCRR & 4SCRR |
| C | B | 5SCRF & 6SCRF | 5SCRR & 6SCRR |

SCR GATE PULSES SHOWN IN FULL CONDUCTION MODE




NOTE: ONLY FORWARD 6SCR BRIDGE SHOWN

See Figure 3-2 for 12SCR Bridge

Figure 3-4. SCR Gate Pulses, AC Line Waveforms and 6SCR Power Bridge

## 3.3 CIRCUIT DESCRIPTIONS

Following are detailed circuit level descriptions for printed circuit boards in the Power Cube. Refer to the "Drawings" section for the schematic diagrams of each.

### 3.3.1 Gate Firing PCB

The 12 Channel Gate Firing PCB (4PC) is mounted inside the Power Cube, with wiring connections to the SCRs in the rectifier bridge heat sink assembly. Each gate firing channel delivers firing pulses from the appropriate Firing Logic Pulse Amplifier on the 12SCR Controller PCB. Pulse transformers on the Gate Firing PCB isolate the firing circuitry from the AC line.

The Voltage Dividers are mounted on the Gate Firing PCB. Inputs to this PCB are:

1. The three-phase input line voltages after they have gone through the input fuses; designated as Fused Line Voltages (A, B, C).

2. Converter Voltage (F+, F-).

The voltage levels are scaled down to low level signals through resistive voltage dividers.

For wiring convenience, the current sense signals from the current transformers are fed through this board. All output signals from this board are inputted to the 12SCR Controller PCB via connector 3CONN.

### 3.3.2 12SCR Controller PCB

The 12SCR Controller PCB is mounted on the front of the swing-out panel and performs the following functions:

1. Power Line Sensing and Synchronization

Power line sensing and synchronization uses the scaled fused line voltages from the Gate Firing PCB. The fused line voltage has been reduced to 1% of the input AC line-to-line and is connected to the 12SCR Controller PCB at 3CONN(12), (13), (14), and (15). Differential amplifiers on the circuit board provide signal buffering and noise isolation. The generated signal voltages monitored at 4TP, 5TP, and 6TP duplicate the line-to-line voltage LAB, LBC, LCA respectively. The three-phase line-to-line signals are rectified, by 7-12RT, to produce a DC signal proportional to the combined line voltages, monitored at 9TP. The voltage at 9TP must be 7.5 VDC ±0.25 VDC. Switches 2SS and 3SS have been provided for the correct scaling of either 460 VAC or 230 VAC line-to-line input voltages. The magnitude of these signals is an important part of safe operation sensing. Line synchronization uses the line AB signal as a primary source. The signal is delayed 30 electrical degrees by capacitor 1C and resistor 2R. Switch 1SS must be in the CLOSED position for 60HZ application, and OPENED for 50HZ application. Switch 1SS being opened, adds resistor 1R into the circuit, thereby, ensuring a 30 degree phase shift at 50HZ input power line frequency. This 30 degree phase shifted signal is then amplified by a two stage comparator. The synchronizing signal appears at 7TP as a clean square wave. A second line signal, BC is used to determine power line phase rotation to adjust the SCR firing sequence accordingly. Each SCR timing generator circuit operates with its own clock phase locked to these synchronizing signals.

Noise filtering is done by 5C. A low line limit threshold is generated by resistors 3 and 17R. If the measured line voltage is less than 70% of nominal, 11TP will be at a logic low level causing a shutdown of the SCR Timing Generators, and the LINE LOSS indicator 2LED will illuminate red.

2. Current Regulator and Phase Control

The primary control mechanism of the 12SCR Controller PCB is a closed loop current regulator with a closed loop phase angle regulator. Each of these control loops provide functions necessary for smooth response and protection of the power converter. The current reference command enters at 5CONN(17) and can be of either polarity. A negative signal at 21TP will call for "FORWARD" motor current. Analog switch 15MC provides local startup and shutdown control of the current reference in sequence with external RUN commands. Current limit for the controller is provided by clamping of the current reference at 22TP. The current feedback signal is available at 26TP. These signals are compared and the difference, or error, is amplified by 7MC with associated components providing adjustment for crossover frequency (3RH) and phase lead (4RH). The resultant current error signal at 24TP is used as the power converter phase angle command for the SCR Timing Generator integrated circuits. This phase command is limited in order to protect the motor and converter from commutation failure during regeneration. The actual signal clamping is initiated by 2MC and is a function of the polarity and magnitude of current flow and phase reference magnitude. The converter voltage limit is increased with increased motoring quadrant current flow. When the power converter phase angle command at 24TP is at zero volts, the SCR firing(s) will occur at a delay angle of 120 degrees or just at the AC line zero crossings. The phase angle command at 24TP is applied directly to the reverse analog to digital converter and SCR Timing Generator, while the forward channel uses an inverted version of that same signal. In this manner, as the forward power circuit timing is advanced for more output voltage, the reverse power circuit timing is retarded. Because of the way in which the power converter is constructed, this allows the forward and reverse power circuits to track one another in equivalent voltage output. The direction control logic will allow only one direction at a time to be enabled, but the phase controls will continue to track one another so that a smooth forward to reverse transfer of current can be made without delay. The control of analog to digital signal conversion, generation of phase control action via SCR firing pulses and startup/shutdown sequencing is accomplished entirely within the SCR Timing Generator integrated circuits.

3. Pulse Amplifiers

The firing pulses for the individual power circuit SCR devices are generated within the SCR Timing Generator integrated circuits, 10MC (Forward) and 11MC (Reverse). These signals are amplified by a field effect transistor, one for each of 12 channels, and applied to the individual SCR pulse transformers located on the Gate Firing PCB. Pulse power is 24 volts DC and is controlled by an electronic switch, 2 and 4TS, as part of the startup/shutdown sequencing. This ensures that no spurious firing pulses can be generated due to abnormal levels. For direction control, the SCR firing pulses are suppressed by the SCR Timing Generator whenever the ENABLE signal at pin 22 is at a logic low.

4. Reversing Logic

The reversing logic determines which directional power converter will be energized at a given instant and controls the conditions under which a change in direction transfer is made. The outputs of the direction logic enables either the Forward or Reverse SCR Timing Generator pulse outputs, but never both at the same time. Inputs to the circuit are a desired direction command, derived from the phase reference signal at 24TP and converter output voltage feedback at 35TP, and a zero current detector (ZCD) at 41TP. When the desired direction is not the same as that presently enabled, and when there is no converter current flow, the logic will switch to the new direction. The internal Run or Phaseback command is also tied into the forward and reverse enable logic. When the Phaseback command is ON, both forward and reverse firing will be inhibited as soon as current flow stops. Zero power circuit current is determined by comparing (27MC-B) converter voltage feedback on 3MC pin 1 to the synthesized converter voltage signal at 40TP. If the two signals are different, then the current is zero and a direction change is allowed.

5. Current Sensing

Current sensing is accomplished with current transformers on the three-phase power lines feeding the power circuit. These isolated secondary signals are rectified by 49-54RT and the CT burden resistor (located on the 6CONN plug) to provide the necessary scaling to convert actual measured current to a -1 volt signal. This signal is selectively inverted to represent current flow of the opposite polarity when the reversing logic is in the forward direction at 26TP. The CT burden resistor voltage is also sensed by the Overcurrent Trip (IST) circuit as a safety shutdown mechanism. The IST level is set at 325% of rated current (1V = rated).

6. Converter Voltage Feedback

Voltage feedback sensing is done at the DC output of the power converter. A resistor voltage divider and differential amplifier is used for signal isolation. Converter voltage feedback is used to detect zero current and is also compared with the phase angle command to determine the desired direction of current flow. The magnitude scaling of this signal is critical for proper operation of the controller. When the instantaneous DC output voltage is the same as the rated RMS AC input voltage, 35TP will be at 6 volts. The polarity will depend upon the direction selected at that instant. Switch 4SS has been provided to properly scale either 240V or 500V armatures.

7. Start/Stop Sequencing

During a cold startup, spurious SCR gating pulses are suppressed by both the SCR Timing Generator circuits and the gate power electronic switch, 2 and 4TS. When both Forward and Reverse SCR Timing Generators have achieved phase lock with the power line, switch 2 and 4TS are activated making the pulse amplifier circuits ready to function.

The current reference at 21TP is held to zero by analog switch 15MC. When a Run command is received via 5CONN(11), the signal is passed thru 11MC, exiting out at pin 3 (phaseback) where it is passed on to the Run input pin 4 of 10MC exiting again at the phaseback output pin 3 of 10MC. This command signal now enables the current reference analog switch and resets flip-flop 14MC in the reversing logic to enable either of the SCR Timing Generators to generate SCR gating pulses as required. The error amplifier clamps are also released at this time allowing the entire circuit to begin operating. When the external Run command stops, the current reference analog switch clamps the effective current reference to zero via the same path thru 11MC and 10MC as described earlier. The current regulator then extinguishes voltage on the load motor, but the SCR Timing Generators and error amplifiers remain enabled until zero voltage is actually detected. In the event of an Overcurrent Trip (IST) or detection of a low power line level, the shutdown sequence is as described above, but initiated from either the IST TRIP inputs on pin 38 or Line Monitor input on pin 34 of either 10 or 11MC. With an emergency shutdown such as IST or low line, however, the power delay output on pin 40 will also go LOW causing an eventual cut off of SCR gating power via the gate power switch. Receipt of an IST RESET command or restoration of the power source voltage after a power loss, will cause a cold restart as described previously.

### 3.3.3 Relay/Interface PCB, 5PC

The Relay/Interface PCB, mounted in the bottom of the Power Cube, provides a variety of interface connections and mounting for standard functions.

Tachometer voltage divider series resistors are connected between 2TB(20) and connector pin 18CONN(11). Any one or all of the resistors may be jumpered out of the divider using .187 inch male fastons 1-5.

5PC also provides 115VAC control voltage to +15 volt control "RUN" command interfacing and isolation. The 115 VAC run command is connected to 1TB(21). Rectification and optical isolation is provided by optocoupler 1MC. This run command is used in the start and stop sequence of the PCU.

5PC provides 115 VAC connections for the 12SCR heat sink cooling fan(s) and the signal power supply transformer. The PCU Ready/Fault relay, 5CR, is also mounted on 5PC. The Speed Reference connection is made at 2TB(19). Signal common connections are made at 1TB(1) and 2TB (22).

### 3.3.4 Power Supply PCB, 6PC

This PCB receives center tapped 36 VAC from the secondary of power supply transformer 1PT and converts it to ±15 VDC and ±24 VDC control voltages which are connected to the Regulator PCB, 7PC.

### 3.3.5 Regulator PCB, 7PC

The Regulator PCB, mounted on the front of the swing-out panel, provides for connection and mounting of various standard industrial functions.

±15 VDC and ±24 VDC control voltages used by circuits on this PCB are received from the Power Supply PCB, 6PC, via 6CONN. These voltages are also fed to the Relay/Interface PCB, 5PC, (via 18CONN and 19CONN) and the 12SCR Controller PCB (via 5CONN). In addition, this PCB uses the ±15 VDC to produce ±10 VDC (unregulated) reference voltages. The Speed Reference and scaled tachometer speed feedback are compared by amplifier 4MC-A. This signal is further calibrated by the MAX SPEED pot with regulator connections at pins 4CONN(1) and (3). The Speed Reference signal is connected from the Relay/Interface PCB at pin 18CONN(3).

The speed error is now the current reference and can be monitored at 55 and 58TP. All connections for the 12SCR Controller PCB are made to the Regulator PCB by connector 5CONN. A ±10% of rated reference zero speed bias is connected from the Adjustment PCB, 8PC, to the Regulator PCB at connector pin 4CONN(13).

The electronic overload circuit includes amplifiers 8MC-A, 8MC-B, 5MC-A, 6MC-A, 6MC-B and 1TS. The bipolar current feedback voltage from the 12SCR Controller PCB at 10TP is rectified by the absolute value circuit with amplifiers 8MC-A and 8MC-B. The unipolar current feedback voltage at 64TP is magnitude sensed by comparator 5MC-A and timed by amplifier 6MC-A. See the overload vs. trip time curve in Figure 1-3. The electronic overload may be reset manually with 11PB on the Adjustment PCB, 8PC, when switch 13SS(4) is OPEN. The overload is automatically reset in approx. 60 sec. with switch 13SS(4) CLOSED.

Separately adjustable jogging is provided as standard on all Saber 3412 controls. Jogging provides for operation of the drive at an adjustable preset low speed for as long as the JOG push button is depressed. When the JOG push button is released, the drive will stop. Jog speed is limited to 30% of top speed.

NOTE

When using a reversing power unit, the drive will have Jog capability in both forward and reverse directions. When the JOG push button is pressed, the drive will jog in the direction selected by the FORWARD/REVERSE selector switch. A single JOG speed setter (internal or remote) is used so that Jog speed will be the same in both directions of rotation.

### 3.3.6 Adjustment PCB, 8PC

This PCB, mounted to standoffs on the Regulator PCB, contains adjustment potentiometers, indicator LEDs, and a RESET push button, associated with the functional circuits on the Regulator PCB.

# SECTION 4. ADJUSTMENT AND CHECKS OF FIXED SETTINGS

## 4.1 GENERAL

The adjustments and checks associated with the PCU must be performed by competent electrical maintenance personnel, familiar with solid state circuitry. It is imperative that personnel familiarize themselves with the theory portion of this manual before attempting any adjustments.

### 4.1.1 Test Equipment

Equipment required for performing adjustment procedures is listed in paragraph 1.5.

## 4.2 WARNINGS AND CAUTIONS

**WARNING**

HAZARDOUS VOLTAGES CAPABLE OF SEVERE INJURY OR DEATH ARE PRESENT AT RECTIFIER HEAT SINKS WITH INPUT POWER APPLIED. WHEN PERFORMING ADJUSTMENT PROCEDURES WITH INPUT POWER APPLIED, DO NOT TOUCH OR GRASP ANY CIRCUIT POINT.

**WARNING**

WHEN USING AN OSCILLOSCOPE, OBSERVE RECOMMENDED OSCILLOSCOPE PROCEDURE, PARAGRAPH 4.2.1.

### 4.2.1 Recommended Oscilloscope Procedure

When using an oscilloscope to observe the high voltage waveforms in the PCU, the two oscilloscope channels should be used in a differential mode with two X100 probes and with the oscilloscope chassis connected to earth ground.

## 4.3 ADJUSTMENTS

**WARNING**

HAZARDOUS VOLTAGES EXIST IN CABINET EVEN WITH CABINET CIRCUIT BREAKER IN OFF POSITION. DISCONNECT AND LOCK OUT THREE-PHASE INPUT POWER AND CONTROL POWER BEFORE:

1. CONNECTING OR DISCONNECTING TEST EQUIPMENT.

2. REMOVING OR REPLACING A COMPONENT.

FAILURE TO OBSERVE THIS WARNING MAY RESULT IN SEVERE INJURY OR EQUIPMENT DAMAGE.

**IMPORTANT**

Armature voltage and current should be monitored by suitable instruments during full load operation of the equipment through the specified duty cycle to ensure that none of the set limits is exceeded.

Table 4-1 identifies controller functions set by switches on the Regulator PCB, 7PC, and the 12SCR Controller PCB. Table 4-2 lists the reference designator, control name, and function of potentiometers 11RH thru 18RH. Figure 4-1 shows the location of potentiometers, LEDS, and overcurrent/overload RESET push button 11PB.

Table 4-3 lists the adjustment procedures for the PCU potentiometers and the procedures to check the fixed settings on the PCU. A brief functional description of each potentiometer and fixed setting is also included. Proceed in the order listed. During the procedures, disregard any PCU LED illumination, unless specifically instructed otherwise. If difficulty is encountered in obtaining the voltages specified, refer to para. 6.5 Preliminary Checks. If the voltages listed in 6.5 are present at the PCU test points but the voltages specified in Table 4.3 still cannot be obtained, refer to Table 6.1.

4.3.1 Initial Adjustments - No Power Applied

The switches on the Regulator PCB and the potentiometers on the Adjustment PCB (see Figure 4-1) are factory adjusted to initial settings. Before energizing the drive, ensure that all settings agree with Table 4-1. If site application requirements differ from factory set-up consitions, the settings will be changed according to modification instruction sheets.

4.3.2 Initial Potentiometer Adjustments

A. Potentiometers 11RH thru 18RH on the Adjustment PCB are factory set and should not require further adjustment prior to application of power.

IMPORTANT

FORWARD CURRENT LIMIT (13RH), REVERSE CURRENT LIMIT (14RH), and IR COMP (16RH) should NOT be changed from their factory settings unless required by the drive application.

B. On Operator Control Station, set SPEED pot to 0% (fully CCW).

4.3.3 Adjustments-Energized Drive

A. Apply incoming 3Ø 50/60HZ power to drive unit.

B. Note green READY LED is illuminated and all red LEDs are extinguished.

C. Connect a voltmeter from 14TP to 63TP (common) on the Regulator PCB (or set Test Meter modification to position 15) and check for -3.75V. This verifies that FORWARD CURRENT LIMIT is at 150%. If reading is incorrect, adjust 13RH to obtain -3.75V.

D. Connect a voltmeter from 68TP to 63TP (common) on the Regulator PCB (or set Test Meter modification to position 13) and check for +3.75V. This verifies that REVERSE CURRENT LIMIT is at 150%. If reading is incorrect, adjust 14RH to obtain +3.75V.

E. Press RUN push button.

F. Slowly turn SPEED control clockwise and observe drive speed increase.

G. With SPEED control fully clockwise, turn MAX SPEED potentiometer clockwise until desired maximum operating speed is reached. Do not set MAX SPEED potentiometer to a setting which will allow a motor speed or armature voltage higher than that indicated on the motor nameplate.

H. Turn SPEED control fully counterclockwise and observe drive speed decrease.

I. Turn ZERO TRACKING potentiometer clockwise until desired minimum operating speed is reached.

J. Stop drive and turn ACCEL RATE and DECEL RATE potentiometers counterclockwise to 0%.

K. Turn SPEED control fully clockwise and start drive. Note the time it takes for drive to reach maximum speed. If shorter acceleration time is desired, adjust ACCEL RATE potentiometer to increase acceleration rate. Stop and start drive several times and adjust potentiometer until desired acceleration rate is obtained.

L. With drive running at maximum speed, turn SPEED control rapidly to fully counterclockwise. Note the time it takes for drive to reach minimum speed. If longer deceleratioin time is desired, adjust DECEL RATE potentiometer to decrease deceleration rate. Change drive speed to maximum and rapidly back to minimum several times and adjust potentiometer until desired deceleration rate is obtained.

M. Press and hold JOG push button. Adjust JOG potentiometer to give desired Jog speed.

N. The factory setting of IR COMP is normally adequate. If adjustment is required, it should be done with an appreciable load applied to the drive. Uncouple the motor from load and run motor at 100% speed, measuring exact motor speed. Stop drive and recouple load. Start drive with SPEED still at 100%, and check motor RPM. Adjust IR COMP potentiometer to give motor speed 0.5% lower than the unloaded speed previously recorded.

Table 4-1. Switchable Controller Functions

| A. On Regulator PCB, 7PC | | | |
|---|---|---|---|
| SWITCH | FUNCTION | ON | OFF |
| 11SS(1) | LAC TIME | 7-40 Sec. | 1-7 Sec. |
| 13SS(1) | JOG | Internal | External |
| 12SS(4) | FDBK CAL. | 500 VDC | 240 VDC |
| 12SS(2) | VOLT/SPEED | VOLT REG | SPEED REG **<br>(tach feedback) |
| 13SS(3) | IR COMP | BOOST INSPEED | DROOP INSPEED |
| 13SS(2)* | IR COMP DELAY | ALWAYS ON | |
| 12SS(3)* | CURRENT REF | ALWAYS ON | |
| 12SS(1)* | 10/7.5V REF | ALWAYS ON (-10V) | |
| 13SS(4)* | OVERLOAD TRIP | AUTOMATIC RESET | MANUAL RESET |

| B. On 12SCR Controller PCB *** | | | |
|---|---|---|---|
| SWITCH | FUNCTION | ON<br>(CLOSED) | OFF<br>(OPEN) |
| 1SS | LINE FREQUENCY | ALWAYS ON (60 HZ) | |
| 2SS & 3SS | LINE VOLTAGE | 460V | 230V |
| 4SS | CONVERTER VOLTAGE | 460V | 240V |

* Do Not Change unless specified by the factory, or according to adjustments in modification instruction sheets.

** Speed Regulator PCB required.

*** Check PCU data plate to ensure proper switch settings when installing a replacement board.

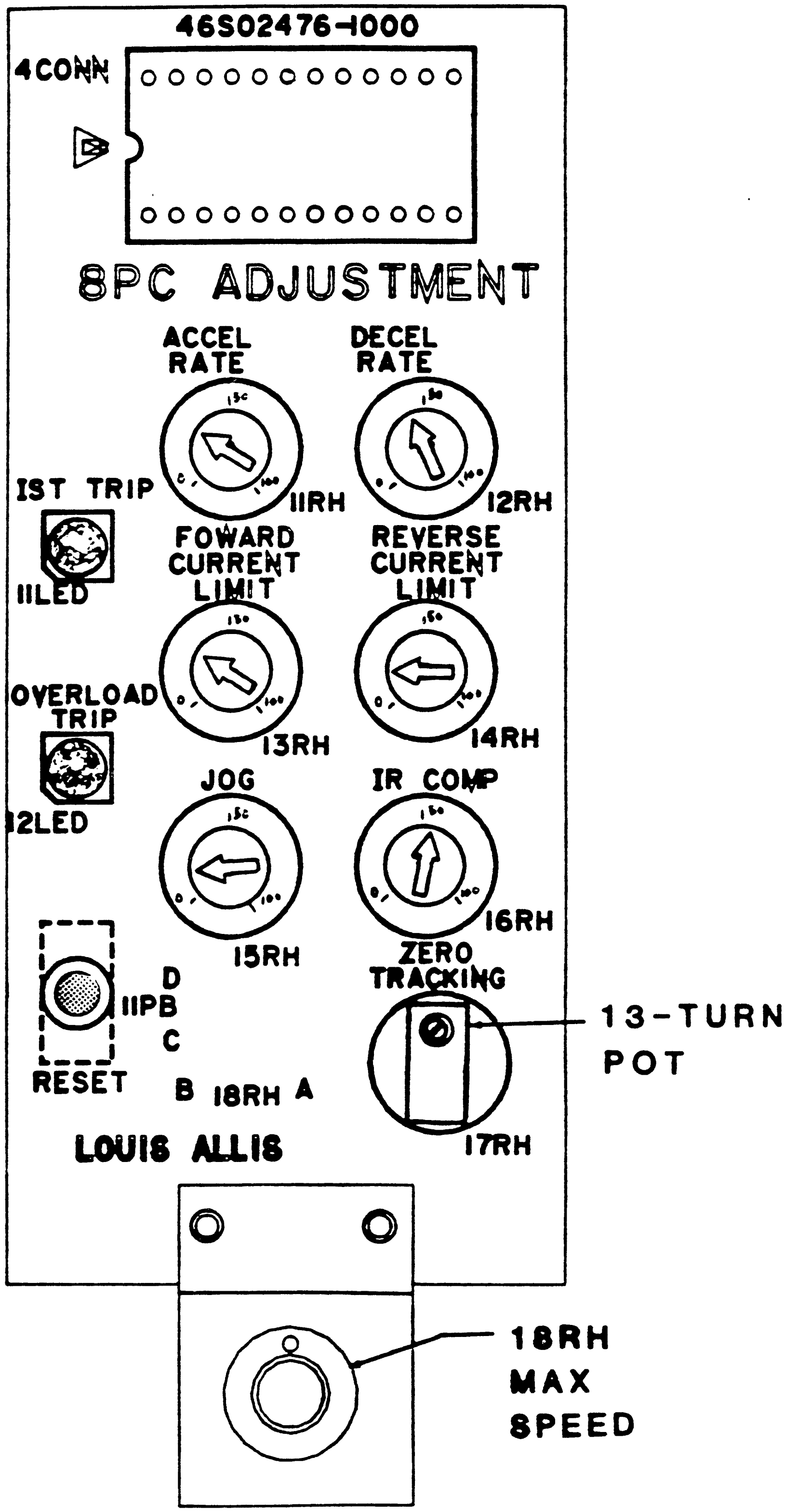



Figure 4-1. Location of Adjustment Controls

Table 4-2. Function of Potentiometers

| REFERENCE DESIGNATOR | CONTROL NAME | FUNCTION |
|---|---|---|
| 11RH | ACCEL RATE | Sets acceleration rate of drive. Turning pot clockwise increases acceleration rate. |
| 12RH | DECEL RATE | Sets deceleration rate of drive. Turning pot clockwise increases deceleration rate. |
| 13RH | FORWARD CURRENT LIMIT | Limits maximum average forward drive current from 0 to 200%. Turning pot CW increases available current. |
| 14RH | REVERSE CURRENT LIMIT | Limits maximum average reverse drive current from 0 to 200%. Turning pot CW increases available current. |
| 15RH | JOG | Sets jog speed when JOG mode internal is selected. Turning pot clockwise increases jog speed. |
| 16RH | IR COMP | When switch 13SS(3) is set to ON: Sets amount of speed boost(regulation) when motor becomes loaded. Turning pot clockwise increases speed under load. When switch 13SS(3) is set to OFF: Sets amount of speed droop when motor becomes loaded. Turnig pot clockwise decreases speed under load. |
| 17RH | ZERO TRACKING | Sets minimum motor speed when Volt/Speed Reference Input is zero. Supplies 0 to ±7.0% of Volt/Speed Reference bias. The pot at mid-range supplies zero speed reference; fully clockwise supplies +7.0% (forward motor rotation) speed reference; fully CCW supplies -7.0% (reverse motor rotation) speed reference. |
| 18RH | MAX SPEED | Sets maximum speed of motor. Turning pot clockwise increases maximum operation speed. |

Table 4-3. Ajustments and Checks

| STEP | PCB POTENTIOMETER NAME | FUNCTIONAL DESCRIPTION | INITIAL SETTING | ADJUSTMENT PROCEDURE |
|---|---|---|---|---|
| 1 | 12SCR Controller LEAD (4RH). | Sets current regulator dynamic characteristics for a particular application. | Factory set at 20%. | Initially set at 20%. (See Step 2) |
| 2 | 12SCR Controller CROSSOVER FREQ (3RH). | Sets current regulator dynamic characteristics for a particular application. | Factory set, will not normally need to be readjusted except when PCB is replaced, or inadvertently tampered with. | 1. Set CROSSOVER FREQ 10% CW from the fully CCW position.<br>2. Set an oscilloscope vertical deflection to 0.05V/cm and the horizontal sweep to 2ms/cm. Connect x10 probe to 29TP I ERROR and ground clip to TP COM.<br>3. Disconnect the motor field supply and lock motor armature. Ensure that friction brake will remain energized even when the run loop is closed.<br><br>CAUTION<br>WITH THE MOTOR ARMATURE LOCKED, DO NOT APPLY POWER TO THE ARMATURE FOR LONGER THAN ONE MINUTE. TO DO SO COULD CAUSE THE ARMATURE WINDING TO BURN OUT. ALLOW A 5 MINUTE COOL DOWN PERIOD. |

Table 4-3. Adjustments and Checks (Continued)

| STEP | PCB POTENTIOMETER NAME | FUNCTIONAL DESCRIPTION | INITIAL SETTING | ADJUSTMENT PROCEDURE |
|---|---|---|---|---|
| 2 | 12SCR Controller CROSSOVER FREQ (3RH). (Cont'd) | | | 4. Energize the unit and apply Run Command. Increase the current reference by slowly turning the SPEED pot CW until continuous current is obtained.<br>5. Slowly increase setting of CROSSOVER FREQ pot until waveform begins to show uneven pulses as in Figure A, then back off 15%. A correct stable waveform should look like Figure B. |


Figure A

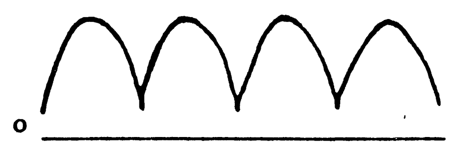



Figure B

IMPORTANT

If drive operation is not smooth or if erratic SCR firing occurs during drive operation, increase the setting of the LEAD pot (4RH) above 20% and repeat Steps 1 thru 5. If system operation does not improve with settings of the LEAD pot above 20%, reduce the LEAD pot setting below 20% and repeat Steps 1 thru 5. DO NOT SET LEAD POT TO LESS THAN 10%. If PCB replacement is necessary, set the pots on the new board to the same setting as the board being replaced.

Table 4-3. Adjustments and Checks (Continued)

| STEP | PCB POTENTIOMETER NAME | FUNCTIONAL DESCRIPTION | INITIAL SETTING | ADJUSTMENT PROCEDURE |
|---|---|---|---|---|
| 2 | 12SCR Controller CROSSOVER FREQ (3RH). (Cont'd) | | | 6. De-energize drive and reconnect any connections removed during setup. |
| 3 | Adjustment PCB IR COMP (16RH) | Provides an added reference proportional to output current when in Voltage Regulator mode to minimize speed variations with load due to the IR drop across the armature resistance. | Fully CCW | When running in Voltage Regulator mode, increase setting to minimize noload to full-load speed variation. |
| 4 | Adjustment PCB FORWARD CURRENT LIMIT (13RH) and REVERSE CURRENT LIMIT (14RH) | Set limit of maximum average drive current, in forward and reverse current, from 0 to 200%. | Factory set at 150%, will not normally need to be readjusted except when PCB is replaced, or inadvertently tampered with. | See paragraph 4.3.3, A-D. |

# SECTION 5 MAINTENANCE

**WARNING**

HAZARDOUS VOLTAGES EXIST ON THE PCU PANEL EVEN WHEN THE DRIVE IS NOT RUNNING. DISCONNECT AND LOCK OUT THREE-PHASE CONTROL POWER BEFORE:

1) PERFORMING PREVENTIVE MAINTENANCE;
2) CONNECTING OR DISCONNECTING TEST EQUIPMENT;

OR

3) REMOVING OR REPLACING A COMPONENT.

FAILURE TO OBSERVE THIS WARNING CAN RESULT IN DEATH, SEVERE INJURY OR EQUIPMENT DAMAGE.

## 5.1 PREVENTIVE MAINTENANCE

Preventive maintenance is primarily a matter of routine inspection and cleaning. The rectifier bridge heat sinks should be kept clean by brushing while using a vacuum cleaner. Excess dust and dirt accumulation on the heat sinks can cause overheating of the SCRs.

Periodically check all electrical connections; tighten as required.

Periodically clean the cooling fans to prevent dirt buildup. At the same time check that the impellers are free and not binding in housing. Each fan motor is permanently lubricated; the fan should be replaced if the shaft does not spin freely.

## 5.2 REPAIR/REPLACEMENT PROCEDURES

### 5.2.1 Fuses

Equipment is protected by the following fuses in the PCU:

1F thru 3F – located in each phase of 3 phase input lines.

4F – provides protection for motor armature.

8F5 – located in 115 Vac line. Provides protection for:

- Power Bridge Fans
- Test Meter modification
- Motor Loop Circuit

9F5 – located in 115 Vac line. Provides protection for:

- 1PT Power Supply Transformer
- Auto/Manual switch
- Test Meter modification

Should fuses require replacement, identical or equivalent type fuses must be used. Refer to the equipment spare parts listing for part number identification.

### 5.2.2 Printed Circuit Boards

Repair of printed circuit boards requires special techniques and test facilities. For this reason, field repair is not authorized and replacement of a suspect board is recommended.

Defective or questionable printed circuit boards should be returned to MagneTek, Service Department, 16555 W. Ryerson Road, New Berlin, Wisconsin 53151, for repair and test. The printed circuit board should be individually protected with one inch thickness of soft wrapping material before it is packed in a suitable carton. MagneTek assumes no responsibility for printed circuit boards returned without proper return tags and forms. Contact your MagneTek representative for proper return tags and forms.

When replacing any PCB containing switches or adjustment potentiometers, check the "ADJUSTMENTS" label inside the PCU cover and set the replacement board to match the recorded settings. If the board being replaced is not in the PCU, set switches and potentiomerers the same as on the board being replaced.

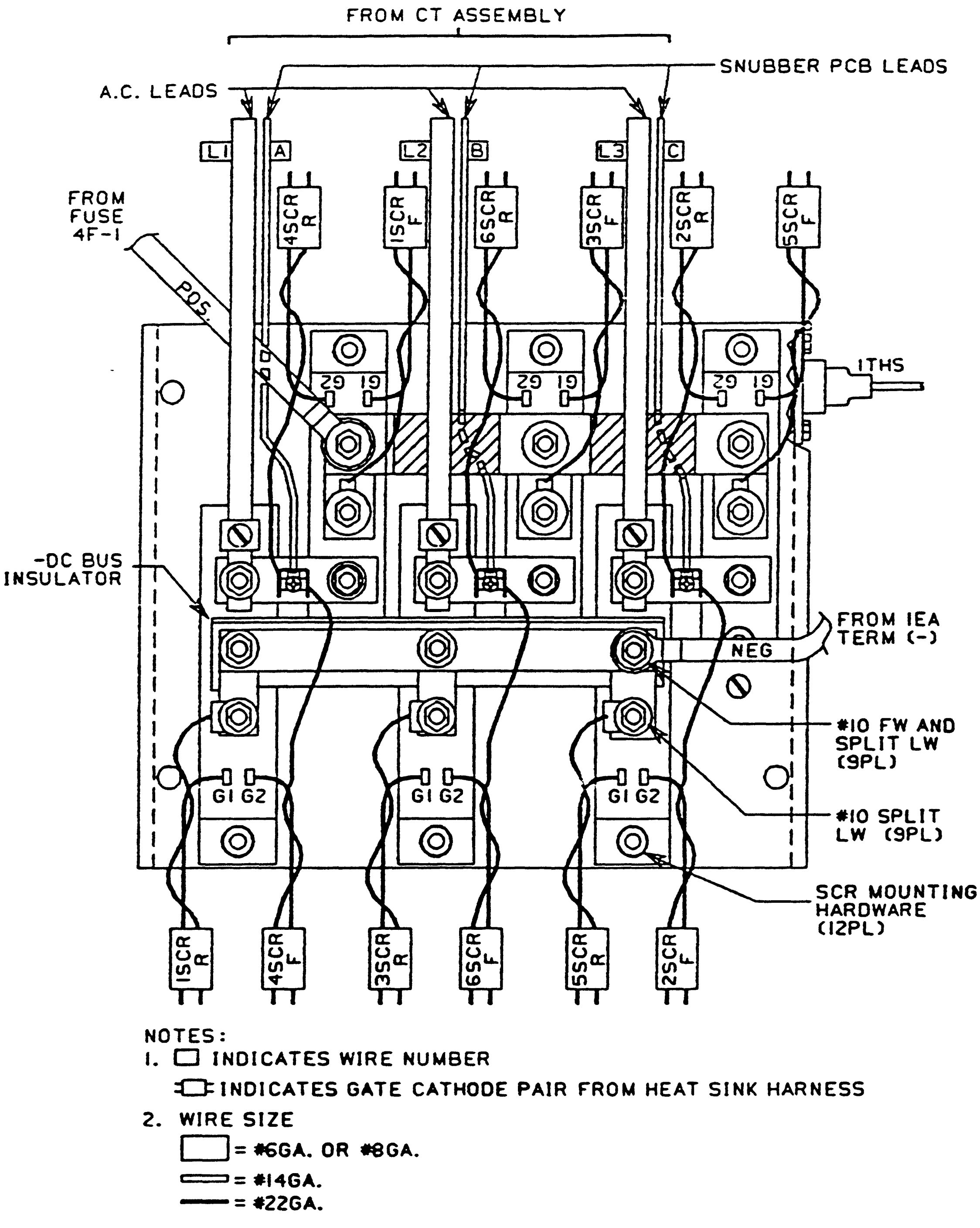



*Figure 5-1. Modular Type Heat Sink Assembly and Wiring*

### 5.2.3 Testing and Replacing Modular Type SCRs (240V 5-30HP, 500V 7.5-60HP units)

#### A. Disassembly of SCR Bridge

In order to test or replace modular SCRs, the bridge must first be disassembled as follows (see Figure 5-1):

NOTE

Metric hex nuts, M5, 8mm, are used on this type assembly. When removing, and during later re-assembly, use the proper tool to remove and replace.

1. Disconnect all heat sink harness gate (white) and cathode (red) leads from faston tabs on the SCR bridge.

2. Disconnect snubber lead wires "A", "B", and "C" from tabs on the bridge.

3. Remove nuts and washers, and remove "POS" DC output cable and bus bar from upper modules. Remove nuts and washers, and remove faston tabs and small bus bars.

4. Remove nuts and washers, and remove AC power lead terminals and bus bars with fastons attached.

5. Remove nuts and washers, and remove "NEG" DC output cable and bus bar from lower modules. Remove nuts and washers, and remove faston tabs, small bus bars and insulator.

#### B. Testing – Check SCRs without removing from the heat sink.

1. Using an ohmmeter in the X10K range, place the positive probe on SCR1 anode (A1), and the negative probe on SCR1 cathode (K1), shown in Figure 5-2. Compare your reading with section 1 of Table 5-1. After checking SCR1, check SCR2 by placing the positive probe on SCR2 anode (A2) and the negative probe on SCR2 cathode (K2), shown in Figure 5-2. Compare your reading with section 1 of Table 5-1.

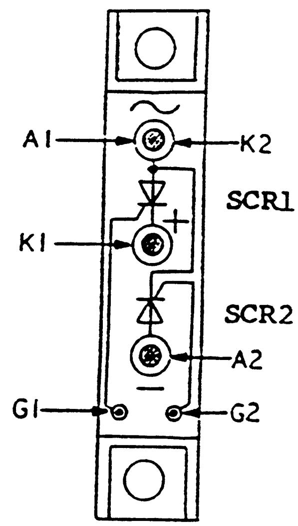
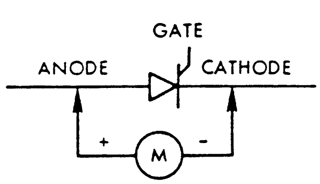
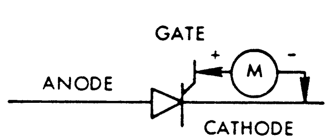



***Figure 5-2. SCR Module Test Points***

**Table 5-1. SCR Testing**

| TEST CONNECTION | METER READING | SCR CONDITION |
|---|---|---|
| 1  | "HOCKEY PUK" type<br>Greater than 20K<br>2K - 20K<br>Less than 2K<br>MODULAR type<br>Greater than 1.7M<br>Less than 1.7M | <br>ACCEPATBLE<br>QUESTIONABLE<br>SHORTED<br><br>ACCEPATBLE<br>SHORTED |
| 2  | "HOCKEY PUK" type<br>5 - 100 ohms<br>100 ohms - 1K<br>Less than 5 ohms<br>Greater than 1K<br>MODULAR type<br>19 - 130 ohms<br>Less than 19 ohms<br>Greater than 130 ohms | <br>ACCEPATBLE<br>QUESTIONABLE<br>SHORTED<br>OPEN<br><br>ACCEPATBLE<br>SHORTED<br>OPEN |

2. Place the positive probe of the ohmmeter on SCR1 cathode (K1), and the negative probe on SCR1 anode (A1). Compare your reading with section 1 of Table 5-1. After checking SCR1, check SCR2 by placing the positive probe on SCR2 cathode (K2) and the negative probe on SCR2 anode (A2). Compare your reading with section 1 of Table 5-1.

3. Set the ohmmeter to the X1 range. Check gate resistance of SCR1 by placing the positive probe on gate terminal G1 of the SCR module, shown in Figure 5-2, and the negative probe on SCR1 cathode (K1). Compare your reading with section 2 of Table 5-1. After checking SCR1, check SCR2 by placing the positive probe on gate terminal G2 of the SCR module, and the negative probe on SCR2 cathode (K2). Compare your reading with section 2 of Table 5-1.

C. Removal and Installation

Using a hex wrench or key, remove the two socket-head screws, with Belleville washers (and flat washer, if present), holding the SCR module to the heat sink, and gently pull the module from its position. Wipe off heat sink surface with a clean soft cloth.

See Figure 5-3. Examine the new module to determine the number of washers (Belleville and flat) required under each socket-head screw. If the module has a plastic housing, a flat washer of appropriate size should be under the Belleville washers. Modules that have a brass eyelet in the mounting hole must also have a flat washer installed. If the module has metal inserts for the Belleville washers to "seat" on, do not use the flat washer.

Apply a thin, even coating of thermal joint compound (NOT Penetrox A) to the entire bottom of the module. Position the module on the heat sink and loosely install the mounting hardware.

NOTE

Do not tighten hardware on the new nodule(s) until the bus bars have been re-installed.

Using a hex wrench or key, remove the three terminal studs from the replaced module and install them into threaded terminals of the new module.

D. Reassembly of SCR Bridge

After testing or replacement of SCRs, reassemble the bridge as follows (see Figure 5-1):

NOTE

Torque all nuts to 20 inch-pounds.

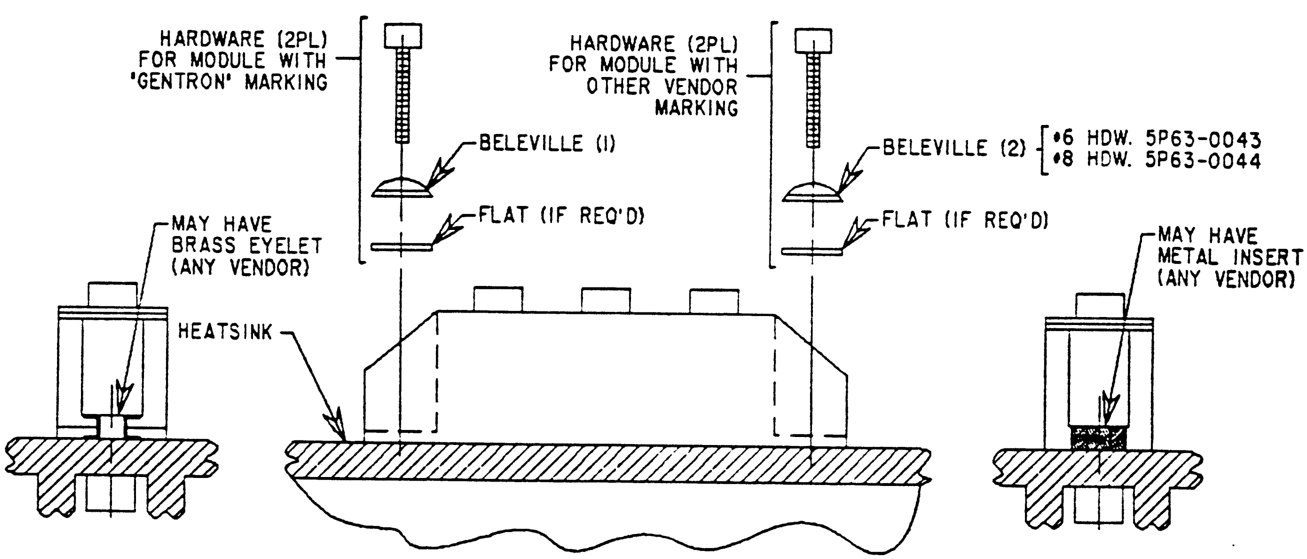



*Figure 5-3. Module Mounting Combinations*

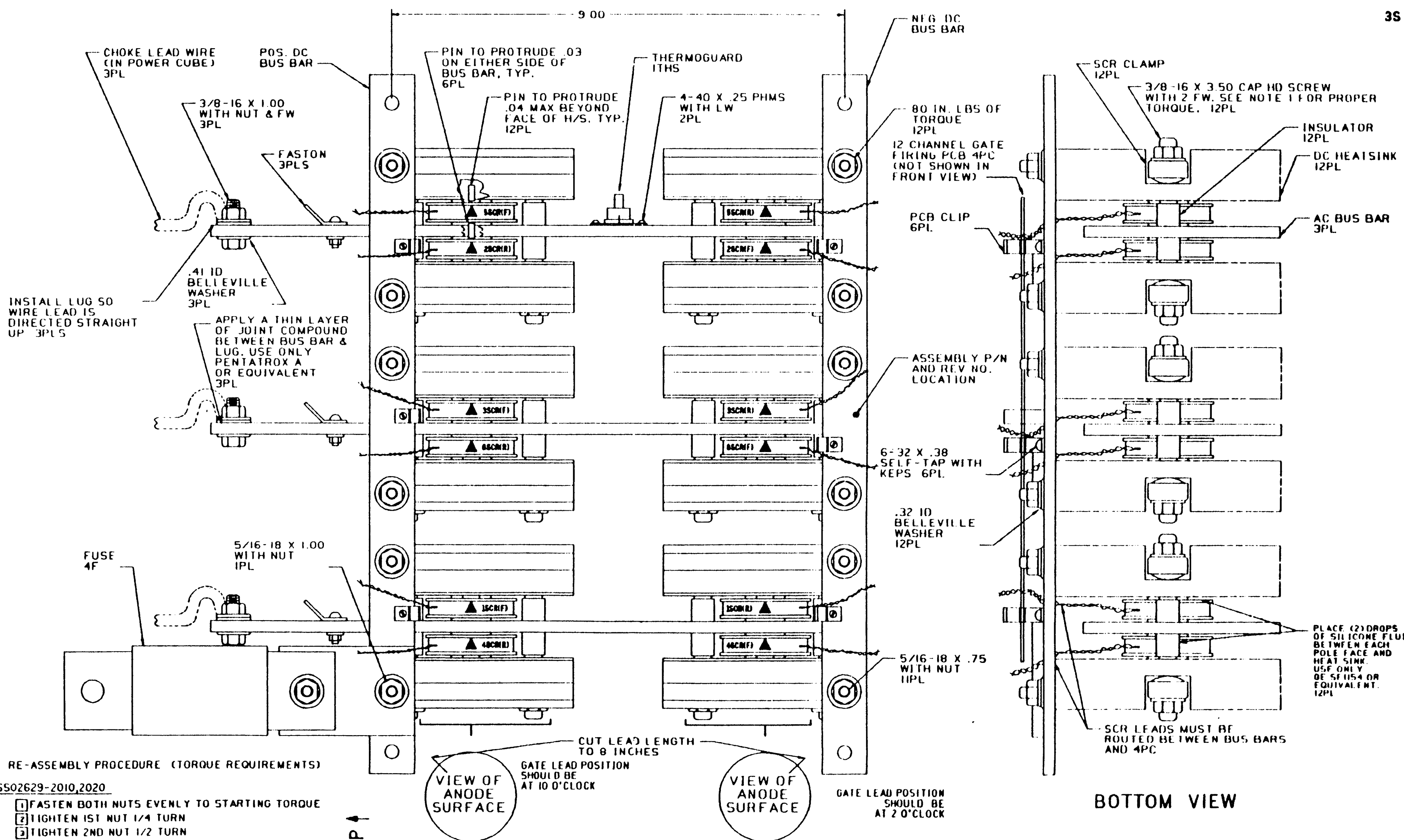



FIGURE 5-2
HOCKEY-PUK TYPE SCR
THREE PHASE HEAT SINK
ASSEMBLY, REMOVED
FROM POWER CUBE

NOTE 1. RE-ASSEMBLY PROCEDURE (TORQUE REQUIREMENTS)

P/N 46502629-2010,2020

1. FASTEN BOTH NUTS EVENLY TO STARTING TORQUE
2. TIGHTEN 1ST NUT 1/4 TURN
3. TIGHTEN 2ND NUT 1/2 TURN

P/N 46502629-2030

1. FASTEN BOTH NUTS EVENLY TO STARTING TORQUE
2. TIGHTEN 1ST NUT 1/4 TURN
3. TIGHTEN 2ND NUT 1/2 TURN
4. TIGHTEN 1ST NUT 1/2 TURN

1. Position insluator across lower modules. Position three small bus bars and faston tabs, turned as shown, and secure with lock washers and nuts.

2. Position –DC bus bar (uninsulated) across the three modules, and position "NEG" DC output lead. Loosely install washers and three metric nuts.

3. Position bus bars with fastons tabs attached across pairs of modules. Secure each at one end with a lock washer and nut. Position AC power lead terminals, and secure each with flat washers, lock washers and nuts.

4. Position three small bus bars and faston tabs on upper modules, and secure with lock washers and nuts.

5. Position bus bar with sleeving across modules, and position "POS" DC output lead. Secure with flat washers, lock washers and nuts.

**IMPORTANT**

DO NOT use a torque wrench for tightening module mounting hardware. The correctly flattened Belleville washer (as described below) provides the proper mounting pressure.

6. Start tightening mounting hardware of the new SCR module(s) by turning both screws equally (alternately) with a hex wrench or key. Continue with this procedure until the Belleville washers are flat. An abrupt change in torque will be detected when the Belleville becomes flat. Where accessible, wipe off excess thermal joint compound from module/heat sink assembly.

7. Reconnect snubber lead wires "A", "B", and "C" to tabs on bridge.

8. Reconnect heat sink harness lead wires to tabs on the bridge. (White leads go to gate (G) terminals.)

Before applying voltage:

Ensure all terminal nuts have been torqued correctly.

Check positive and negative bus bars for shorts.

Check AC lines for shorts.

5.2.4 Testing and Replacing "Hockey Puk" Type SCRS (240V 40-75HP, 500V 75-200HP units)

A. Testing

The SCRs in the rectifier are of the "Hockey Puk" configuration. These devices must be properly secured in their heat sinks to be effectively tested with an ohmmeter. Proper pressure must be applied to the poles of these SCRs to provide continuity. The proper amount of force is achieved by the turns ratio of the clamp mounting hardware. There are several different types of clamps used, and each has a different turns ratio. Testing of SCRs must be accomplished without removing them from the rectifier heat sink assembly. To accomplish the test, proceed as follows:

1. Remove the rectifier bridge heat sink assembly from the Power Cube in the following sequence (see Figure 1-1):

a. Remove ribbon cable connectors 1, 2, and 3CONN and 26CONN.

b. Remove the three quick-connect leads from the faston tabs on the bridge AC bus bars. Disconnect choke lead wires from the AC bus bars.

c. Disconnect 15CONN (thermoguard leads) from 5PC.

d. Remove nut and washer securing fuse 4F to stud on top insulator.

e. Remove the four mounting screws with washers and remove assembly from the Power Cube.

2. Remove all SCR gate and cathode connections from the 12 Channel Gate Firing PCB, and remove the board from clips on the heat sink assembly.

3. Using a multimeter set to the X100 range, press the positive probe of the ohmmeter to the positive

DC bus bar (near the extensions of the AC bus bars) and the negative probe to each of the AC bus bars. Compare your reading to section 1 of Table 5-1. Since most SCRs fail by shorting, a low resistance could indicate a defective SCR. This procedure checks a pair of SCRs in parallel.

4. Reverse the positions of the ohmmeter leads and repeat step 3. Compare reading to section 1 of Table 5-1.

5. Next, press the positive probe to the negative DC bus bar and the negative probe to each of the AC bus bars. Compare reading to section 1 of Table 5-1.

6. Reverse the positions of the ohmmeter leads and repeat step 5. Compare reading to section 1 of Table 5-1.

7. Check the gate resistance of the SCRs by setting the ohmmeter range to X1 and connecting the positive probe to the gate (white) lead of the SCR and the negative probe to the cathode (red) lead. Compare reading to section 2 of Table 5-1.

B. SCR Replacement

1. Remove rectifier bridge heat sink assembly as in steps 1 and 2 above.

2. Each phase assembly (4 SCRs) may be removed individually by removing the four sets of mounting hardware and removing the phase assembly. Note the position of the thermoguard for re-assembly purposes.

3. With the phase assembly removed, the SCRs can be checked with the ohmmeter, and a defective SCR isolated to a given pair. A meter reading of zero ohms across anode to cathode indicates an SCR is shorted, and the pair must be removed to determine if one or both are bad. If a defective device is indicated, the pair of SCRs must be removed from the phase assembly

4. To remove a pair of SCRs, loosen the clamping hardware enough to separate the heat sink sections sufficiently. Then gently remove the SCRs.

5. Check each SCR individually with the ohmmeter, anode to cathode, while applying pressure to the pole faces. A meter reading of zero ohms indicates a shorted device which must be replaced.

6. Check mating surfaces for nicks, scratches, flatness and surface finish. Surfaces are designed for .0004 inch total flatness runout and 32 micro-inch finish.

**CAUTION**

HEAT SINK SURFACES ARE ELECTROPLATED. DO NOT GRIND OR SAND SURFACES AS THE ELECTROPLATING WILL BE REMOVED.

7. Apply a light coat (2 or 3 drops) of silicone fluid (GE SF1154 or equivalent) on the heat sink mounting surfaces. Rotate the SCRs on the heat sink surfaces to ensure an even distribution of the silicone fluid.

8. Position the two SCRs with anode and cathode bases in the proper position (see Figure 5-4). Align the guide pins on the heat sinks with the guide holes in the SCR pole faces, and tighten clamping hardware just enough to ensure SCRs stay in place.

**CAUTION**

SCR MAY FAIL IF FOLLOWING PRECAUTIONS ARE IGNORED:

A. PROPERLY CONNECT AND SECURE GATE AND AUXILIARY CATHODE LEADS.

B. PROPERLY POSITION PROTECTIVE SLEEVING OVER GATE AND AUXILIARY CATHODE LEADS.

C. REPLACE SLEEVING IF CUTS OR NICKS ARE OBSERVED.

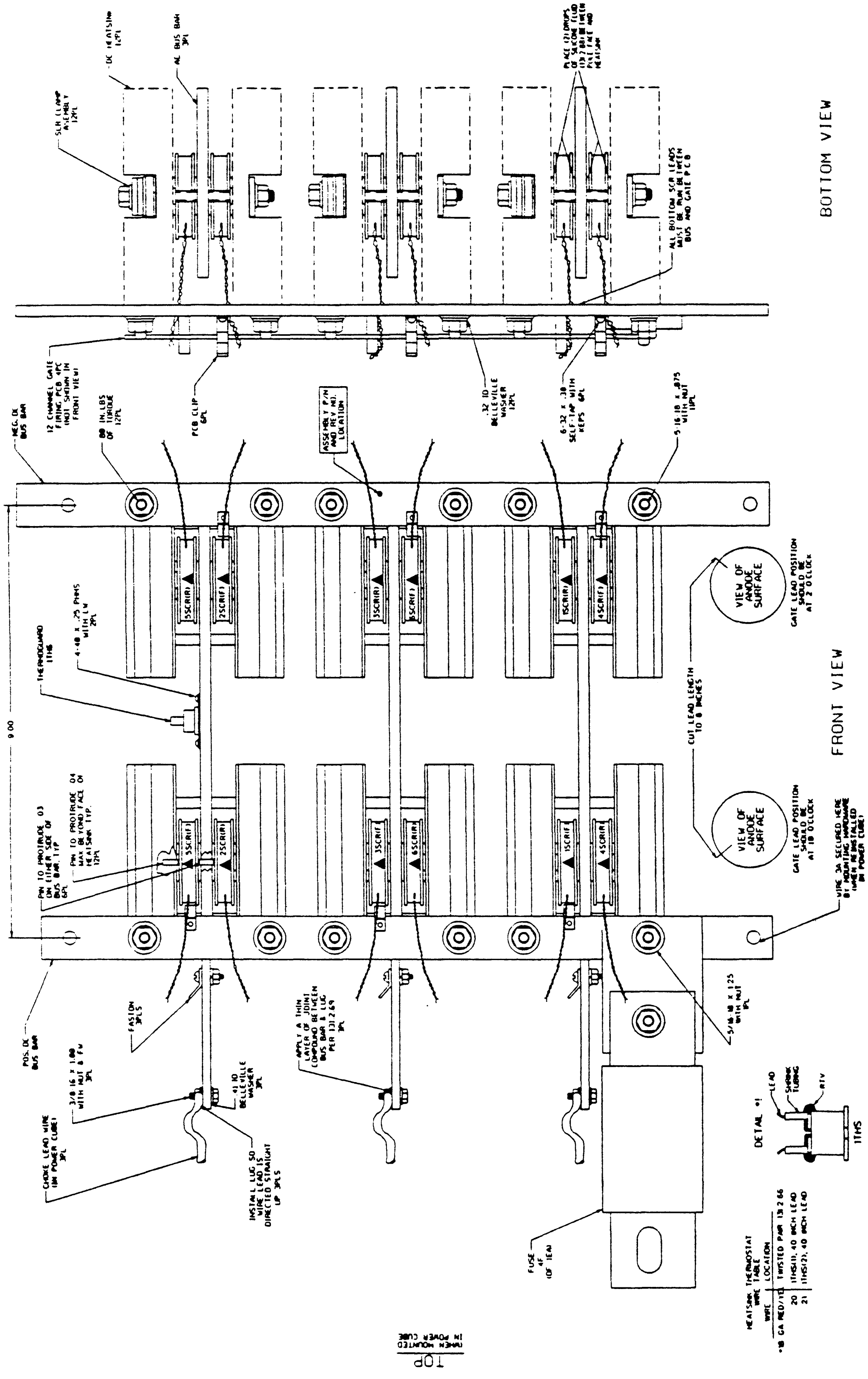



*Figure 5-4. "Hockey Puk" Type SCR Three Phase Heat Sink Assembly, Removed From Power Bridge*

C. Re-assembling 12 SCR Bridge Assembly

1. If clamping hardware is style 1 shown in Figure 5-5, re-assemble the rectifier bridge assembly using the following procedure. Otherwise, go to 2 below.

NOTE

Repeat steps a through d for EACH pair of SCRs.

a. Tighten bolts to starting torque position, with an even exposure of threads through the nuts.

To check for correct starting torque:

(1) Hold heat sink assembly as shown in Figure 5-6 and apply pressure to the outside heat sinks as shown by arrows to check racking (rocking motion from end to end). If racking DOES NOT occur, starting torque must be decreased (back off nuts).

(2) Tighten each nut a small amount, then check again for racking. Continue tightening and checking until the point is reached where racking no longer occurs. Starting torque is now correctly set.

b. Ensure that heat sink surfaces are parallel, square to one another, and pins are properly set into SCR pole face indentures.

c. Tighten bolts as follows:

For Assy P/N Suffix -2010 or -2020

(1) Tighten 1st nut 1/4 turn
(2) Tighten 2nd nut 1/2 turn

For Assy P/N Suffix -2030

(1) Tighten 1st nut 1/4 turn
(2) Tighten 2nd nut 1/2 turn
(3) Tighten 1st nut 1/2 turn

d. Wipe off excess silicone fluid.

e. Reinstall phase assembly into heat sink assembly:

(1) Apply a light coat of thermal joint compound to the areas where the heat sinks will contact bridge assembly bus bars.

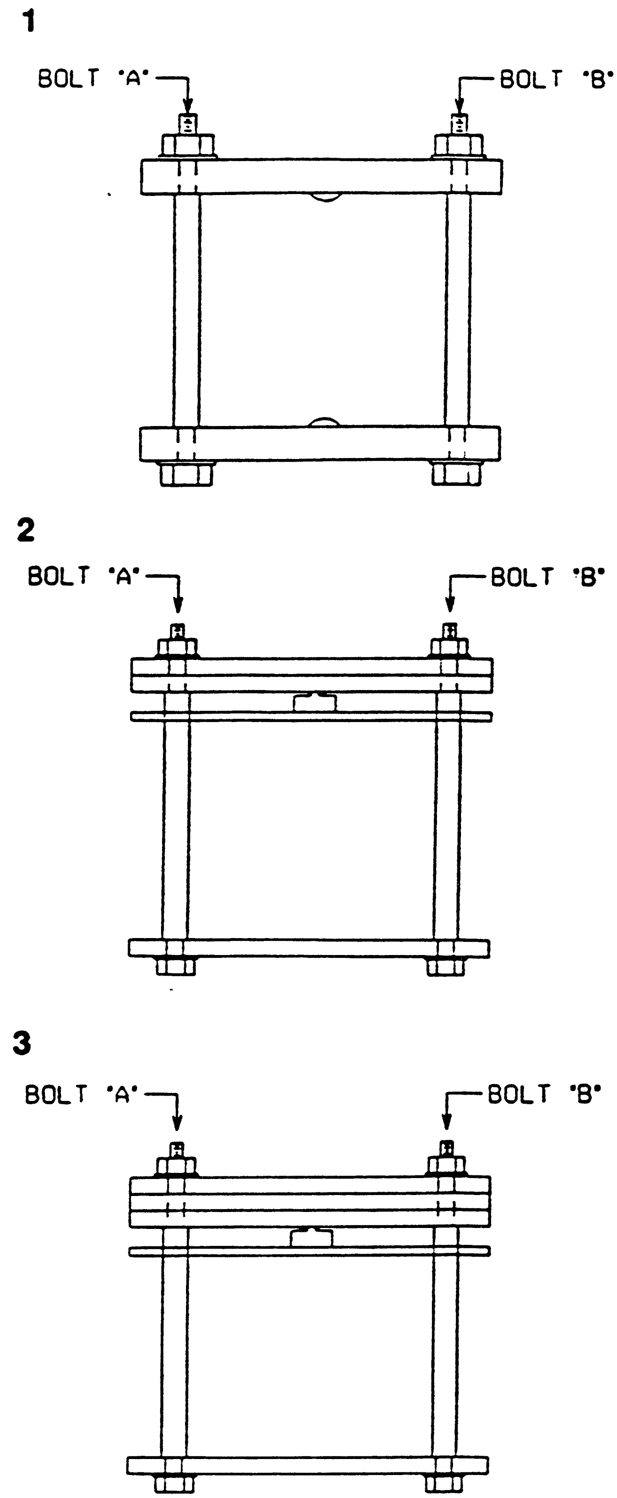



*Figure 5-5. Clamping Hardware Types*

(2) Slide heads of four bolts into slots of heat sinks of the phase assembly.

(3) Fit phase assembly into place, and install flat washer, lock washer and nut on each bolt.

(4) Torque nuts to 80 inch-pounds. Wipe off excess thermal joint compound.

f. When completed, proceed to Step D, "Re-Installing Heat Sink Assembly".

2. If clamping hardware is style 2 or 3 shown in Figure 5-5, re-assemble the rectifier bridge assembly using the following procedure.

IMPORTANT

Do not overtighten bolts. WHEN FOLLOWED, these procedures will result in maximum allowable force being applied to the device.

a. Tighten bolts to starting torque position, with an even exposure of threads through the nuts.

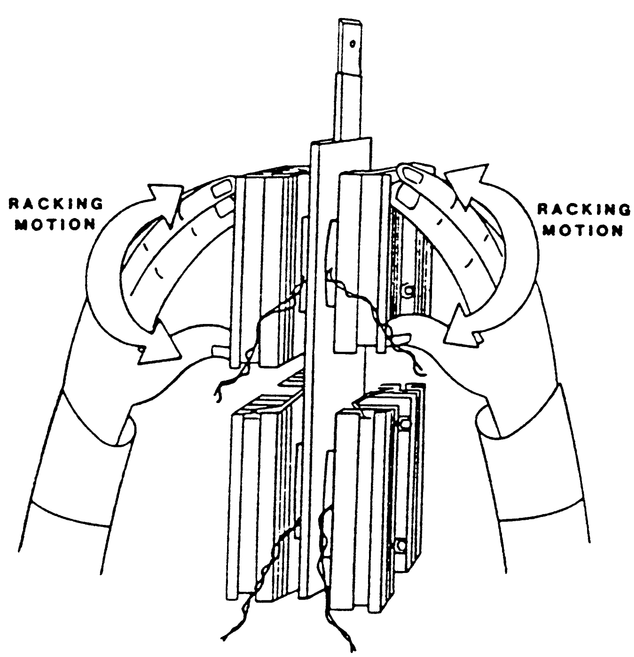



*Figure 5-6. Starting Torque Check - Racking*

b. Using only the index finger and thumb to hold the nut driver, evenly tighten each nut a small amount until both are finger tight. Starting torque is then set correctly.

c. Ensure that heat sink surfaces are parallel, pressure plate portion is flat to heat sink, and all pieces are square to one another.

d. Tighten bolts as follows:

For Clamp Style 2

(1) Tighten 1st bolt 1/2 turn
(2) Tighten 2nd bolt 1/2 turn
(3) Tighten 1st bolt 1/2 turn
(4) Tighten 2nd bolt 1/4 turn

For Clamp Style 3

(1) Tighten 1st bolt 1/2 turn
(2) Tighten 2nd bolt 1/2 turn
(3) Tighten 1st bolt 1/2 turn
(4) Tighten 2nd bolt 1/2 turn
(5) Tighten 1st bolt 1/8 turn

e. Wipe off excess silicone fluid.

f. Reinstall phase assembly into heat sink assembly:

(1) Apply a light coat of thermal joint compound to the areas where the heat sinks will contact bridge assembly bus bars.

(2) Slide heads of four bolts into slots of heat sinks of the phase assembly.

(3) Fit phase assembly into place, and install flat washer, lock washer and nut on each bolt.

(4) Torque nuts to 80 inch-pounds. Wipe off excess thermal joint compound.

g. When completed, proceed to Step D, "Re-Installing Heat Sink Assembly".

D. Re-installing Heat Sink Assembly

1. Reinstall the 12 Channel Gate Firing PCB on the heat sink assembly, and connect SCR gate and cathode leads to the board.

2. Position heat sink assembly on insulators in the Power Cube and install four mounting screws with washers. Also install mounting nut and washer on stud on top of fuse 4F.

3. Reconnect thermoguard connector 15CONN to 5PC

4. Apply thermal joint compound and reconnect the choke lead wires to the AC bus bars. Fit the quick-connect leads onto faston tabs.

5. Reconnect ribbon cable connectors 1, 2, and 3CONN and 26CONN.

# SECTION 6. TROUBLESHOOTING

## 6.1 TROUBLESHOOTING PROCEDURE

Troubleshooting consists of a logical series of operational checks and observations designed to localize a fault to a printed circuit board or major circuit area. This section contains information for two separate troubleshooting techniques. The technique selected depends on the ability and experience of the maintenance technician and the test equipment available for troubleshooting activities. The two techniques are described in the following paragraphs.

**WARNING**

HAZARDOUS VOLTAGES EXIST ON THE PCU PANEL EVEN WHEN THE DRIVE IS NOT RUNNING. DISCONNECT AND LOCKOUT THREE-PHASE INPUT POWER AND CONTROL POWER BEFORE: 1) CONNECTING OR DISCONNECTING TEST EQUIPMENT; OR 2) REMOVING OR REPLACING A PCB OR COMPONENT. FAILURE TO OBSERVE THIS WARNING CAN RESULT IN DEATH, SEVERE INJURY OR EQUIPMENT DAMAGE.

### 6.1.1 PCB Substitution

This technique consists of observing the symptoms, determining which PCB is defective, and replacing the defective PCB with a good PCB . No test equipment is required for this method.

### 6.1.2 Troubleshooting Table

This technique uses Table 6-1 for identifying the probable cause and performing the corrective action for each of the six system faults (see paragraph 6.2). Test equipment required for this method is a multimeter.

## 6.2 SYSTEM FAULTS

Faults of the drive system are manifested in terms of six different symptoms as follows:

1. Motor does not run at all.
2. Motor runs at reduced speed only.
3. Motor runs at full speed only.
4. PCU shuts down on overcurrent trip or blows fuses on startup.
5. Motor runs in one direction only or will not regenerate.
6. PCU shuts down on overcurrent trip, or blows fuses when regenerating or reversing operation (operates well in one direction).

## 6.3 TROUBLESHOOTING INFORMATION

In addition to the troubleshooting table, the following information is also provided to assist in troubleshooting:

A. Table 6-2 lists the functions of the Test Meter modification.

B. Figure 6-1 and 6-2 identify the test points on the Regulator PCB and 12SCR Controller PCB, respectively.

C. A schematic diagram for each assembly of the PCU is contained in the "Drawings" section of this manual.

## 6.4 RECOMMENDED OSCILLOSCOPE PROCEDURE

WARNING
HIGH VOLTAGE

CONNECT OSCILLOSCOPE CHASSIS TO EARTH GROUND. FAILURE TO DO THIS WILL ALLOW THE OSCILLOSCOPE CHASSIS TO RISE TO THE VOLTAGE LEVEL OF THE SIGNAL BEING MEASURED. DEATH OR SEVERE INJURY CAN RESULT.

When using an oscilloscope to observe the high voltage waveforms in the PCU, the two oscilloscope channels must be used in a differential mode with two X100 probes and with the oscilloscope chassis connected to earth ground.

WARNING

HAZARDOUS VOLTAGES CAPABLE OF SEVERE INJURY OR DEATH ARE PRESENT AT RECTIFIER HEAT SINKS WITH INPUT POWER APPLIED. DO NOT TOUCH RECTIFIER HEAT SINK.

## 6.5 PRELIMINARY CHECKS

In the event of any malfunction, make the following checks, in the order presented, before proceeding to the troubleshooting table. The suggested remedies assume component failure, rather than interconnection failure. Where practical, check the inputs and outputs (or input and output lead continuity) directly at a suspected device before concluding that the device is defective.

A. Verify that stated nameplate input voltage is applied to input power transformer 11PT terminals H1, H2 and H3. Verify that the secondary voltage at terminals X1, X2 and X3 is the value specified, ±10%, for the particular drive. Replace blown fuses as required, after checking for and clearing shorts across the line.

B. Verify that 115 VAC, ±10%, control power is present between Power Cube terminals 1TB(15) and 1TB(19). Check control power fuse 4F and control power transformer 2PT.

C. Check the PCB power supply voltages at Regulator PCB test points, with respect to common (63TP), as follows:

| TEST POINT | VDC | TOLERANCE | TEST METER POS. NO. |
|---|---|---|---|
| 37TP | +24 | 0V TO +6V | 10 |
| 35TP | -15 | ±0.75 | 13 |
| 31TP | +15 | ±0.75 | 2 |
| 38TP | -24 | 0V to -6V | 11 |

If test point voltages are not within stated tolerance, proceed as follows:

a. On the Power Supply PCB (6PC), check for 18 VAC ±2 VAC between female molex connector pin numbers 5CONN(1) and (2), and 5CONN(3) and (2).

b. If voltage is not within tolerance or missing, replace power supply transformer 1PT.

c. If voltage is within tolerance, check 6CONN ribbon cable continuity from Power Supply PCB to Regulator PCB. If okay, replace the Power Supply PCB.

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 1. Motor Does Not Run At All | a. No AC input power. | a. Using multimeter, ensure that proper input power is present. |
| | b. Defective interlock or thermoguard switches. | b. Repair or replace as required. Check relay & contactor operation. |
| | c. Blown fuse(s). | c. Replace as required. Try starting drive system. If PCU IST's or blows fuses on startup, go to symptom 4. |
| | d. Defective voltage divider. | d. If LINE LOSS LED is illuminated, measure AC line voltage signals (line-to-line input voltage divided by 99) from 1RT anode (AØ) to 2RT anode (BØ), 2RT anode to 3RT anode (CØ), and 3RT anode to 1RT anode on 12SCR Controller PCB. If missing or improper voltage, check 3CONN ribbon cable continuity from 12 Channel Gate Firing PCB to 12SCR Controller PCB. If okay, replace Gate Firing PCB. |
| | e. Defective 12SCR Controller PCB. | e. Measure AC line voltage signals for 6 VAC at 4TP (LAB), 5TP (LBC), and 6TP (LCA) with with respect 43TP (COM) on 12SCR Controller PCB. Voltage should be line-to-line input voltage divided by 89.5. If missing or improper voltage, replace the 12SCR Controller PCB. |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTON | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 1. Motor Does Not Run At All (Continued) | f. Defective field supply rectifier, 1RT (3 phase half-wave). | f. Check for proper field supply voltage as shown on schematic. If missing or improper voltage, replace rectifier module. |
| | g. Improper I FBK voltage. | g. Check for -1.0 to +1.0 VDC at 26TP on 12SCR Controller PCB. Measure voltage at 21TP on 12SCR Controller PCB. Voltage at 26TP should be opposite in polarity to 21TP. If voltage is improper, replace 12SCR Controller PCB. |
| | h. Improper current reference. | h. Proceed to Chart 6-1, Improper Current Reference. |
| 2. Motor Runs at Reduced Speed Only | NOTE<br>For any given direction of rotation, the polarity of the speed reference and speed feedback signals is always opposite. By convention, a negative speed reference signal into the Regulator PCB corresponds to forward rotation, thus requiring the speed feedback signal to be positive. Conversely, a positive speed reference signal and negative speed feedback signal correspond to reverse rotation. | |
| | a. Defective +10 and/or -10 volt power supply on Regulator PCB. | a. Check for +10 and -10 VDC at Power Cube 1TB (4) and (3) respectively, ref 1TB(2) (COM). If improper, check 18CONN and 19CONN continuity then replace Regulator PCB. |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 2. Motor Runs At Reduced Speed Only (Continued) | b. Defective SPEED pot or Linear Accel (if used with drive system). | b. Check voltage on wiper of SPEED pot. Voltage should be -10 VDC at 100% setting. Check that all interlocks are good. If SPEED SPEED pot & interlocks are good, check output of Linear Accel. If output is not -10V ±2, replace Regulator PCB. |
| | c. Improper Current Reference. | c. Proceed to Chart 6-1, Improper Current Ref. |
| | d. Improper I FBK voltage. | d. Check for -1.0 to +1.0 VDC at 26TP on 12SCR Con- PCB. Measure voltage at 21TP. Voltage at 26TP should be opposite in polarity to polarity at 21TP. If voltage is improper, replace 12SCR Controller PCB. |
| | e. Insufficient Torque. | e. Check for field supply voltage. If voltage is incorrect, replace 1RT, field rectifier. |
| | f. Improper voltage feedback. | f. The voltage at 35TP of the 12SCR Controller PCB should be of the same polarity as the output voltage measured from bridge terminal +F to bridge terminal -F and should be proportional to the output voltage; where 6V at 35TP corresponds to output equal to rated input voltage. If improper, check the Gate Firing PCB connections. If necessary, replace the 12SCR Controller PCB. |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 2. Motor Runs At Reduced Speed Only (Continued) | g. Improper current feedback signal. | g. 12SCR Controller PCB 26TP should be positive and at a level proportional to armature current, with +1 VDC corresponding to the forward motoring full load amps. -1 VDC is equal to reverse full load amps.<br><br>Measure armature current and compare with I FBK. If I FBK is incorrect, check the burden resistor and current transformers. If these are correct, replace the 12SCR Controller PCB. |
| | h. Insufficient torque. | h. Check for proper field excitation. If incorrect, replace 1RT, field supply rectifier. |
| 3. Motor Runs at Full Speed Only | a. Defective power supply. | a. Perform preliminary checks in para. 6.5.<br><br>Note the tach voltage at max speed embossed on tach nameplate. |
| | b. Defective tachometer (tach). | b. Measure tach voltage from 2TB(20) to 2TB(22). If tach voltage is not the value embossed on nameplate, replace tach. Verify tach voltage is opposite in polarity to reference voltage at 30TP on Regulator PCB. If Test Meter modification is present, refer to Table 6-2. |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 3. Motor Runs at Full Speed Only (Continued) | c. Defective SPEED pot. | c. Check voltage at SPEED pot wiper. Voltage should be zero, with pot at zero speed setting. Note that on some reversing drives, the pot position for zero wiper voltage is at 50% rotation. If voltage is not zero at zero speed setting, repair or replace as required. |
| | d. Defective Linear Accel Circuit (LAC), if used. | d. 1. Check for 0 VDC at 30TP (with SPEED pot wiper voltage at zero) on Regulator PCB. Check voltage at 58TP; if voltage is "HI", replace Regulator PCB.<br><br>2. Check for between 0 to -10 VDC (but not zero) at 58TP, as the SPEED pot is rotated thru its range. If proper, replace Regulator PCB. If improper, proceed. |
| | e. Defective regulator circuit. | e. Check regulator as follows:<br>1. Check for opposite polarities at 30TP and 40TP with respect to common 63TP on Regulator PCB. If polarities are not opposite replace: 1) the Speed Regulator plug-in option PCB (if tach FBK is used); 2) 12SCR Controller PCB (if voltage FBK is used). |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 3. Motor Runs at Full Speed Only (Continued) | f. Defective 12SCR Controller PCB. | f. Check voltage at 21TP I REF. Voltage should be between -5.0 and +5.0 VDC. If Test Meter Module is available, use Table 6-2. If voltage is incorrect, replace 12SCR Controller PCB. |
| 4. PCU IST's or Blows Fuses on Start-Up | a. Shorted motor. | a. Ensure that motor is not shorted. If in doubt, disconnect motor armature. |
| | b. Shorted SCR(s). | b. Check for shorted SCR(s) per para. 5.2.3 or 5.2.4. |
| | c. Short across DC bus. | c. Remove short across DC bus. |
| | d. Defective power supply. | d. Check per para 6.5. |
| | e. Defective voltage divider. | e. If LINE LOSS LED is lit, measure AC line voltage signals (line to line voltage divided by 99) at 12SCR Controller PCB 1RT anode (AØ) to 2RT anode (BØ), 2RT anode to 3RT anode (CØ), and 3RT anode to 1RT anode. If missing or improper, check 3CONN continuity. Check SCR faston connections. If okay, replace Gate Firing PCB. |

Table 6-1. Drive System Troubleshooting Using Multimeter or Test Meter Modification (Continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 4. PCU IST's or Blows Fuses On Start-Up (Continued) | f. Defective 12SCR Controller PCB. | f. Measure AC line voltage signals LAB (4TP). LBC (5TP) and LCA (6TP) on 12SCR Controller PCB with respect to common (43TP). Voltage should be line to line input voltage divided by 89.5. If missing or improper, replace the 12SCR Controller PCB. |
| | g. Defective field supply rectifier 1RT (3 phase half-wave). | g. Check for field supply voltage. If voltage is incorrect, replace 1RT, field supply rectifier. |
| 5. Motor Runs in One Direction Only or Will Not Regenerate | a. Defective 12SCR Controller PCB. | a. Replace 12SCR Controller PCB. |
| 6. PCU IST's or Blows Fuses When Regenerating or Reversing Operation (Operates Well in One Direction) | a. Defective 12SCR Controller PCB. | a. Replace 12SCR Controller PCB. |

Table 6-2. Test Meter Modification Voltage Measurements

| SWITCH POSITION | FUNCTION | PIN ON 14CONN | 7PC TP MONITORED |
|---|---|---|---|
| 0 | +10V | 3 | 32TP |
| 1 | -10V | 4 | 34TP |
| 2 | +15V | 15 | 31TP |
| 3 | -15V | 1 | 35TP |
| 4 | LAC INPUT 0 TO -10V | 14 | 36TP |
| 5 | VOLT/SPD REF 0 TO ±10V (- = Fwd) | 2 | 30TP |
| 6 | VOLT/SPD FDBK 0 TO ±5V | 16 | 40TP |
| 7 | NO CONNECTION | -- | -- |
| 8 | CURRENT FDBK 0 TO ±1V (+ = Fwd) | 10 | 10TP |
| 9 | CURRENT REF 0 TO ±2.5V (- = Fwd) | 9 | 8TP |
| 10 | +24V UNREG | 7 | 37TP |
| 11 | -24V UNREG | 8 | 38TP |
| 12 | (SCALED) DC OUTPUT 0 TO ±9.2V | 6 | 9TP |
| 13 | (SCALED) NOM AC VOLT (LINE) 7.45V | 12 | 25TP |
| 14 | GEN TEST PTS 0 TO ±10V | 5 | 39TP |
| 15 | CURRENT LIMIT (FWD) 0 TO +5V | 11 | 14TP |
| -- | ANALOG GROUND | 13 | -- |

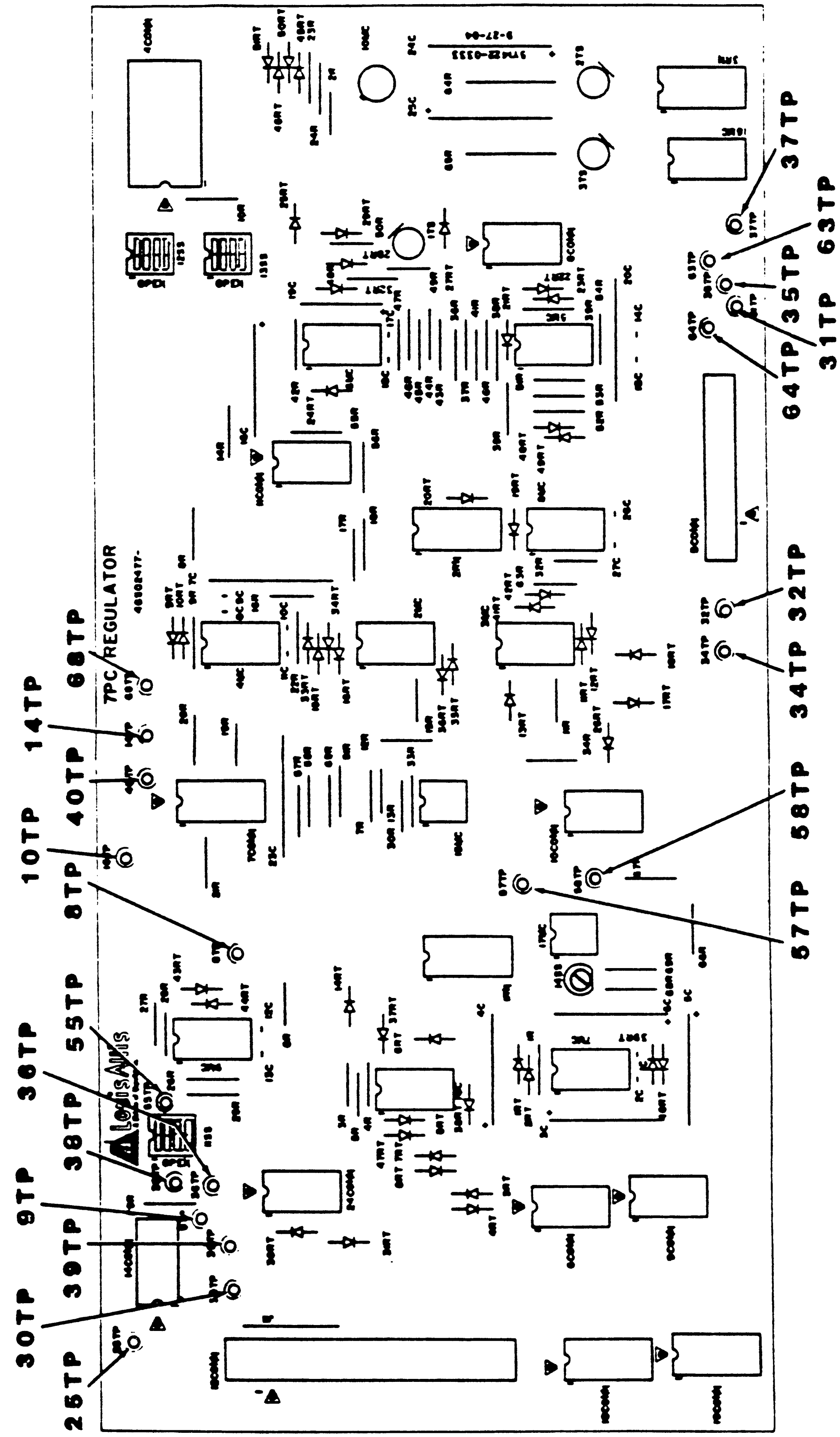
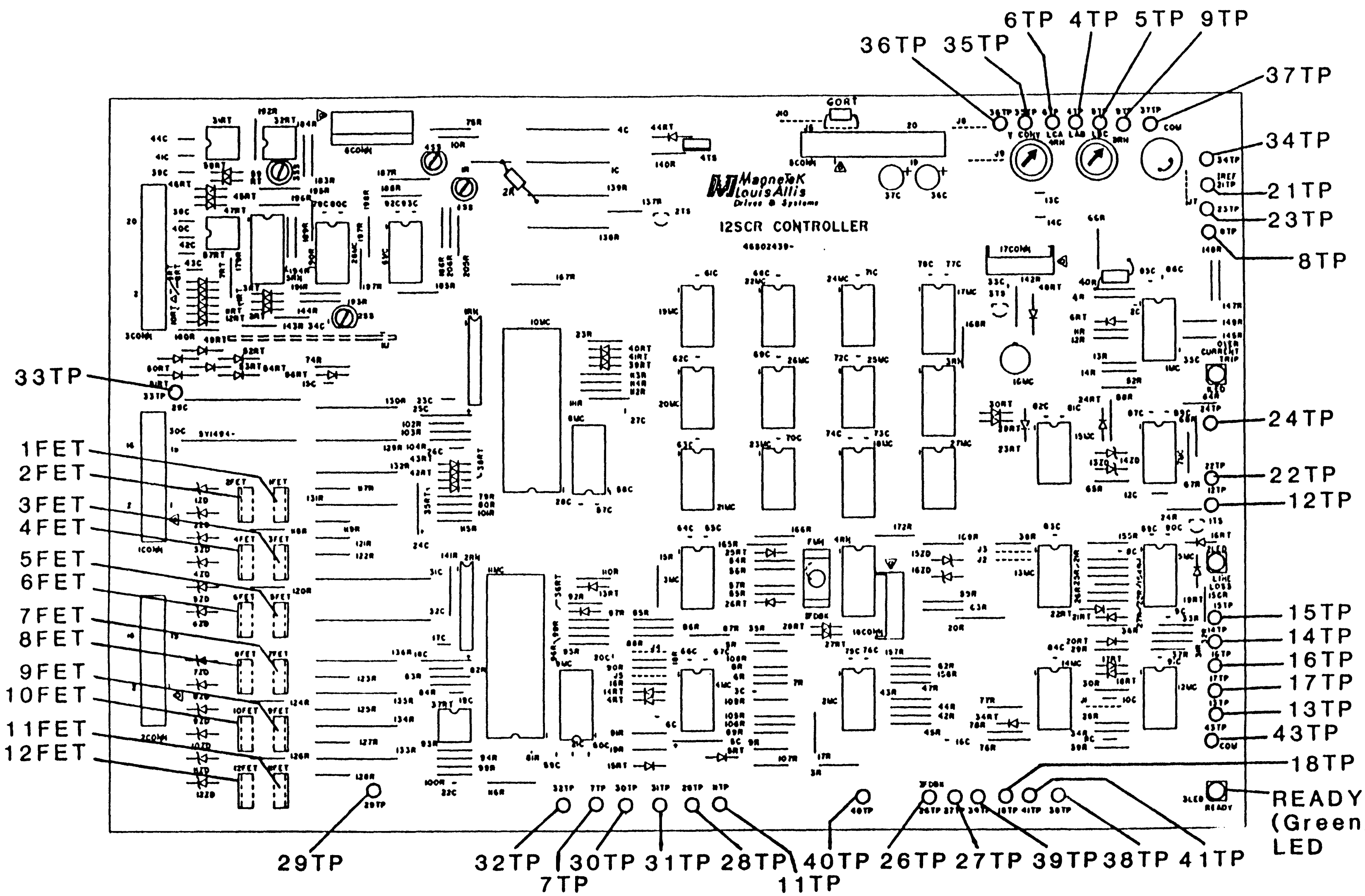


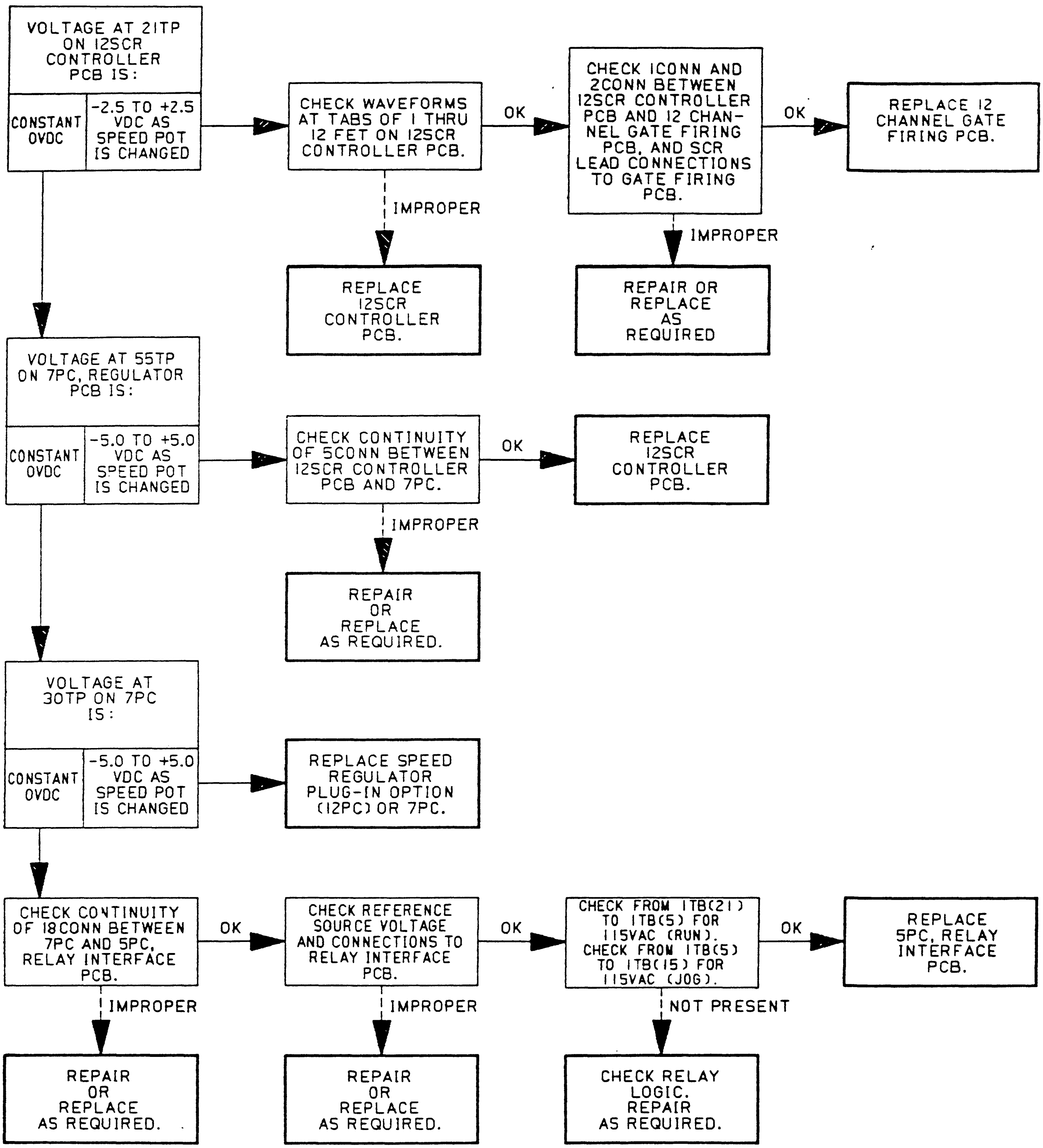

Figure 6-1. 7PC, Regulator PCB Test Point Location




Board P/N: 46S02439-0031

Figure 6-2. 12SCR Controller PCB Test Point Location

# CHART 6.1 IMPROPER VOLTAGE REFERENCE



# SECTION 7. MODIFICATION KIT INSTALLATION

## 7.1 MODIFICATION PCB INSTALLATION
(See Figures 7-1 and 7-2)

WARNING

DO NOT INSTALL MODIFICATION KIT WHILE POWER IS APPLIED TO CONTROLLER.

1. Locate modification area on Regulator PCB or Relay/Interface PCB by locating the connector receptacle with the same number as the receptacle on the modification PCB (7CONN, etc.). (Refer to the installation figure in the modification's 2Y25 instruction sheet.)

2. Remove continuity plug from modification area, when required. This plug may be kept for possible future use.

3. Install standoffs into holes. On Regulator PCB, the holes for standoffs form a triangular or rectangular arrangement around the connector receptacle. On Relay/Interface PCB, the triangular or rectangular arrangement is above the receptacle (or behind the receptacle when Relay/Interface PCB is mounted in the Power Cube). Standoffs will snap into place.

Standoffs are designed for permanent mounting on PCB. Do not attempt to remove standoffs after they are installed.

4. Insert the necessary ribbon cable connector(s) to the appropriate receptacles on the PCB. Insure that the polarizing marks or guide pin and slot on mating connectors match up. Then curve the other end of the ribbon cable to the front of the modification PCB and insert the connector into the receptacle on the modification PCB, again matching polarizing marks or guide pin and slot. If required, insure that 2TB is installed on Relay/Interface PCB and Regulator PCB.

NOTE

When making connections, insure that no connector pins are bent and that all pins are properly inserted into receptacle.

5. Align a hold down clip over each cable connector and press gently until locked in place.

6. Align the holes in the modification PCB with the standoffs and gently press the modification PCB until it snaps into position.

NOTE

After modification PCB is installed, check that the ribbon cable connections are secure.

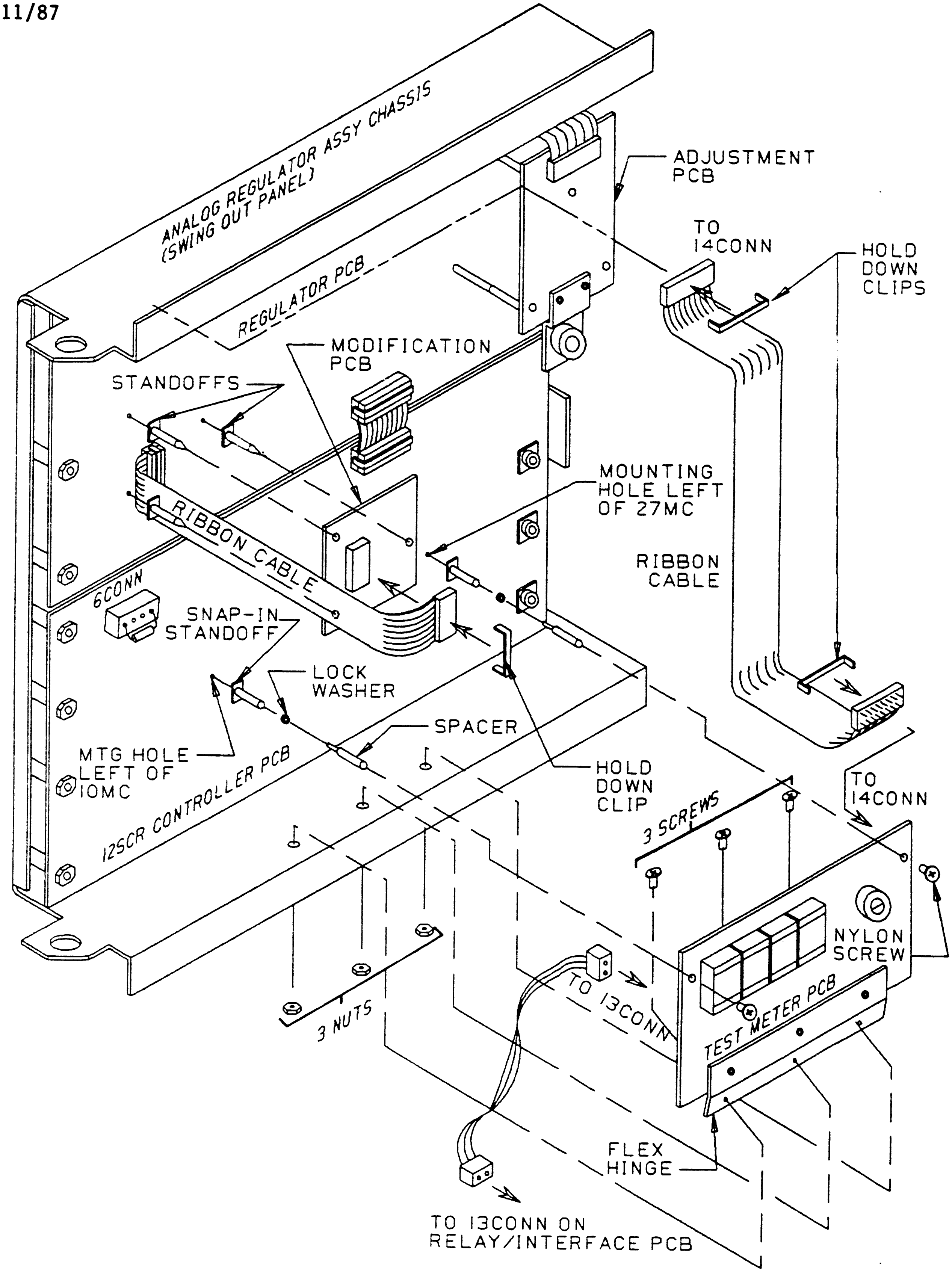



Figure 7-1. Mod Kit Installation on Analog Regulator Assembly



TD.I.3S.FIG7.I

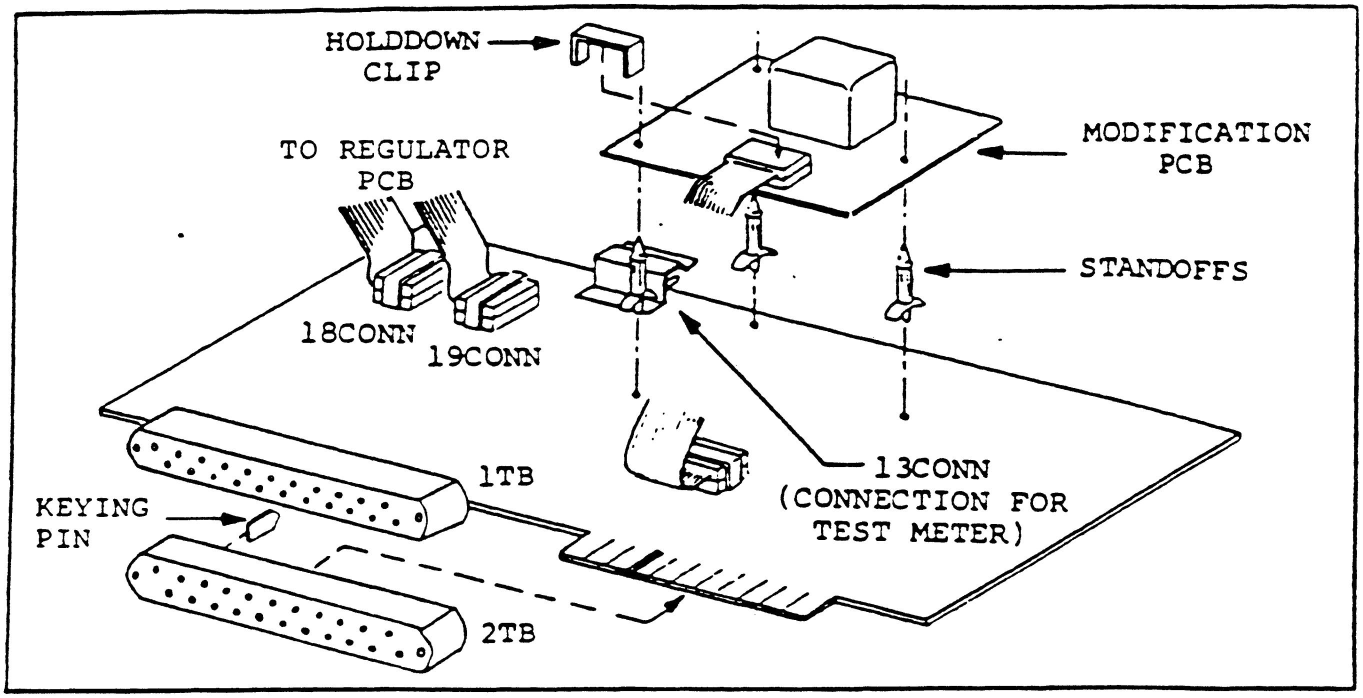



Figure 7-2. Mod Kit Installation on Relay/Interface PCB

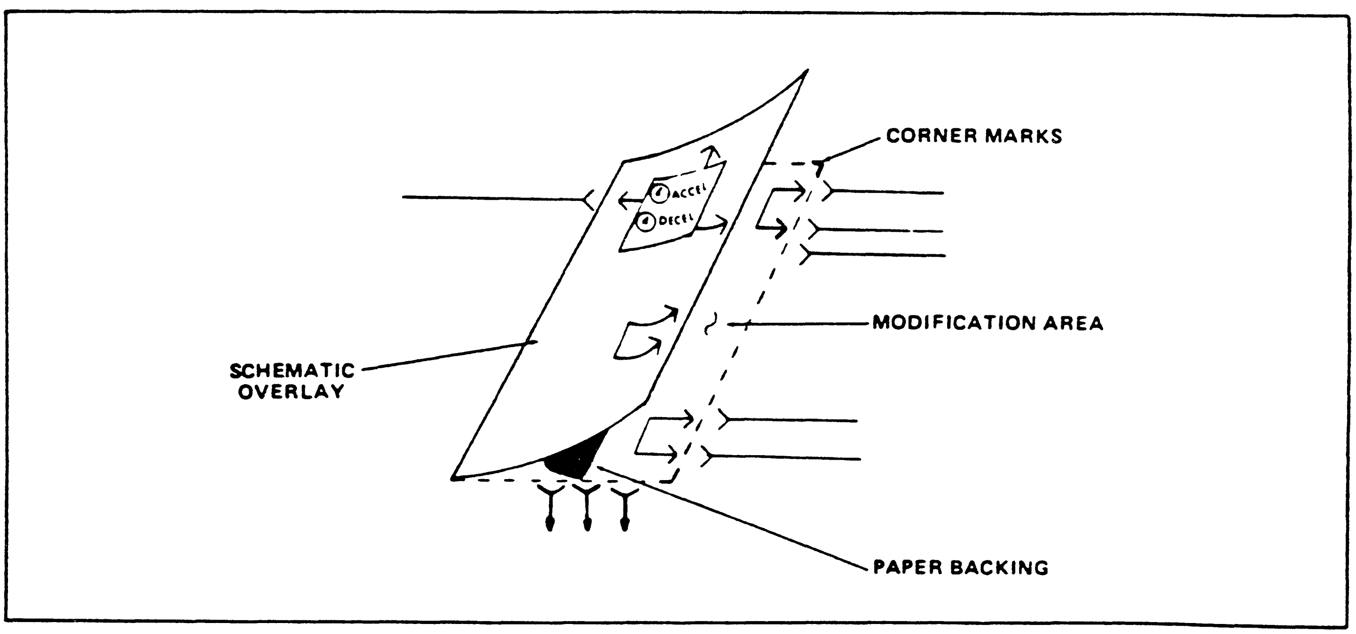



Figure 7-3. Application of Schematic Overlay

7.2 SCHEMATIC MODIFICATION
(See Figure 7-3)

Each Modification Kit contains one or more schematic overlays to be applied to the basic schematic diagram. Apply overlays as follows:

A. Locate the proper position for installing each overlay to the basic schematic diagram. To determine proper position, refer to the 45T number at the bottom of the overlay. The last two characters identify the schematic sheet number and which modification area the overlay is to be placed in.

Example: 45T00208-0211 3E

Sheet number (3)
Mod area on Sheet 3 (E)

B. Carefully peel paper backing from the left edge of the schematic overlay and fold back about 3/8 of an inch of the backing.

C. Align the schematic overlay with interconnecting wires using the corner mark on the schematic diagram as a guide.

D. Press the left edge of the schematic overlay onto the schematic diagram.

E. Peel off the remaining paper backing and at the same time press the overlay into position. DO NOT attempt to lift the overlay after it has been pressed into position.

NOTE

In case of loss or damage, additional schematic diagrams and schematic overlays can be obtained from your nearest Louis Allis representative.

# SECTION 8. SPARE PARTS

## 8.1 GENERAL

Louis Allis recommends the customer stock on site spare parts to minimize costly down time. Prices may be obtained from your local Louis Allis District Office.

Table 8.1 lists parts which have a high probability of needing replacement.

Table 8.1. Recommended Spare Parts

| DESCRIPTION | DRIVE HP | AC VOLTS | SYMBOL | PART NUMBER | Recommended Stock Quantity Based on Number Of Identical Drives or Assemblies: 1-4 | 5-9 | 10-25 | 26 or More |
|---|---|---|---|---|---|---|---|---|
| LINE FUSES | 5<br>7.5,10 | 230<br>460 | 1F<br>2F<br>3F | 05P00017-0226 | 6 | 12 | 18 | 24 |
| | 7.5,10<br>15,20 | 230<br>460 | | 05P00017-0227 | 6 | 12 | 18 | 24 |
| | 15<br>25,30 | 230<br>460 | | 05P00017-0155 | 6 | 12 | 18 | 24 |
| | 20,25<br>40,50 | 230<br>460 | | 05P00017-0228 | 6 | 12 | 18 | 24 |
| | 30<br>60 | 230<br>460 | | 05P00017-0166 | 6 | 12 | 18 | 24 |
| | 40,50<br>75,100 | 230<br>460 | | 05P00017-0179 | 6 | 12 | 18 | 24 |
| | 60,75<br>125-200 | 230<br>460 | | 05P00017-0234 | 6 | 12 | 18 | 24 |

Table 8.1. Recommended Spare Parts (Continued)

| DESCRIPTION | DRIVE HP | AC VOLTS | SYMBOL | PART NUMBER | Recommended Stock Quantity Based on Number of Identical Drives or Assemblies: 1-4 | 5-9 | 10-25 | 26 or More |
|---|---|---|---|---|---|---|---|---|
| DC LOOP FUSE | 5<br>7.5,10 | 230<br>460 | 4F | 05P00017-0226 | 3 | 6 | 9 | 12 |
| | 7.5,10<br>15,20 | 230<br>460 | | 05P00017-0227 | 3 | 6 | 9 | 12 |
| | 15<br>25,30 | 230<br>460 | | 05P00017-0155 | 3 | 6 | 9 | 12 |
| | 20,25<br>40,50 | 230<br>460 | | 05P00017-0228 | 3 | 6 | 9 | 12 |
| | 30<br>60 | 230<br>460 | | 05P00017-0166 | 3 | 6 | 9 | 12 |
| | 40,50<br>75,100 | 230<br>460 | | 05P00017-0179 | 3 | 6 | 9 | 12 |
| | 60, 75<br>125,150 | 230<br>460 | | 05P00017-0234 | 3 | 6 | 9 | 12 |
| | 200 | 460 | | 05P00017-0213 | 3 | 6 | 9 | 12 |
| THYRISTORS | 5-10<br>7.5-20 | 230<br>460 | 1-6 SCR F, 1-6 SCR R (2-in-1) | 05P00050-0311 | 3 | 6 | 9 | 12 |
| MODULE TYPE | 15<br>25,30 | 230<br>460 | | 05P00050-0312 | 3 | 6 | 9 | 12 |

Table 8.1. Recommended Spare Parts (Continued)

| DESCRIPTION | | | | SYMBOL | PART NUMBER | Recommended Stock Quantity Based on Number of Identical Drives or Assemblies | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1-4 | 5-9 | 10-25 | 26 or More |
| THY-RISTORS (Con't) | MODULE TYPE (Con't) | 20-30<br>40-60 | 230<br>460 | 1-6 SCR F, 1-6 SCR R | 05P00050-0313 | 3 | 6 | 9 | 12 |
| | | 40,50<br>75,100 | 230<br>460 | | 05P00050-0277 | 6 | 12 | 18 | 24 |
| | HOCKEY "PUK" TYPE | 60<br>125 | 230<br>460 | | 05P00050-0280 | 6 | 12 | 18 | 24 |
| | | 75<br>150,200 | 230<br>460 | | 05P00050-0283 | 6 | 12 | 18 | 24 |
| SNUBBER NETWORK PCB | | 5-30<br>7.5-60 | 230<br>460 | 1-3PC | 46S02265-0010 | 1 | 2 | 3 | 4 |
| | | 40-75<br>75-200 | 230<br>460 | | 46S02265-0020 | 1 | 2 | 3 | 4 |
| 12 CHANNEL GATE FIRING PCB | | | | 4PC | 46S02592-0010 | 1 | 1 | 1 | 2 |
| RELAY INTERFACE PCB | | | | 5PC | 46S02274-0041 | 1 | 1 | 1 | 2 |
| POWER SUPPLY PCB | | | | 6PC | 46S02263-0020 | 1 | 1 | 2 | 2 |
| REGULATOR PCB | | | | 7PC | 46S02477-0021 | 1 | 1 | 2 | 2 |
| 12SCR CONTROLLER PCB | | | | | 46S02439-0031 | 1 | 1 | 2 | 2 |
| ADJUSTMENT PCB | | | | 8PC | 46S02476-1000 | 1 | 1 | 2 | 2 |

Table 8.1. Recommended Spare Parts (Continued)

| DESCRIPTION | SYMBOL | PART NUMBER | Recommended Stock Quantity Based on Number of Identical Drives or Assemblies 1-4 | 5-9 | 10-25 | 26 or More |
|---|---|---|---|---|---|---|
| VOLTAGE/CURRENT FOLLOWER PCB | 9PC | 46S02269-0010 | 1 | 1 | 2 | 2 |
| S CURVE PCB | 11PC | 46S02271-0020 | 1 | 1 | 2 | 2 |
| SPEED REGULATOR PCB | 12PC | 46S02268-0030 | 1 | 1 | 2 | 2 |
| TACH DAMPING PCB | 13PC | 46S02273-0020 | 1 | 1 | 2 | 2 |
| TEST METER PCB | 14PC | 46S02272-0010 | 1 | 1 | 2 | 2 |
| CONTROLLED STOP PCB | 15PC | 46S02277-0010 | 1 | 1 | 2 | 2 |
| AUTO/MANUAL PCB | 16PC | 46S02276-0010 | 1 | 1 | 2 | 2 |
| THREAD PCB | 17PC | 46S02275-0010 | 1 | 1 | 2 | 2 |
| STATIC REVERSING PCB * | 18PC | 46S02478-0010 | 1 | 1 | 2 | 2 |

* Only used in specially engineered controllers.

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