

Installation and Service Manual

# **Multi-Axis 3 Phase SCR Servo Amplifier TPA/1/2/3 SERIES**

M - 7801 - Issue 7

**Caution:**

Dangerous voltages exist in this equipment. Do not attempt connecting or probing in this equipment with power on.

Should any question arise regarding any step outlined in this manual please call the factory.



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**KOLLMORGEN  
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Radford, Virginia 24141

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MODEL NUMBER SYSTEM

TPA/"A" - "B""C" - "D""E" - "F""G"

TPAOX/1 - "B""C" - "D""E" - "F""G"

- TPA . . . . . Three-Phase Amplifier (W/out Option Card)
- TPAOX . . . . . Three-Phase Amplifier with Option Card  
(X = 1 for OPT 1, etc.)
- A - /1, /2, /3 . . . . . Number of Axes
- B - 120, 138, 158 . . . . . Secondary Line to Neutral Voltage
- C - 25, 40, 85 . . . . . Continuous Current Rating
- D - 5, 6 . . . . . 50Hz or 60Hz Rating
- E - 01 . . . . . System using 50 Watt Current Sense Resistors (OBSOLETE).
- 02 . . . . . UL Recognized System Using 100 Watt Current Sense Resistors.
- 03 . . . . . Non-UL Unit Using 100 Watt Current Sense Resistors.
- 04 . . . . . Not Available. To be UL Version of 05.
- 05 . . . . . Unit w/Terminal Block in Place of Fuses.
- 06 . . . . . Not Available. To be UL Version of 07.
- 07 . . . . . GSO Signal Brought out to Term. 14.  
TPA/1 Units Only. No Fuses.
- 12 . . . . . Not Available. To be UL Version of 13.
- 13 . . . . . Unit w/out Fuses or Motor Overload Relay.
- 14 . . . . . 19" UL Unit w/Term. Blocks Only (N/A).
- 15 . . . . . 19" Non-UL w/Terminal Blocks Only.
- F - . . . . . Motor and Winding.
- G - . . . . . Compensation Number
- 1 . . . . . Standard Two-Step Current Limit.
- 2 . . . . . Horsepower Current Limit & External Current Limit.
- 3 . . . . . Horsepower Current Limit & External Current Limit & Hi Decel. (This is not a Standard System. To be Used only with Engineering Approval).

Any other number denotes a customer special.

## 1.0 DESCRIPTION

The Inland Motor TPA/1,/2, and /3 series are multi-axis three phase, half-wave, four-quadrant, fully regenerative SCR "Rate Loop" Servo amplifiers.

Except for minor component changes on the Motor Control Cards, the basic modules of these amplifiers are interchangeable and the operation of the modules is identical whether used in the TPA/1, TPA/2 or TPA/3 (Power Supply components will vary depending on secondary voltage from isolation power transformer).

Due to the interchangeability of the modules, spare parts cost can be minimized.

Modular construction and the liberal use of test points assure easy field maintenance and troubleshooting.

A unique approach to phase control (Patent No. 3864612) and a full-time electronic current limiter assure excellent high speed commutation. Large life-shortening first-half-cycle current pulses are eliminated.

Other features are:

- Fail Safe Dynamic Braking (Patent No. 3786329)
- Programmable Torque
- Fusing for System Protection, or Circuit Breakers
- Overspeed Protection
- Motor Overload Protection
- Not Sensitive to Line Phasing
- Drive-Up Indication
- Motor Current Monitor Output

### 1.1 Simplified Theory of Operation

This amplifier is a "Rate Loop" amplifier. A rate loop amplifier is a device that maintains a speed proportional to a command input signal.

The amplifier consists of eight basic modules as shown in the System Block Diagram (A-78256) found in the back of this manual:

- |                             |                            |
|-----------------------------|----------------------------|
| 1. Motor Control Card       | 6. Suppression Cards       |
| 2. Pulse Generator Card     | (1, 2, or 3)               |
| 3. Ramp Generator Card      | 7. SCR Paks (3, 6, or 9)   |
| 4. Interlock and Brake Card | 8. Mother Board Containing |
| 5. Power Supply Card        | Items 1-5                  |

The Motor Control Card incorporates the necessary circuitry to provide the Rate (or Velocity) Loop function, the Current

Loop function, the Motor Current Monitor, and the Overspeed protection. The Rate Loop compares the actual speed as indicated by the tachometer to the commanded speed and generates an error signal to the Current Loop. The Current Loop then monitors the actual motor current, compares it with the error signal from the Rate Loop, and commands more or less current into the motor to cause it to run faster or slower as necessary to satisfy the Rate Loop. Current limiting is also performed by this card, allowing maximum motor performance without encountering commutation problems. The Motor Current Monitor issues a signal for external use which is in direct relation to the actual motor current. This signal will be approximately 8 volts equal 100 amps in the motor unless otherwise specified on the system Test Limit sheet.

The Overspeed circuit monitors the speed of the motor, inhibits the Rate Loop and Current Loop when this speed becomes excessive, and indicates this condition by illuminating the "Overspeed Fault" LED located on the Interlock and Brake Card.

The Pulse Generator Card accepts the output from the Motor Control Card and produces a pulse train whose position, with respect to line zero crossover, depends on the value of the Motor Control Card output. As the Motor Control Card output increases, the pulse position advances, and current in the motor increases.

The Ramp Generator Card produces a reference signal based on line zero crossover allowing the Pulse Generator Card to produce pulse trains to control the SCR firing angles.

The Interlock and Brake Card monitors the line voltage and shuts off the firing pulses for all axes upon loss of any line input phase, delays turn-on until transients have settled at start-up, performs the RGS0 (Remote Gate Shut-Off) "Inhibit" function, and provides a contact opening for external indication that a fault condition exists which has inhibited one or more axes. This card also contains the Fail-Safe Dynamic Brake, which in the event of the loss of prime power applies pulses to all SCRs, dynamically braking the motor(s) to an emergency stop.

The Power Supply Card supplies +15 volts (regulated) and +24 volts (unregulated) DC voltage to the amplifier.

The Suppression Card contains the circuitry for line transient suppression and SCR protection. This card also contains the SCR pulse transformers, and outputs a signal to the Interlock and Brake Card for use in phase-loss detection.

The SCR Paks are the basic power section of the amplifier. Each Pak contains two SCRs--one "forward" and one "reverse".



Current is generated into the motor as each SCR is "gated" on by a Pulse Generator Card.

The Mother Board serves as a receptacle for all plug-in cards, providing interconnections between cards and holds the input and signal-level output terminal strips.

## 2.0 INSTALLATION AND ALIGNMENT

Upon receipt of the amplifier, closely inspect the components to ensure that no damage has occurred in shipment. If damage has occurred, notify the appropriate carrier at once.

### 2.1 Mounting

The amplifier is not position sensitive but it should be mounted to allow vertical circulation of air through the SCR heat sink.

### 2.2 Preliminary Testing

Once the equipment is installed on the machine per the appropriate system wiring diagram, the initial start-up should be made with the control command disconnected, using a DC signal source instead. In this fashion, the Rate Loop portion can be individually checked without complications from the control circuitry.

NOTE: IT IS RECOMMENDED THAT THE AMPLIFIER BE CHECKED OUT ONE AXIS AT A TIME UNTIL ALL AXES HAVE BEEN CHECKED. THE FOLLOWING PROCEDURE WILL APPLY TO ANY AXIS. AXES NOT BEING CHECKED SHOULD BE INHIBITED (CAGED) AS FOLLOWS:

- (1) Place a jumper on the terminal block from the +15 volt terminal to the "cage" terminal of the axis or axes to be inhibited.
- (2) Remove the armature motor lead connected to the motor overload relay for TPA/1, TPA/2, or terminals P01-3,6, and 9 (whichever is applicable) for TPA/3.

#### 2.2.1 Equipment Required

Adjustable Signal Source 0 - +10 VDC @ 15 ma  
(+15 VDC is available from a terminal block on the amplifier).

Volt-Ohmmeter (Simpson or Triplett, etc.)

Dual Trace Oscilloscope

Clip-On RMS Ammeter (not necessary if oscilloscope available)

Clip-On Integrated Circuit "Dip-Clip"

Card Extender, EM-6-01.

### 2.2.2 Wiring Check

After wiring is completed double check all wiring to ensure that it is properly and securely connected, well soldered, etc., and is as shown per the appropriate system wiring diagram found in the back of this manual. (NOTE: IMPROPER WIRING WILL RESULT IN FUSE BLOWING!). Observe the following precautions:

- (1) Pay particular attention to the grounding scheme.
- (2) Twist all A.C. leads to minimize electromagnetic emission & pickup.
- (3) Avoid running signal leads in close proximity to power leads, armature leads, or other sources of electromagnetic noise.
- (4) Minimize lead lengths as much as is practical.

**CAUTION:** When using a contactor to switch the primary line, assurance must be made that if the contactor is dropped out while the motor is running (can happen if emergency stop is required), a mandatory delay occurs before the contactor is pulled back in to allow the motor to stop. In a normal application the motor should stop within .200 to .300 seconds.

Under no circumstances should the contactor be allowed to chatter, especially while the motor is

In other words, don't turn the power off and reapply it before the motor comes to a complete stop, or Dynamic Brake circuitry may cause fuse or circuit breaker operation.

2.2.3 Initial Conditions (Ref. Figures 1, 3 or 5 & the Approp. Sys. Wiring Dia.; Fig. 7 and C-78173 for MC1, Fig. 8 and C-78509-1 for MC2)

NOTE: WITH THE EXCEPTION OF THE SPEED SCALE FACTOR POT (LABELED "SPEED") ON THE MOTOR CONTROL CARD, ALL ADJUSTMENTS ON THIS AMPLIFIER ARE PRE-SET AT THE FACTORY AND SHOULD BE LEFT AS ADJUSTED DURING INITIAL TURN-ON.

With primary power OFF, open the leads between "RGS0" or "Inhibit All" at the terminal block. With the volt-ohmmeter on a sensitive VDC scale, place the positive lead on the choke center-tap, (or P01-1, or -4, or -7, whichever is applicable, for TPA/3) and the negative lead on GND TP on the Mother Board.

Manually rotate the motor shaft sharply CW as viewed from the large shaft end. Note the direction of meter needle deflection. Place the positive volt-ohmmeter lead on terminal 4 of MC1, MC2, or MC3 terminal strip (whichever is applicable), leaving the negative lead on GND TP. Rotate the motor shaft sharply CW. The meter should now deflect in the opposite direction from the previous step.

2.2.4 Power Application

Remove the command input wires from terminals 1 and 2 of each MC terminal strip. On initial turn-on, it is advisable to have the load disconnected from the motor shaft. Turn on the primary power, being ready to switch it off quickly if runaway occurs. If runaway occurs, refer to Section 3.0 of this manual. If the motor sits still, proceed. Close the connection at the "RGS0" or "Inhibit All" terminals. The motor will either sit still or run up to a very high speed and get stopped by the Overspeed Control. If runaway occurs, it is probable that the tach leads are improperly phased. Turn off power and reverse the leads on terminals 4 and 5 of the MC terminal strip for the axis being checked. Leave the shield ground on terminal 3.

Turn on power again. If the motor runs away, quickly remove power and proceed to the troubleshooting section of this manual.

If the motor sits still, grasp the shaft and attempt to rotate it. The motor should stiffly resist any effort to rotate the shaft. If it does not, proceed to the troubleshooting section of this manual. Remove primary power.

2.2.5 Speed Scale Factor "Speed" on Motor Control Card (Ref. Figures 1,3, or 5; Figure 7 and C-78173 for MC1, Figure 8 and C-78509-1 for MC2)

Since driving signals vary considerably, it is a good idea to check the speed scale factor. Proceed as follows, making connections at the MC terminal strip (see appropriate System Wiring Diagram) for the axis being checked:

Connect the D.C. signal source "HI" to terminal 1 and "LO" to terminal 2. If the +15 VDC supply on the amplifier is used, connect a jumper from terminal 2 to terminal 3. Connect the scope between terminals 4 and 5. Turn the speed scale factor pot, "SPEED", on the Motor Control Card fully CCW.

Compute the necessary tachometer voltage as follows:

$$\text{Desired Voltage} = \frac{(\text{Speed in RPM}) (\text{Tach Sensitivity, Volts})}{\text{RPM}}, \text{ where Tach Sensitivity} =$$

Speed Scale Factor of Tach.

EXAMPLE:

$$\begin{aligned} \text{Desired Voltage} &= (2000 \text{ RPM}) \left( \frac{.018 \text{ Volts}}{\text{RPM}} \right) \\ &= 36 \text{ Volts} \end{aligned}$$

CAUTION: In No Case Must You Run The Motor Faster Than The Speed Allowed Per the TL Sheet Enclosed.

Apply primary power, beginning with a small input command signal, and drive the system backward and forward to familiarize yourself with directions, speed, time you can run, etc. IF NO RESPONSE IS OBTAINED, ROTATE THE SPEED SCALE FACTOR POT, "SPEED", FIVE (5) TURNS CW AND REPEAT.

Slowly increase the voltage from the DC source until you have reached the maximum signal the control command normally delivers. Have another person observe the scope and record the tachometer voltage while you control the signal and observe slide position to avoid overrun and accidents. If the distance to run is restricted, remove the load from the motor and allow the motor to run free.

While running the system, observe the scope and read the tach voltage. If the voltage is too low, adjust

"SPEED" (Scale Factor) on the Motor Control Card to obtain the proper match of input signal vs. desired speed. Remove primary power. After the speed scale factor pot has been set and the system is functioning properly, the load may be reconnected to the motor shaft if it was removed previously.

2.2.6 Current Check (Ref. Figures 7, 16 for MC1) (Ref. Figures 8, 17 for MC2).

TURN OFF POWER and connect the scope LOW to TP GND on Mother Board and the scope HI to TP8 on MC1 Card, or TP75 on MC2 Card for the axis being checked.

The scale factor at this point is as follows:

| Current Sense Resistance    | Scale Factor  |
|-----------------------------|---------------|
| .01 Ohm (25 & 40 Amp Units) | 100 Amps/Volt |
| .005 Ohm (85 Amp Units)     | 200 Amps/Volt |

Set the DC input signal (connected to terminals 1 and 2 of the MC terminal strip for the axis being checked) to the maximum expected value, then be sure it is turned off.

TURN ON POWER (close "RGS0" or "Inhibit All" if it has been opened). Using the signal source, command speed and observe the current waveform on the scope. With the step input command, the waveform should be as indicated in Figure 16 for axes incorporating Motor Control Cards MC1. For axes incorporating Motor Control Cards MC2, the current profile should be as indicated in Figure 17. Remove power, open "RGS0" or "Inhibit All."

NOTE: REPEAT SECTION 2.2 FOR EACH REMAINING AXIS.

2.3 Connection to the Control Command Output.

If this amplifier is being used in a numerically controlled system, we are now ready to close the position loop with the N/C. If this amplifier is being used in a manually controlled system, proceed to Section 2.3.2.

2.3.1 Connection to the N/C

Remove the DC signal source. Remove any jumpers installed between terminals 2 and 3 on the "MC" terminal strips.

**CAUTION:** Incorrect phasing can cause large excursion oscillations or runaways. Appropriate precautions should be taken to stop the machine if necessary. Slides should be moved a reasonable distance away from hard stops before applying power.

**NOTE:** IT IS RECOMMENDED THAT THE AMPLIFIER BE CHECKED OUT ONE AXIS AT A TIME, UNTIL ALL AXES HAVE BEEN CHECKED. THE FOLLOWING PROCEDURE WILL APPLY TO ANY ONE AXIS. AXES NOT BEING CHECKED SHOULD BE INHIBITED AS FOLLOWS:

- (1) Place a jumper on the terminal block from the +15 volt terminal to the "cage" terminal of the axis or axes to be inhibited.
- (2) Remove the armature motor lead connected to the motor overload relay for TPA/1, TPA/2, or terminals P01-3, 6, and 9 (whichever is applicable) for TPA/3 for the axis or axes to be inhibited.

There are two ways of checking the phasing of the position loop:

- (1) Determine the proper phasing by analyzing the feedback based on the design of the complete machine. Then attach the N/C output to the amplifier and turn on the power.
- (2) Insert a 47K (33K to 68K is o.k.) ohm resistor in series with the N/C Hi output and terminal 1 of the "MC" terminal strip for the axis being checked. Then with one hand on the start button and one on the emergency stop button, apply power and observe the action of the machine.

In most cases, if the servo (position loop) phasing is wrong the motor will accelerate to some reasonable speed of about 500 RPM and then the system will oscillate at a low frequency and produce large excursions. The resistor (47K) ensures that if a runaway occurs the speed will not reach dangerous levels.

If it is determined that the direction of rotation of the Inland system must be reversed, you must reverse both the tach leads and the motor leads.

When the phasing of the servo (position loop) is correct, the 47K resistor may be removed and the N/C HI connected directly to terminal 1.

The axis may now be exercised by the N/C. The last items to be set are the position loop gain in the N/C and the speed scale factor pot, "SPEED", on the Inland amplifier.

The speed scale factor must be set such that the max N/C output is sufficient to drive the Inland system to about 20% over max traverse speed, to allow for some overshoot on acceleration. The scale factor should be checked and adjusted by running the system with the N/C in max traverse and measuring the N/C output voltage at terminals 1 and 2. Determine the max swing capability of the controller either by reading the N/C specs or actually measuring the max N/C control, program max traverse and measure the voltage at terminals 1 and 2. Adjust the speed scale factor pot "SPEED" to obtain about 80% of the N/C max output while the machine is moving.

The position loop gain may now be set in the N/C. This may be adjusted by observing the overshoot of the motor at max traverse by observing the tachometer response, or the command vs. feedback pulses in the N/C. In any case the position loop gain should be set as high as possible without overshoot.

NOTE: REPEAT SECTION 2.3.1 FOR EACH REMAINING AXIS.

### 2.3.2 Connection to a Manually-Operated Machine

Should the system be used on a manually-operated machine, some form of DC input signal will be required. Drawing A-78255 (for TPA/1, /2) in the back of this manual illustrates one method of doing this. (Also see A-78254 for TPA/3).

The +15 VDC supply in the Inland amplifier can be utilized to supply +15 VDC to the external command circuitry provided its load impedance is not less than 10K ohms. If this impedance is less than 10K ohms, the required top speed may not be obtained.

An external power supply may be utilized, provided its common is returned to the power supply common on the terminal block and it does not exceed +15 VDC. The system connections will be similar to those shown in A-78254 or A-78255. The connections made to the right side of the DIR relay contacts should go to the +15 VDC external power supply rather than of the internal supplies.

This system will operate as follows:

Apply power and energize the RUN relays to close "RGS0" or "Inhibit All." If FEED #1 relay is energized, the system will run at a rate set by the FEED #1 Speed Potentiometer until the FEED #1 relay is de-energized, and in a direction set by the contacts of the DIR Relay. The direction is selected by either energizing or de-energizing the DIR relay. FEED #2 operates in the same manner. Rapid traverse speed is selected by energizing the TRAV relay, and set by the TRAV Speed Potentiometer.

## 2.4 Other Adjustments

The following paragraphs describe adjustments which are factory pre-set and will normally not be performed on a new unit in the field. These adjustments may become necessary in the event of component failure or card replacement.

### 2.4.1 Zero Adjustment ("ZERO") on Motor Control Card; (Ref. Figs. 1, 3, or 5; Fig. 7 & C-78173 for MC1, Fig. 8 & C-78509-1 for MC2)

The Zero Adjustment is factory set and sealed and should never require adjustment. The following procedure is given only in the event that the seal is unintentionally broken. The adjustment should be resealed after it has been adjusted.

Remove N/C HI and jumper terminals 1 and 2 on the "MC" terminal strip for the axis being adjusted. Connect a voltmeter on a sensitive volts DC scale from TP8 on MC1 Card or TP75 on MC2 Card to TP GND. Apply power, close "RGS0", on "Inhibit All" and adjust "ZERO" (Zero Adjust) on the Motor Control Card for 0 VDC on the voltmeter. Remove power, remove jumper, reconnect N/C HI.

### 2.4.2 Bias Adjustment (Via 3 Pots in Component Locations 8, 34, 60 on the Ramp Generator Card; Ref. C-78181, Figs. 1, 3, or 5, and Figure 10)

The Bias Adjustment is factory set and sealed and should never require adjustment. The following procedure is given only in the event that the seal is broken. The adjustment pots should be resealed after adjustment.



TURN OFF POWER. Inhibit all axes by placing jumpers on the terminal block from the +15 volt terminal to the "cage" terminals. With respect to TP GND, connect the HI input of an oscilloscope\* to TP8 on the MC1 Card, or TP75 on the MC2 Card of the axis having the motor with the lowest continuous torque rating, or the appropriate test point on any Motor Control Card if all motors are of the same rating. Adjust the pots at the upper edge of the Ramp Generator Card until all current pulses are at the peak value specified on the Test Limits Sheet for the system. (Ref. Figure 16-A(e) for MC1 Card, or Figure 17-A(e) for MC2 Card). Reference Section 2.2.6 for the scale factor in volts/amp at TP8 or TP75. If this adjustment cannot be accomplished, refer to Troubleshooting Section.

NOTE: IF NO OSCILLOSCOPE IS AVAILABLE, THE BIAS ADJUSTMENT CAN BE PERFORMED USING A CLIP-ON RMS AMMETER AS FOLLOWS:

Place clip-on ammeter around one lead going to the motor having the lowest continuous torque rating, or one lead of any motor if all motors are of the same rating.

Jumper TP7 to TP8 and TP13 to TP14 (located at upper edge of Ramp Generator Card). Apply power, close "RGS0" or "Inhibit All". Adjust the top potentiometer (component location 8, next to "Inhibit 1") until 1.5 amps are read on the clip-on ammeter. Remove power. Remove jumper from TP7 to TP8.

Place jumper from TP1 to TP2. Apply power. Adjust the center potentiometer (component location 34, next to "Inhibit 2") until 1.5 amps are read on the clip-on ammeter. Remove power. Remove jumper from TP13 to TP14.

Place jumper from TP7 to TP8, apply power. Adjust the bottom potentiometer (component location 60, next to "Inhibit 3") until 1.5 amps are read on the clip-on ammeter. Remove power.

Remove all jumpers from Ramp Generator Card. Apply power and note that a reading of 3-4 amperes bias current is indicated on the clip-on ammeter. If this bias current reading does not agree with that specified on the enclosed system Test Limits Sheet, repeat

\*See Note

the above procedure for more or less current as required to obtain the correct reading with all jumpers removed. If this adjustment procedure cannot be accomplished, refer to Troubleshooting Section 3. Remove power, clip-on ammeter, and "Inhibit" jumpers.

2.4.3 Overspeed Adjustment ("OVSPD") on Motor Control Card; (Ref. Figures 1, 3, or 5; Figure 7 and C-78173 for MC1 Card, Figure 8 and C-78509-1 for MC2 Card)

The Overspeed Adjustment is factory set and sealed and should never require adjustment. The following procedure is given only in the event that the seal is unintentionally broken. The adjustment should be resealed after it has been adjusted.

Remove power. Disconnect the motor from the load. Turn the "OVSPD" pot fully CW. Connect a DC 0 to +10 VDC adjustable signal source to the MC terminal strip for the axis being checked. Connect the DC signal source "HI" to terminal 1 and "LO" to terminal 2. If the +15 VDC supply on the amplifier is used, connect a jumper from terminal 2 to terminal 3. Apply main power and close the RGS0 contacts. Starting with zero, adjust the signal source, gradually increasing the speed of the motor until the Overspeed Trip Point, listed on the appropriate TL Sheet, is obtained (as determined by hand-held tachometer or by monitoring the DC tachometer feedback at terminals 4 and 5 of the appropriate MC terminal strip). While the motor is running at the "Overspeed Trip" speed, adjust the "OVSPD" pot CCW until the system just shuts down. Remove the main power and seal the pot.

2.4.4 Power Supply Adjustments ("NEG ADJ" and "POS ADJ") on Power Supply Card PS2; (Ref. Figures 1, 3, or 5; Figure 12 and C-78530-1)

The power supply adjustments are factory set and sealed and should never require adjustment. The following procedure is given only in the event that seal is unintentionally broken. The adjustments should be resealed after they have been adjusted.

Apply power. Connect a digital D.C. voltmeter to -15V TP with respect to the GND TP and adjust the "NEG ADJ" pot in position 22 for -15 volts  $\pm 0.1$  volt.

Connect a digital D.C. voltmeter to +15V TP with respect to the GND TP and adjust the "POS ADJ" pot in position 29 for +15 volts  $\pm 0.1$  volt. If these

adjustments cannot be accomplished, refer to troubleshooting section.

### 3.0 TROUBLESHOOTING

#### A. Card Component Location

The card components are identified by position on the individual cards rather than by nomenclature. This method of identifying the components by position helps to quickly locate the component on the card. The component locations are numbered from left to right starting from the PIN end of the card.

#### B. Special Equipment

An EM6-01 card extender may be helpful when troubleshooting the individual cards. The card extender can be ordered directly from Inland. It will be necessary to remove the key from the card receptacle before the extender can be inserted. After troubleshooting the card, be sure to replace the key.

Since in-line component packages are used extensively on the printed circuit cards, it will be necessary to keep on hand a small DIP clip device to aid in monitoring points on the in-line component packages. These devices can be obtained from local electronics distributors.

#### C. Troubleshooting Charts

In using the Troubleshooting Charts, keep in mind the following:

- I. There are three distinct areas given in the charts where a fault may occur. They are:
  - (1) External Interface (Chart #1)
  - (2) Power Stage (Chart #2)
  - (3) Control Section Card Level (Chart #3)
- II. There are two basic fault characteristics given in the charts. They are:
  - (1) One or more axes totally inoperative.
  - (2) Erratic or improper operation of one or more axes.

III. The recommended procedure for using the flow charts is as follows:

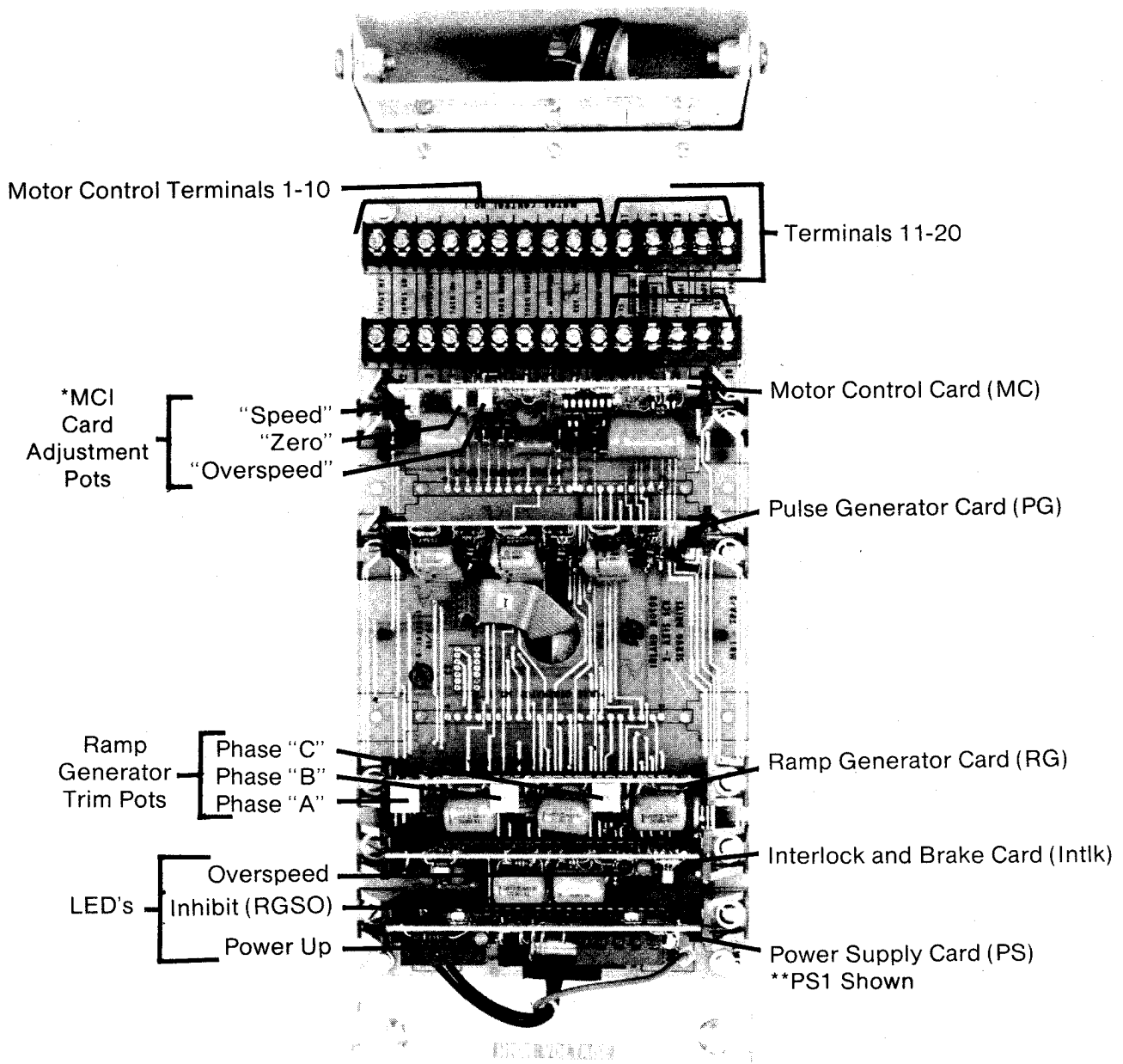
- (1) Please use caution when troubleshooting this servo system. Remove the main power when arranging the circuits for testing.
- (2) Begin with the "START" block of Chart #1 (External Interface) and proceed as instructed until the fault is located.
- (3) If directed to Chart #3 (Control Section), begin with Chart 3a and troubleshoot the PS (Power Supply) Card first. Proceed then to Chart 3b and troubleshoot the INTLK (Interlock & Brake) Card. These two cards contain the "circuit vitals" for the drive-up mode. Next, go to Chart 3c and 3d and check motor current and operation of PG (Pulse Generator) and RG (Ramp Generator) cards. These two cards produce the waveforms for phase angle control. Lastly, proceed to Chart 3e and 3f to troubleshoot the MC (Motor Control) Card, which contains the circuits for speed and current control.
- (4) If a component is replaced, return to the "START" block of the chart being used, and begin the troubleshooting procedure again to ensure that multiple problems do not exist in the circuitry.

4.0 RECOMMENDED SPARE PARTS LIST TPA/1/2/3

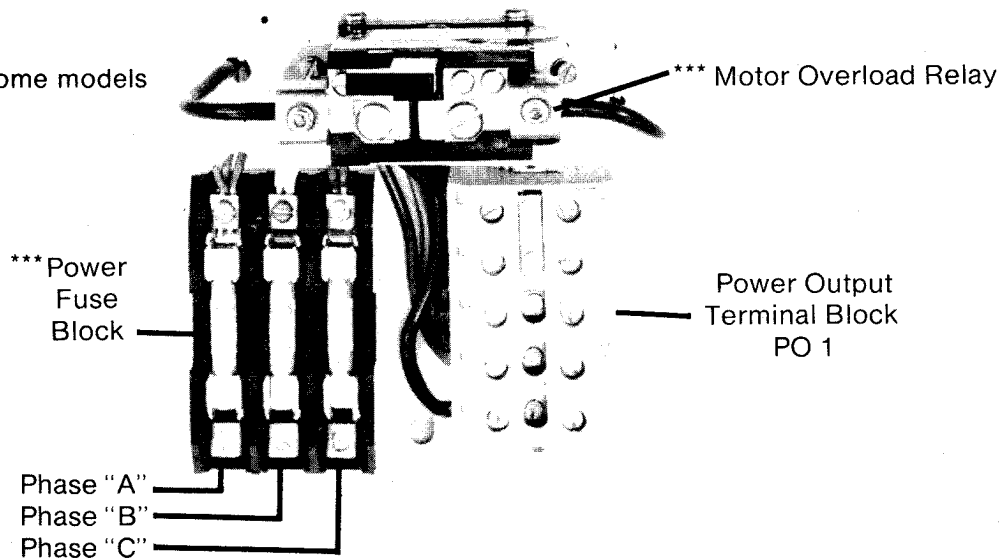
| QTY. USED PER:       |       |       | QTY. RECOMM. | DESCRIPTION  |
|----------------------|-------|-------|--------------|--|
| TPA/1                | TPA/2 | TPA/3 | FOR SPARE    |  |
| <u>PC CARDS</u>      |       |       |              |  |
| 1                    | 2     | 3     | 1*           | Motor Control MC1 or MC2   |
| 1                    | 2     | 3     | 1            | Pulse Generator PG2  |
| 1                    | 1     | 1     | 1            | Ramp Generator RG1   |
| 1                    | 1     | 1     | 1            | Interlock INTLK2   |
| 1                    | 1     | 1     | 1**          | Power Supply PS2   |
| 1                    | 2     | 3     | 1            | Suppression C-78354-00   |
| 1                    | 1     | ---   | 1            | Mother Board MB1-TPA/1/2   |
| ---                  | ---   | 1     | 1            | Mother Board MB1-TPA/3   |
| <u>MAIN ASSEMBLY</u> |       |       |              |  |
| 3                    | 6     | 9     | 10           | Fuses (See Test Limit Sheet for Proper Fuse Size).   |
| 3                    | 6     | 9     | 3            | SCR Paks (Specify Amplifier Model No. When Ordering).  |
| 1                    | 2     | 3     | 1            | Overload Relay with Heater. (See Test Limits Sheet for Proper Value of Overload Relay and Heater). |
| 1                    | 2     | 3     | 1            | Current Sensing Resistor:<br>A-78297 .01 ohm, 5%, 100w or<br>A-32892 .005 ohm, 5%, 100w.           |
| 1                    | 2     | 3     | 1            | A-78376 Cable Assembly (Need Model Number & Axis Number or Length).                                |

\*Motor Control Cards vary with motor types. Recommend stocking one spare of each type.

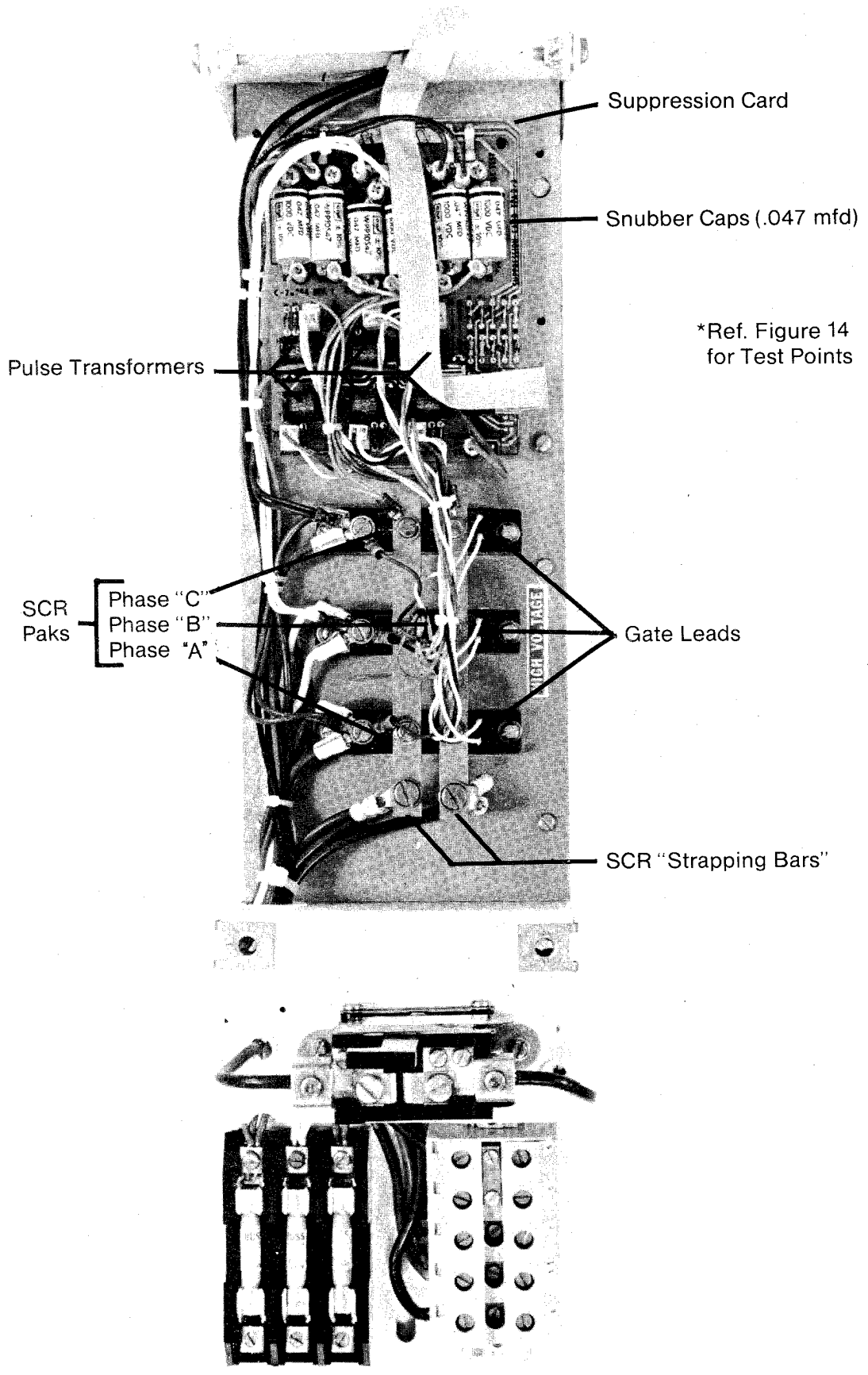
\*\*Power Supply Cards vary with the 3-phase power transformer secondary voltage.



- \* For MC2 see Fig. 8
- \*\* For PS2 See Fig. 12
- \*\*\* May not appear on some models

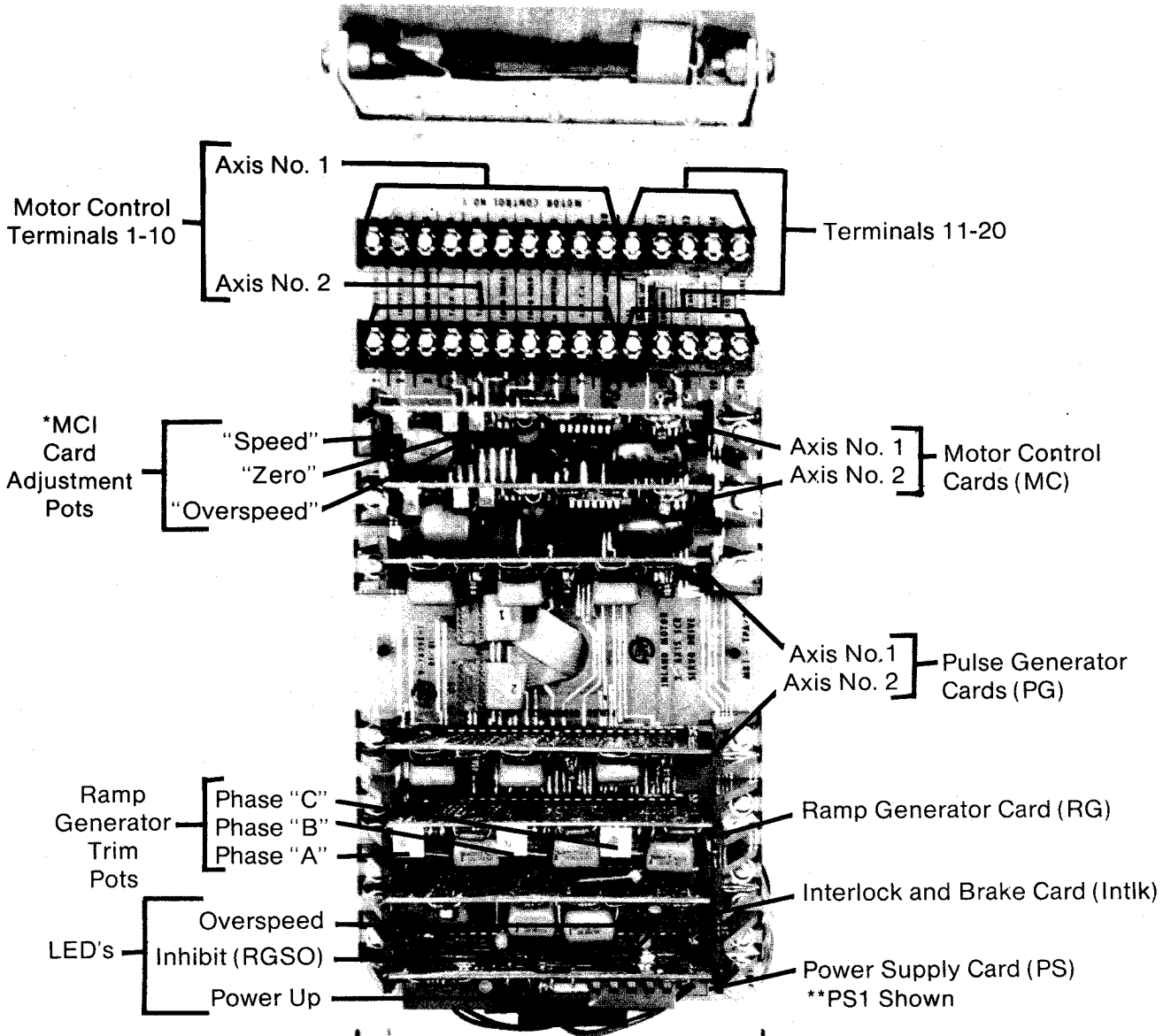


**FIGURE 1**  
**TPA/1 AMPLIFIER**

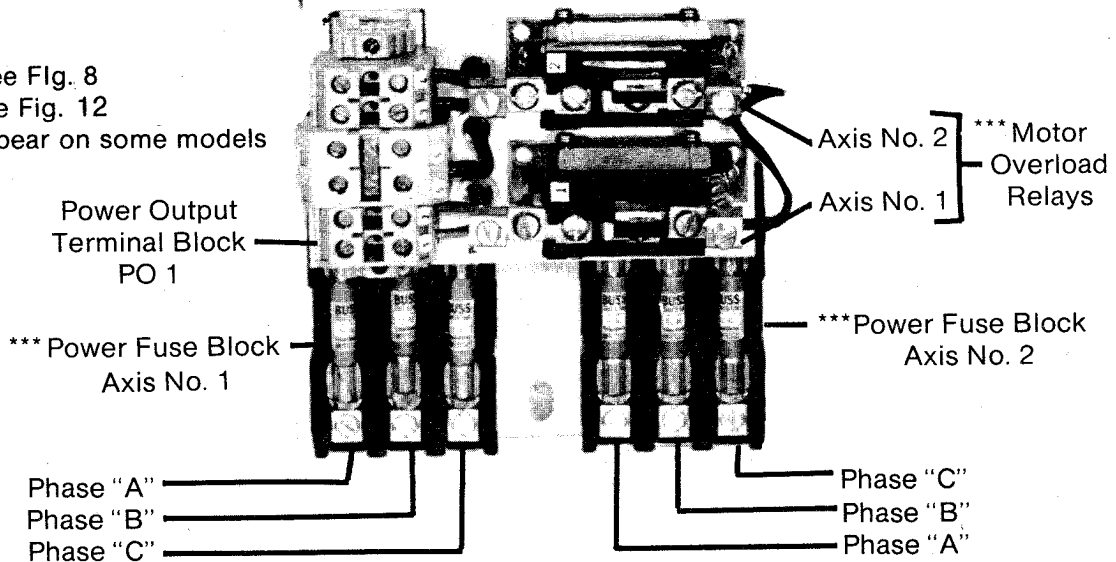


\*Ref. Figure 14  
for Test Points

**FIGURE 2**  
**TPA/1 AMPLIFIER (OPENED, SHOWING POWER SECTION)**

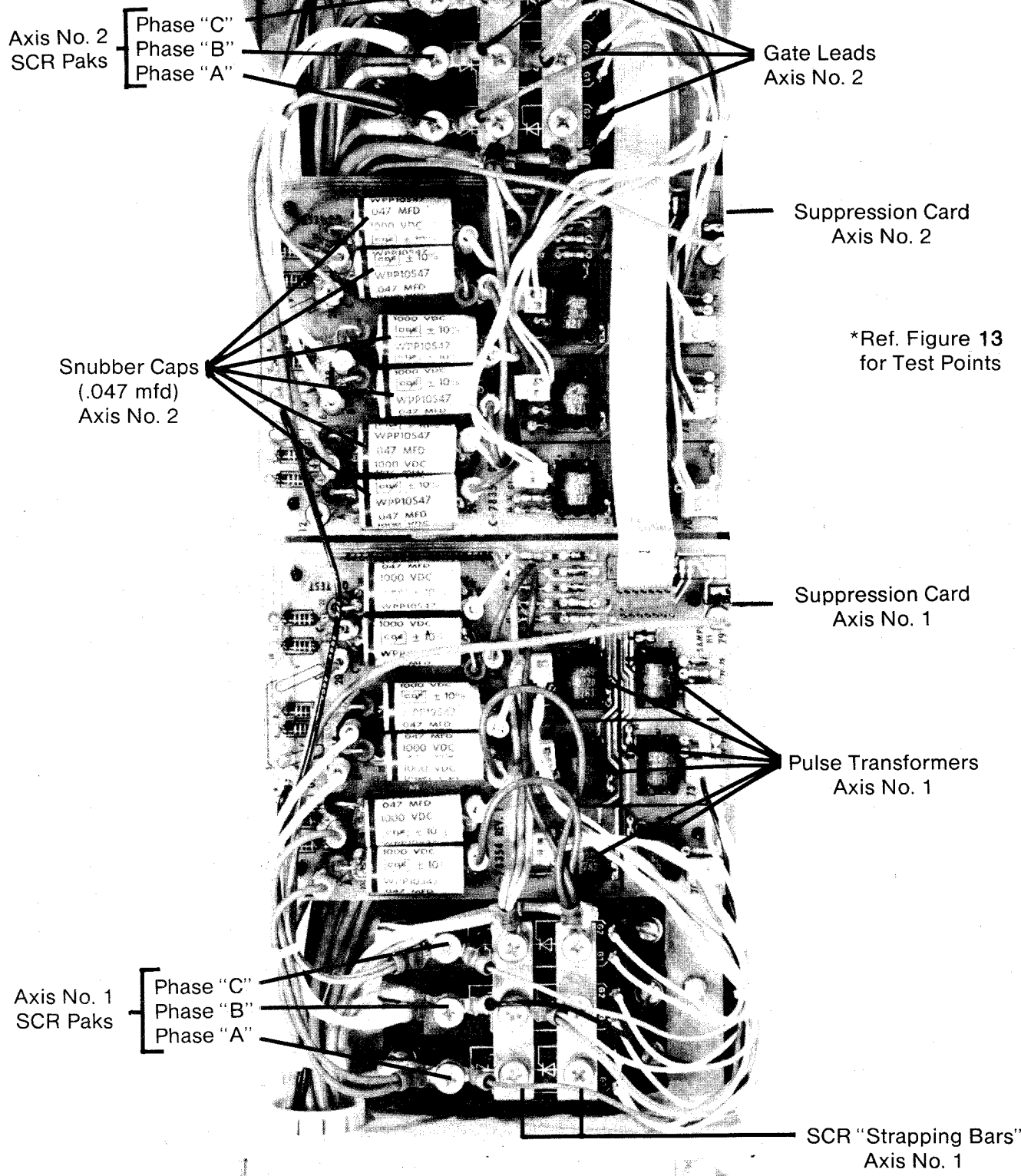


- \* For MC2 See Fig. 8
- \*\* For PS2 See Fig. 12
- \*\*\* May not appear on some models

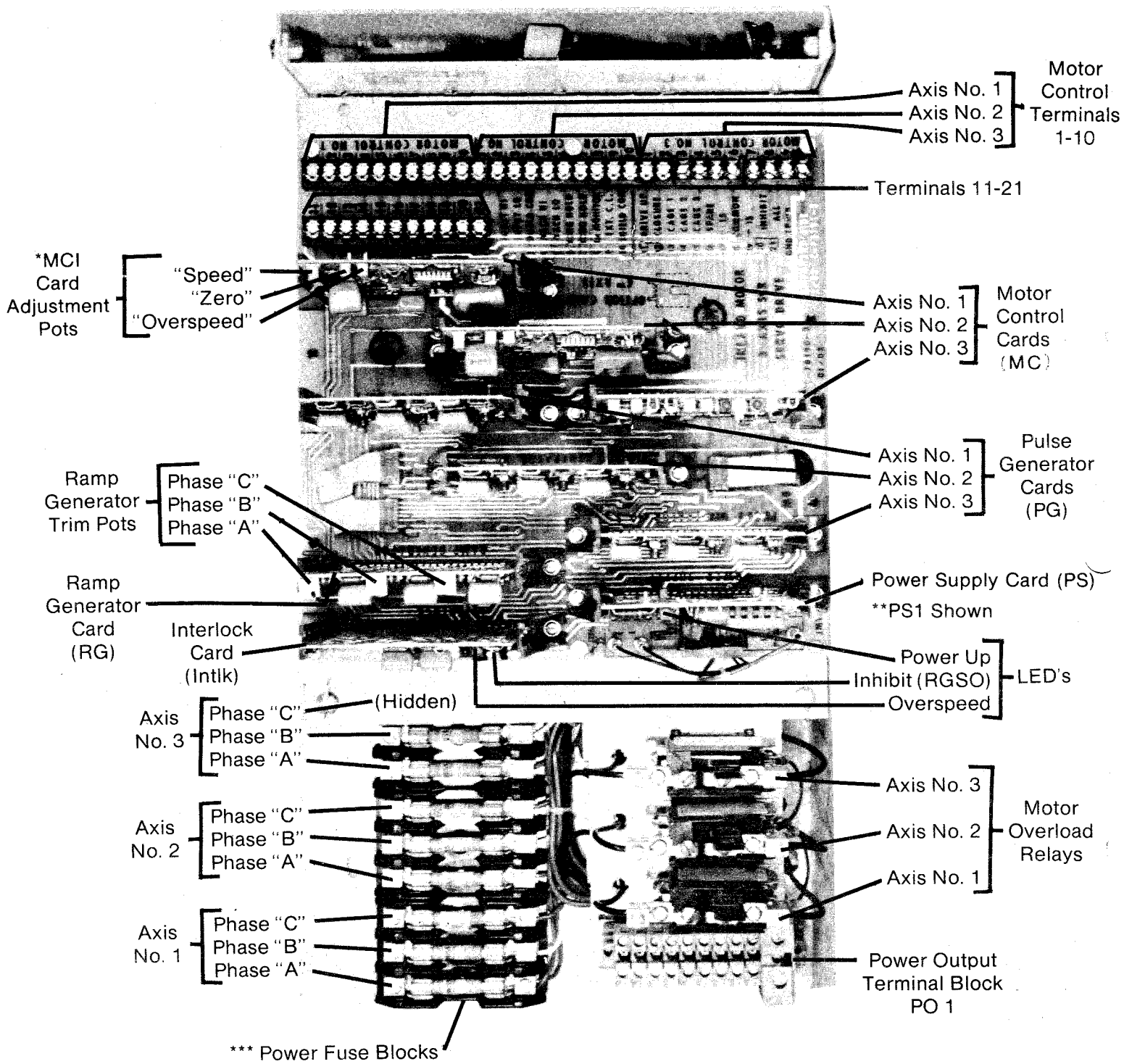


**FIGURE 3**  
**TPA/2 AMPLIFIER**





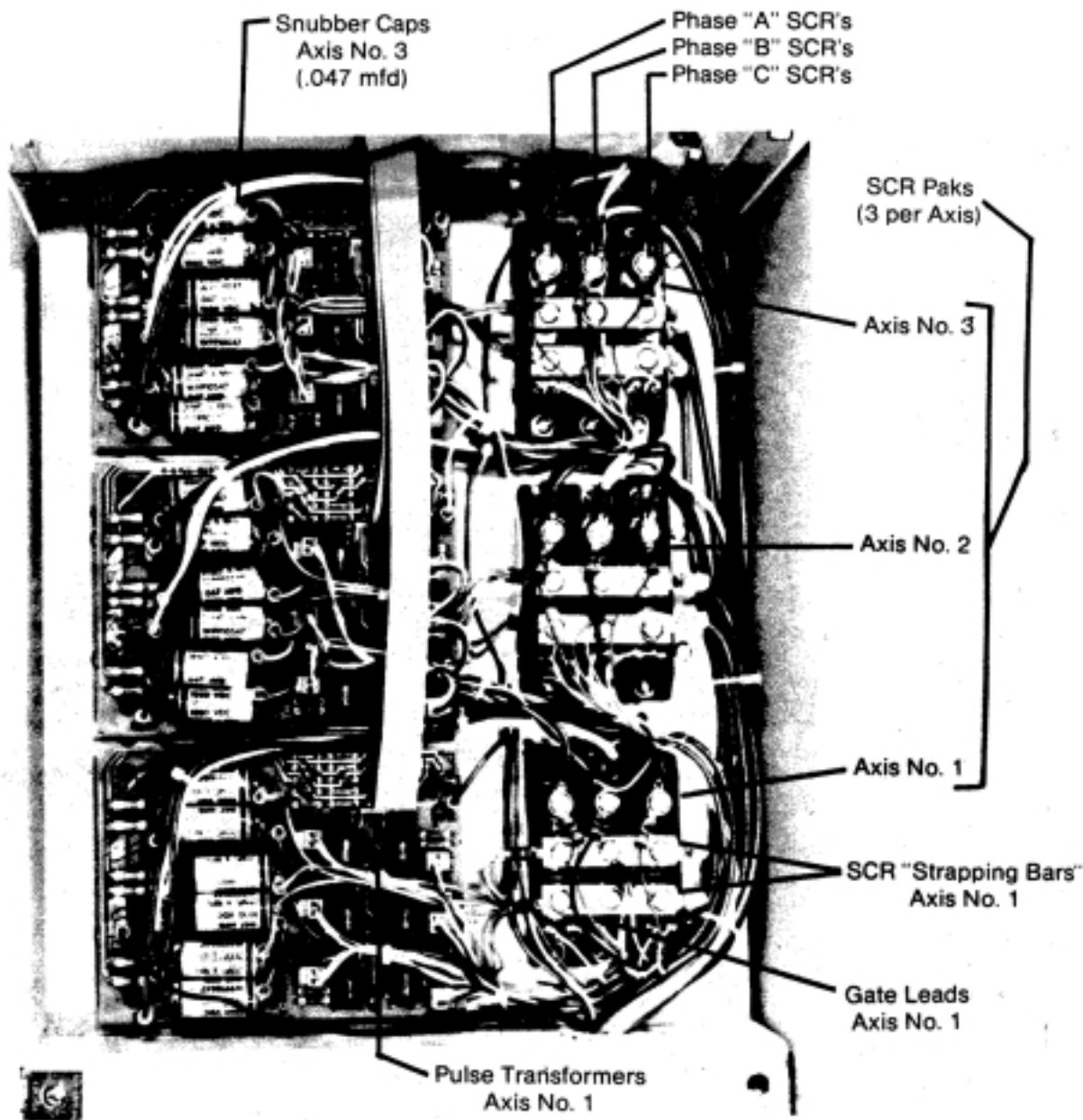
**FIGURE 4**  
**TPA/2 AMPLIFIER (OPENED, SHOWING POWER SECTION)**



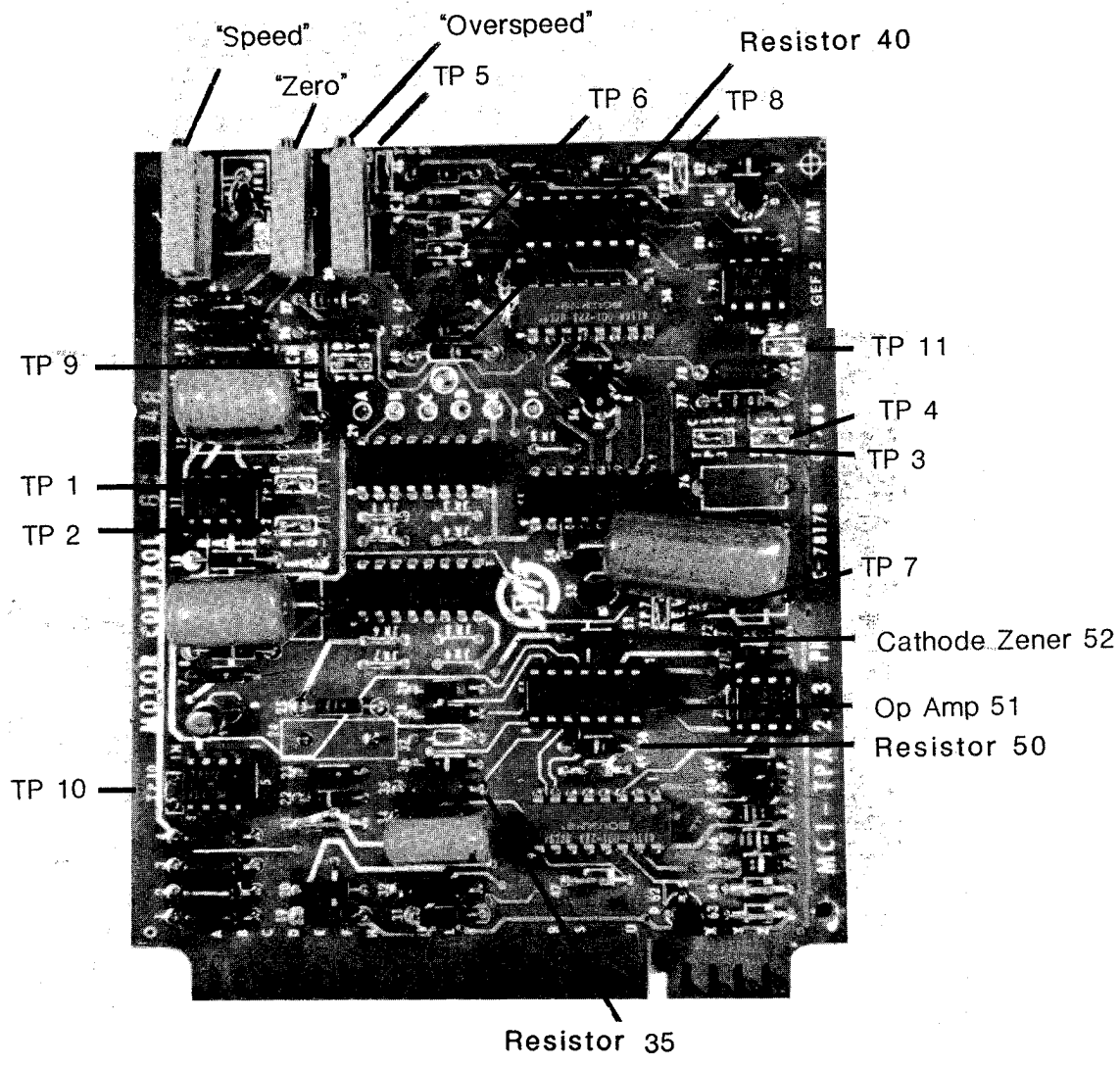
\* For MC2 See Fig. 8  
 \*\* For PS2 See Fig. 12  
 \*\*\* May not appear on some models

**FIGURE 5**  
**TPA/3 AMPLIFIER**

\*Ref. Figure 14  
for Test Points



**FIGURE 6**  
**TPA/3 AMPLIFIER (OPENED, SHOWING POWER SECTION)**



**FIGURE 7**  
**MOTOR CONTROL CARD (MC 1)**

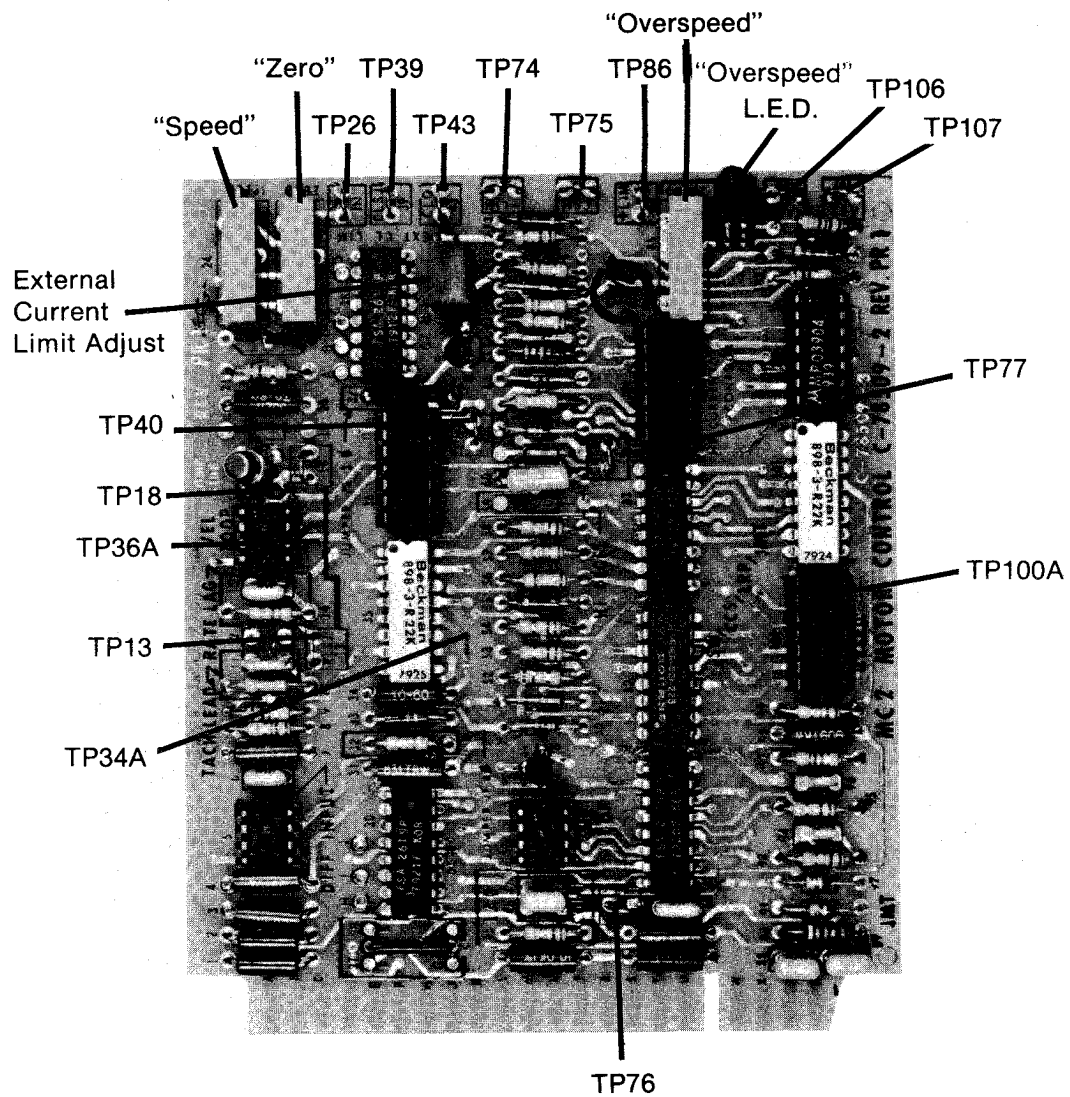


FIGURE 8  
MOTOR CONTROL CARD (MC 2)

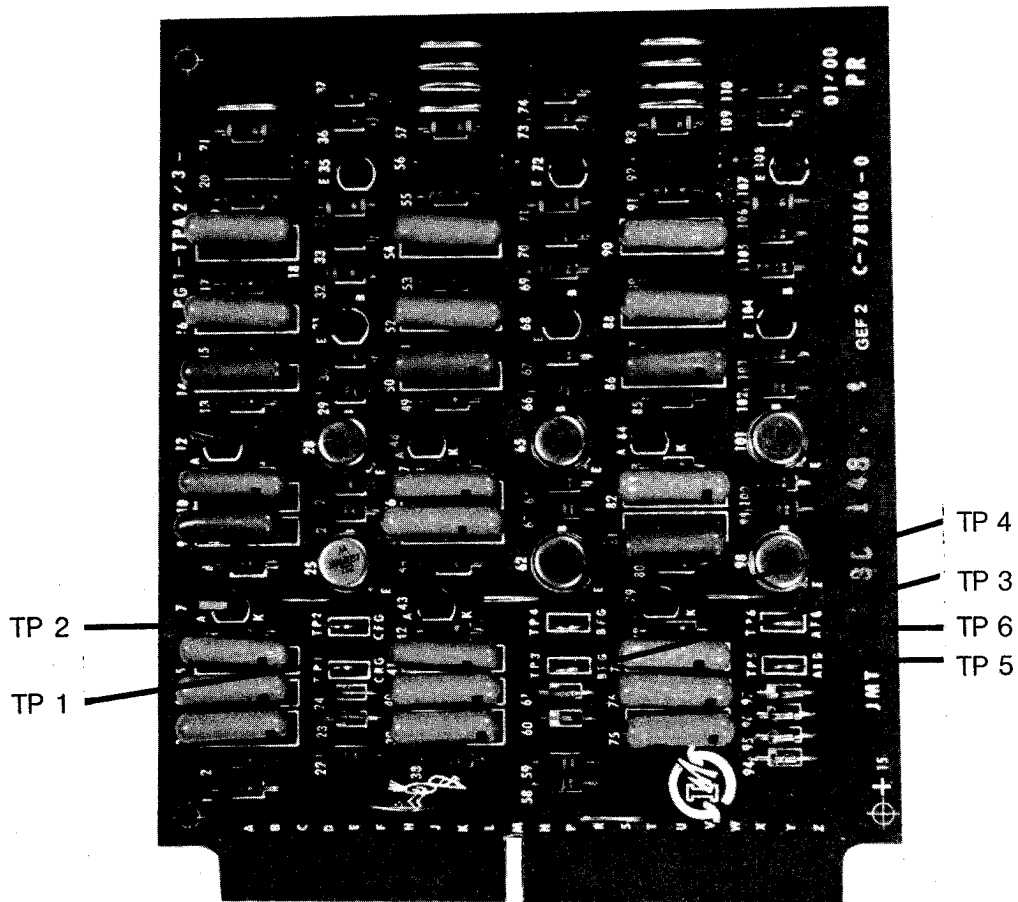
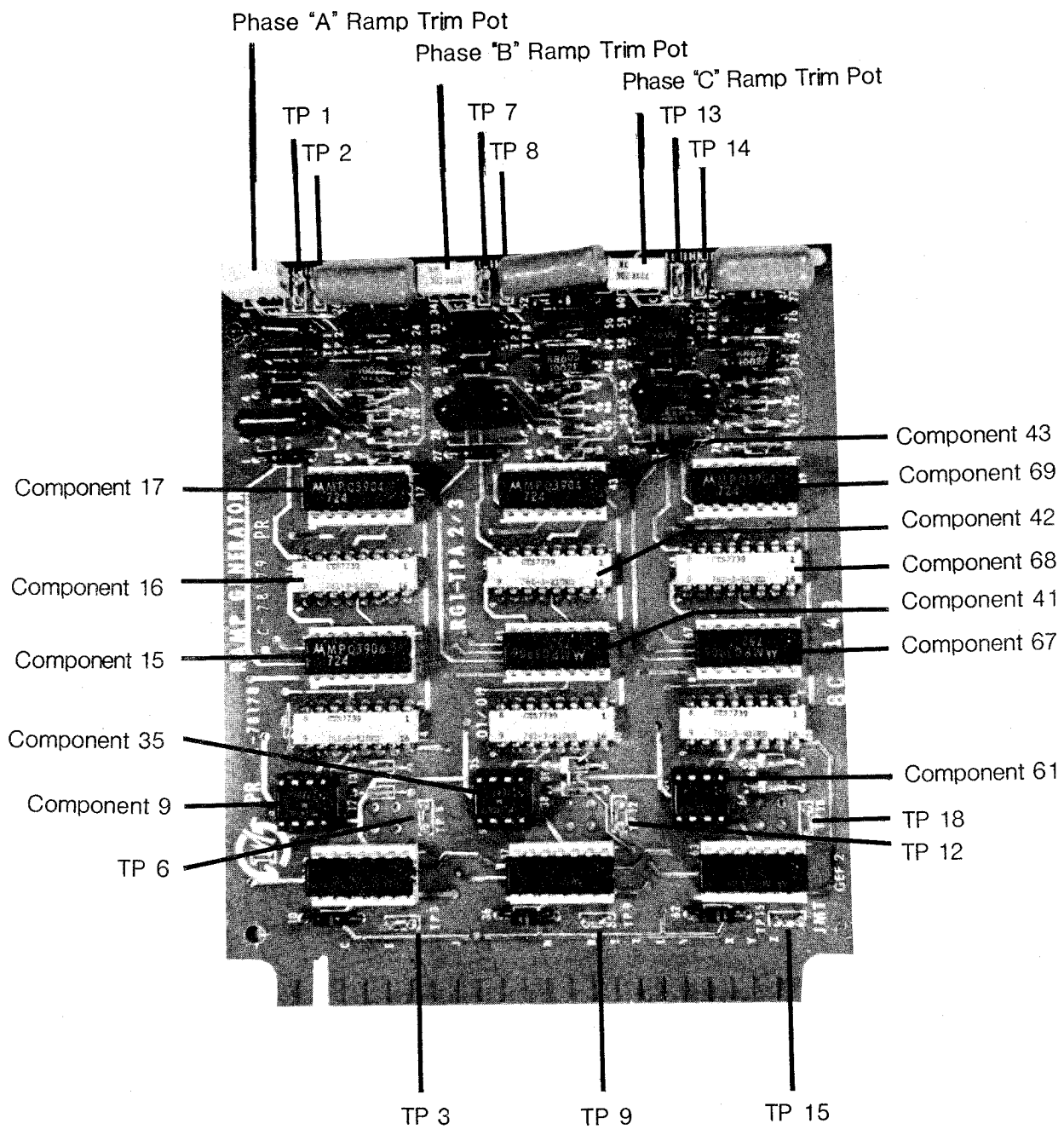
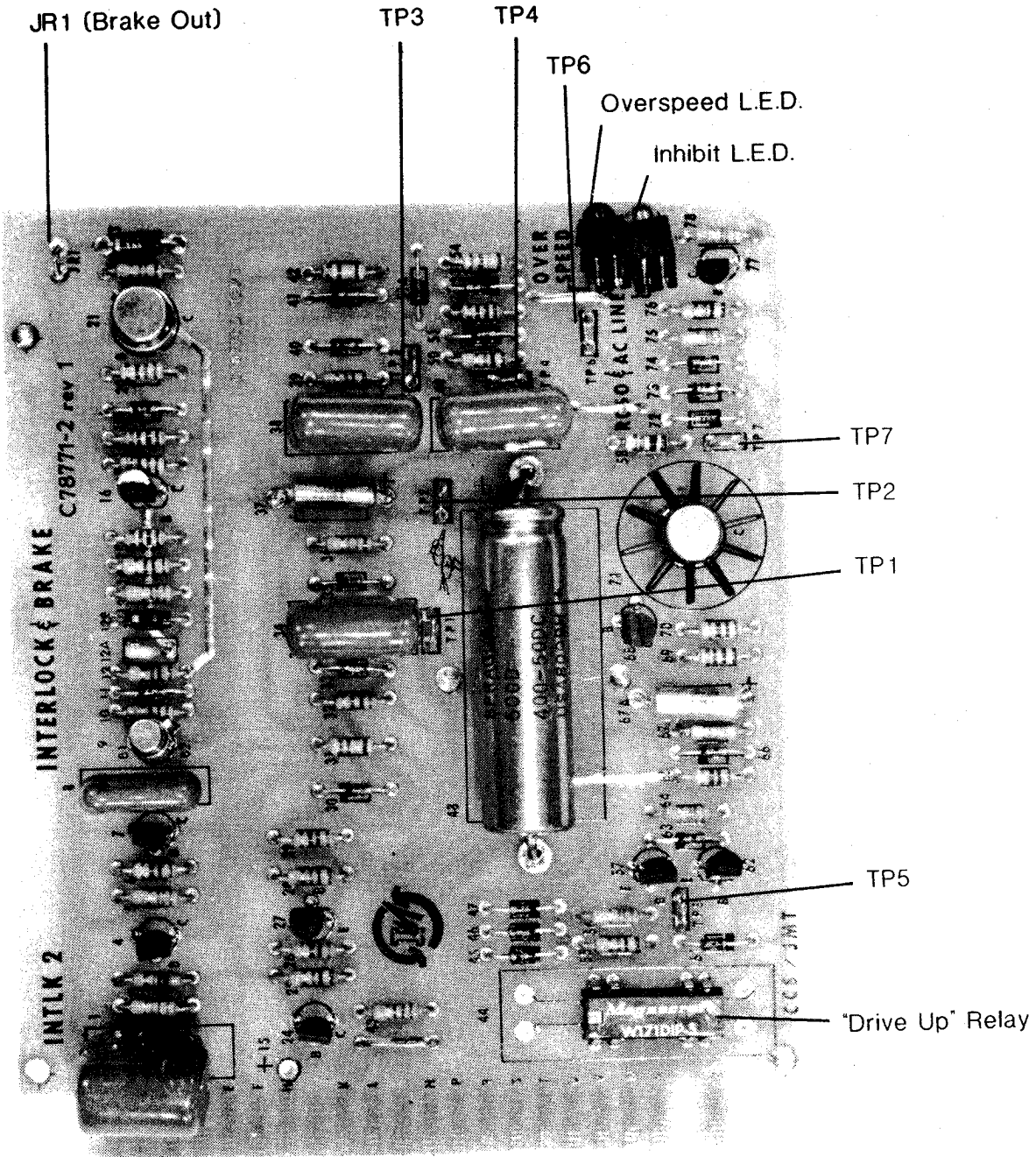


FIGURE 9  
PULSE GENERATOR CARD (PG 1)



**FIGURE 10**  
**RAMP GENERATOR (RG 1)**



**FIGURE 11**  
**INTERLOCK AND BRAKE CARD**  
**(INTLK 2)**



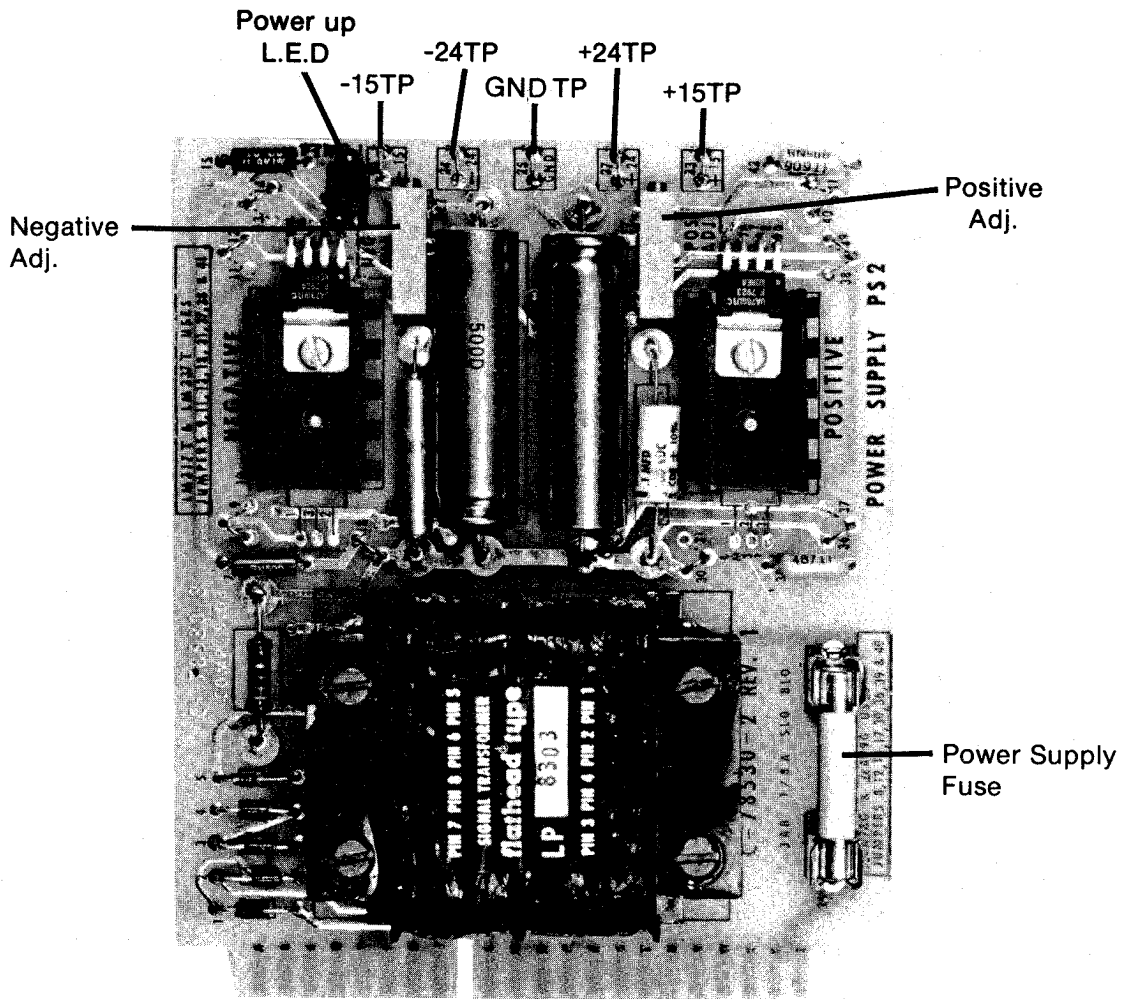
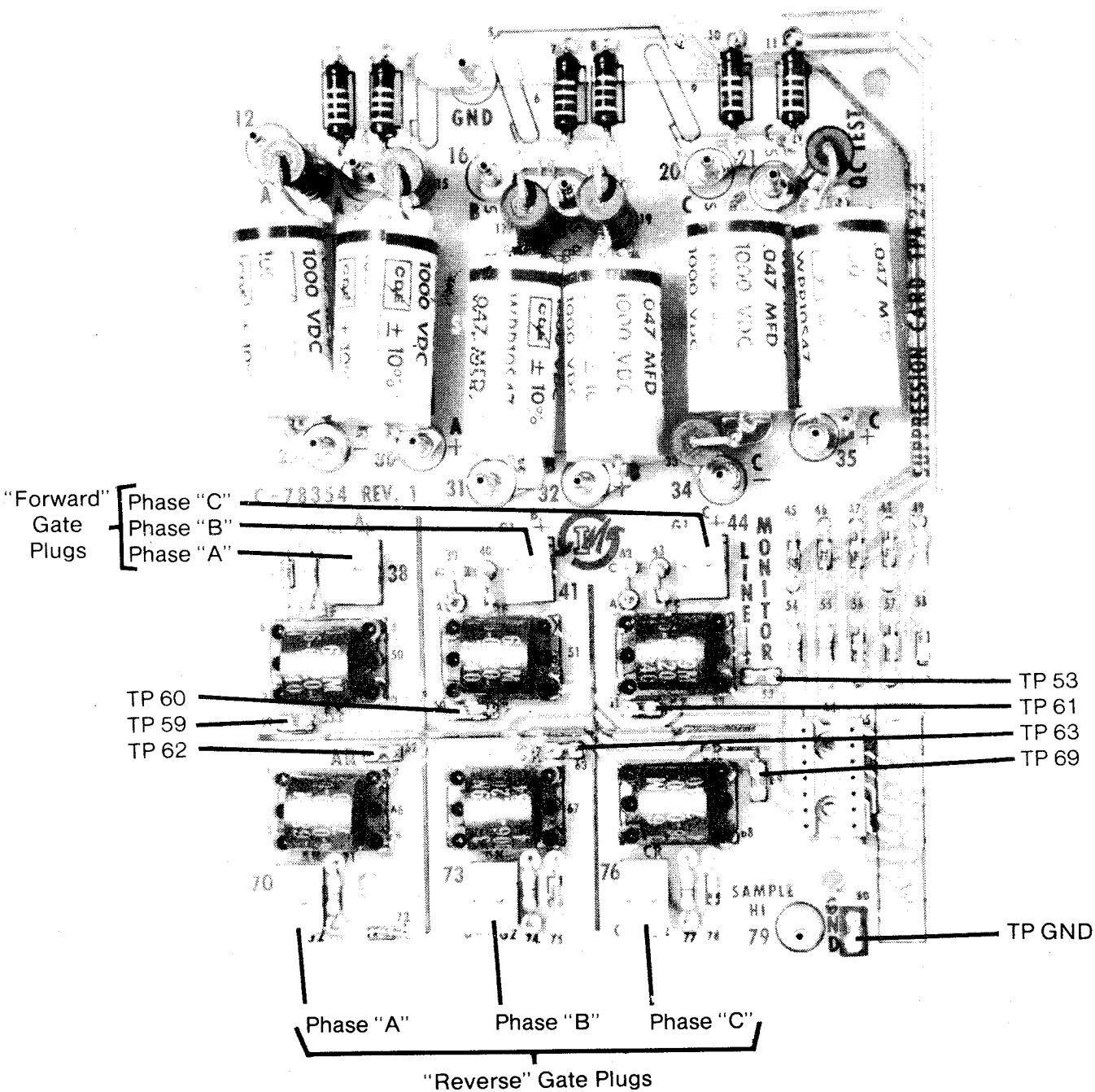


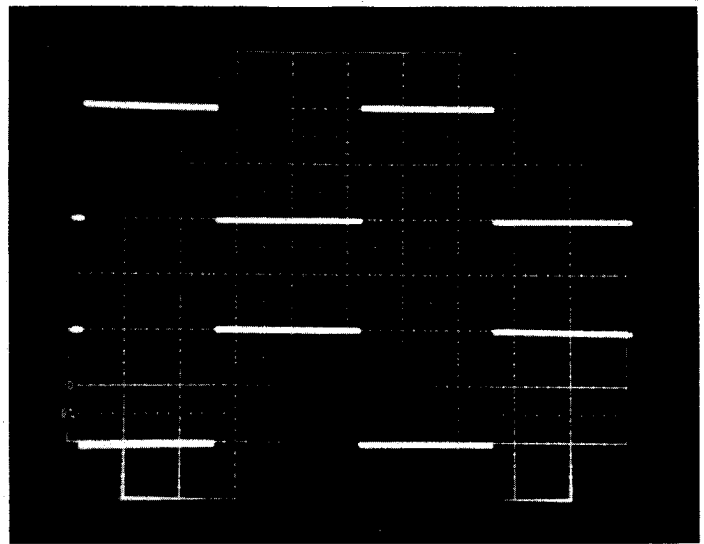
FIGURE 12  
POWER SUPPLY CARD (PS 2)



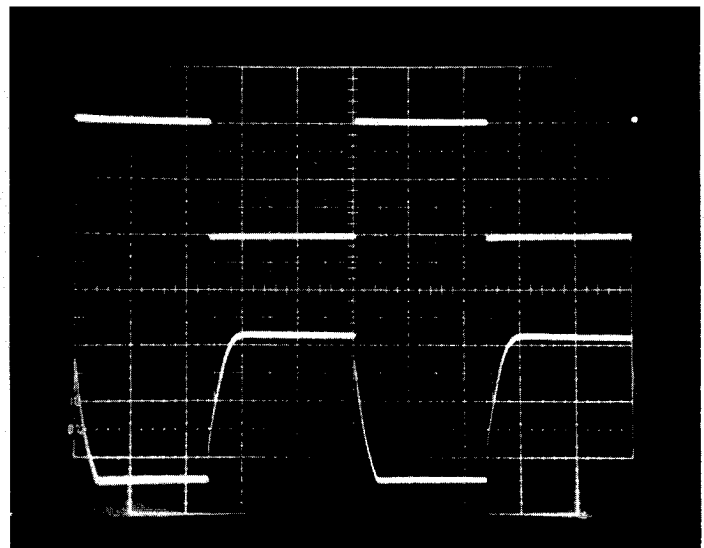
**FIGURE 13**  
**SUPPRESSION CARD (SUP 2)**

a. 20 Volt Peak to Peak 1 Hz. squarewave from signal generator applied at terminals 1 & 2 of MC terminal strip for axis being checked. (10V/Div., 0.2 Sec/Div.)

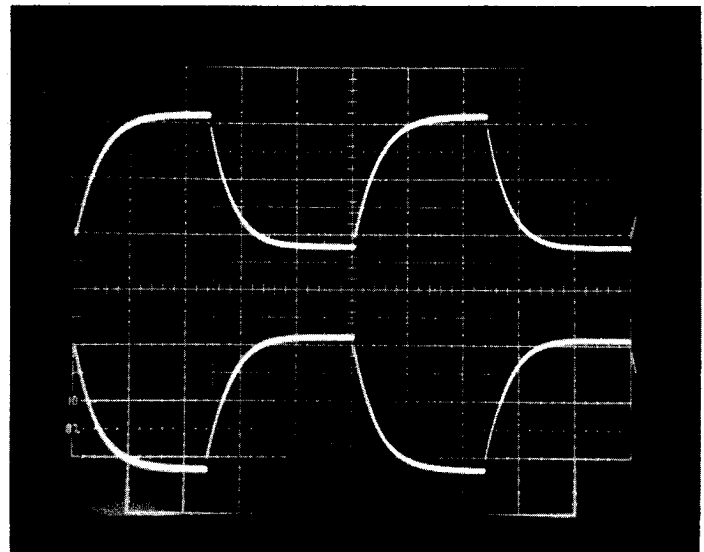
b. Output at TP10 of MC1 Card  
Output at TP26 and TP36A of MC2 Card  
(10V/Div., 0.2 Sec/Div.)



c. Output at TP2 of MC1 Card  
Output at TP18 and TP34A of MC2 Card (10V/div., 0.2 Sec/Div.)



d. Output at TP4 of MC1 Card  
Output at TP43 of MC2 Card (5V/Div., 0.2 Sec/Div.)



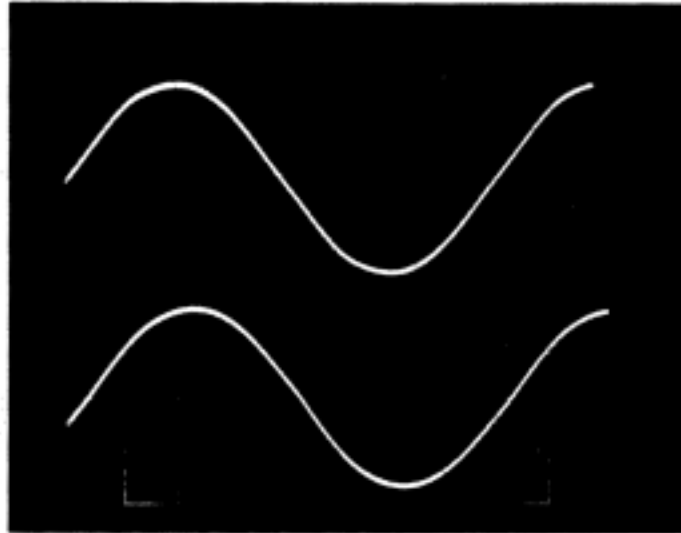
e. Output at TP11 of MC1 Card  
Output at TP40 of MC2 Card (5V/Div., 0.2 Sec/Div.)

f. Output at TP7 of MC1 Card  
Output at TP76 of MC2 Card (5V/Div., 0.2 Sec/Div.)

FIGURE 14

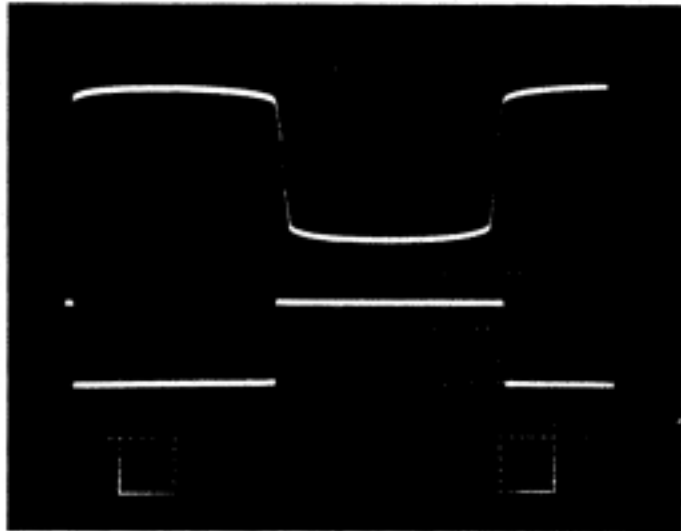
MOTOR CONTROL CARD (MC 1, MC 2)

- a. Reference Phase  
Line Phase "A", "B", or "C" at  
Fuse Block for Axis No. 1  
(100V/Div., Time base adjusted to give  
45°/Div.)



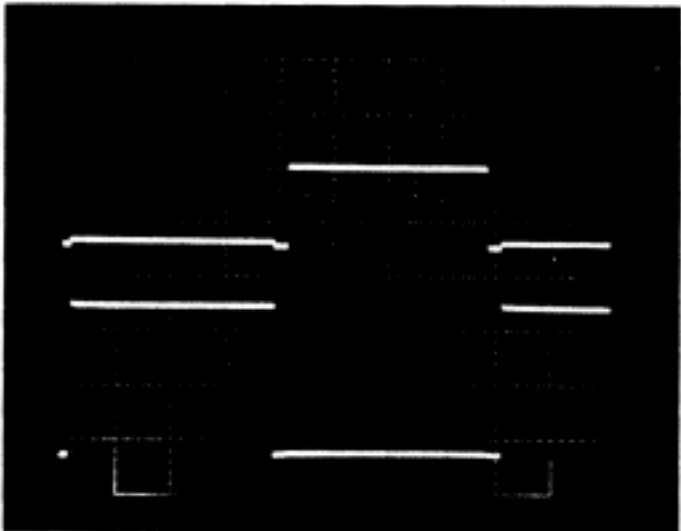
- b. Line Phase reduced and shifted 15°.  
Seen at TP2, TP8, or TP14 of RG1 Card.  
(10V/Div., 45°/Div.)

- c. Waveform seen at component location  
16-8 for "A" phase  
42-8 for "B" phase  
68-8 for "C" phase (RG1 Card)  
(1V/Div., 45°/Div.) ± 1.4V



- d. Waveform seen at component location  
17-14 for "A" phase  
43-14 for "B" phase  
69-14 for "C" phase (RG1 Card)  
(10V/Div., 45°/Div.) 0 to + 15V

- e. Waveform seen at component location  
15-7 for phase "A"  
41-7 for phase "B" (RG1 Card)  
67-7 for phase "C" 0 to  
(10V/Div., 45°/Div.) - 15V

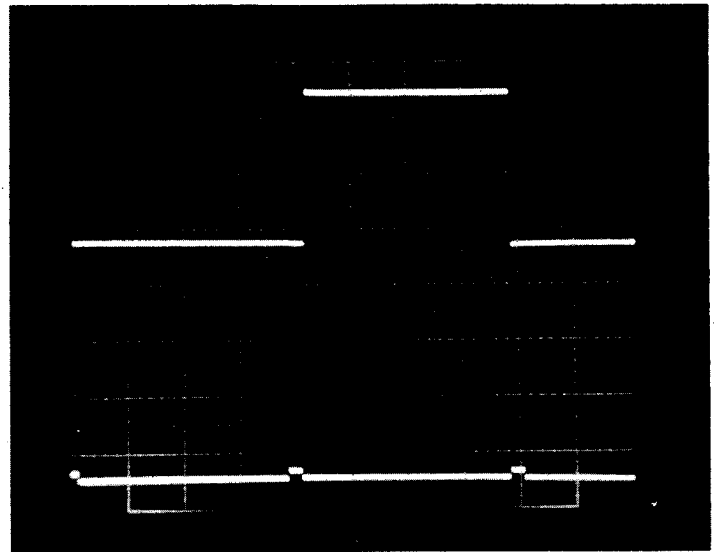


- f. Waveform seen at component location  
9-7 for phase "A"  
35-7 for phase "B" (RG1 Card)  
61-7 for phase "C" ± 15V  
(10V/Div., 45°/Div.)

FIGURE 15-A  
RAMP GENERATOR (RG 1)

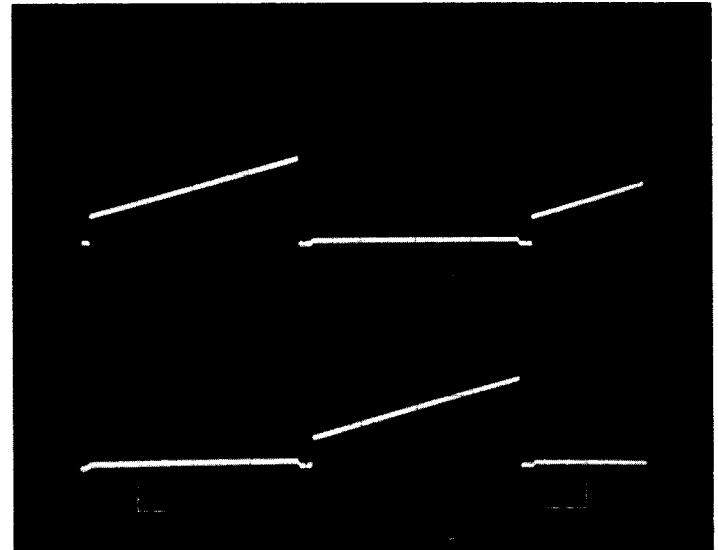
g. Waveform seen at component location  
 9-1 for phase "A"  
 35-1 for phase "B"  
 61-1 for phase "C" (RG1 Card)  
 (10V/Div., 45°/Div.) ± 15V

h. Waveform seen at component location  
 16-6 for phase "A"  
 42-6 for phase "B"  
 68-6 for phase "C" (RG1 Card)  
 (10V/Div., 45°/Div.) - 15V



i. Forward Ramp seen at TP6, TP12 or TP18  
 (10V/Div., 45°/Div.) (RG1 Card)

j. Reverse Ramp seen at TP3, TP9, or TP15  
 (10V/Div., 45°/Div.) (RG1 Card)



k. Typical Forward Firing Pulses Seen at  
 TP 59, 60, 61 of Suppression Card, and  
 TP 6, 4, 2 of PG 1 Card.  
 (10V/Div., 45°/Div.)

m. Typical Reverse Firing Pulses Seen at  
 TP 62, 63, 69 of Suppression Card, and  
 TP 5, 3, 1 of PG 1 Card.  
 (10V/Div., 45°/Div.)

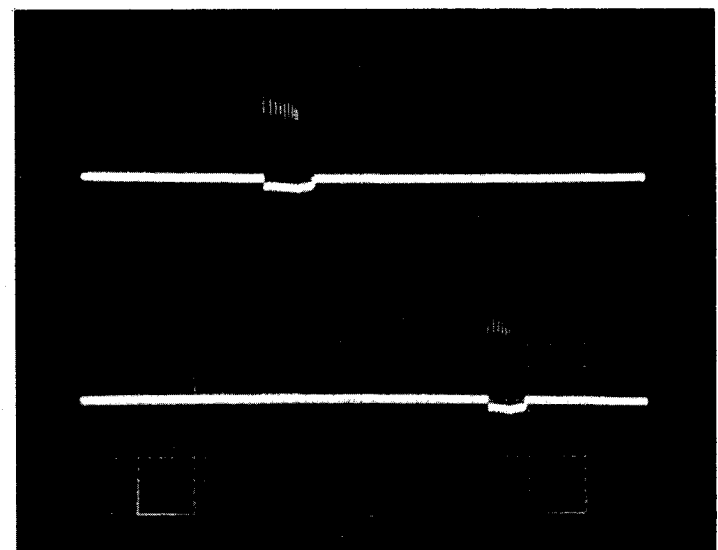
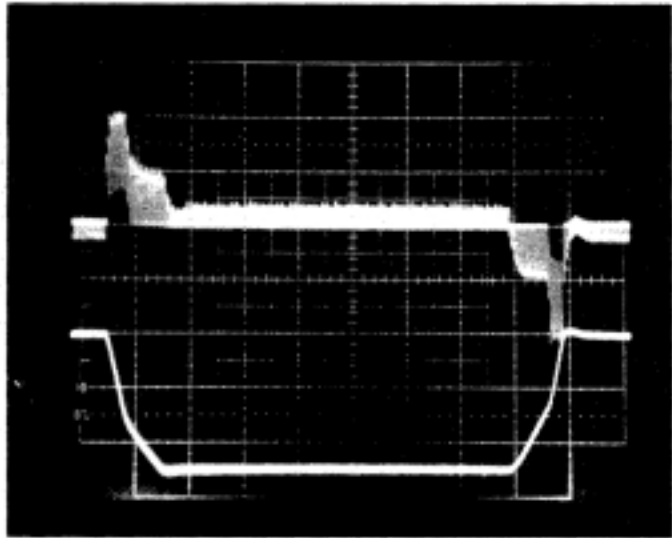
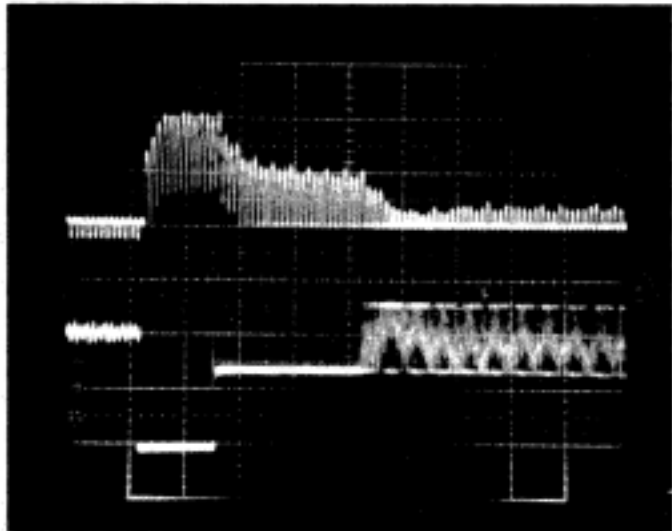


FIGURE 15-B  
 RAMP GENERATOR (RG 1) AND PULSE GENERATOR (PG 1)

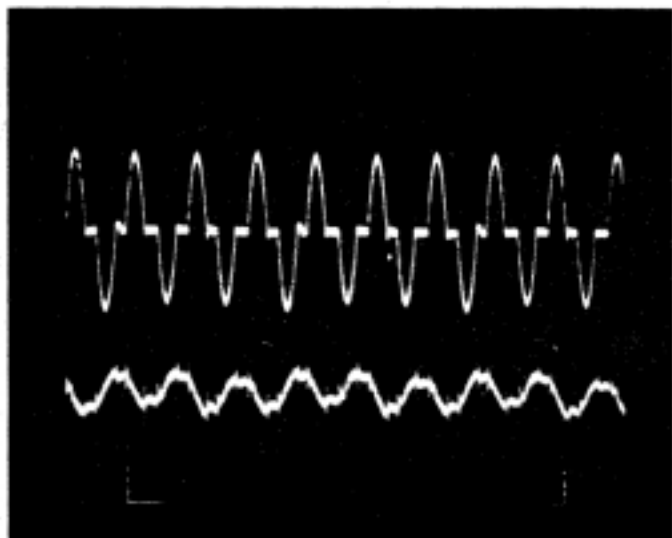
- a. Typical Current Profile seen at TP8 of MC1 Card for systems having two-step current limits. Ref. enclosed TL sheet for specific peak current levels.
- b. Typical tach feedback voltage profile seen at TP5 of MC1 Card for above current limits.



- c. Typical current step profile enlarged from a.
- d. Two-step current command to current loop Op-Amp from output of velocity loop as seen at TP 2 of MC1 card.



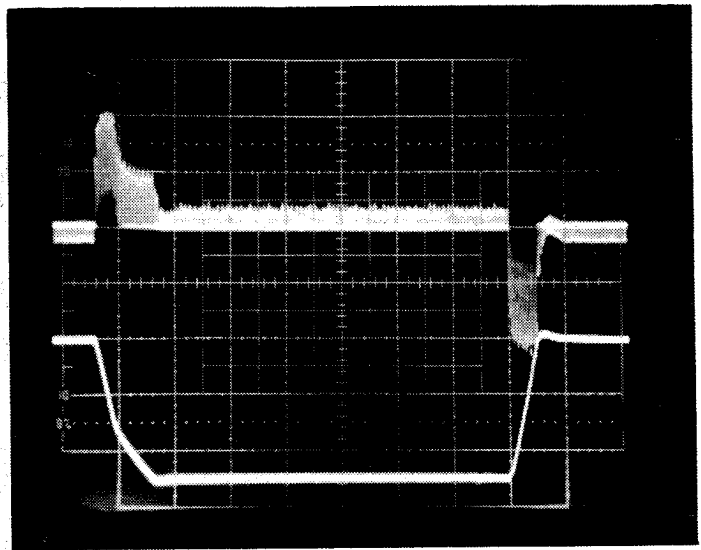
- e. Typical Bias current at zero motor speed as seen at TP8 of MC1 Card with jumper from TP1 to TP2 on MC1 card. (5A/Div., 5ms/Div.)
- f. Tach Ripple seen at Zero Speed at TP5 of MC1 Card. (0.1V/Div., 5ms/Div.)



**FIGURE 16-A  
CURRENT WAVEFORMS FOR MC 1**

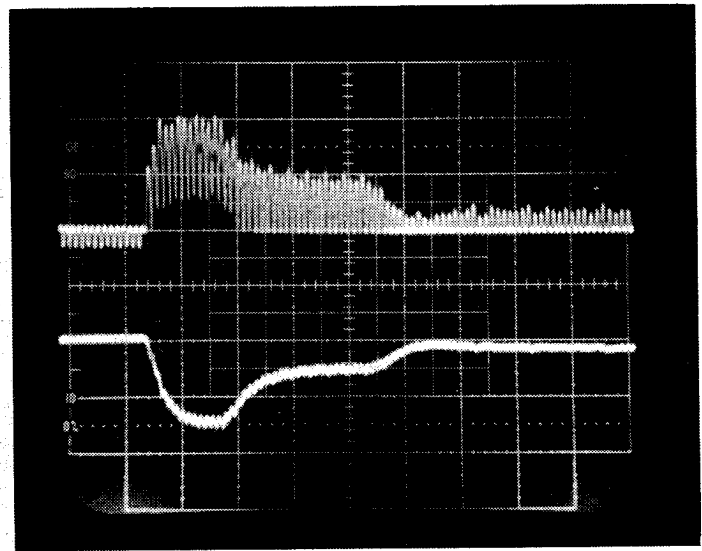
g. Typical Current profile seen at TP8 of MC1 Card for systems having two-step current limits for acceleration only, single current level for deceleration.

h. Typical Tach feedback voltage profile seen at TP5 of MC1 Card for above current limits.



i. Typical current step profile enlarged from a. or g. (Same profile as shown in c).

j. "Current Monitor" output as seen at Terminal 8 of the specific axis terminal strip with the current profile shown in i. or c.



k. Typical motor current waveform seen at TP8 of MC1 Card while motor is running.

m. Typical tach ripple voltage as seen at TP5 of MC1 Card while motor is running.

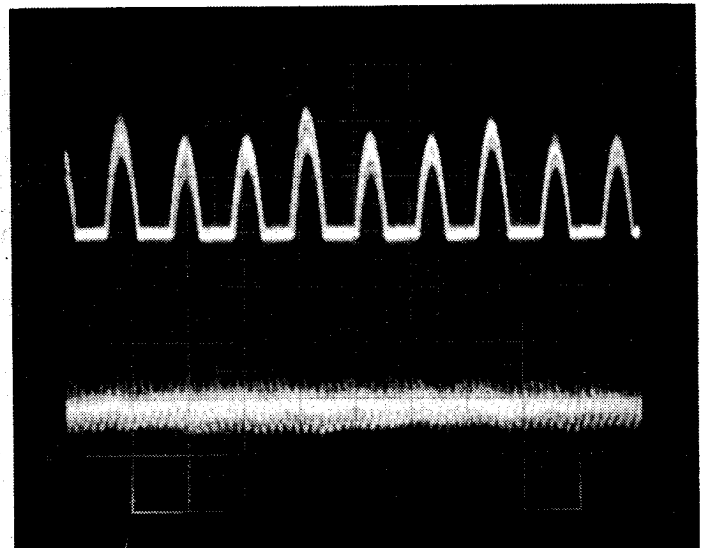
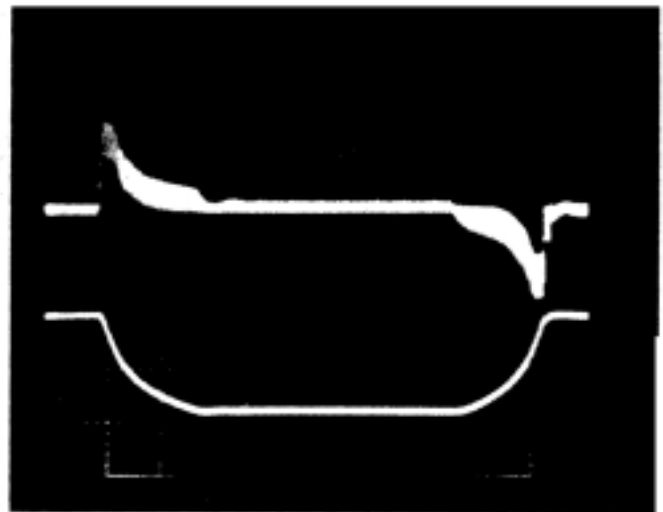


FIGURE 16-B  
CURRENT WAVEFORMS FOR MC 1

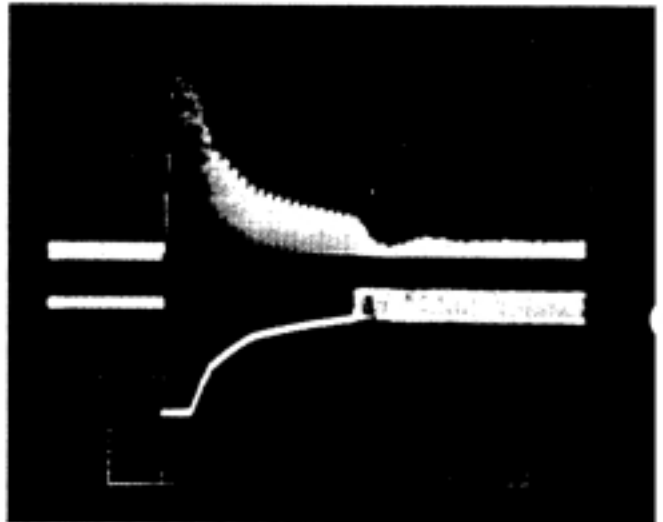
a. Typical Current Profile seen at TP75 of MC2 Card for systems having horsepower-based current limits. Ref. enclosed TL sheet for specific peak current levels.

b. Typical tach feedback voltage profile seen at TP106 of MC2 for above current limits.



c. Typical current profile enlarged from a.

d. Horsepower - based current command to current loop Op-Amp from output of velocity loop as seen at TP18 of MC2 card.



e. Typical Bias current at zero motor speed as seen at TP75 of MC2 Card with jumper from TP13 to TP18 on MC2 card. (5A/Div., 5ms/Div.)

f. Tach Ripple seen at Zero Speed at TP106 of MC2 Card. (0.1V/Div., 5ms/Div.)

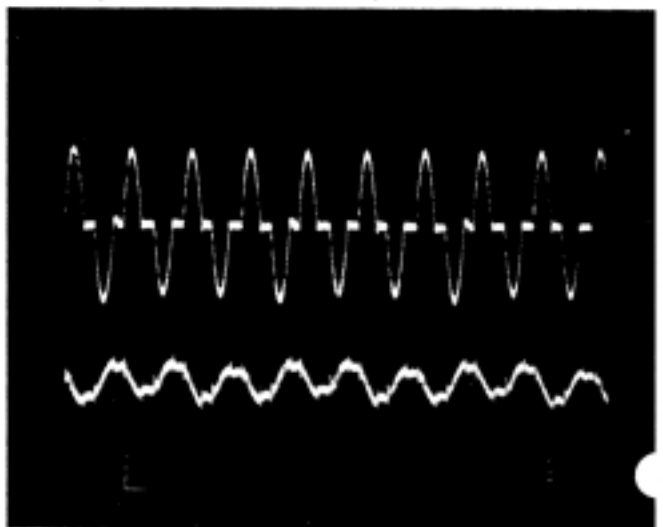
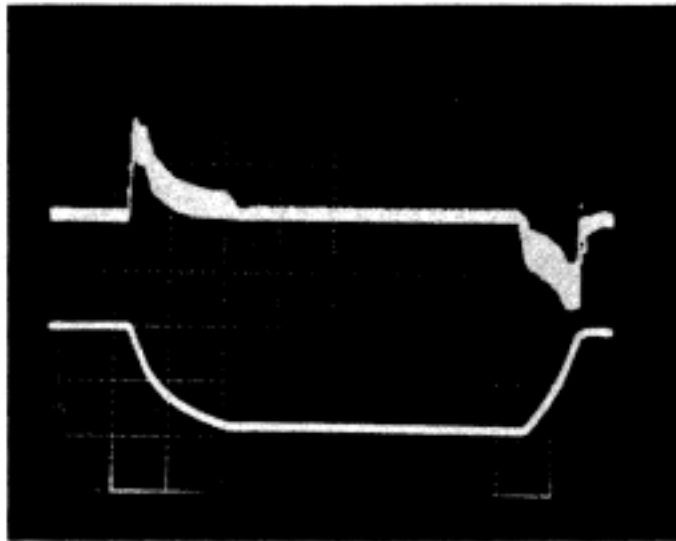


FIGURE 17-A  
CURRENT WAVEFORMS FOR MC 2

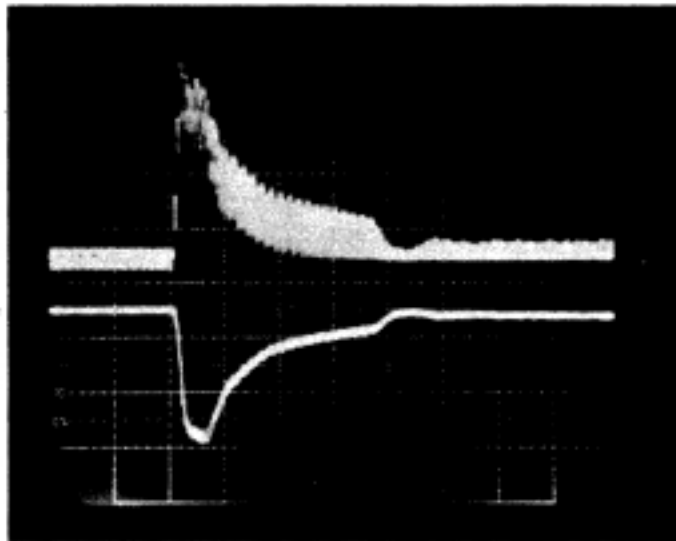


Typical Current profile seen at TP75 of MC2 Card for systems having standard horsepower-based current limits for acceleration, and, using "Hi-Decel" circuit, increased horsepower-based current limits for deceleration.



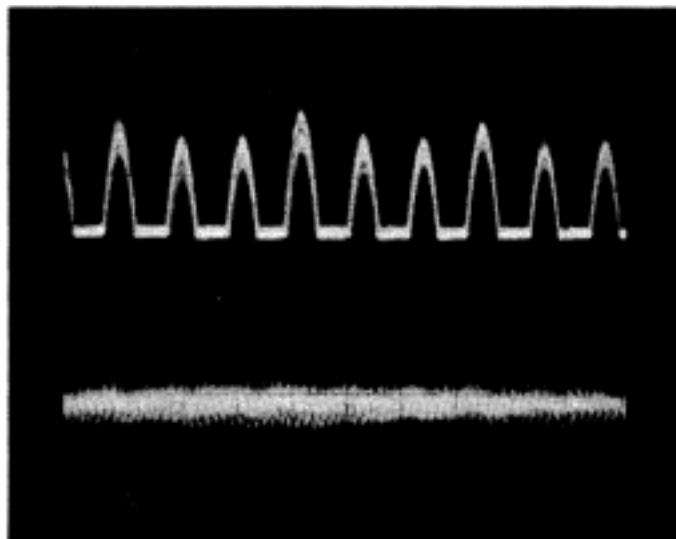
- h. Typical Tach feedback voltage profile seen at TP106 of MC2 Card for above current limits.

- i. Typical current step profile enlarged from a. or g. (Same profile as shown in c).



- j. "Current Monitor" output as seen at Terminal 8 of the specific axis terminal strip with the current profile shown in i. or c.

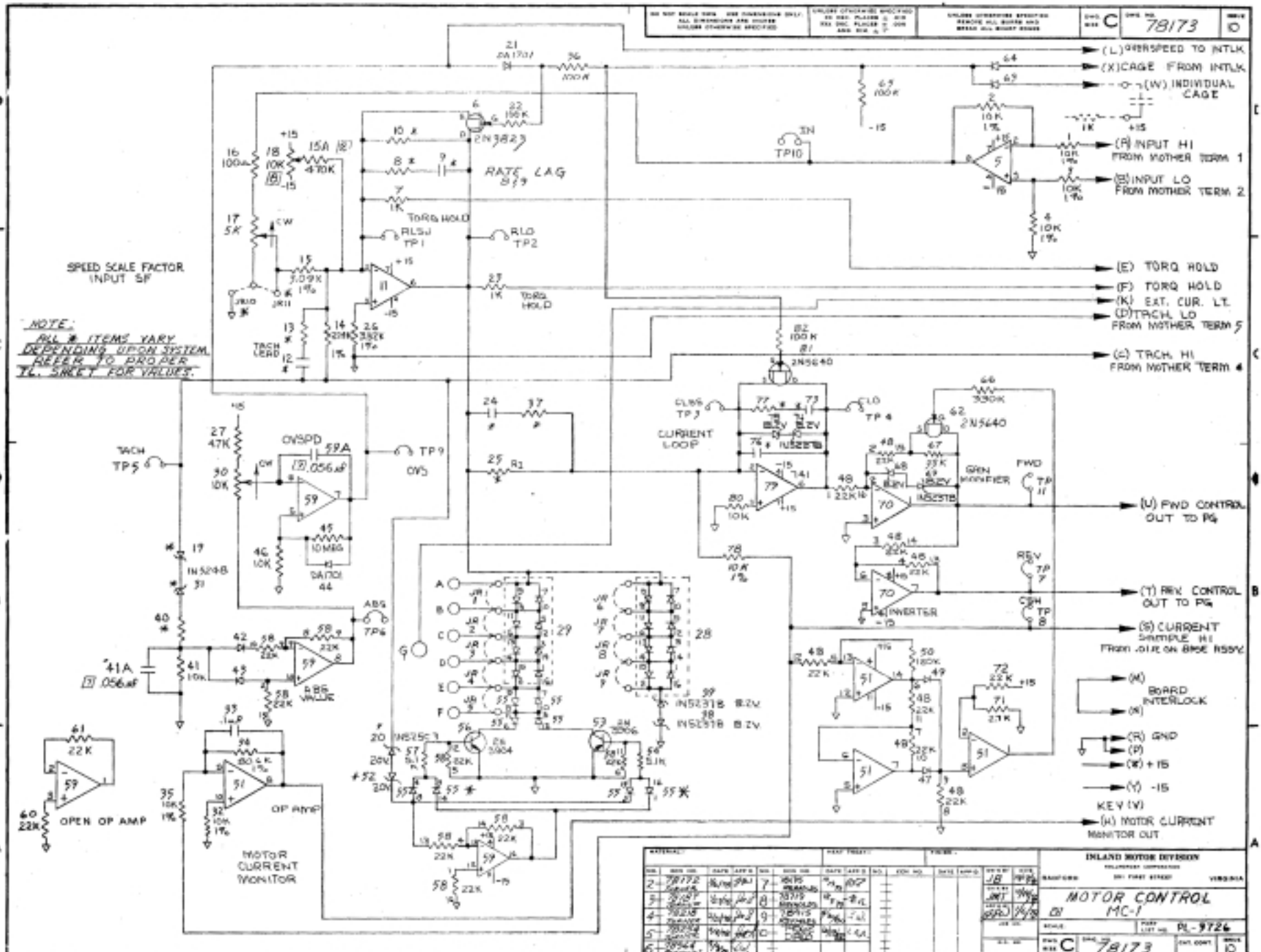
- k. Typical motor current waveform seen at TP75 of MC2 Card while motor is running.



- m. Typical tach ripple voltage as seen at TP106 of MC2 Card while motor is running.

**FIGURE 17-B**  
**CURRENT WAVEFORMS FOR MC 2**





NOTE:  
ALL # ITEMS VARY  
DEPENDENT UPON SYSTEM,  
PLEASE TO PRO DSR  
T.L. SURETY FOR VALUES.

| REV. | DATE | BY  | APP'D. | REV. | DATE | BY  | APP'D. | REV. | DATE | BY | APP'D. |
|------|------|-----|--------|------|------|-----|--------|------|------|----|--------|
| 2    | 7/77 | ... | ...    | 7    | 6/75 | ... | ...    |      |      |    |        |
| 3    | 2/78 | ... | ...    | 8    | 8/75 | ... | ...    |      |      |    |        |
| 4    | 3/78 | ... | ...    | 9    | 6/75 | ... | ...    |      |      |    |        |
| 5    | 5/78 | ... | ...    | 10   | ...  | ... | ...    |      |      |    |        |
| 6    | ...  | ... | ...    | ...  | ...  | ... | ...    |      |      |    |        |

**INLAND MOTOR DIVISION**  
PULPULVER DIVISION  
801 FIRST STREET VIRGINIA

**MOTOR CONTROL MC-1**

|            |      |
|------------|------|
| REV. 78173 | DATE |
| REV. 10    | DATE |

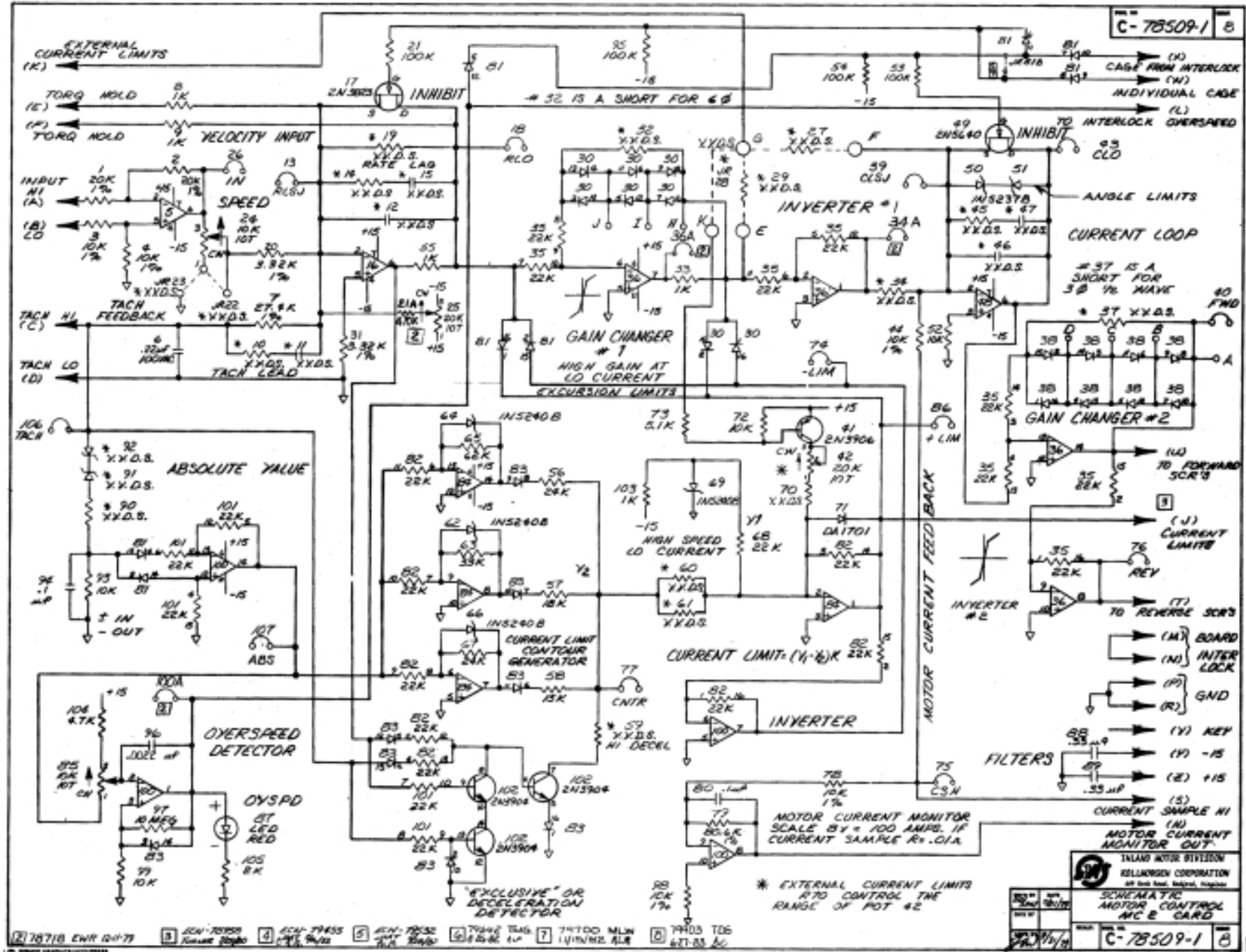
37

D

C

B

A



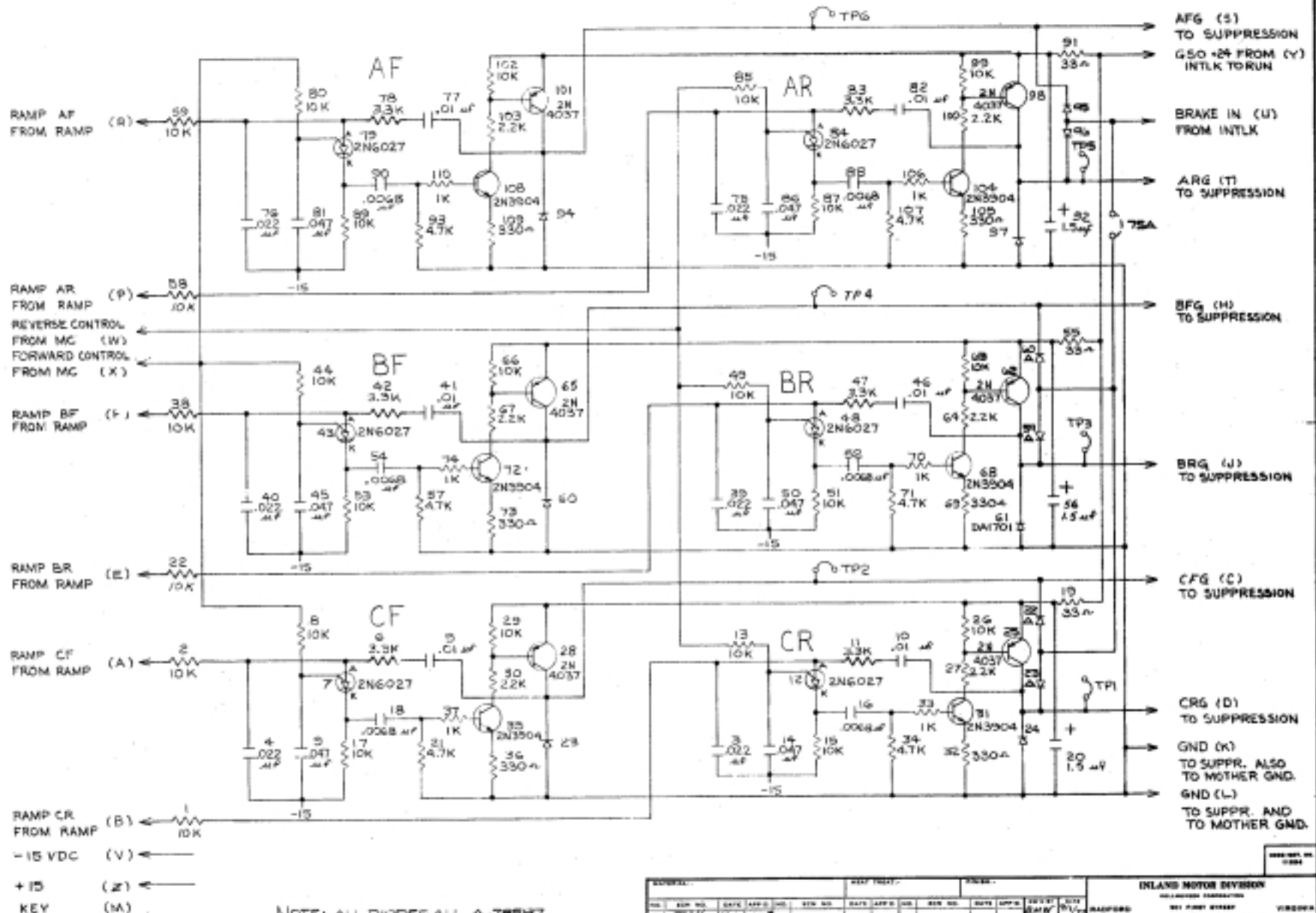
38

INLAND MOTOR DIVISION  
 KELLORGEN CORPORATION  
 200 East 10th Street, Chicago, Ill. 60611  
 SCHEMATIC MOTOR CONTROL  
 MC E CARD

DO NOT SCALE DRAW. USE DIMENSIONS ONLY.  
 ALL DIMENSIONS ARE IN INCHES  
 UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED  
 ALL DIMENSIONS ARE IN INCHES  
 UNLESS OTHERWISE SPECIFIED

REV C  
 PWD NO 78169  
 SHEET 4



39

| REVISION |          | DATE     |      | BY  |      | CHKD |     | APPV |      | INLAND MOTOR DIVISION |      |
|----------|----------|----------|------|-----|------|------|-----|------|------|-----------------------|------|
| NO.      | REV. NO. | DATE     | APPV | NO. | DATE | APPV | NO. | DATE | APPV | NO.                   | DATE |
| 2        |          | 11/10/52 |      |     |      |      |     |      |      |                       |      |
| 3        |          | 11/10/52 |      |     |      |      |     |      |      |                       |      |
| 4        |          | 11/10/52 |      |     |      |      |     |      |      |                       |      |

INLAND MOTOR DIVISION  
 PULSE GENERATOR  
 3 PG 1

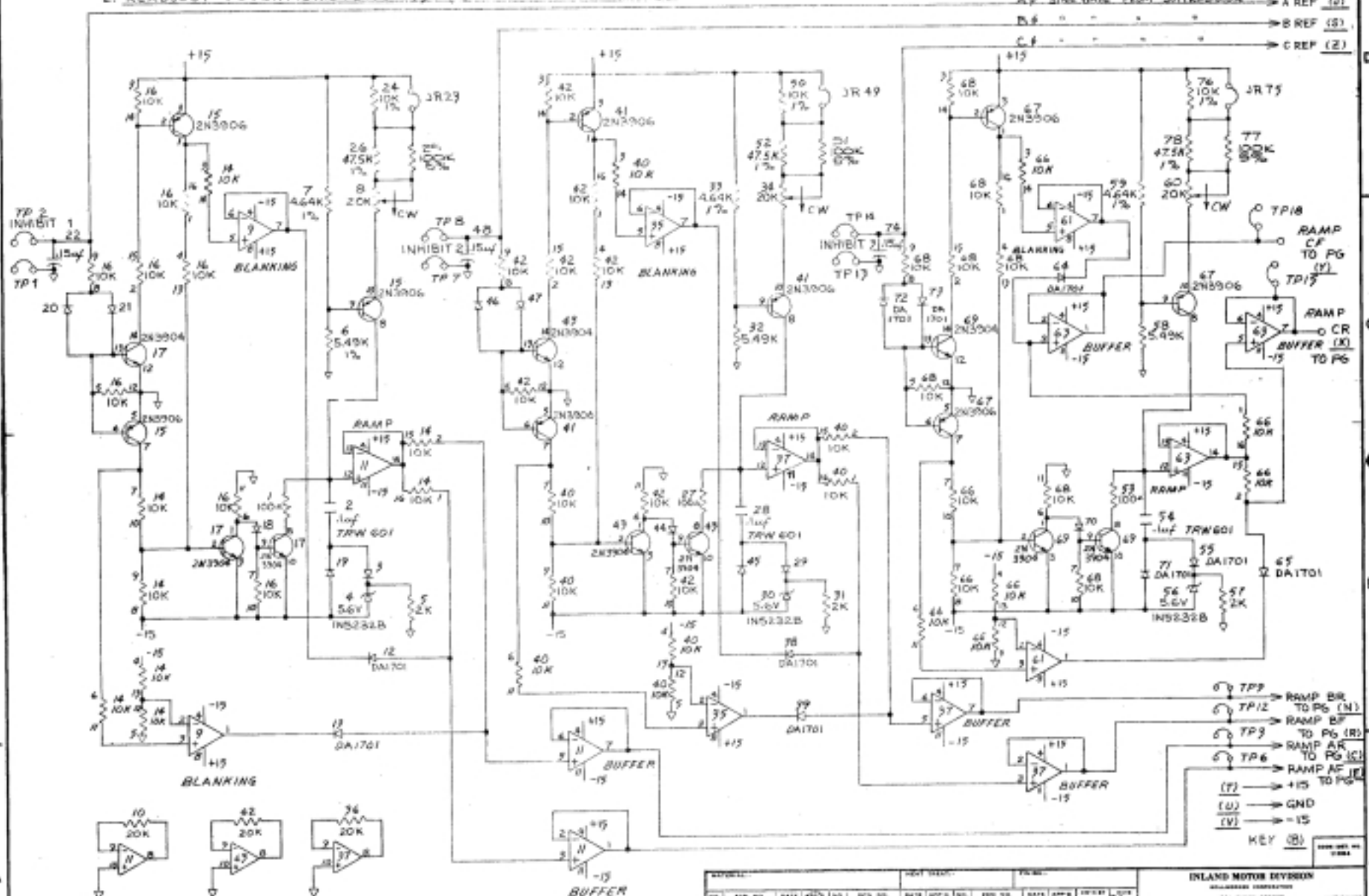
REV C  
 PWD NO 78169  
 SHEET 4

NOTE: 50HZ OPERATION

1. REMOVE JUMPEWS JR 23, 49 & 75.
2. READJUST POTENTIOMETERS R, 34 & 60 FOR PROPER BIAS.

|   |  |  |        |                |   |
|---|--|--|--------|----------------|---|
| DO NOT SCALE DIM. AND DIMENSIONS UNLESS OTHERWISE SPECIFIED | UNLESS OTHERWISE SPECIFIED USE STD. PLAIN & ANG. DIM. UNLESS OTHERWISE SPECIFIED | UNLESS OTHERWISE SPECIFIED USE STD. PLAIN & ANG. DIM. UNLESS OTHERWISE SPECIFIED | REV. C | REV. NO. 78181 | 5 |
|---|--|--|--------|----------------|---|

A # SINE WAVE FORM SUPPRESSION  
 B #  
 C #

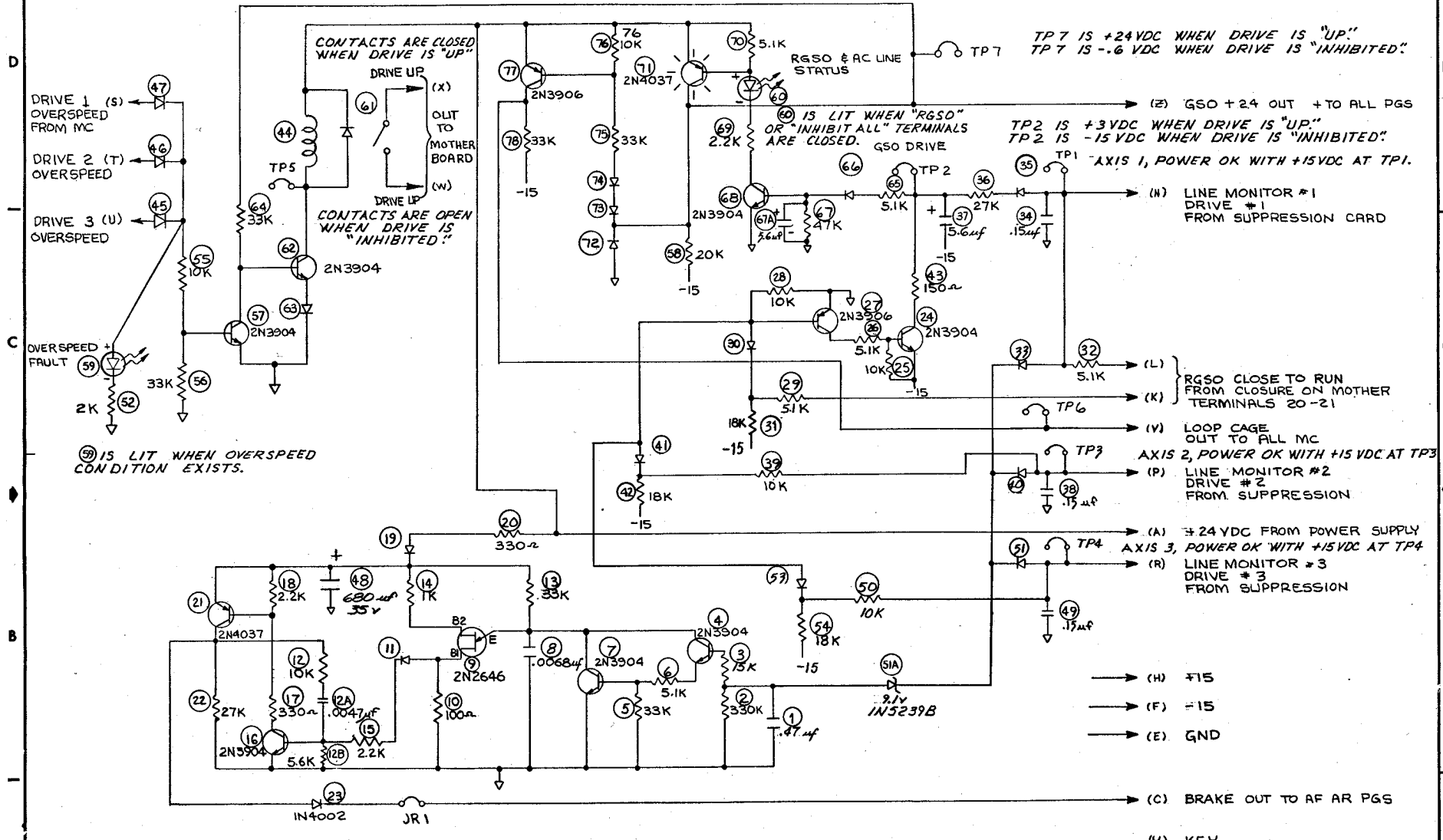


OPEN OP AMP

NOTE:  
 TEST POINTS NOT USED  
 TP 4, 5, 10, 11, 17

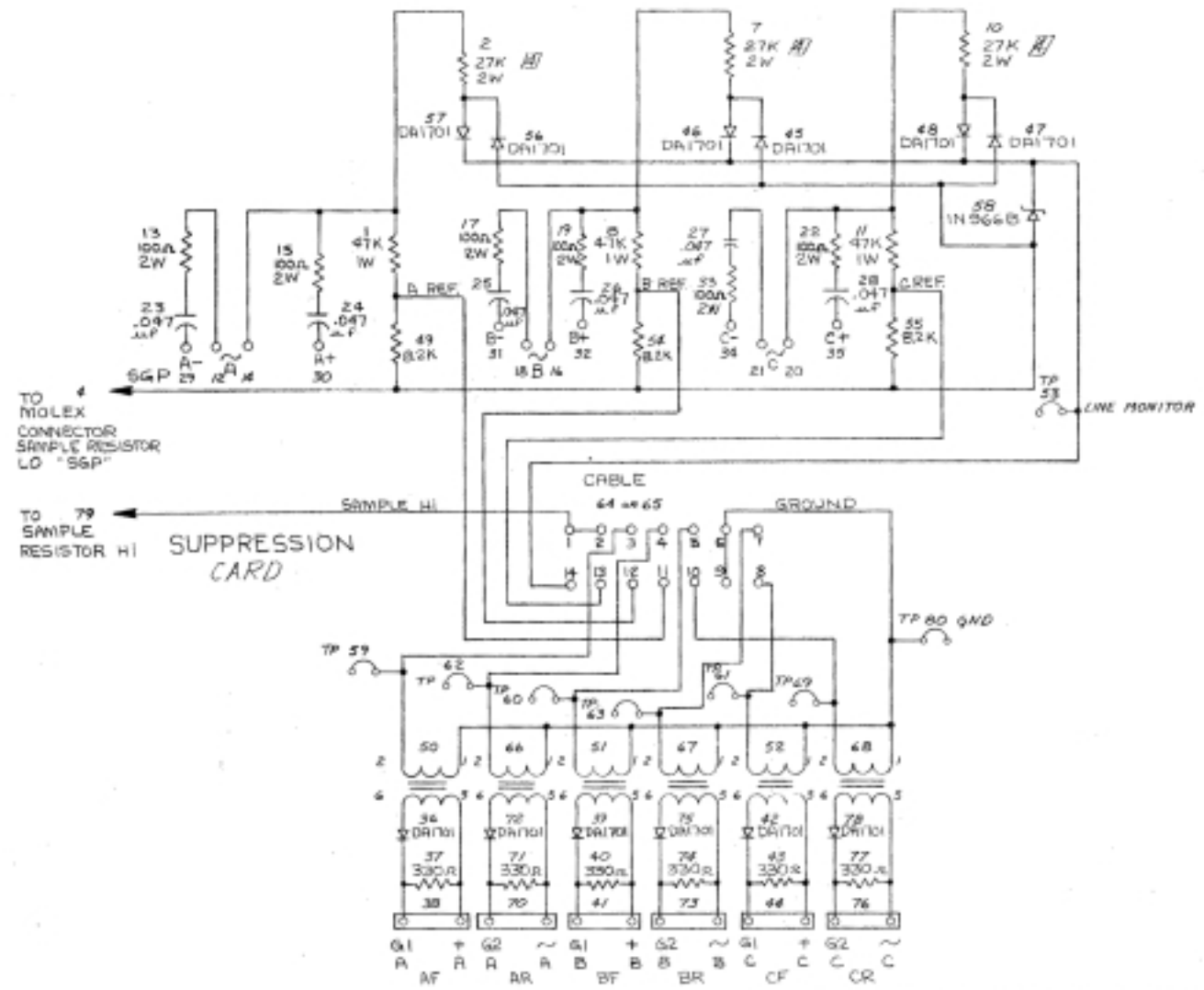
|                       |  |                |  |
|-----------------------|--|----------------|--|
| INLAND MOTOR DIVISION |  | RAMP GENERATOR |  |
| PL-3727               |  | 78181          |  |

40



**NOTES:**  
 1- CIRCLED NUMBERS ARE COMPONENT DESIGNATIONS.  
 2- ALL DIODES ARE A-785B7 UNLESS OTHERWISE SPECIFIED.

| MATERIAL |         |         |       | HEAT TREAT |         |      |       | FINISH |         |      |       | INLAND MOTOR DIVISION         |      |                                   |  |  |
|----------|---------|---------|-------|------------|---------|------|-------|--------|---------|------|-------|-------------------------------|------|-----------------------------------|--|--|
| NO.      | ECN NO. | DATE    | APP'D | NO.        | ECN NO. | DATE | APP'D | NO.    | ECN NO. | DATE | APP'D | REV BY                        | DATE | RADIOLOG CORPORATION              |  |  |
| 2        | 78771-1 | 1/12/71 | PL 1  |            |         |      |       |        |         |      |       |                               | 3-20 | RADFORD 801 FIRST STREET VIRGINIA |  |  |
|          |         |         |       |            |         |      |       |        |         |      |       | INTERLOCK & BRAKE INTLK 2     |      |                                   |  |  |
|          |         |         |       |            |         |      |       |        |         |      |       | SCALE: PART LIST NO PL 78771  |      |                                   |  |  |
|          |         |         |       |            |         |      |       |        |         |      |       | DWG. NO. 78771-1 CAT. CONT. 2 |      |                                   |  |  |

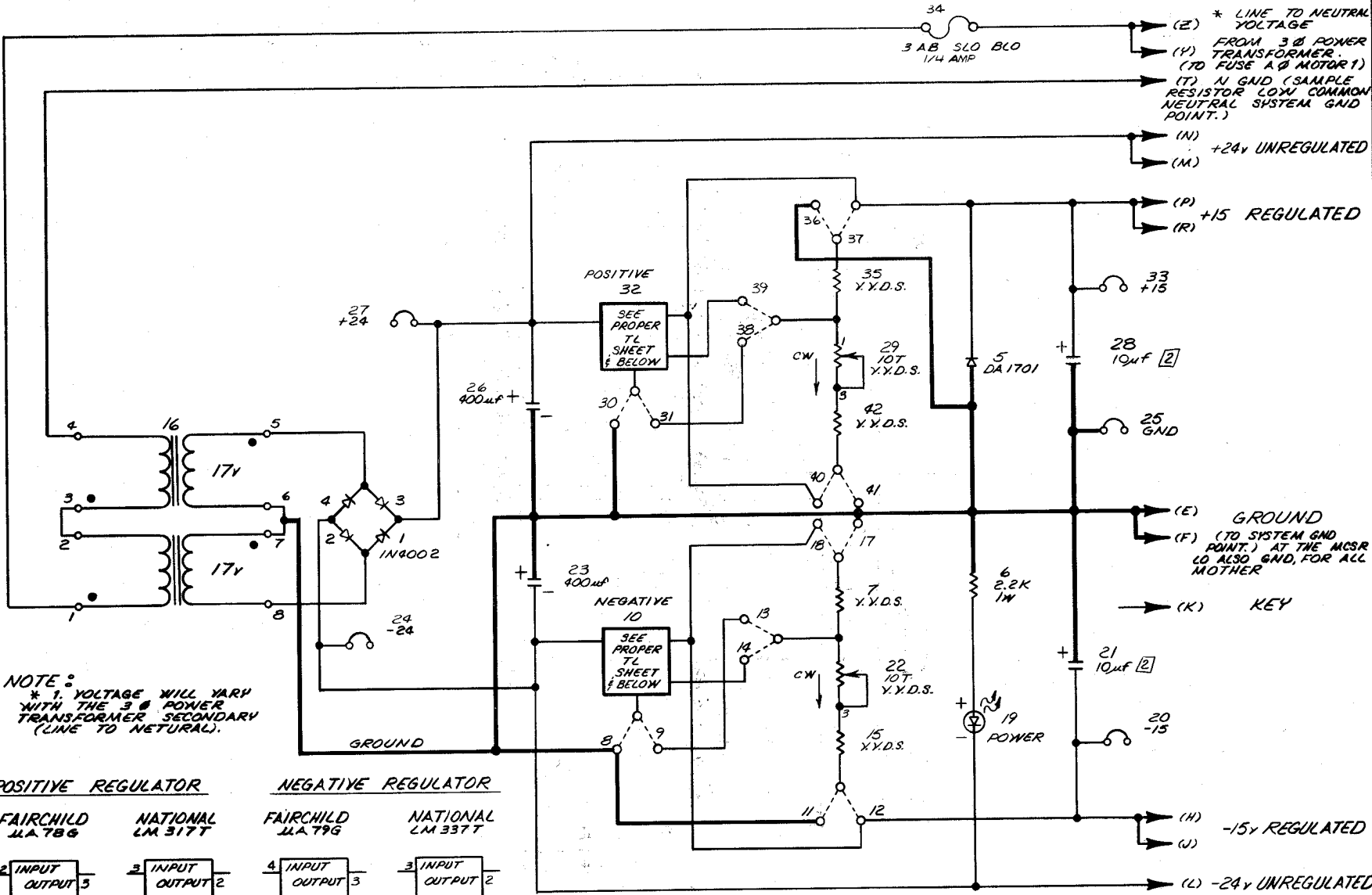


| REV. NO. |  | DATE |  | BY |  | CHECKED |  | APPROVED |  | TITLE |  |
|----------|--|------|--|----|--|---------|--|----------|--|-------|--|
| 1        |  |      |  |    |  |         |  |          |  |       |  |
| 2        |  |      |  |    |  |         |  |          |  |       |  |
| 3        |  |      |  |    |  |         |  |          |  |       |  |
| 4        |  |      |  |    |  |         |  |          |  |       |  |
| 5        |  |      |  |    |  |         |  |          |  |       |  |

|                       |                 |           |        |
|-----------------------|-----------------|-----------|--------|
| INLAND MOTOR DIVISION |                 |           |        |
| REVISIONS             |                 |           |        |
| SUPPRESSION CARD      |                 |           |        |
| SUP 2                 |                 |           |        |
| REV. NO. C            | QWC NO. 78354-1 | REV. DATE | FORM 5 |





(Z) \* LINE TO NEUTRAL VOLTAGE  
 FROM 3 Ø POWER TRANSFORMER.  
 (Y) (TO FUSE A Ø MOTOR)  
 (T) N GND (SAMPLE RESISTOR LOW COMMON NEUTRAL SYSTEM GND POINT.)

(N) +24v UNREGULATED  
 (M)

(P) +15 REGULATED  
 (R)

(E) GROUND  
 (TO SYSTEM GND POINT.) AT THE MCSR LO ALSO GND, FOR ALL MOTHER

(K) KEY

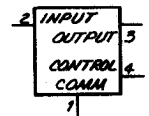
(H) -15v REGULATED  
 (J)

(L) -24v UNREGULATED

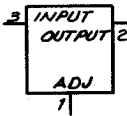
NOTE:  
 \* 1. VOLTAGE WILL VARY WITH THE 3 Ø POWER TRANSFORMER SECONDARY (LINE TO NEUTRAL).

POSITIVE REGULATOR

FAIRCHILD  
 LM 786

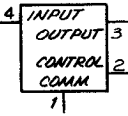


NATIONAL  
 LM 317T

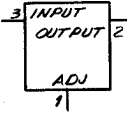


NEGATIVE REGULATOR

FAIRCHILD  
 LM 796



NATIONAL  
 LM 337T



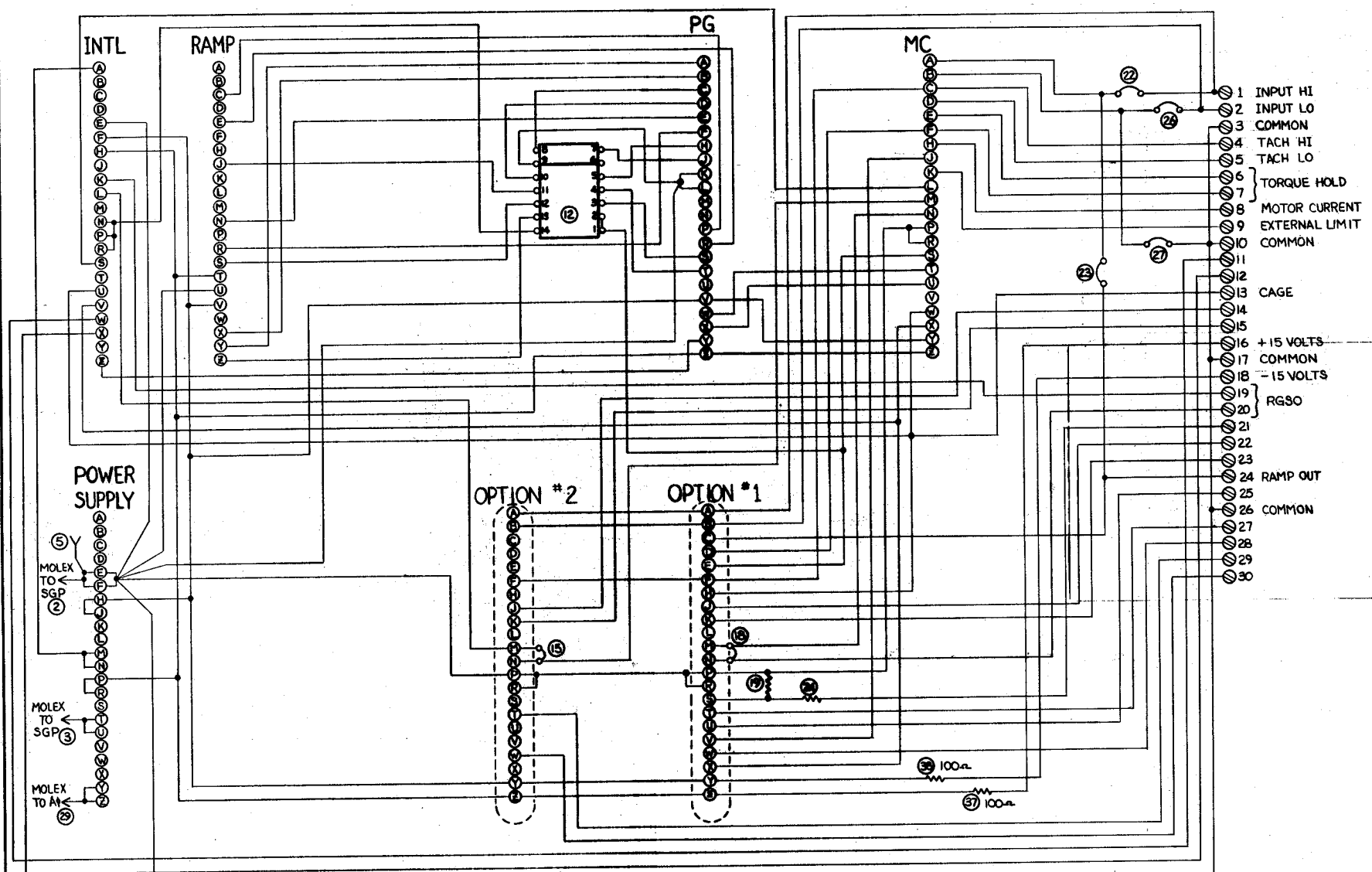
NOTES:  
 1. NATIONAL REGULATOR USES JUMPERS 9, 11, 13, 18, 31, 37, 38, 41  
 2. FAIRCHILD REGULATOR USES JUMPERS 5, 12, 14, 17, 30, 36, 39, 40

INLAND MOTOR DIVISION  
 KOLLMORGEN CORPORATION  
 699 Rock Road, Radford, Virginia

± 15 VOLTS ADJUSTABLE  
 POWER SUPPLY  
 RS 2

| NO | ECN NO. | DATE     | APP'D. | NO      | ECN NO. | DATE    | APP'D. | NO      | ECN NO. | DATE | APP'D. | DRW BY | DATE |
|----|---------|----------|--------|---------|---------|---------|--------|---------|---------|------|--------|--------|------|
| 2  | 78785   | EMC 9/80 | RFD    | 2/14    | 78785   | 9/21/79 | CCS    | 10/9/79 |         |      |        |        |      |
| 3  | 78785   | W/80     | RFD    | 10/9/79 |         |         |        |         |         |      |        |        |      |

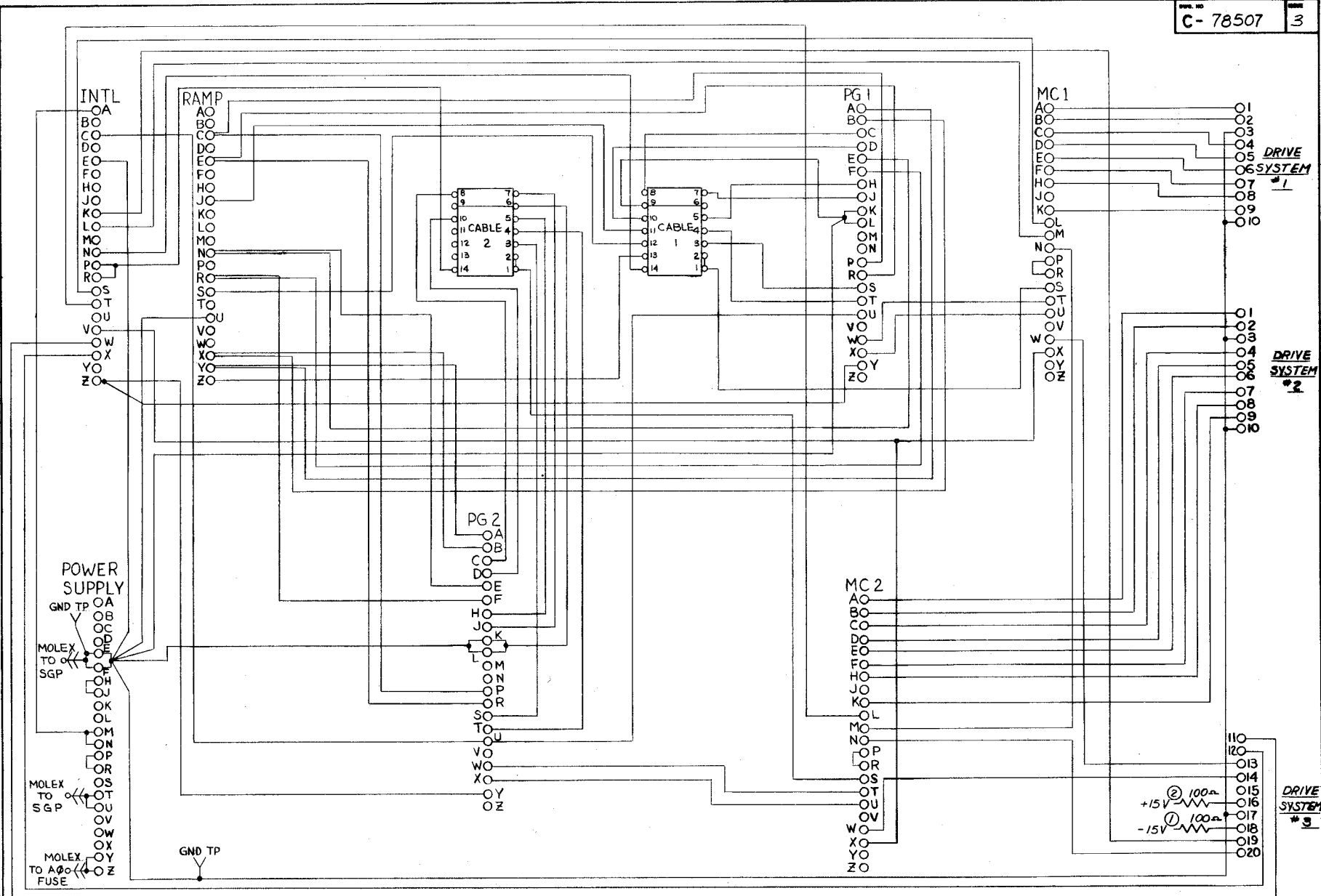
SCALE: DRW. NO. C-78530-1 ISSUE 3



44

- NOTES:**
- 1- CIRCLED NUMBERS ARE COMPONENT DESIGNATIONS.
  - 2- IF RAMP GENERATOR ON OPT #1 IS USED (IN OPTION #1 RECEPTACLE), INSTALL (23) & (27) AND DELETE (22) & (25).  
IF RAMP GENERATOR ON OPT #1 IS NOT USED, INSTALL (22) & (25) AND DELETE (23) & (27).
  3. USED FOR OPTION CARDS-AMPLIFIER MODEL \* WILL BE TPA-0X/1.  
WHEN NO OPTION CARDS ARE USED, MODEL \* WILL BE TPA/1
  4. (15) & (18) ARE INTERLOCK DEFEAT JUMPER.

|                  |               |   |                            |
|------------------|---------------|---|----------------------------|
|                  |               | <b>INDIAN MOTOR</b><br>INDUSTRIAL DRIVE DIVISION<br>KOLLMOGER CORPORATION<br>505 Rock Road, Bedford, Virginia |                            |
| DRAWN BY<br>EWR. | DATE<br>12/80 | <b>MOTHER BOARD SCHEMATIC</b><br>TPA-0X/1/TPA/1   |                            |
| CHECK BY<br>JMT  | APP'D<br>JMT  | SCALE:  | REV. NO. C-78973-1 ISSUE 2 |



45

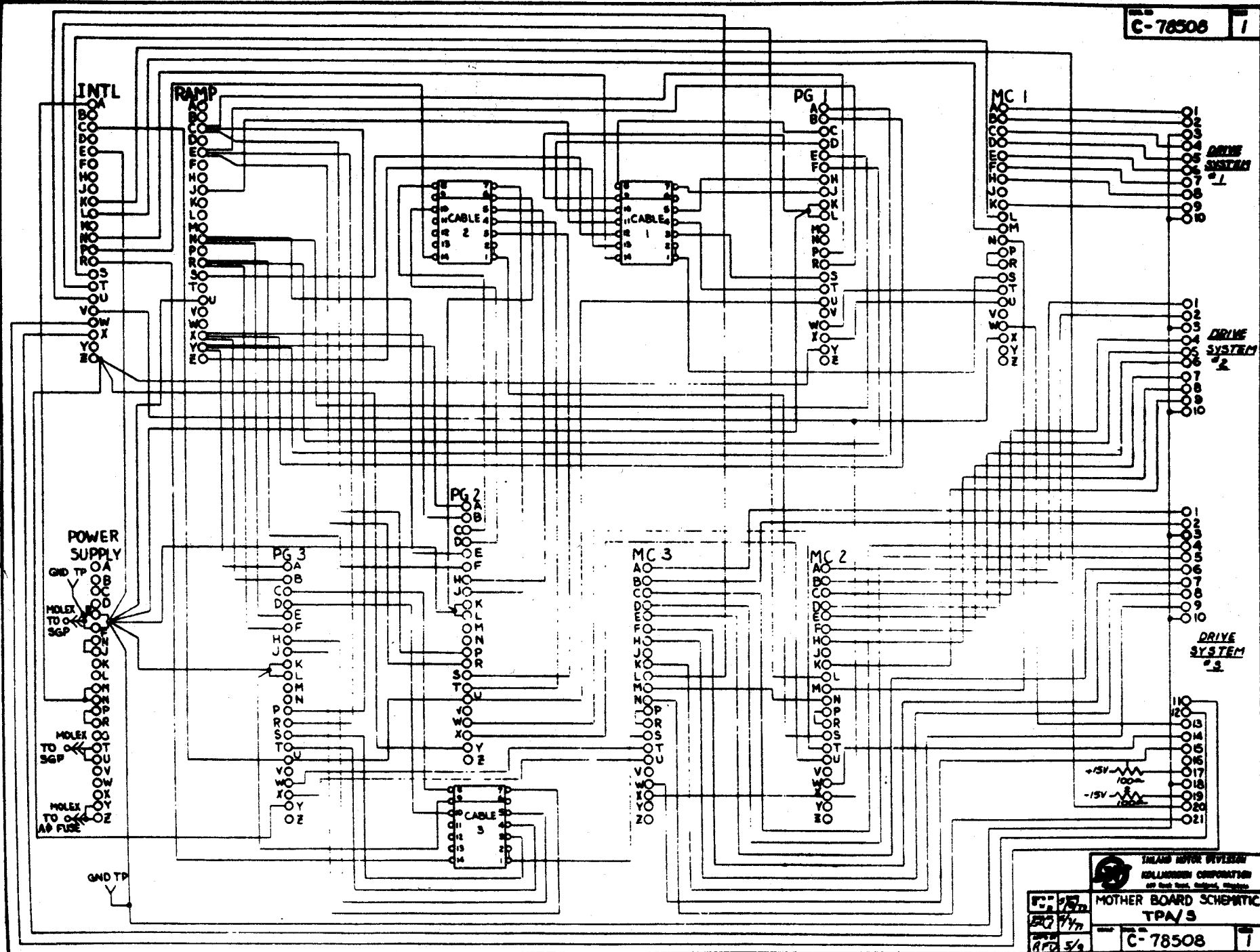
**NOTE:**  
1 - CIRCLED NUMBERS ARE COMPONENT DESIGNATIONS.


**INLAND MOTOR DIVISION**  
KOLLMORGEN CORPORATION  
409 Rock Road, Radford, Virginia

**MOTHER BOARD SCHEMATIC**  
TPA / 2

SCALE: DWG. NO. **C-78507** DRAWING NO. **3**

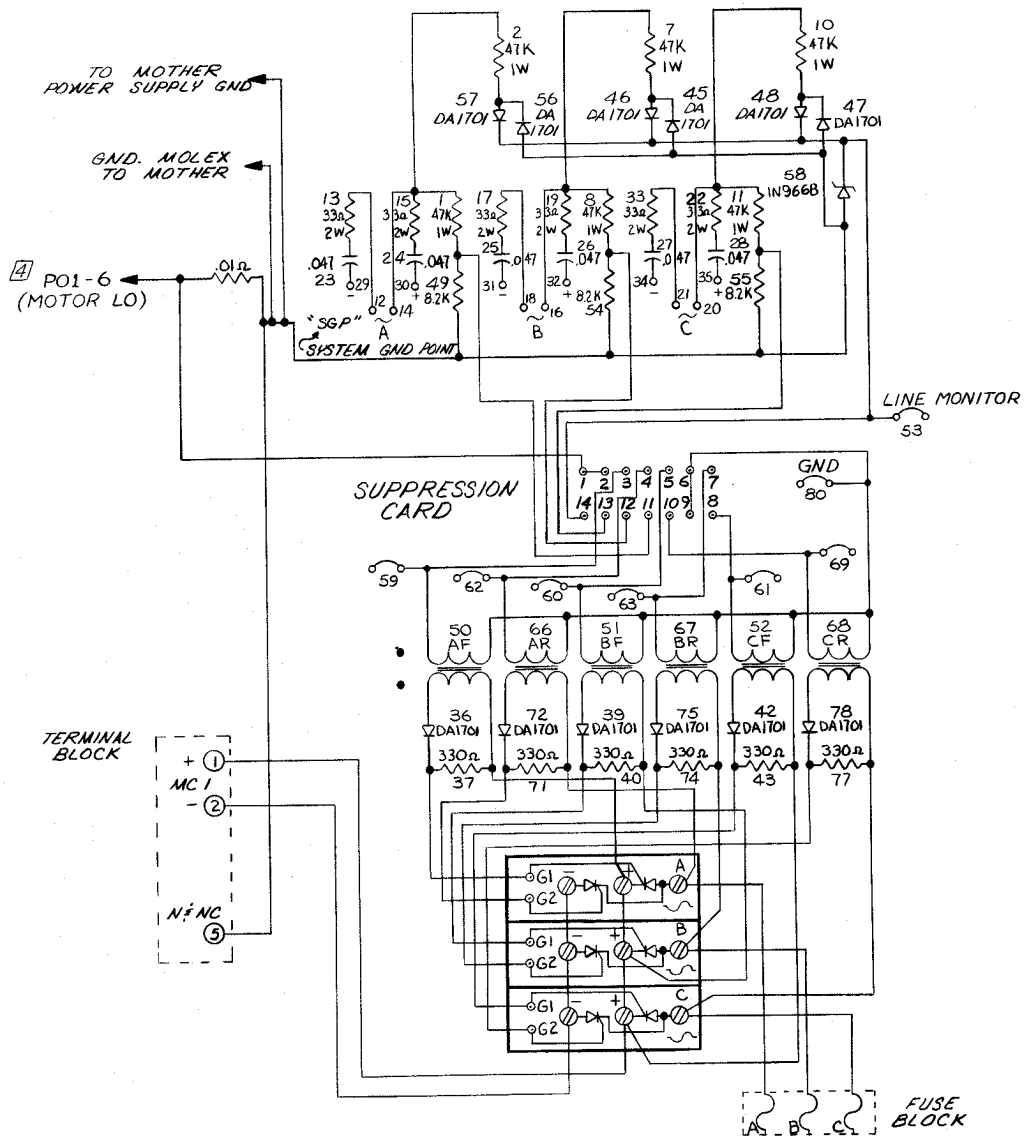
| NO. | ECN NO. | DATE | APP'D. | NO. | ECN NO. | DATE | APP'D. | NO. | ECN NO. | DATE | APP'D. | DWG BY | DATE | CHK BY | DATE |
|-----|---------|------|--------|-----|---------|------|--------|-----|---------|------|--------|--------|------|--------|------|
|     | 2       | 7/27 | EWR    |     | 2       | 8/20 | RFD    |     | 3       | 7/27 | MT     |        |      |        |      |
|     | 3       | 7/27 | MT     |     |         |      |        |     |         |      |        | RFD    | 5/9  |        |      |




**INLAND MICRO SYSTEMS**  
 HOLLANDER CORPORATION  
 600 East 10th, Oakland, Michigan

**MOTHER BOARD SCHEMATIC**  
 TPA/3

C-78508 1



47

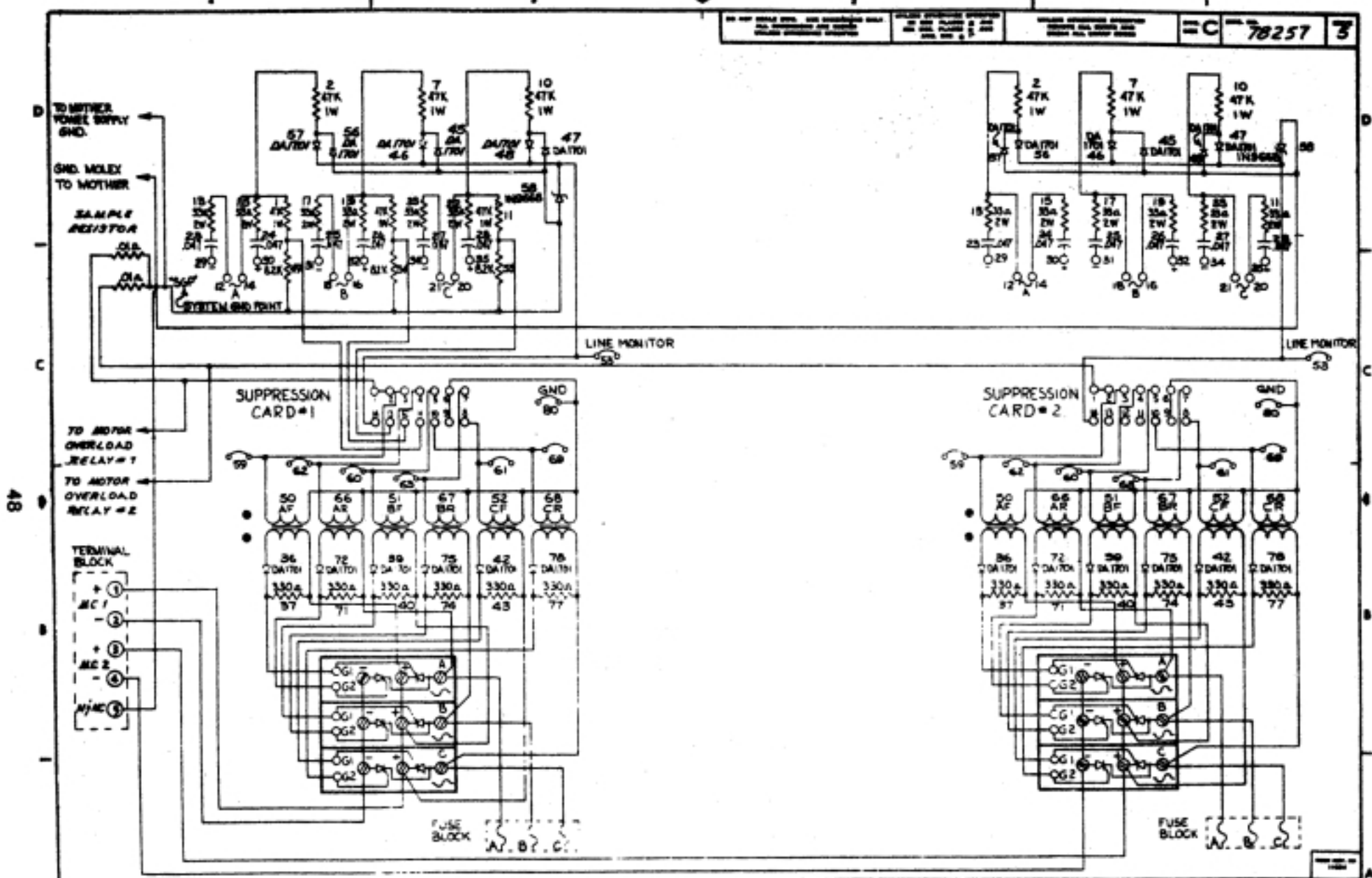
**INLAND MOTOR DIVISION**  
**KOLLMORGEN CORPORATION**  
 699 Rock Road, Radford, Virginia

| NO. | ECN NO.  | DATE    | APP'D | NO. | ECN NO. | DATE | APP'D | OWN BY | DATE   |
|-----|----------|---------|-------|-----|---------|------|-------|--------|--------|
| 2   | REYNOLDS | 3/16    | RF    | 3   | 78167   | 1/16 | RF    |        | 3/1/79 |
| 3   | REYNOLDS | 1/17/80 | RF    | 4   | 79020   | 2/6  | RF    |        | 3/1/79 |
| 4   | REYNOLDS |         | RF    |     |         |      |       |        |        |

**POWER STAGE WIRING DIAGRAM TPA/1**

SCALE: DRAW. NO. **C-78466** SHEET **4**

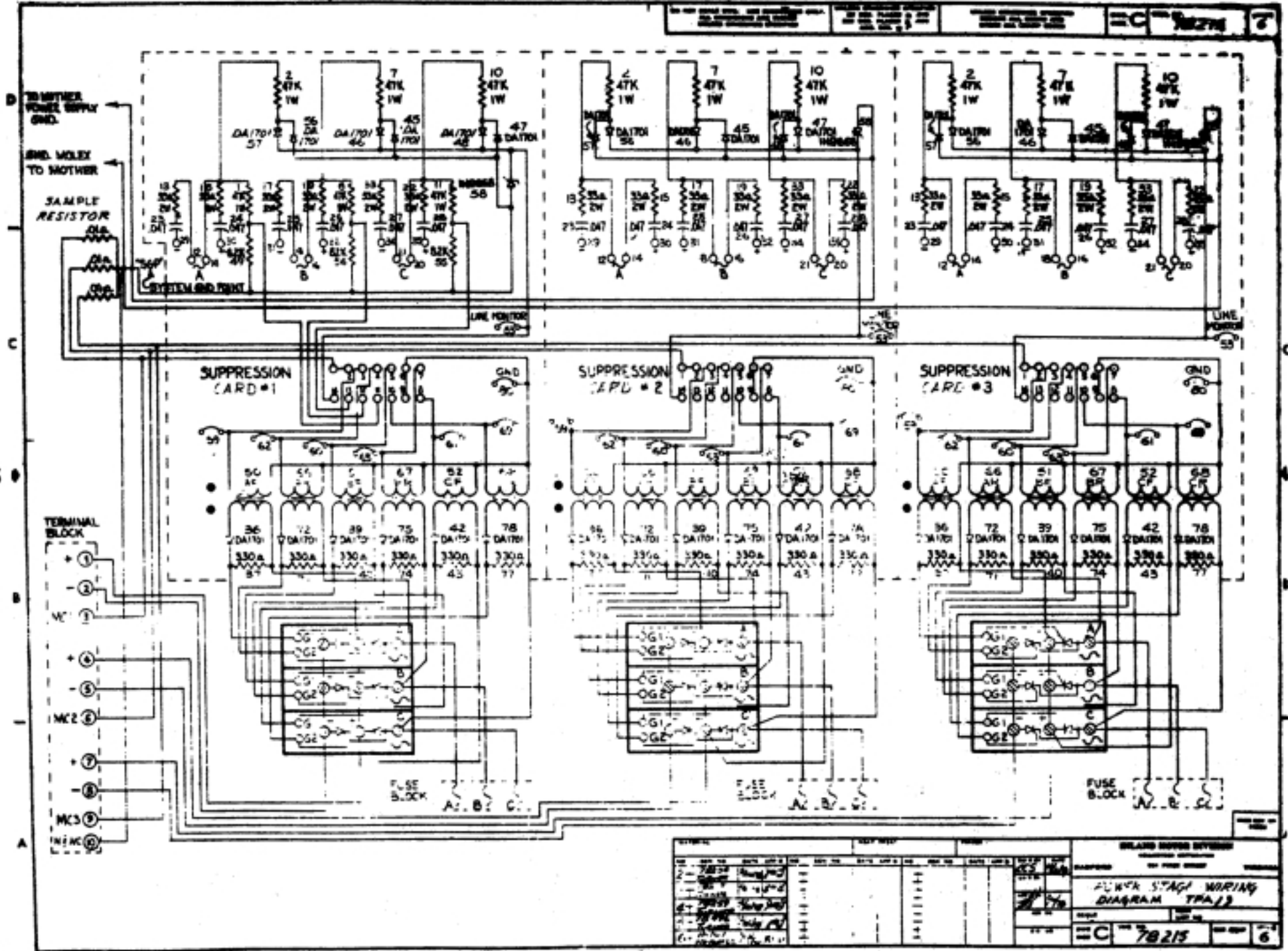
BISHOP GRAPHICS/ACCUPRESS  
 REORDER NO. A3134



40

| REV. | BY | DATE | APP. | DATE | BY | DATE | APP. | DATE | BY | DATE | APP. | DATE | BY | DATE | APP. | DATE | BY | DATE | APP. |
|------|----|------|------|------|----|------|------|------|----|------|------|------|----|------|------|------|----|------|------|
| 1    |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |
| 2    |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |
| 3    |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |
| 4    |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |
| 5    |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |    |      |      |

ISLAND MOTOR DIVISION  
 POWER STAGE WIRING  
 DIAGRAM TPA/2  
 C 78257 3



DO NOT SCALE DWG. USE DIMENSIONS ONLY.  
ALL DIMENSIONS ARE INCHES  
UNLESS OTHERWISE SPECIFIED

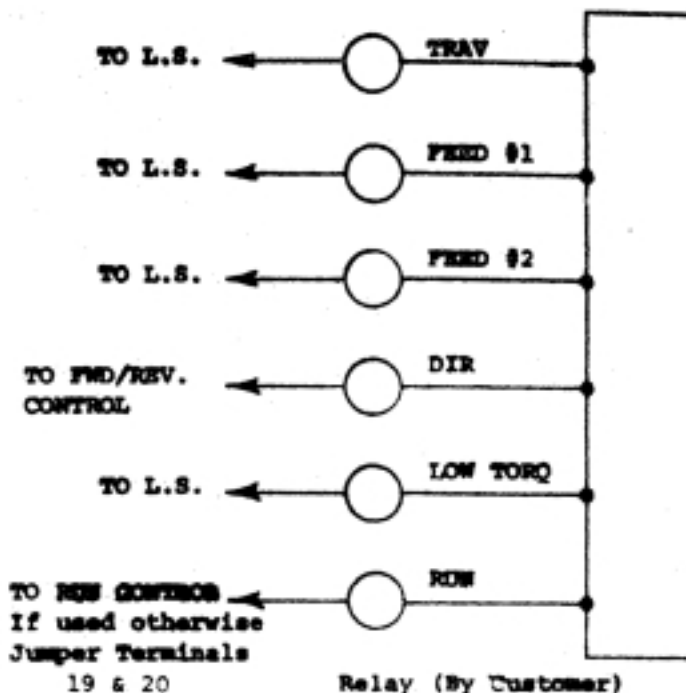
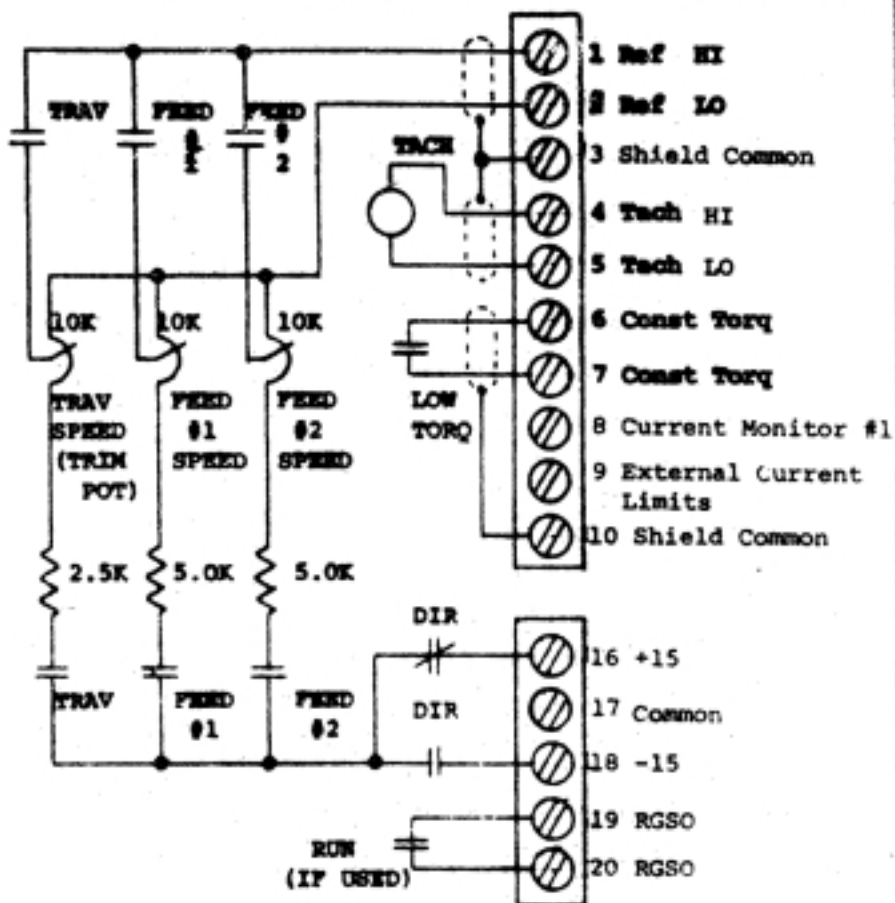
UNLESS OTHERWISE SPECIFIED  
X1 REC. PLACES ± .015  
X12 ESR. PLACES ± .005  
ANG. DIM. ± 1'

UNLESS OTHERWISE SPECIFIED  
REMOVE ALL BURRS AND  
BREAK ALL SHARP EDGES

DWG. SIZE **A**

DWG. NO. 78255

ISSUE 1



FORM REV. NO. 11884

MATERIAL

HEAT TREAT

FINISH

| NO | ECH NO | DATE | APP'D | NO | ECH NO | DATE | APP'D | NO | ECH NO | DATE | APP'D |
|----|--------|------|-------|----|--------|------|-------|----|--------|------|-------|
|    |        |      |       |    |        |      |       |    |        |      |       |
|    |        |      |       |    |        |      |       |    |        |      |       |
|    |        |      |       |    |        |      |       |    |        |      |       |
|    |        |      |       |    |        |      |       |    |        |      |       |

| DW'N BY  | DATE    |
|----------|---------|
| TURNER   | 2/10/78 |
| DW'G BY  |         |
| APP'D BY |         |
| APP'D BY |         |
| APP'D BY |         |

**INLAND MOTOR**  
DIVISION OF COLLEGEBROOK CORP.  
RADFORD 501 FIRST STREET VIRGINIA

**INPUT CIRCUITRY**  
TPA/1/2

SCALE: D.O. NO. PARTS LIST NO.

DWG. SIZE **A** DWG. NO. 78255 CAT. CONT. ISSUE 1



DO NOT SCALE DWG. USE DIMENSIONS ONLY.  
ALL DIMENSIONS ARE INCHES  
UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED  
XX DEC. PLACES ± .018  
XXX DEC. PLACES ± .009  
ANG. DIM. ± 1°

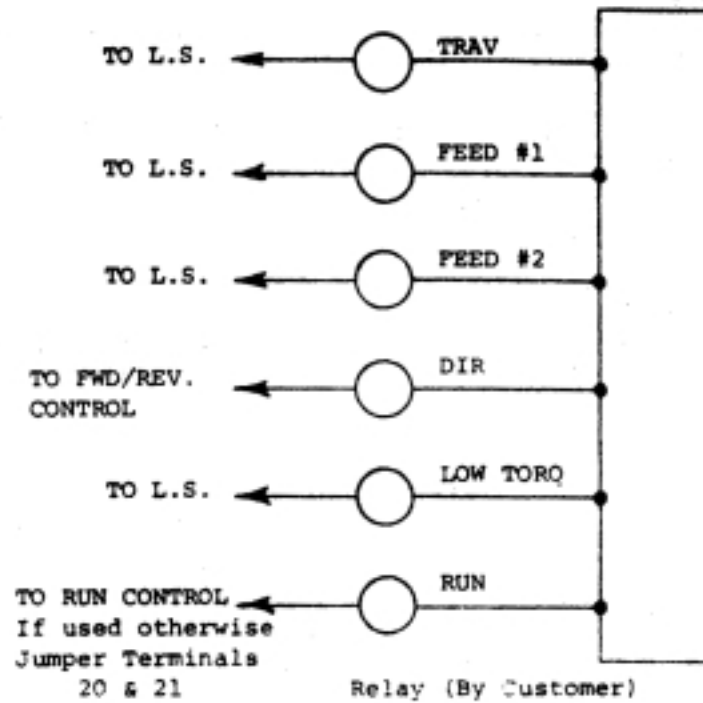
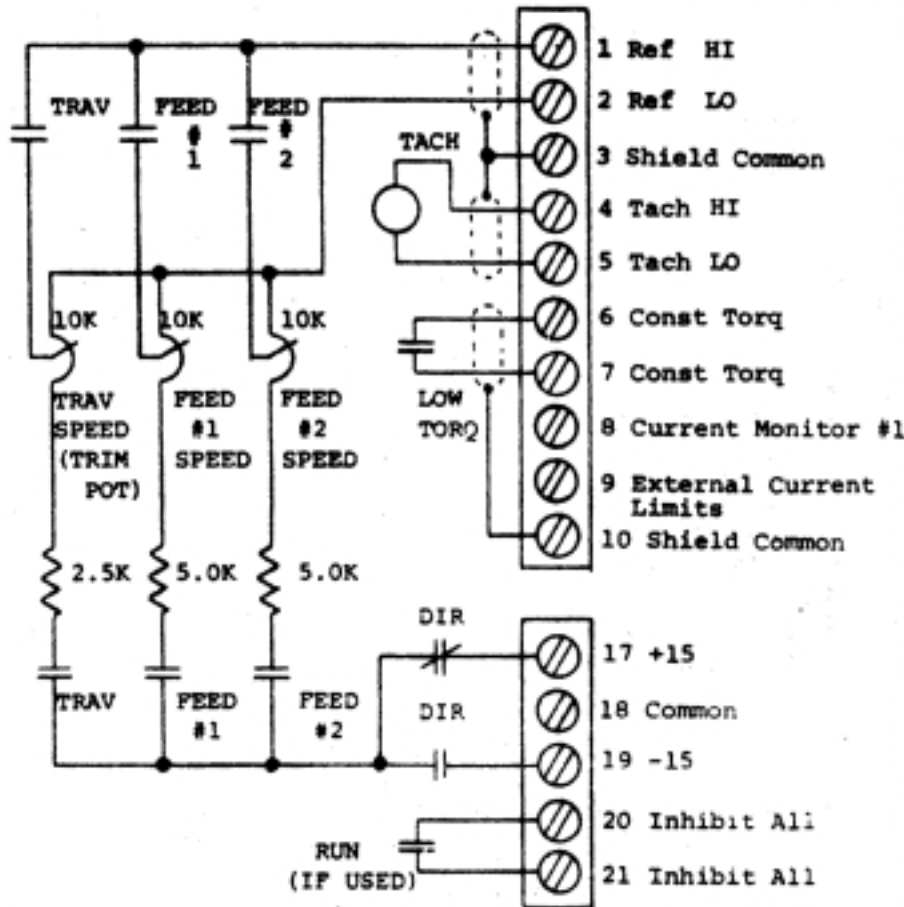
UNLESS OTHERWISE SPECIFIED  
REMOVE ALL BURRS AND  
BREAK ALL SHARP EDGES

DWG. SIZE **A**

DWG. NO. 78254

ISSUE 1

51



CODE REF. NO. 11884

| MATERIAL: |         |      |        | HEAT TREAT: |         |      |        | FINISH: |         |      |        |
|-----------|---------|------|--------|-------------|---------|------|--------|---------|---------|------|--------|
| NO.       | ECN NO. | DATE | APP'D. | NO.         | ECN NO. | DATE | APP'D. | NO.     | ECN NO. | DATE | APP'D. |
|           |         |      |        |             |         |      |        |         |         |      |        |
|           |         |      |        |             |         |      |        |         |         |      |        |
|           |         |      |        |             |         |      |        |         |         |      |        |
|           |         |      |        |             |         |      |        |         |         |      |        |

**INLAND MOTOR**  
DIVISION OF KOLLMOEDER CORP.

RADFORD      501 FIRST STREET      VIRGINIA

**INPUT CIRCUITRY**  
TPA/3

|                    |                |                    |
|--------------------|----------------|--------------------|
| SCALE:             | D.O. NO.       | PARTS LIST NO.     |
| DWG. SIZE <b>A</b> | DWG. NO. 78254 | CAT. CONT. ISSUE 1 |

DR'N BY: **TURNER** 2/8/78  
DATE: 2/8/78  
CHK'D BY:        
APP'D BY:        
APP'D BY:        
APP'D BY:

**CODE DATA CHART**

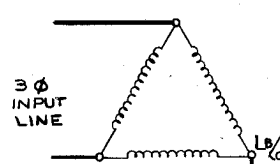
TPA/I-XXXXY-SERIES

| "E"      | "D"      | "B"     | "A"     |
|----------|----------|---------|---------|
| 120 VRMS | 208 VRMS | 40 AMPS | 24 AMPS |
| 138 VRMS | 240 VRMS | 70 AMPS | 42 AMPS |
| 158 VRMS | 275 VRMS | 85 AMPS | 51 AMPS |

IF "XXX" IS "E", CORRESPONDING "D" WILL APPLY. IF "YY" IS "B", CORRESPONDING "A" WILL APPLY.

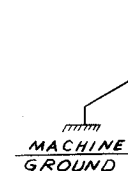
NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10Ω AND .47μF IS SUGGESTED.

\* SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL 3, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.



THE DETERMINATION OF PHASE ROTATION DIRECTION OF THE 3Φ PRIMARY LINE IS NOT REQ'D.

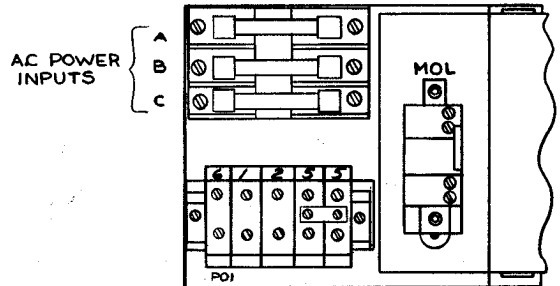
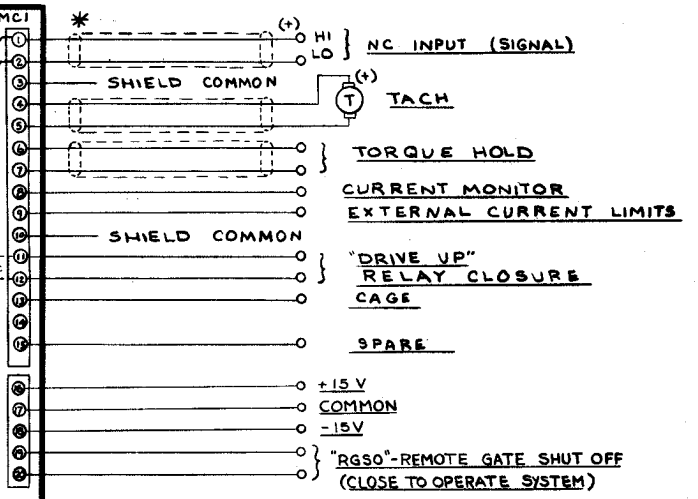
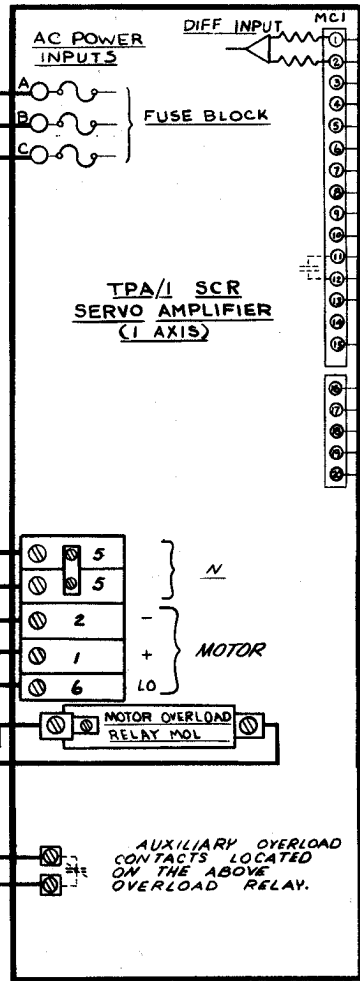
NC OR MACHINE GROUND #10 AWG OR LARGER



THESE CONTACTS, RATED 120VAC-3AMPS AC, 240VAC-1.5AMPS AC, SHALL BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN "RGSO".

**NOTES:**

- IMPORTANT - TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK:  
THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND (IN SAME DIRECTION).  
CHECK THE POLARITIES AT TERMINAL MCI-4 FOR THE TACH AND TERMINALS POI-1 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND.
- USE TWISTED SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON MCI AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.
- SERIES CHOKE NOT USED ON 40 AMP SYSTEM.



INLAND MOTOR DIVISION  
KOLLMORGEN CORPORATION  
441 Rock Road, Bedford, Virginia

System Wiring Diagram  
TPA(DX)/L  
SCALE: 1:1  
C-78486 4

| NO. | REV. NO. | DATE    | APP'D | NO. | REV. NO. | DATE    | APP'D | BY | DATE |
|-----|----------|---------|-------|-----|----------|---------|-------|----|------|
| 2   |          | 7/8/64  |       | 3   |          | 5/1/72  |       |    |      |
| 3   |          | 7/8/73  |       | 4   |          | 11/1/73 |       |    |      |
| 4   |          | 8/22/79 |       |     |          |         |       |    |      |

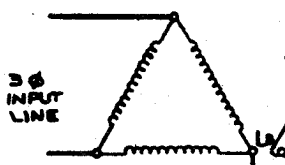
**CODE DATA CHART**  
TPA/1-XXXXY-SERIES

|          |          |         |         |         |         |         |         |
|----------|----------|---------|---------|---------|---------|---------|---------|
| "B"      |          | "D"     |         | "B"     |         | "A"     |         |
| 120V RMS | 300V RMS | 40 AMPS | 24 AMPS | 40 AMPS | 24 AMPS | 40 AMPS | 24 AMPS |
| 180V RMS | 240V RMS | 70 AMPS | 42 AMPS | 70 AMPS | 42 AMPS | 70 AMPS | 42 AMPS |
| 180V RMS | 270V RMS | 85 AMPS | 51 AMPS | 85 AMPS | 51 AMPS | 85 AMPS | 51 AMPS |

IF "X" IS "B", CORRESPONDING "D" WILL APPLY. IF "Y" IS "B", CORRESPONDING "A" WILL APPLY.

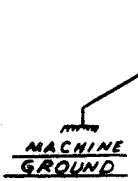
**NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10R AND .47UF IS SUGGESTED.**

**\* SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL 5, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.**



THE DETERMINATION OF PHASE ROTATION DIRECTION OF THE 3Ø PRIMARY LINE IS NOT REQ'D.

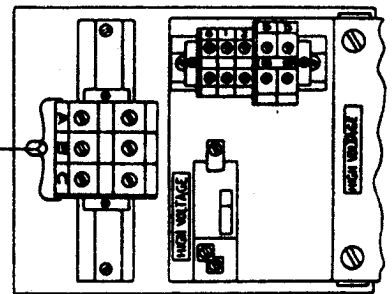
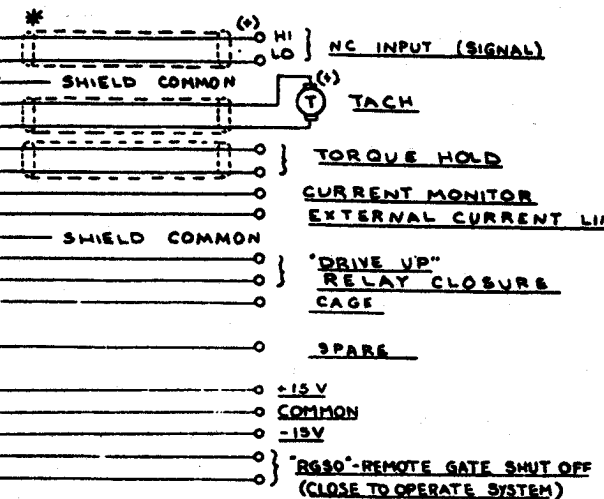
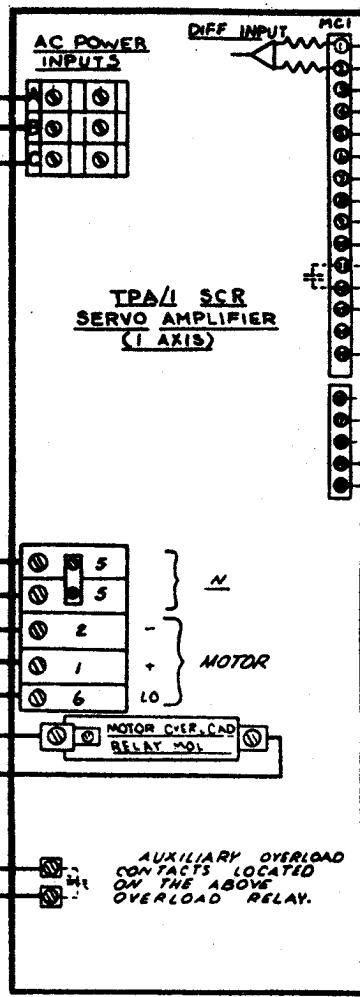
NC OR MACHINE GROUND #10 AWG OR LARGER



THESE CONTACTS, RATED 120VAC-5AMPS AC 240VAC 1.5AMPS AC SHALL BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN RGSO.

**NOTES:**

- IMPORTANT. TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK. THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND (IN SAME DIRECTION). CHECK THE POLARITIES AT TERMINAL MCI-4 FOR THE TACH AND TERMINALS PO1-1 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND.
- USE TWISTED SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON MCI AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.
- SERIES CHOKES NOT USED ON 40 AMP SYSTEM.



INLAND MOTOR DIVISION  
KOLLMOEDER CORPORATION  
507 West 2nd, Oakland, California

|     |        |      |       |    |        |      |       |    |        |      |       |    |
|-----|--------|------|-------|----|--------|------|-------|----|--------|------|-------|----|
| REV | REV NO | DATE | APP'D | NO | REV NO | DATE | APP'D | NO | REV NO | DATE | APP'D | NO |
|     |        |      |       |    |        |      |       |    |        |      |       |    |

SYSTEM Wiring Diagram  
TPA/1-15840/504/60A/50S/40S  
REV RFD 12-71  
C-78695 1

**CODE DATA CHART**

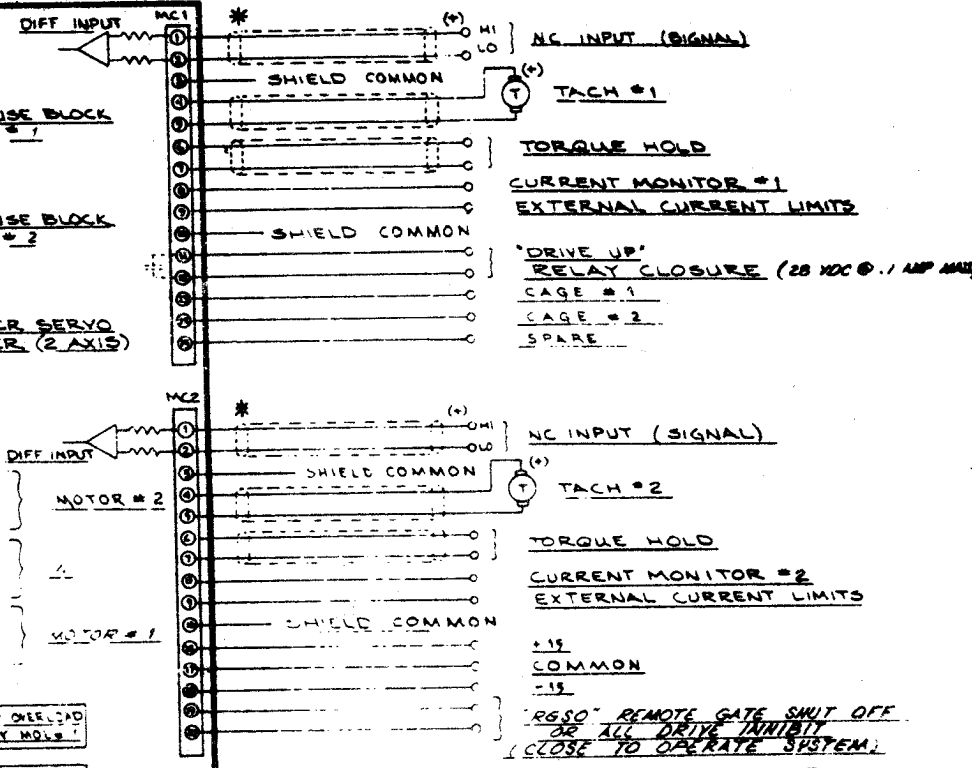
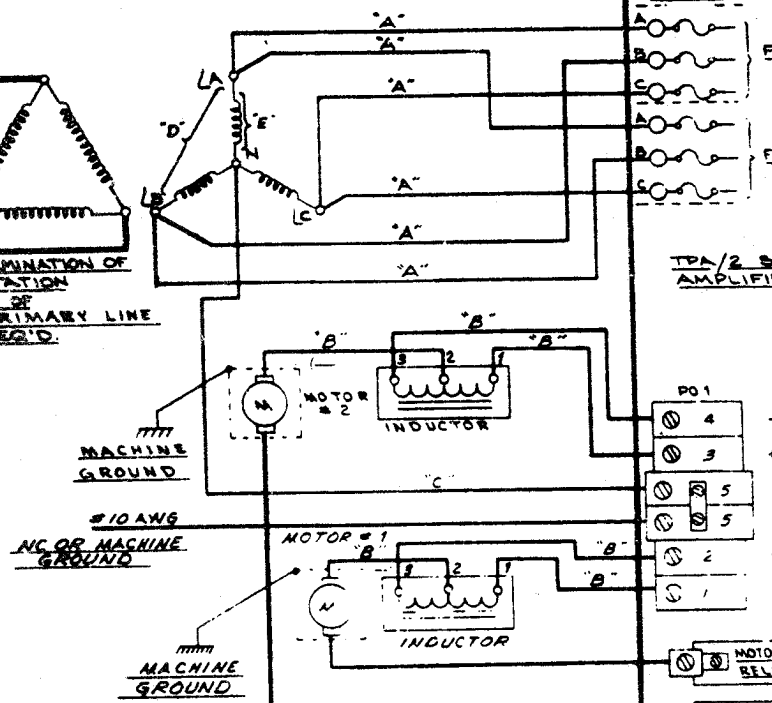
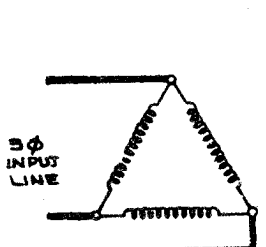
| MODEL | 'A'        | 'B'        | 'C'        | 'D'        | 'E'        |
|-------|------------|------------|------------|------------|------------|
| 15040 | 30<br>AMPS | 40<br>AMPS | 80<br>AMPS | 275<br>L-L | 150<br>L-N |
| 13040 | 30<br>AMPS | 40<br>AMPS | 80<br>AMPS | 240<br>L-L | 130<br>L-N |

**IMPORTANT**

\* **NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10R AND .1MF IS SUGGESTED.**  
 EACH SECONDARY PHASE WIRE (A,B,C) MUST BE CONNECTED AS SHOWN.

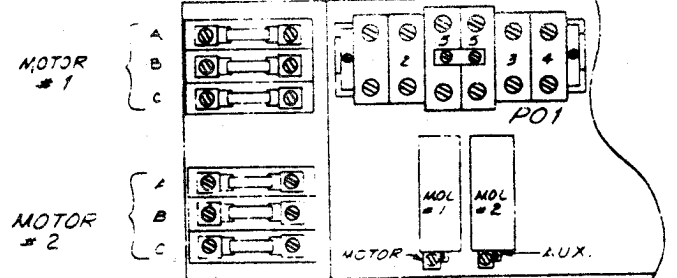
|   |  |  |   |       |   |
|---|--|--|---|-------|---|
| DO NOT SCALE DIMS. USE DIMENSIONS ONLY.<br>ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED. | WELDED CONNECTIONS SPECIFIED<br>BY THE PLACES 2 AND 3<br>ON THE PLACES 2 AND 3<br>AND THE 2. | WELDED CONNECTIONS SPECIFIED<br>BY THE PLACES 2 AND 3<br>ON THE PLACES 2 AND 3<br>AND THE 2. | C | 78443 | 2 |
|---|--|--|---|-------|---|

\* **SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL B, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.**



THESE CONTACTS, RATED 120VAC - 5AMPS AC, 240VAC 1.5AMPS SE, SHALL BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN 'EGSC'.

**NOTES:**  
 1- IMPORTANT - TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK:  
 THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND. (IN SAME DIRECTION).  
 CHECK THE POLARITIES AT TERMINAL MC1-4, MC2-4 FOR THE TACH AND TERMINALS PO1-1, PO1-3 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND.  
 2- USE TWISTED SHIELDED WIRE (#18 20 GA) FOR ALL INPUTS ON MC1 AND MC2 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.



| REV | DATE | APP'D | NO | REV | DATE | APP'D | NO | REV | DATE | APP'D | NO | REV | DATE | APP'D | NO |
|-----|------|-------|----|-----|------|-------|----|-----|------|-------|----|-----|------|-------|----|
|     |      |       |    |     |      |       |    |     |      |       |    |     |      |       |    |
|     |      |       |    |     |      |       |    |     |      |       |    |     |      |       |    |

INLAND MOTOR DIVISION  
 RADFORD, VIRGINIA

SYSTEM WIRING DIAG.  
 TPA/2 - 02 AND 03

SCALE: 1" = 100'

DATE: 7/3

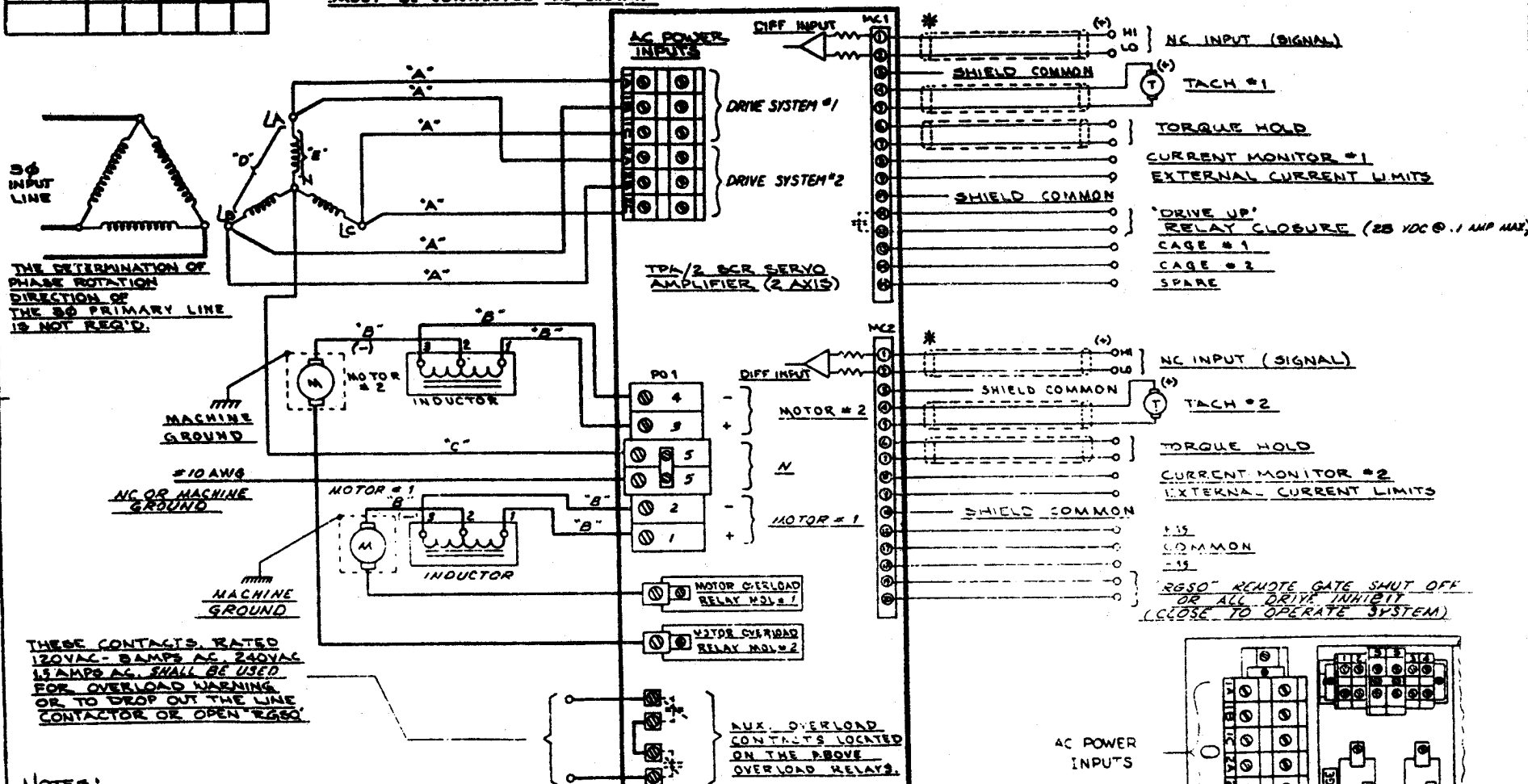
REV: 2

**IMPORTANT**

**NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10Ω AND .47μF IS SUGGESTED.**  
**EACH SECONDARY PHASE WIRE (A,B,C) MUST BE CONNECTED AS SHOWN.**

**CODE DATA CHART**

| MODEL | A    | B    | C    | D   | E   |
|-------|------|------|------|-----|-----|
| 13840 | 30   | 40   | 80   | 240 | 438 |
|       | AMPS | AMPS | AMPS | L-L | L-N |
| 14000 | 30   | 40   | 80   | 275 | 438 |
|       | AMPS | AMPS | AMPS | L-L | L-N |



THE DETERMINATION OF PHASE ROTATION DIRECTION OF THE 50 PRIMARY LINE IS NOT REQ'D.

MACHINE GROUND

NC OR MACHINE GROUND

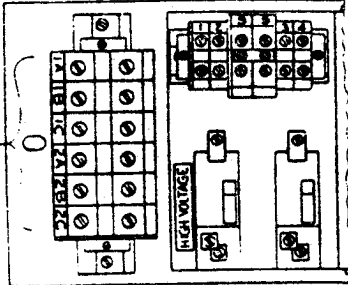
MACHINE GROUND

THESE CONTACTS, RATED 120VAC - 2AMPS AC, 240VAC 1.5AMPS AC, SHALL BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN RELAY.

- NOTES:**
- IMPORTANT - TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK:  
 THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND. (IN SAME DIRECTION)  
 CHECK THE POLARITIES AT TERMINAL MC1-4, MC2-4 FOR THE TACH AND TERMINALS PO1-1, PO1-3 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND.
  - USE TWISTED, SHIELDED WIRE (1/8" 20 GA) FOR ALL INPUTS ON MC1 AND MC2 AS INDICATED. ALL THE WIRES CAN BE NON-SHIELDED.

\* SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL 2, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.

RG50 REMOTE GATE SHUT OFF OR ALL DRIVE INHIBIT (CLOSE TO OPERATE SYSTEM)



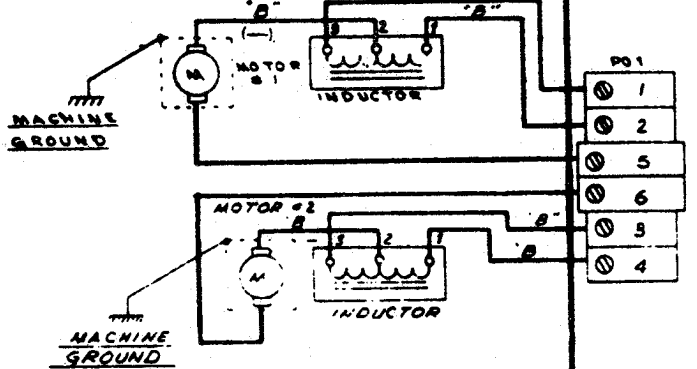
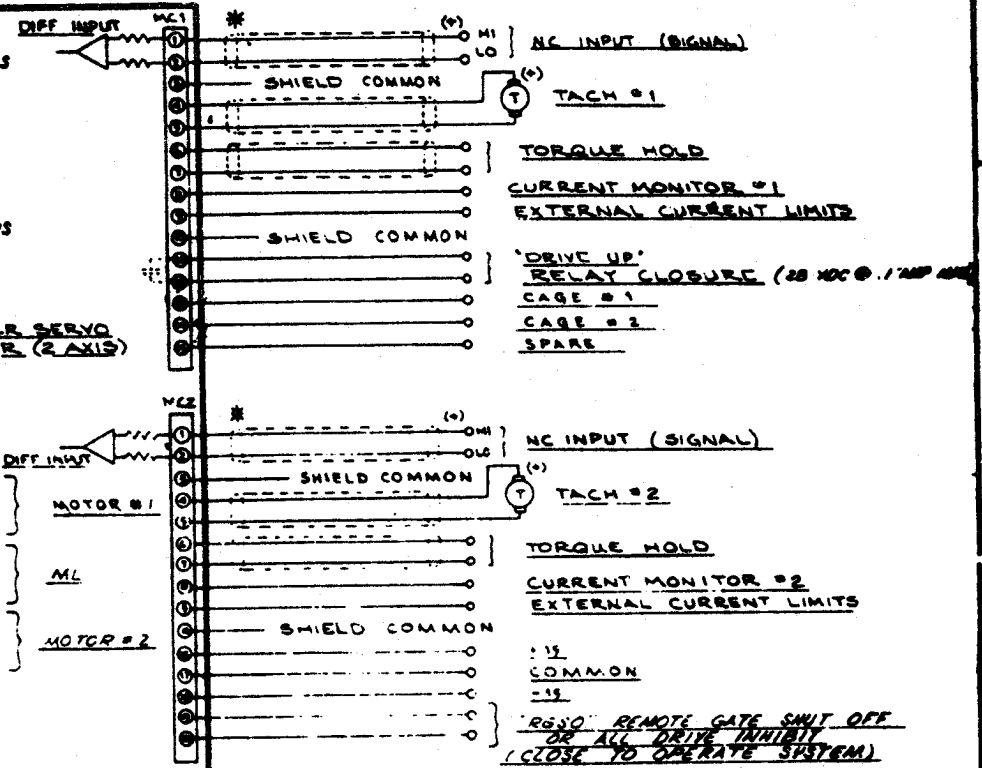
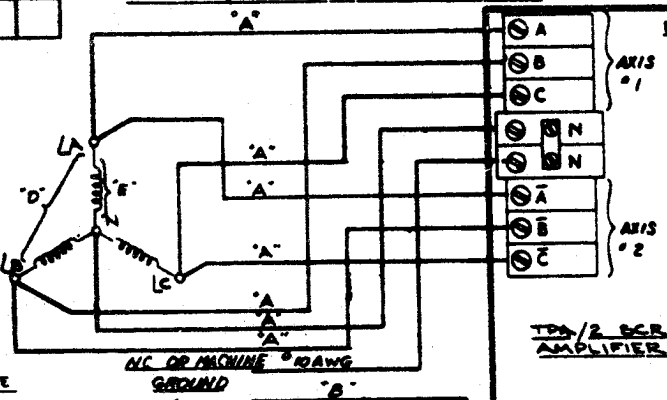
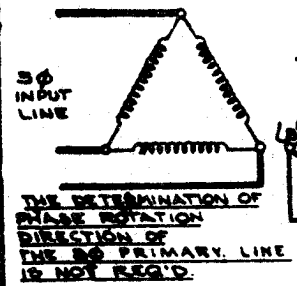
| MATERIAL |          |      |        | REVISION |          |      |        | DATE |          | BY   |        | INLAND MOTOR DIVISION             |       |
|----------|----------|------|--------|----------|----------|------|--------|------|----------|------|--------|-----------------------------------|-------|
| NO.      | REV. NO. | DATE | APP'D. | NO.      | REV. NO. | DATE | APP'D. | NO.  | REV. NO. | DATE | APP'D. | RADFORD 301 FIRST STREET VIRGINIA |       |
|          |          |      |        |          |          |      |        |      |          |      |        | SYSTEM WIRING DIAG.               |       |
|          |          |      |        |          |          |      |        |      |          |      |        | TPA/2-15840/504/504/505/605       |       |
|          |          |      |        |          |          |      |        |      |          |      |        | PL 78660                          |       |
|          |          |      |        |          |          |      |        |      |          |      |        | REV C                             | 78696 |

| MODEL | A   | B   | C   | D   | E   |
|-------|-----|-----|-----|-----|-----|
| 15040 | 50  | 40  | 80  | 275 | 150 |
|       | AMP | AMP | AMP | L-L | L-N |
| 15040 | 50  | 40  | 80  | 240 | 150 |
|       | AMP | AMP | AMP | L-L | L-N |

**IMPORTANT**

\* NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10Ω AND .1μF IS SUGGESTED.  
 EACH SECONDARY PHASE WIRE (A,B,C) MUST BE CONNECTED AS SHOWN.

\* SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL 5, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.



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**NOTES:**  
 1- IMPORTANT - TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK:  
 THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND. (IN SAME DIRECTION)  
 CHECK THE POLARITIES AT TERMINAL MC1-4, MC2-4 FOR THE TACH AND TERMINALS PO1-1, PO1-3 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND & USE TWISTED SHIELDED WIRE (#20 GA) FOR ALL INPUTS ON MC1 AND MC2 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

| REV | DATE | BY | CHKD | DATE | BY | CHKD | DATE | BY | CHKD | DATE | BY | CHKD |
|-----|------|----|------|------|----|------|------|----|------|------|----|------|
|     |      |    |      |      |    |      |      |    |      |      |    |      |

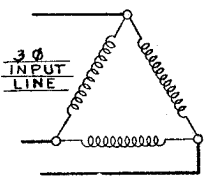
INLAND MOTOR DIVISION  
 SYSTEM WIRING DIAG.  
 TPA/2-512/612/513/613  
 PL 78550  
 78550 1

**\* IMPORTANT**  
 NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSION. 10Ω AND .47μF IS SUGGESTED.  
 EACH SECONDARY PHASE WIRE (A,B,C) MUST BE CONNECTED AS SHOWN.

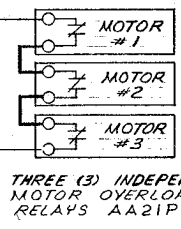
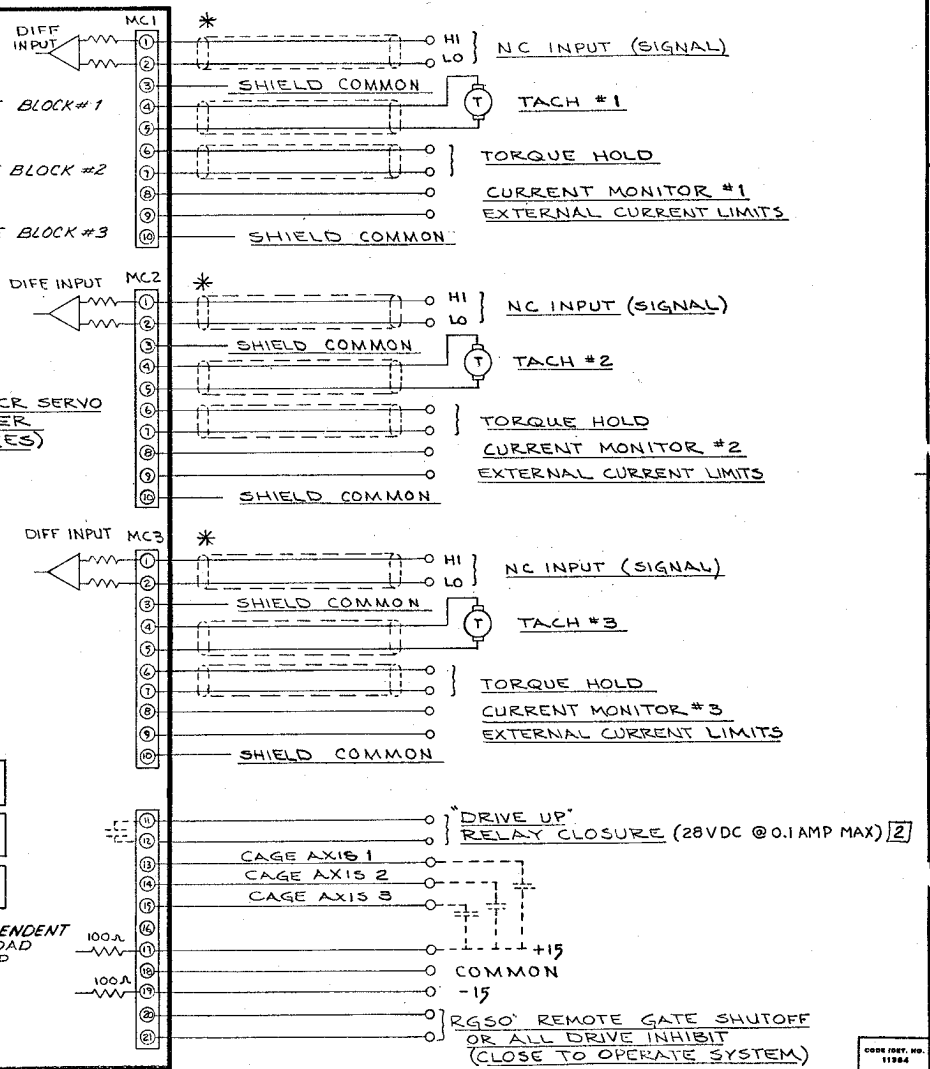
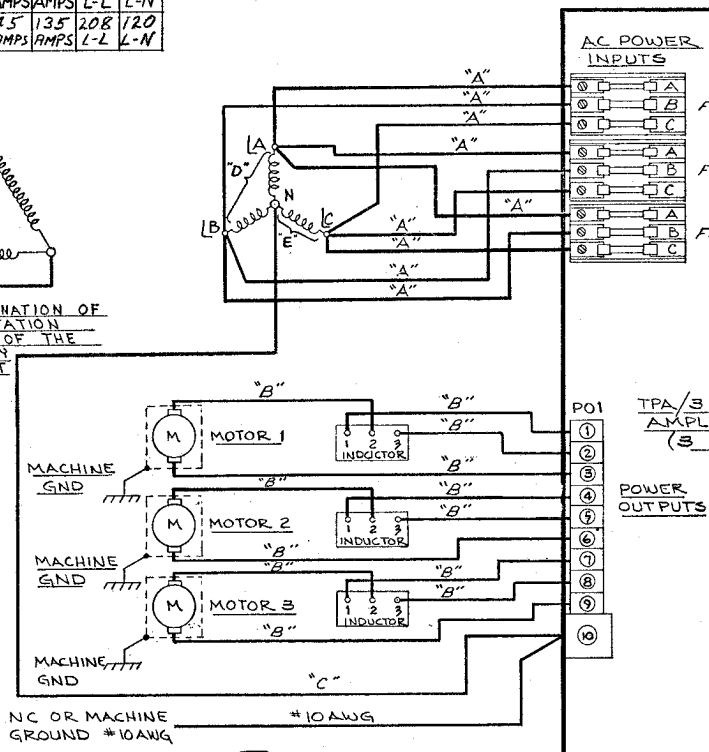
**\* SHIELDS ARE TO BE TERMINATED TO EITHER THE NC GROUND OR TERMINAL 8, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.**

**CODE DATA CHART**

| MODEL | "A" AMPS | "B" AMPS | "C" AMPS | "D" L-L | "E" L-N |
|-------|----------|----------|----------|---------|---------|
| 13840 | 27       | 45       | 135      | 240     | 138     |
| 15840 | 27       | 45       | 135      | 275     | 158     |
| 12040 | 27       | 45       | 135      | 208     | 120     |



THE DETERMINATION OF PHASE ROTATION DIRECTION OF THE 3Φ PRIMARY LINE IS NOT REQ'D.



THESE CONTACTS, RATED 120VAC-3AMPS AC, 240VAC 1.5VAC, SHALL BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN RGSO.

- NOTES:**
- IMPORTANT- TO AVOID RUNAWAY BEFORE APPLYING POWER MAKE THE FOLLOWING SERVO POLARITY CHECK;  
 THE BEMF VOLTAGE GENERATED BY THE MOTOR ARMATURE MUST BE OPPOSITE THAT GENERATED BY THE TACH FEEDBACK WHEN THE MOTOR IS ROTATED BY HAND. (IN SAME DIRECTION).  
 CHECK THE POLARITIES AT TERMINAL MC1-4, MC2-4, MC3-4 FOR THE TACH AND TERMINALS 1,4 AND 7 ON THE POWER OUTPUT TERMINALS PO1. ALL VOLTAGES ARE WITH RESPECT TO GROUND.
  - USE TWISTED, SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON MC1, MC2, MC3. EXCEPT TERMINAL #8 CAN BE NON-SHIELDED.
  - DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

| MATERIAL |         | HEAT TREAT |           | FINISH |      | INLAND MOTOR DIVISION |         |
|----------|---------|------------|-----------|--------|------|-----------------------|---------|
| NO.      | ECN NO. | DATE       | APP'D NO. | NO.    | DATE | APP'D NO.             | RADFORD |
| 2        | 78564   | 7/12       | RD        |        |      |                       |         |
| 3        | 78438   | 7/14       | RD        |        |      |                       |         |
| 4        | 78438   | 7/14       | RD        |        |      |                       |         |

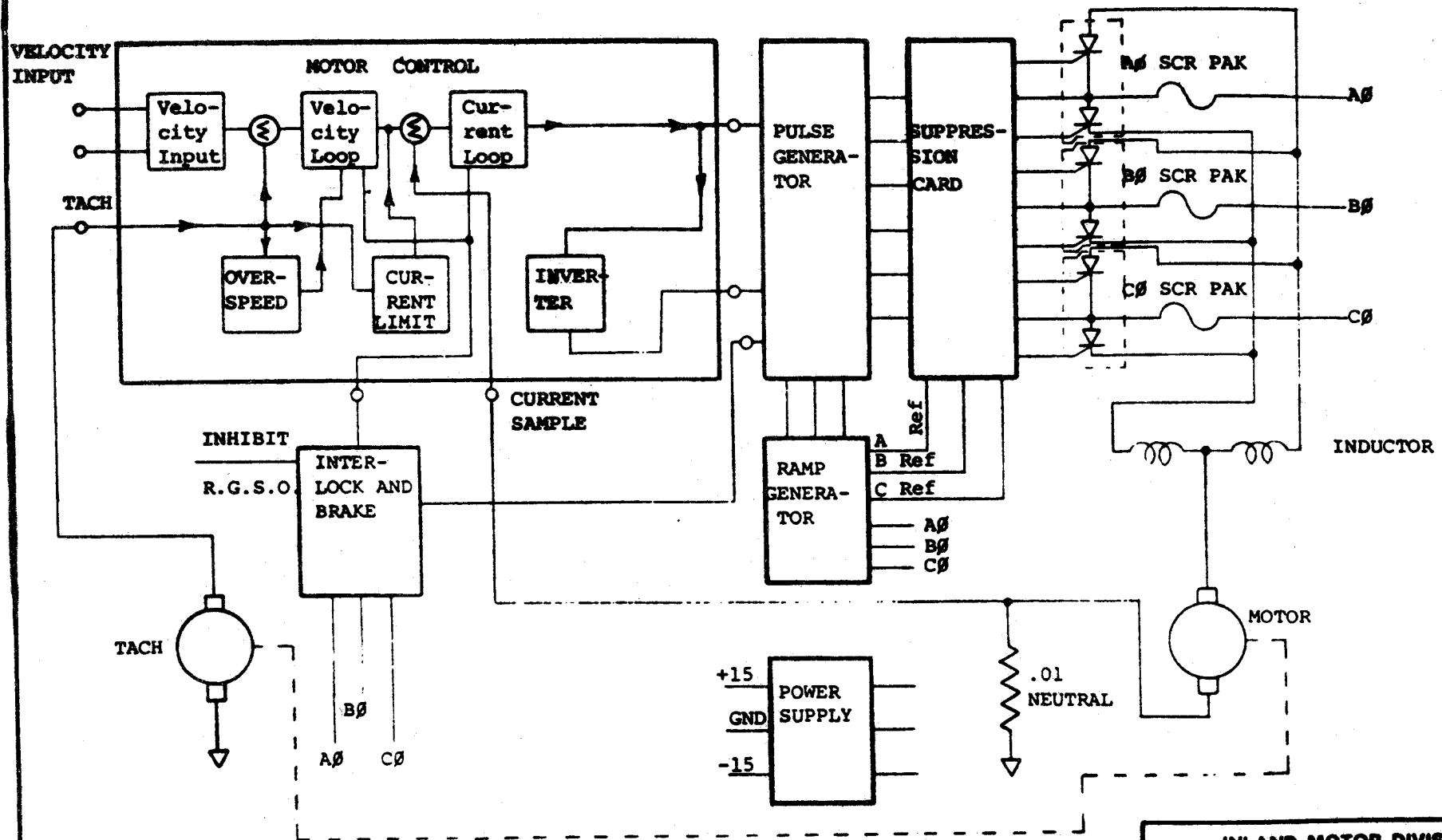
SCALE: NONE LIST NO. PL-78436

DWG. NO. 78438 CAT. CONT. 4

57







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**INLAND MOTOR DIVISION**  
 KOLLMORGEN CORPORATION  
 501 FIRST ST RADFORD, VIRGINIA

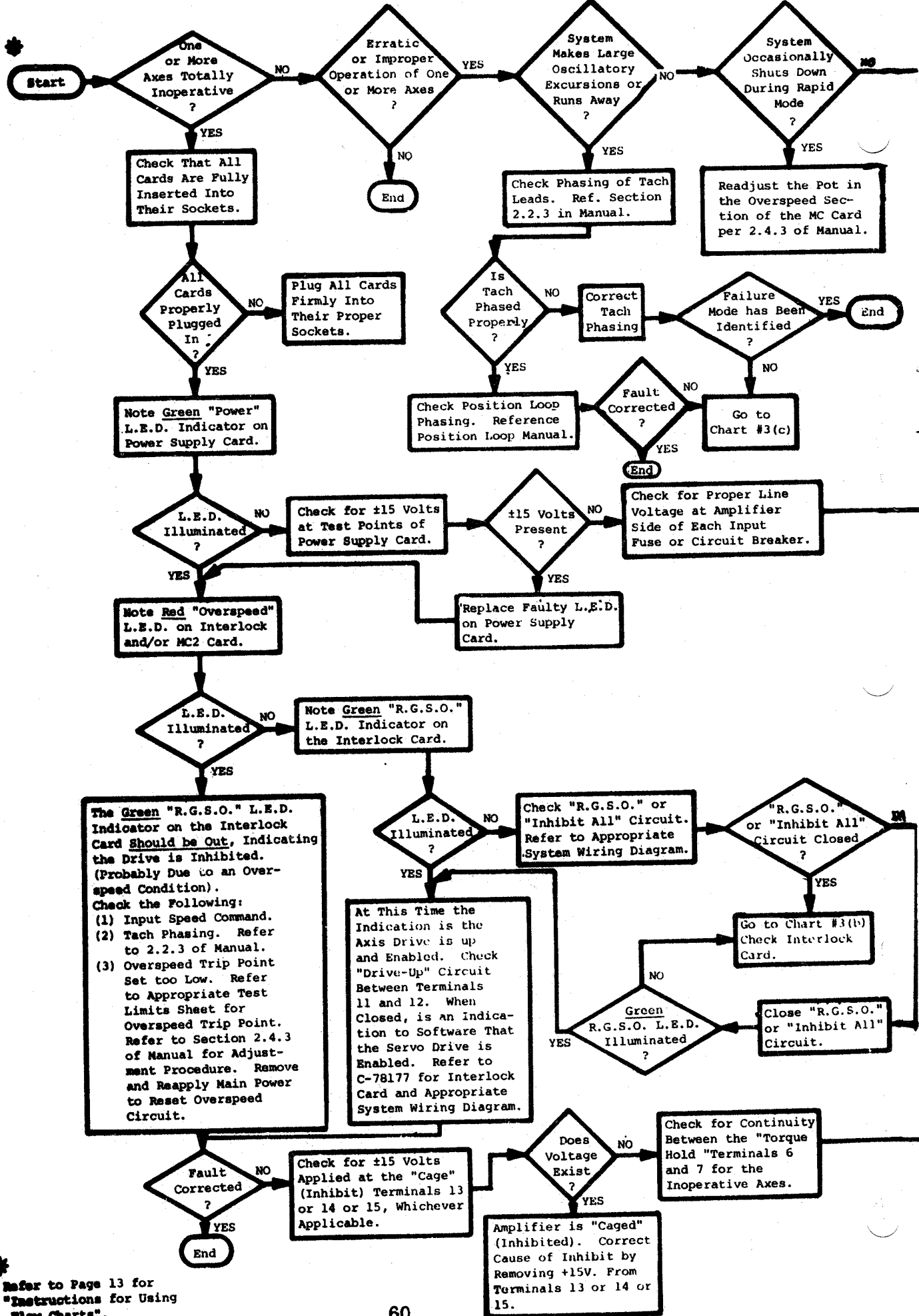
**SYSTEM BLOCK DIAGRAM**  
 TPA/1/2/3

SCALE: \_\_\_\_\_ DWG. NO: **A- 78256**

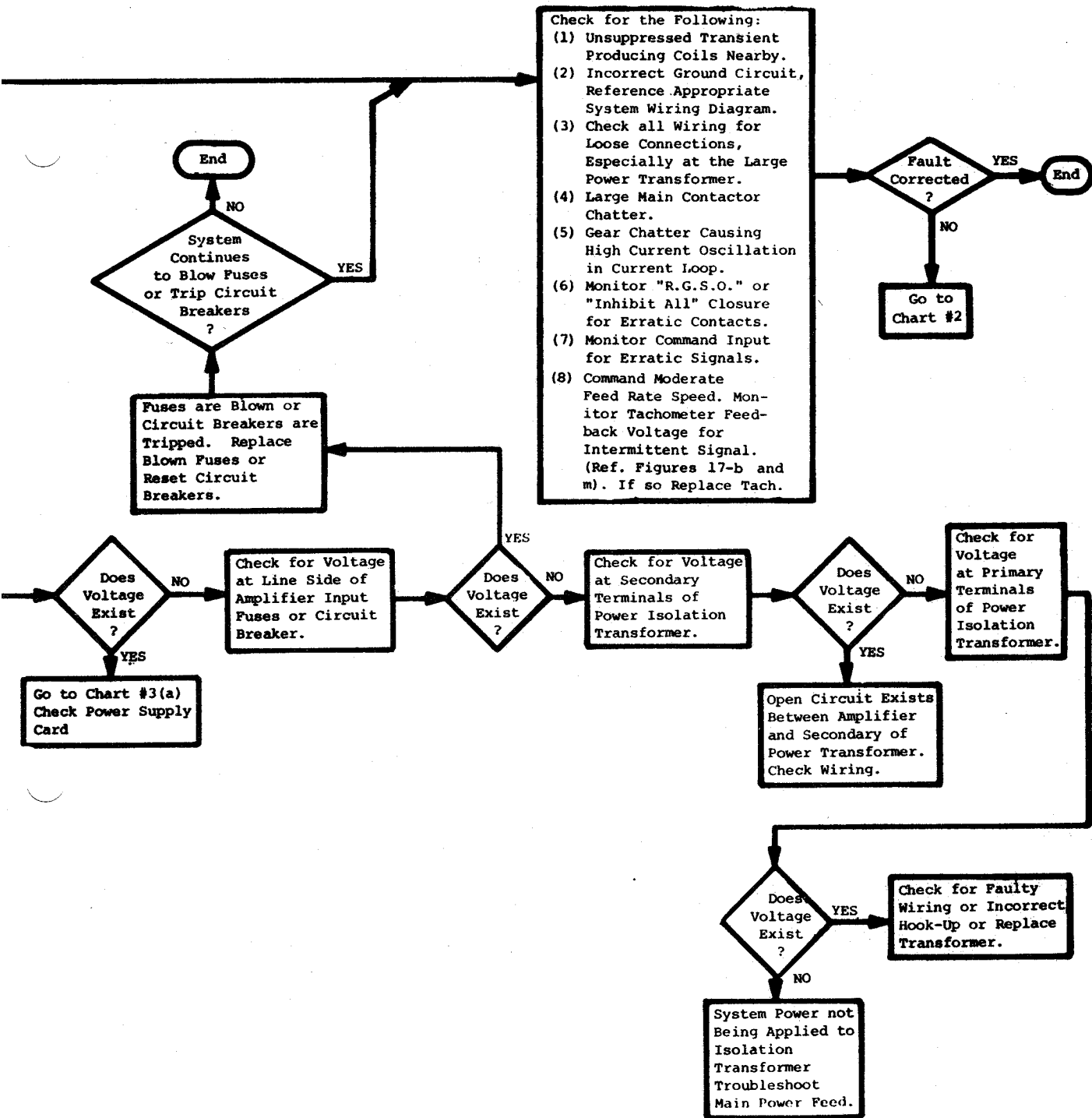
UNLESS OTHERWISE SPECIFIED  
 XX DEC. PLACES ± .015  
 XXX DEC. PLACES ± .006  
 ANG. DIM. ± 10

DO NOT SCALE DWG. USE DIMENSIONS ONLY  
 ALL DIMENSIONS ARE INCHES  
 UNLESS OTHERWISE SPECIFIED

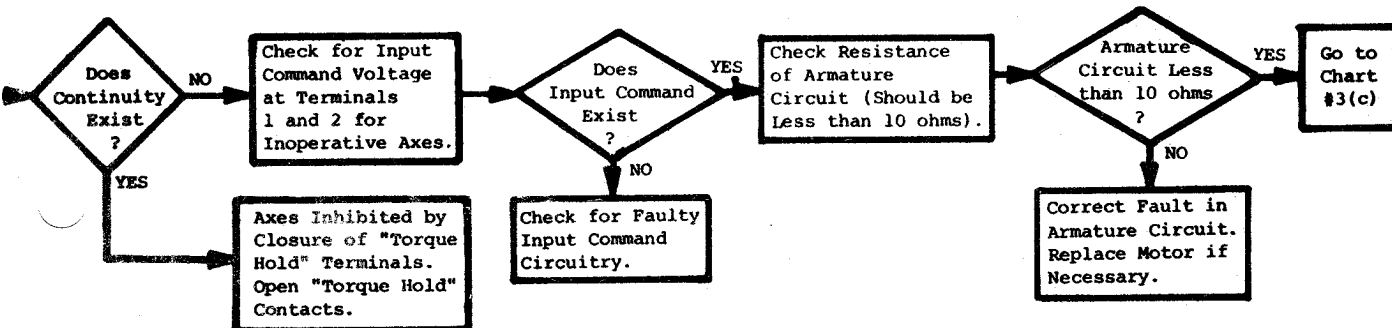
| NO | ECN NO. | DATE     | APP'D. | NO. | ECN NO. | DATE | APP'D. | DW'N BY  | DATE    |
|----|---------|----------|--------|-----|---------|------|--------|----------|---------|
| 2  | 177     | 11/15/78 |        |     |         |      |        | TURNER   | 2/10/78 |
|    |         |          |        |     |         |      |        | CHK BY   | 1/3/80  |
|    |         |          |        |     |         |      |        | APP'D BY |         |

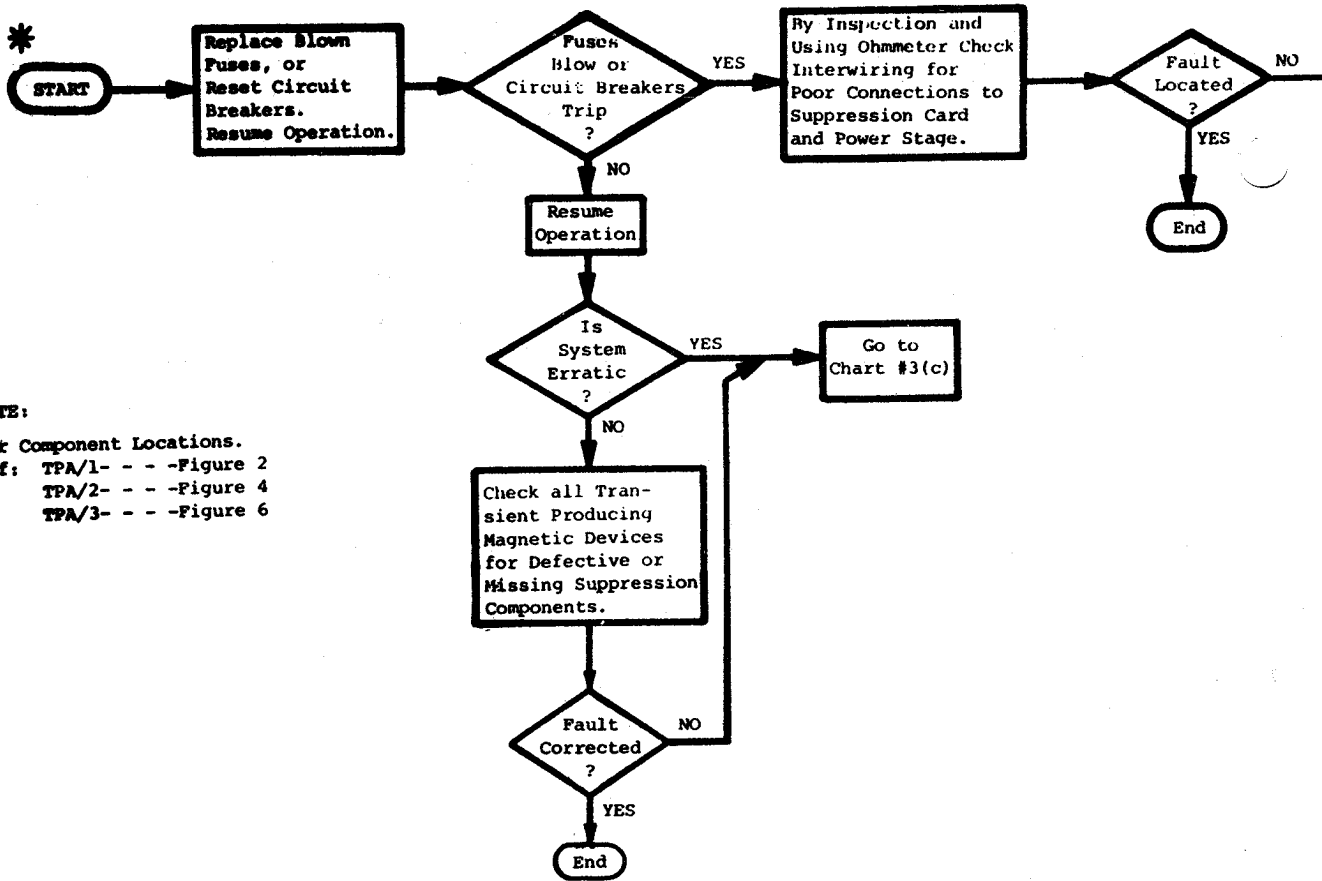


Refer to Page 13 for "Instructions for Using Flow Charts".



External Interface  
Chart #1





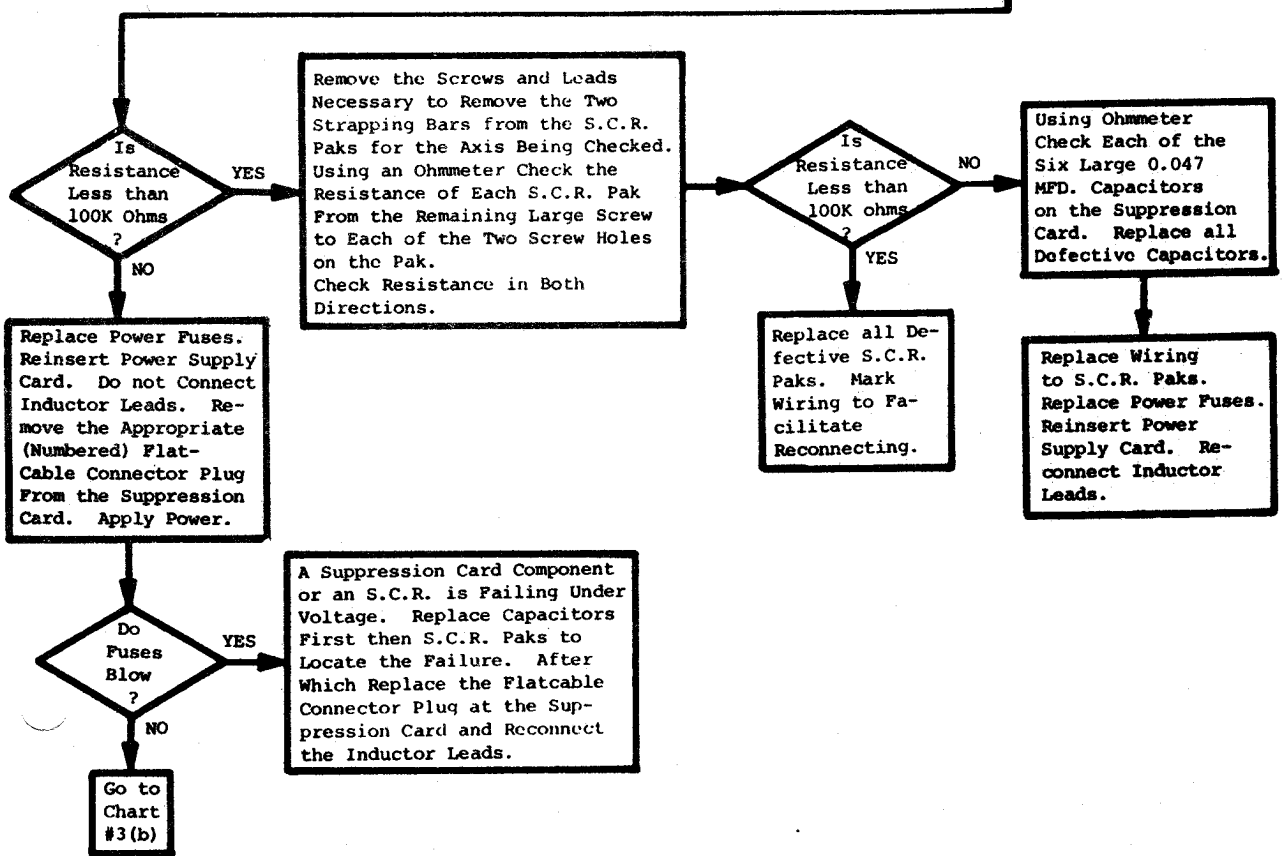
**NOTE:**

For Component Locations.  
 Ref: TPA/1- - -Figure 2  
 TPA/2- - -Figure 4  
 TPA/3- - -Figure 6

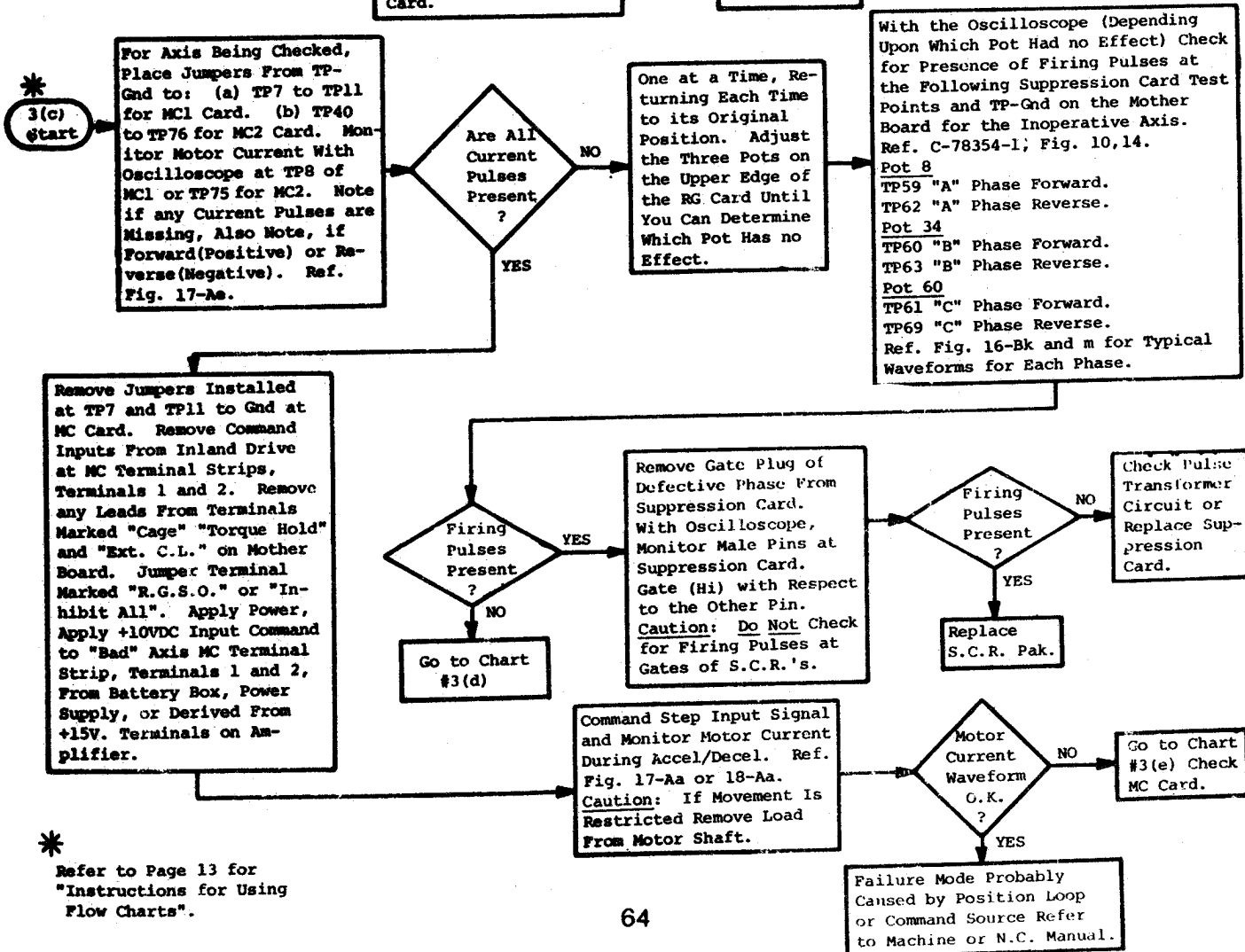
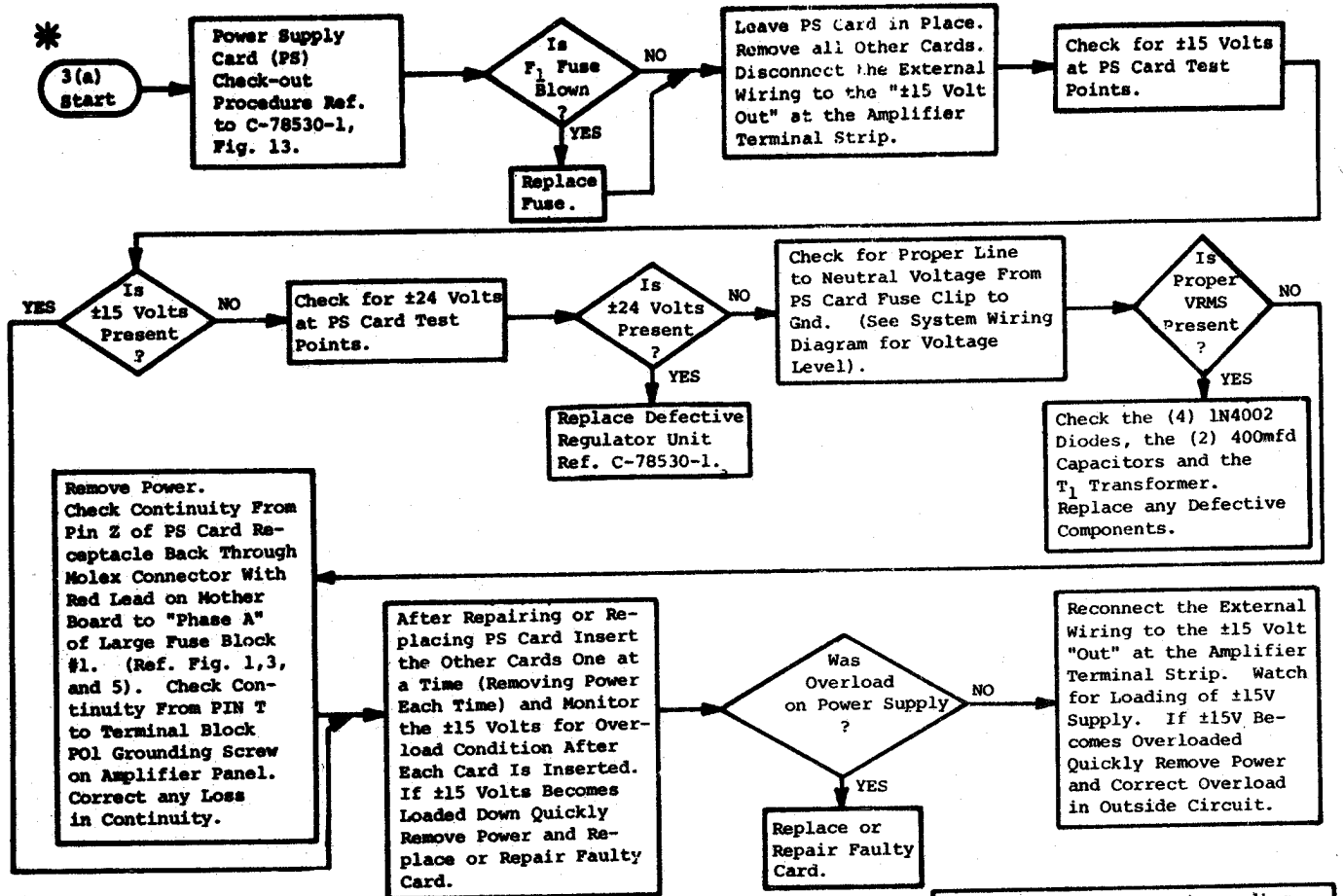
\*  
 Refer to Page 13 for  
 "Instructions for Using  
 Flow Charts".

(1) Remove Both Leads to the Inductor for the Axis Being Checked (Ref. Appropriate System Wiring Diagram).  
 (2) Remove the Power Fuses for the Axis Being Checked.  
 (3) Remove the Power Supply Card.

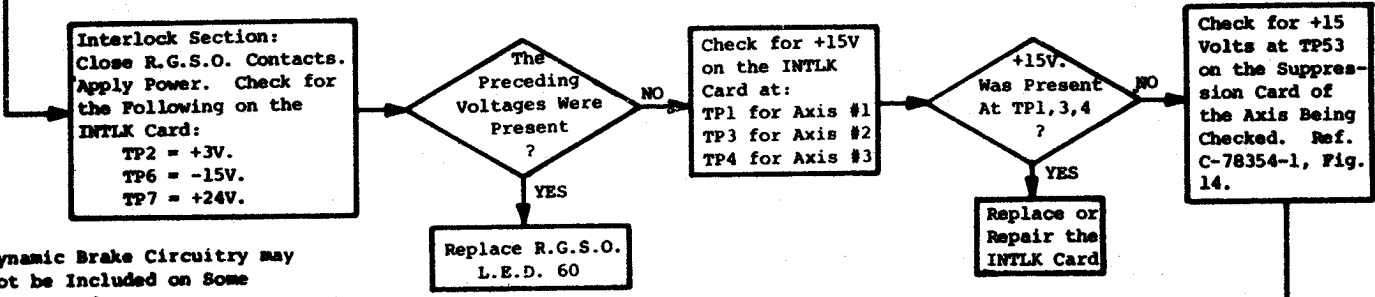
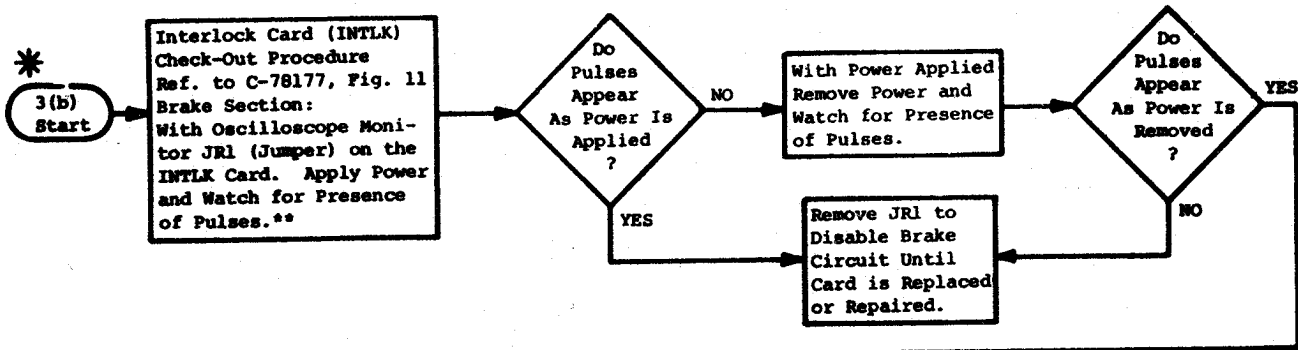
Using an Ohmmeter Measure the Resistance Between the "+" Output on the P01 Terminal Block and Each of the Screws on the Amplifier Side of Fuse Mounting Block.  
 Next: Measure Resistance Between the "-" Output on the P01 Terminal Block and Each of the Screws on the Amplifier Side of the Fuse Mounting Block.



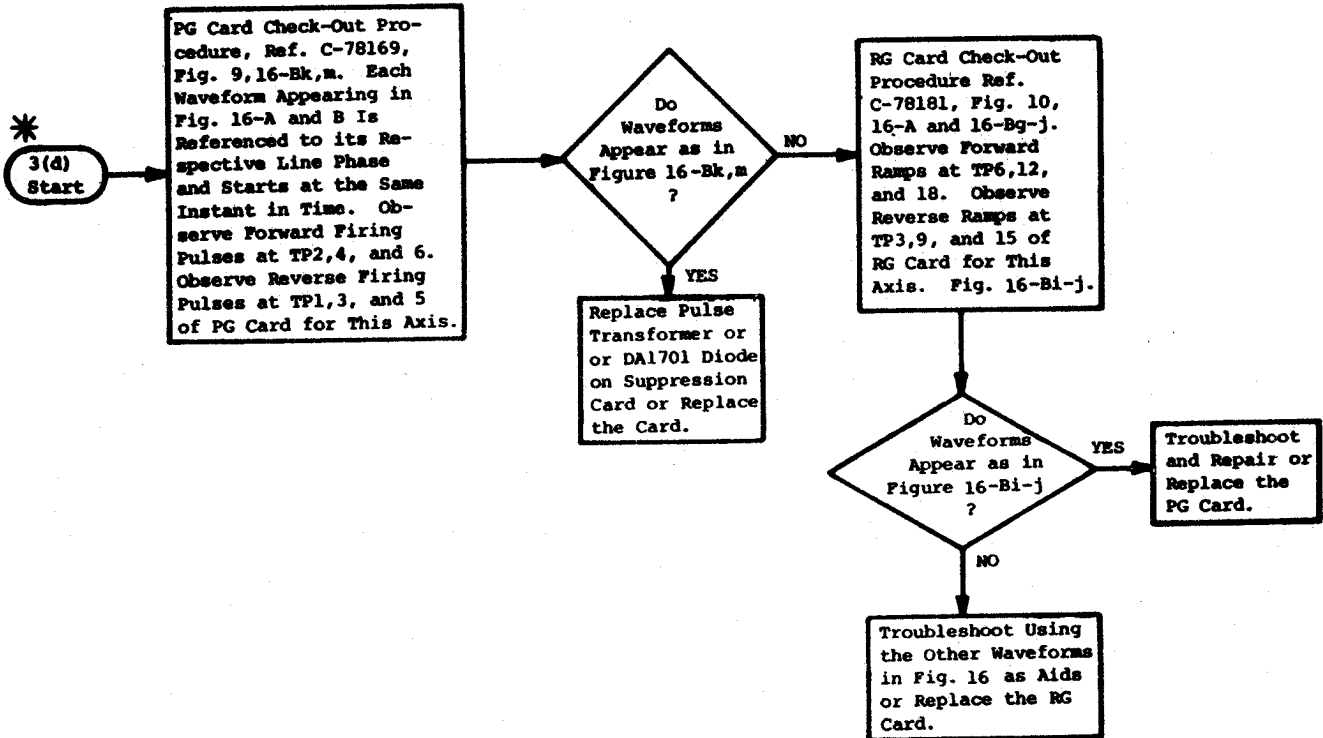
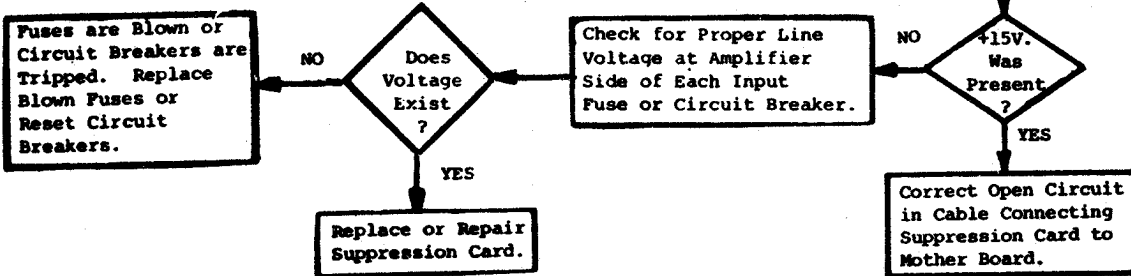
Power Stage  
 Chart #2

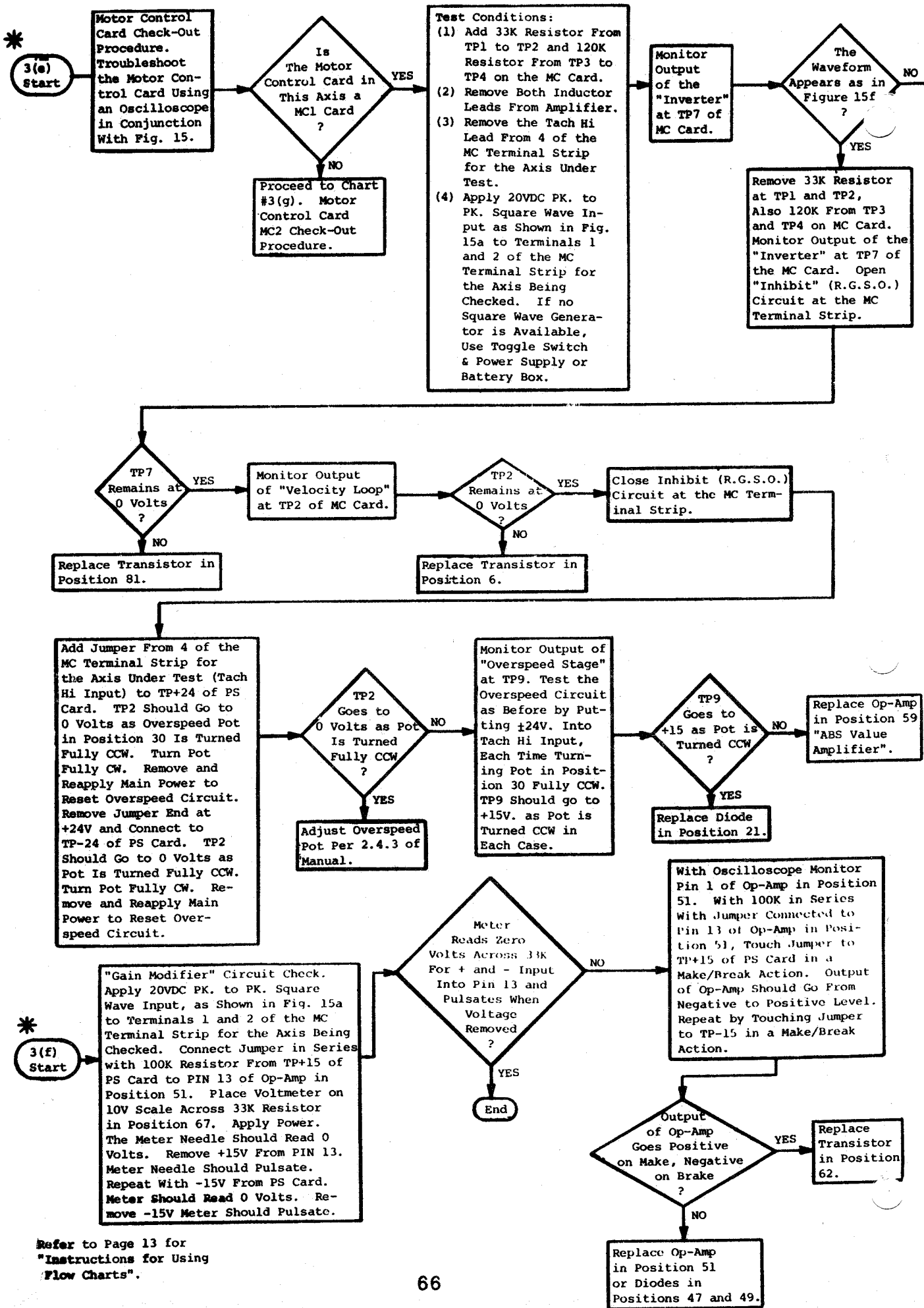


\* Refer to Page 13 for "Instructions for Using Flow Charts".



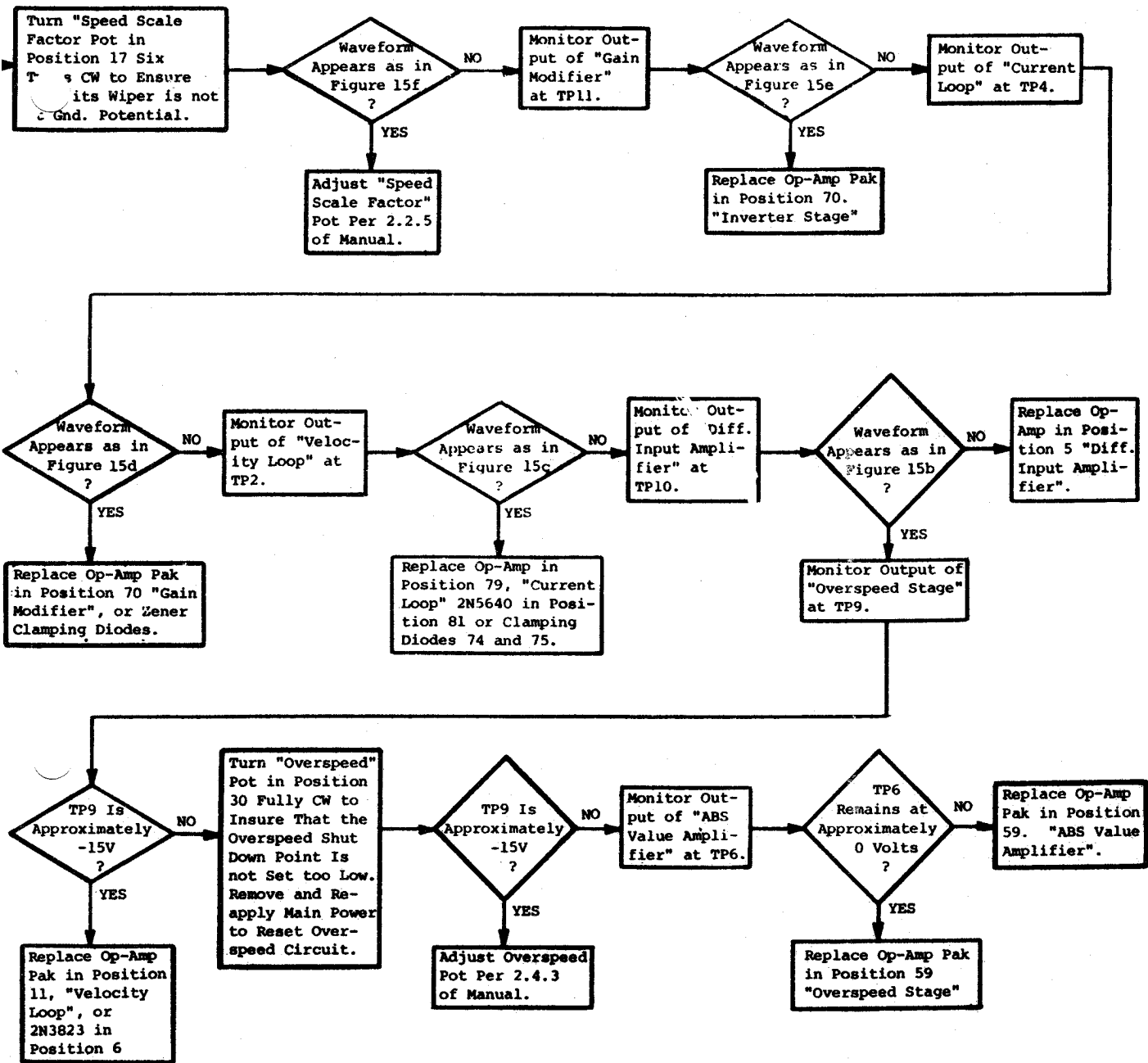
\*\*Dynamic Brake Circuitry may not be Included on Some INTLK Cards.



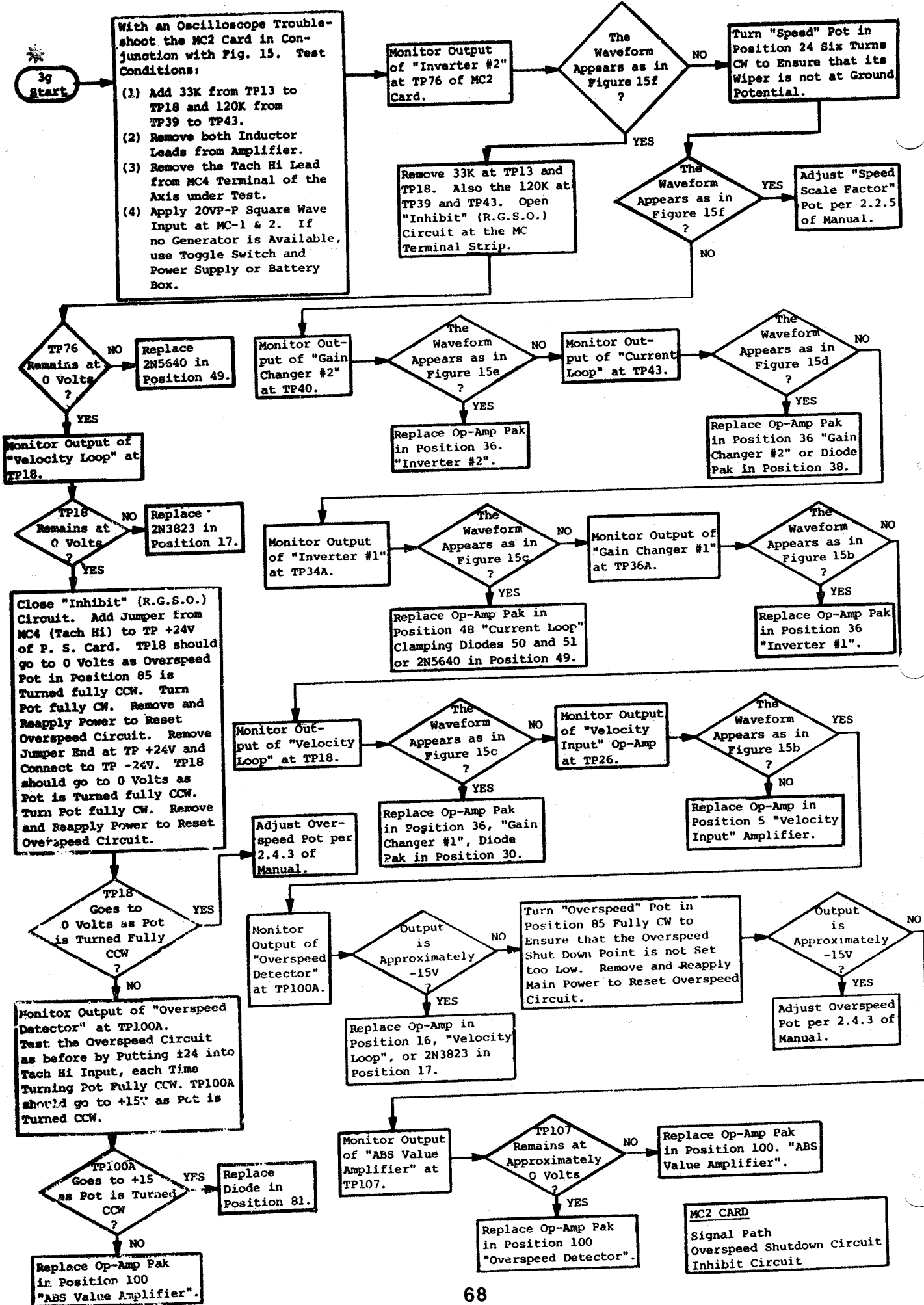


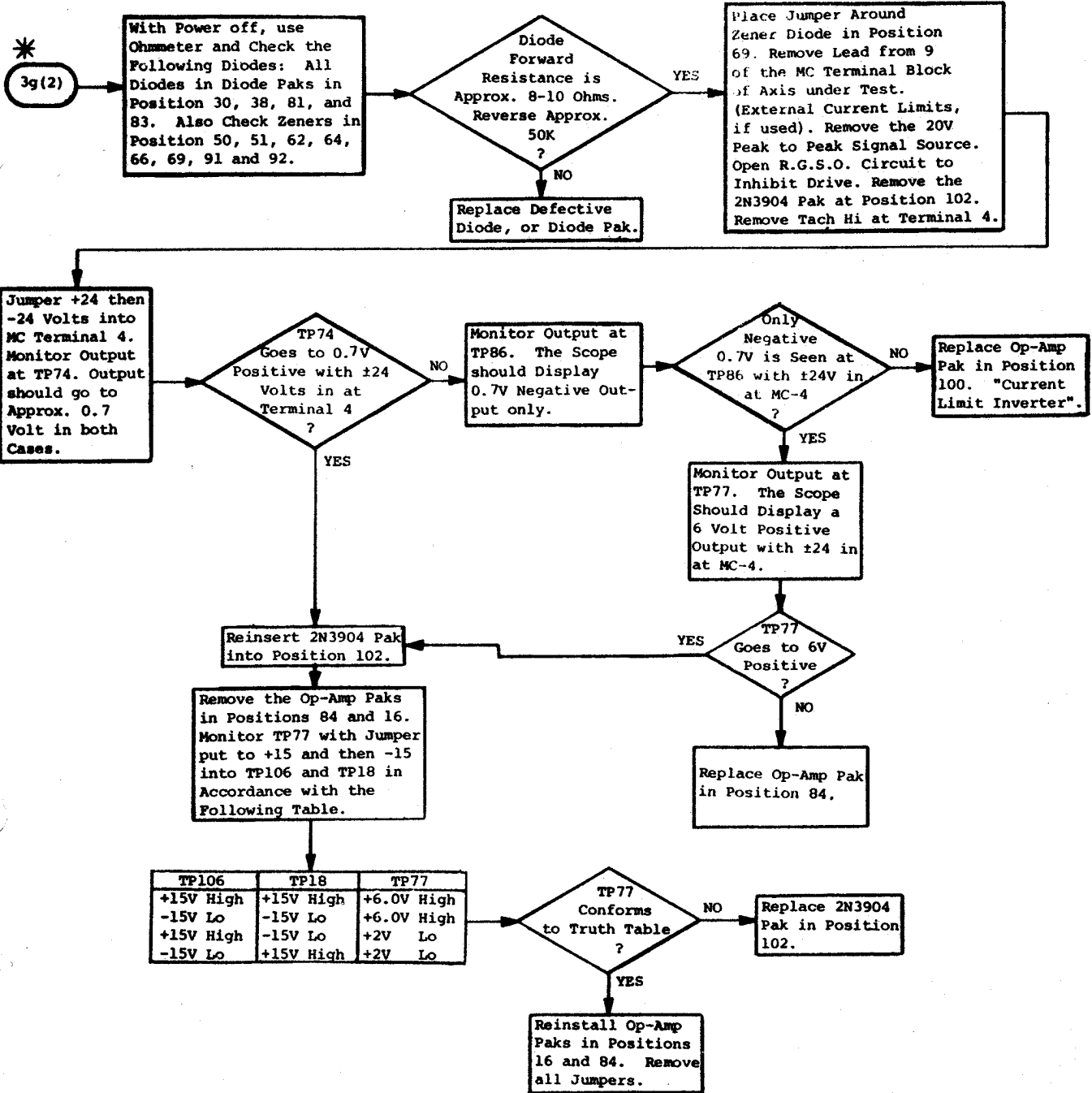
Refer to Page 13 for "Instructions for Using Flow Charts".





Control Section  
Chart #3  
Sheet 2 of 3





MC2 CARD  
Current Limit Circuit

Control Section  
Chart #3  
Sheet 3 of 3

\*Refer to Page 13 for Instruction for using Flow Charts

