Installation and Service Manual

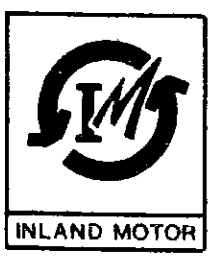
Six (6) Phase SCR Servo Amplifier
HPA Series

M-8004 - Issue 5

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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NOTICE:

UPON RECEIPT OF THE AMPLIFIER, CLOSELY INSPECT THE COMPONENTS TO INSURE THAT NO DAMAGE HAS OCCURRED IN SHIPMENT. IF DAMAGE HAS OCCURRED, NOTIFY THE APPROPRIATE CARRIER AT ONCE.

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This Service and Installation Manual is a general document and is applicable to the entire HPA product line. However, since these amplifiers are married to motors of varying sizes with different operating characteristics such as internal resistance, inductance, rotor inertia, etc. the complete model numbers of these amplifiers will vary more or less with the motors to which they are married. Thus, after the amplifier is mated with a particular motor, along with the inductor and a six-phase secondary power transformer, to form a complete servo system, the model number applied to the amplifier nameplate is in reality the model number for the system.

The Test Limits and Modification Sheet (TL) is a specific document and is applicable only to individual systems. The TL Sheet contains such information as peak current limits, bias current setting, maximum operating speed and the motor control compensation values which make a particular motor compatible with the amplifier.

The TL Sheet will be found in the inside pocket of the front cover of the Manual shipped with each amplifier.

MODEL NUMBER SYSTEM

HPA - "A""B" - "C""D" - "E""F"

HPA0X - "A""B" or "C""D" - "E""F"

HPA	Six-Phase Amplifier (without Option Card)
HPA0X	Six-Phase Amplifier with Option Card (X = 1 for OPT 1, etc.)
A - 15	Secondary Line to Neutral Voltage
B - 40, 85, 100	Continuous Current Rating
C - 5, 6	50Hz or 60Hz Rating
D - 01	Standard Model Number
E -	Motor and Winding
F -	Compensation Number

1.0 DESCRIPTION

The Inland Motor HPA series are six-phase, half-wave, four-quadrant, fully regenerative SCR "Rate Loop" servo amplifiers.

Except for minor component changes on the Motor Control Card, the basic modules of these amplifiers are interchangeable. (The Power Supply Card will change from system to system depending on secondary line voltage from the three-phase isolation power transformer (120 V.A.C. Line to Neutral), (138 V.A.C. Line to Neutral) or (158 V.A.C. Line to Neutral).

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

Modular construction and the liberal use of test points assure easy 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. The choice of six-phase star instead of three-phase full-wave allows for the elimination of "lock-out" (deadband or transport lag at null). No vibration at null is produced as the quiescent (bias) current circulates through the inductor and not the motor armature circuit.

Other features are:

- Fail-Safe Dynamic Braking (Patent No. 3786329)
- Programmable Torque
- Overspeed Protection
- Not Sensitive to Line Phasing
- Horsepower-Based Current Limiting
- "Drive-Up" Indication
- Motor Current Monitor Output
- Option Card - See Appendices

1.1 Amplifier Inputs and Modes of Operation (Refer to the Appropriate Sys. Wiring Dia.)

The Velocity Input Signal (not to exceed ± 10 volts) is applied to the amplifier at TB1-1 with respect to TB1-2.

TB1-3, 10, 20, and 27 are all used to provide adequate points for Signal Grounds without overloading terminal block screws.

The Tach feedback voltage is connected to TB1-4 with respect to TB1-5.

The Torque Hold mode of operation can be utilized when the motor is required to dwell against hard stops or operate in a tension control system. Closing a set of contacts between TB1-6 and 7 will convert the amplifier from a constant velocity to a constant torque system.

The Current Monitor waveform may be observed at TB1-8. There is a direct relationship between this waveform and the actual motor current. A D.C. voltmeter placed between TB1-8 and TB1-10 and calibrated in either current or lb.ft can serve as a means by which the constant load levels placed on the motor may be monitored.

The scale factor at TB1-8 is 12.5 amps/volt unless specified otherwise by the TL Sheet for the system.

The External Current Limit Control may be utilized, when external control of motor torque is desired, by closing a set of contacts from TB1-9 to TB1-10, provided a simple modification is made to the MC 2 Motor Control Card. (Check the TL Sheet for the system).

The "Drive-Up" contacts are provided at TB1-11 and 12, and when closed, is an indication to the outside world (software, etc.) that the servo amplifier is in its Drive-Up mode; or, when open is an indication that it is in its Inhibit mode.

The Loop Cage Input provides a means by which the amplifier may be caged (torque limited to zero) by closing a set of contacts between TB1-13 and TB1-19 (+15V) or if desired, a +15 volt level may be applied to TB1-13 from some optional source (software, etc.).

The Motor Volts Input at TB1-15 is the connection point for the motor back E.M.F., which is used in conjunction with the tach feedback to initiate an optional overspeed shutdown function. This will automatically shut the system down in the event the motor reaches an excessive speed due to loss of tach feedback, shorted tach feedback, reversed tach hook-up, or if an excessive speed is commanded. The Tach Loss circuit is located on one of the option cards (see Appendices).

The ±15 Volt Outputs (TB1-19, 28) may be used to provide an input control signal for the amplifier. Drawing A-78758 in the back of this manual is one method by which this may be achieved.

The Inhibit allows a means by which the amplifier may be disabled without removing the main power. When a set of contacts is closed between TB1-29 and

30, the amplifier will be put in the "Drive-Up" mode. Opening the contacts will Inhibit the amplifier.

1.2 Simplified Theory of Operation (Refer to System Block Diagram A-78759)

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 nine (9) basic modules as shown in the System Block Diagram A-78759.

1. Motor Control (MC 2) Card
2. Pulse Generator (PG 1) Card
3. Ramp Generator (RG 1) Card
4. Interlock & Brake (INTLK 2) Card
5. Power Supply (PS 2) Card
6. Option Card
7. Suppression Card
8. SCR Paks
9. Mother Board (MB 1) HPA Containing Items 1-6.

The Motor Control Card incorporates the necessary circuitry to provide the Rate (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.

Horsepower based 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.

The Overspeed circuit monitors the speed of the motor and inhibits the Rate Loop when this speed becomes excessive and indicates this condition by illuminating an "Overspeed Fault" LED located on both the Motor Control and Interlock cards.

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 level 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 ramp signal based on line zero crossover allowing the Pulse Generator Card to produce pulse trains to control the SCR firing angles.

The Interlock & Brake Card monitors the line voltage and shuts off the firing pulses upon loss of any line input phase, delays turn-on until transients have settled at start-up, performs the "Inhibit" function, and provides a contact opening for external indication that the HPA amplifier is in its Inhibit or Drive-Up mode. This card also contains the Fail-Safe Dynamic Brake, which in the event of the loss of prime power applies pulses to the SCRs, dynamically braking the motor to an emergency stop.

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

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

The SCR Paks, in conjunction with the suppression cards, form the power stage. Each SCR pak contains two SCRS - one "forward" and one "reverse". Current is generated into the motor as each SCR is "gated" on by the Pulse Generator Cards.

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

2.0 INSTALLATION

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

2.1 Wiring (Refer to the Appropriate System Wiring Diagram)

NOTE: Improper wiring will result in fuse blowing or possible damage. Observe the following precautions:

(1) Twist all A.C. leads to minimize electromagnetic emission and pickup.

(2) Avoid running signal leads in close proximity to power leads, armature leads, or other sources of electromagnetic noise.

(3) Minimize lead lengths as much as practical.

(4) Double-check all wiring. Carefully inspect all connections.

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 time to stop. In a normal application the motor should stop within 0.200 to 0.300 seconds. Under no circumstances should the contactor be allowed to chatter, especially while the motor is running, or Dynamic Brake circuitry may cause fuse or circuit breaker operation.

3.0 PRELIMINARY CHECKS (Refer to the Appropriate System Wiring Diagram)

Once the Inland HPA system has been installed, the initial start-up should be made with the motor load and control command disconnected. The following equipment will be required:

(1) Adjustable signal source 0 - ±10VDC @ 10ma (±15VDC is available from TB1-19 and 28 on the amplifier.

(2) Volt-Ohmmeter (Simpson or Triplett, etc.)

(3) Dual Trace Oscilloscope.

3.1 The Six-Phase Power Transformer Hook-Up

Before applying power do the following:

(1) Open the power circuit of the six-phase isolation transformer secondary by removing the fuses or opening the circuit breaker.

(2) Check the model number on the nameplate of the amplifier to determine what the input line voltage (RMS) should be:

Model No.	Line to Neutral	Line to Line	Line to Line	Line to Line
	A-N, B-N, C-N, $\bar{A}$-N, $\bar{B}$-N, $\bar{C}$-N	A-B-C	$\bar{A}$-$\bar{B}$-$\bar{C}$	A-$\bar{A}$, B-$\bar{B}$, C-$\bar{C}$
HPA-158	158V	275	275	317
HPA-138	138V	240	240	277
HPA-120	120V	208	208	240

Apply power and check the secondary line voltage in accordance with the above table. After it has been determined the line voltage is correct remove the primary power and replace the fuses or reset the circuit breaker in the transformer secondary.

3.2 The Motor and Tachometer Hook-Up

Important: To avoid runaway the Motor and Tach must be phased properly.

Before applying power to the amplifier make the following servo polarity check. With a voltmeter on a sensitive VDC scale (3 volts or so), place the positive lead of the voltmeter on the motor armature lead at the center tap of the inductor. Place the common lead of the voltmeter at PO1-Common. Have an assistant rotate the motor shaft and note the direction of meter needle deflection. Place the positive voltmeter lead on terminal TB1-4, leaving the common lead of the meter at PO1-Common. Have the assistant rotate the motor shaft again in the same direction. The meter should now deflect in the opposite direction from the previous step. If not, reverse the tach leads at TB1-4 and 5.

4.0 POWER APPLICATION

Before applying power to the amplifier, it is advisable to have the load disconnected from the motor shaft and the command input wires to TB1-1 and 2 removed. Connect the D.C. signal source from TB1-1 with respect to TB1-2. (If the external ±15VDC at TB1-19 and 28 is used as the signal source, a circuit similar to the one shown in drawing A-78758 in the back of this manual may be necessary. Also, temporarily disable the Position Loop Control to prevent automatic shutdown.

Place one channel of a dual-trace oscilloscope to TP106 of the MC 2 Card to monitor the tach feedback voltage. Place the second channel of the oscilloscope on TP75 of the same card to monitor the motor current. (Refer to Figure 12 for typical waveforms and the TL Sheet for peak current magnitudes, etc.). Apply the main power. Close the connection to the "Inhibit" terminals at TB1-29 and 30, being ready to switch off the main power if runaway occurs. If the motor sits still and the results to this point are satisfactory, proceed.

Using the D.C. signal source, and starting with a small signal, apply a command to the input of the amplifier at TB1-1 and 2. Run the motor in both directions while observing the waveforms on the oscilloscope. Also, have an assistant observe the operation of the motor if possible. The motor should accelerate and decelerate with a quick crisp response and run with constant speed for any given signal level. Do not run the motor in excess of the maximum speed specified by the TL Sheet for the system. Remove power.

4.1 Connecting the N/C or C/N/C

Remove the D.C. signal source. Remove any jumper at TB1-2 and 3 if installed as in drawing A-78758.

Connect the load to the motor shaft.

CAUTION: Incorrect servo to position loop 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. As an added precaution a 47K ohm resistor may be connected in series with the N/C or C/N/C output and TB1-1.

Apply power and observe the action of the machine. In most cases, if the phasing is incorrect the motor may either oscillate and produce large excursions or appear to runaway. The 47K ohm resistor will insure that if a runaway occurs the speed will not reach dangerous levels.

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

After the phasing of the system is determined to be correct, the 47K resistor may be removed and the N/C or C/N/C connected directly to TB1-1.

For adjustment of the Speed Scale Factor refer to Section 5.1.

4.2 Connecting a Manually Operated Machine

Should the system be used on a manually operated machine, (not in position loop) some form of D.C. input signal will be required. Drawing A-78758 in the back of this manual illustrates one method of doing this.

The ±15VDC supply in the Inland amplifier can be utilized to supply ±15VDC 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 output does not exceed 15VDC and its common is connected to one of the shield common points on TB1 of the amplifier. The input circuit should appear similar to that shown in A-78758. The connections made to the right side of the DIR relay contacts should go to the ±15VDC external power supply rather than to the internal supply.

This system will operate as follows: Apply power and energize the RUN relay to close "Inhibit". If FEED #1 relay is energized, the system will run at a rate set by the FEED #1 Speed Potentiometer, in a direction determined by the DIR relay, until the FEED #1 relay is de-energized. FEED #2 operates in a similar manner. Rapid traverse speed is selected by energizing the TRAV relay, and is set by the TRAV Speed Potentiometer.

For adjustment of the Speed Scale Factor pot on the MC 2 Card refer to Section 5.2.

5.0 ADJUSTMENTS (Refer to Figures 1, 6, 8, and 10)

With exception of the Speed Scale Factor adjustment (SPEED) all adjustments are factory set and sealed and should never require adjustment. The following procedures are given only in the event of component or card replacement or in the event the seals are unintentionally broken. Reseal all pots after adjustment.

5.1 Speed Scale Factor Adjustment, Position Loop Machines (Refer to Figures 1 or 6)

Monitor TB1-1 with respect to TB1-2 with a digital voltmeter. Command maximum traverse speed from the N/C or C/N/C. Adjust the SPEED pot on the MC 2 card to obtain the voltage level which the control normally delivers at maximum traverse speed. (Consult N/C or C/N/C manufacturer for output delivered at maximum traverse speed).

If the following error is displayed by way of readout, adjust the SPEED pot on the MC 2 card for the proper amount of following error. (Consult N/C or C/N/C manufacturer).

5.2 Speed Scale Factor Adjustment, Manually Controlled Machines, (Refer to Figures 1 or 6)

Monitor TB1-1 with respect to TB1-2 with a digital voltmeter. Apply command signal of proper voltage level (4 to 10 volts) which represents maximum traverse speed. Adjust the SPEED pot on MC 2 card for maximum traverse speed.

If it is desired that some input voltage level (4 to 10 volts) represent a maximum speed of the motor in RPM (not to exceed its maximum speed) do the following:

(1) Compute the necessary tachometer voltage at the desired speed as follows:

Desired Tach Voltage = (Desired Speed in RPM) (Tach Sensitivity, $\frac{\text{Volts}}{\text{RPM}}$), where Tach Sensitivity = Speed Scale Factor of Tach. (Check nameplate of motor).

Example:

Desired Tach Voltage = (2000 RPM) (0.0189 $\frac{\text{Volts}}{\text{RPM}}$) = 38 Volts.

(2) Apply command signal of desired voltage level, which represents maximum speed, to TB1-1 and 2. Adjust SPEED pot on MC 2 card for desired tach feedback as monitored at TP106 on MC 2 card. In the example above the tach feedback should be 38 volts when the motor runs at the speed of 2000 RPM.

5.3 Zero Adjustment (Refer to Figures 1 or 6)

Remove power. Remove the command input lead at TB1-1. Jumper TB1-1 to 2. Connect a voltmeter on a sensitive volts D.C. scale from TP75 on the MC 2 card to TP "Common". Apply power, close "Inhibit" and adjust ZERO pot on the MC 2 card for 0 VDC on the voltmeter. Remove power, remove jumper from TB1-1 to 2, reconnect command input lead to TB1-1.

5.4 Bias Adjustment (Refer to Figures 1 or 8)

The Bias Adjustment is made via 3 phase ramp trim pots in component locations 8, 34, and 60 on the Ramp Generator Card (RG 1).

Remove power. Inhibit amplifier by placing a jumper from TB1-13 to TB1-19. Place a clip-on RMS ammeter around one of the outside Inductor leads (not the motor armature lead).

Place a jumper from TP7 to TP8. Place a jumper from TP13 to TP14. These test points are located on the upper edge of the Ramp Generator Card (RG 1).

Apply power. Close the "Inhibit" contacts. Adjust the pot in component location 8 until 2 amps are read on the clip-on RMS ammeter. Remove power. Remove jumper from TP7 to TP8.

Place jumper from TP1 to TP2. Apply power. Adjust the center pot in component location 34 until 2 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 pot in component location 60 until 2 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.

Remove power. Remove clip-on ammeter and jumper at TB1-13 to TB1-19.

5.5 Overspeed Adjustment (Refer to Figures 1 or 6)

Turn the Overspeed Adjustment pot OVSPD on the MC 2 card fully CW. Command maximum speed. Turn the OVSPD pot CCW until the system just shuts down or until the Overspeed fault LED's on the MC 2 and INTLK 2 cards just come on. Turn the OVSPD pot back 1/2 turn CW.

Remove and reapply the main power to reset the Overspeed circuit.

5.6 Power Supply Adjustments (Refer to Figures 1 or 10)

With a digital D.C. voltmeter monitor TP33 (+15V) on the Power Supply (PS 2) Card with respect to TP-GND. Adjust the POS ADJ pot in position 29 for +15 volts ±0.1 volt.

Monitor TP20 (-15V). Adjust the NEG ADJ pot in position 22 for -15 volts ±0.1 volt.

NOTE: THIS ADJUSTMENT MAY AFFECT OTHER ADJUSTMENT SETTINGS.

5.7 External Current Limit Adjustment (Refer to Figures 1 or 6)

When the optional External Current Limit Control circuit is utilized (by closing contacts between terminals TB1-9 and -10) the pot in component location 42 on the MC 2 card may be adjusted to give a desired continuous torque limit.

Monitor TP75 on the MC 2 card with an oscilloscope. Close the external current limit contacts. Accelerate and decelerate the motor to some medium speed level. Adjust the pot in position 42 on the MC 2 card for current peaks specified on the TL Sheet for the system for External Current Limit.

The scale factor at TP75 is 100 amps/volt.

6.0 TROUBLESHOOTING

A. Waveforms

Typical waveforms of a properly operating system are shown in the back of this manual for reference and troubleshooting purposes.

B. 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 out edge of the card.

C. Special Equipment

An EM6-01 card extender may be helpful in 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.

D. Troubleshooting Charts

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

I. There are three (3) distinct areas given in the charts where a fault may occur. They are:

(1) External Interface, Amplifier Vitals (Chart #1)

(2) Power Stage (Chart #2)

(3) Control Section Card Level (Chart #3)

II. There are two (2) basic fault characteristics given in the charts. They are:

(1) Amplifier Inoperative

(2) Erratic or Improper Operation of Amplifier

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

(1) Please use caution when troubleshooting this servo system.

(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 2 (Power Supply) Card first. Proceed then to Chart 3b and troubleshoot the INTLK 2 (Interlock & Brake) Card. These two cards contain the "circuit vitals" for the drive-up mode. Next, go to Charts 3c and 3d and check motor current and operation of the PG 1 (Pulse Generator) and RG 1 (Ramp Generator) Cards.

These two cards produce the waveforms for phase-angle control. Lastly, proceed to Charts 3e and 3f to troubleshoot the MC 2 (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 trouble-shooting procedure again to insure that multiple problems do not exist in the circuitry.

7.0 OPTION CARDS

The Option Cards, when used, are inserted into the MB1 HPA(OX) mother board at the card receptacle marked "Option Card". Normally this card receptacle will be absent from the standard amplifier.

Option Cards consist of separate and independent circuits which provide additional functions for diverse applications and are brought into existence as the need for them arises.

These cards and their functions are described in the Appendices' section of this manual.

8.0 RECOMMENDED SPARE PARTS LIST

NOTE: Please provide complete amplifier model number when ordering spare parts.

QTY. USED PER: HPA		QTY. RECOMM. FOR SPARE		DESCRIPTION	
				PC CARDS	
	1		1*	Motor Control	MC 2
	2		1	Pulse Generator	PG 1
	1		1	Ramp Generator	RG 1
	1		1	Interlock	INTLK 2
	1		1**	Power Supply	PS 2
	2		1	Suppression	SUP 2 or SUP 3
	1		1	Mother Board	(MB 1) HPA(OX)
When Used	1	If Used	1***	Option Card	(See Test Limit Sheet for Model No).
				MAIN ASSEMBLY	
	6		10	Fuses (See Test Limit Sheet for Proper Fuse Size).	
	6		3	SCR Paks A-78490	
	1		1	Overload Relay with Heater. (See Test Limit Sheet for Proper Value of Overload Relay & Heater).	
	1		1	Current Sensing Resistor: A-78297 .01 ohm, 5%, 100 Watt	
	2		1	Cable Garry P14D36, Samtec CP-14-D-36T	

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

**Power Supply Cards vary with 3Ø power transformer secondary voltage.

***Option Cards may vary from system to system.

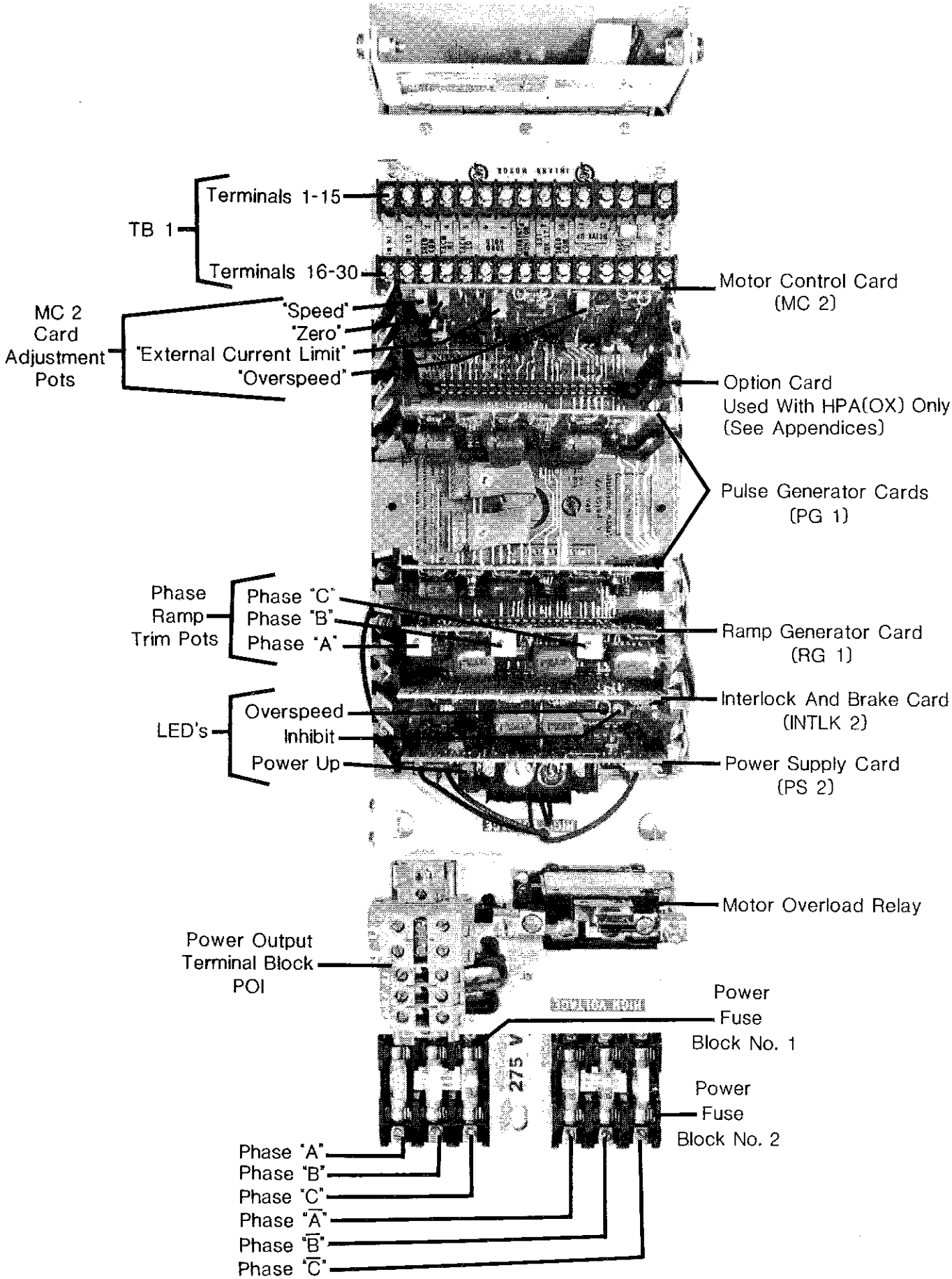


FIGURE 1
HPA(OX) AMPLIFIER

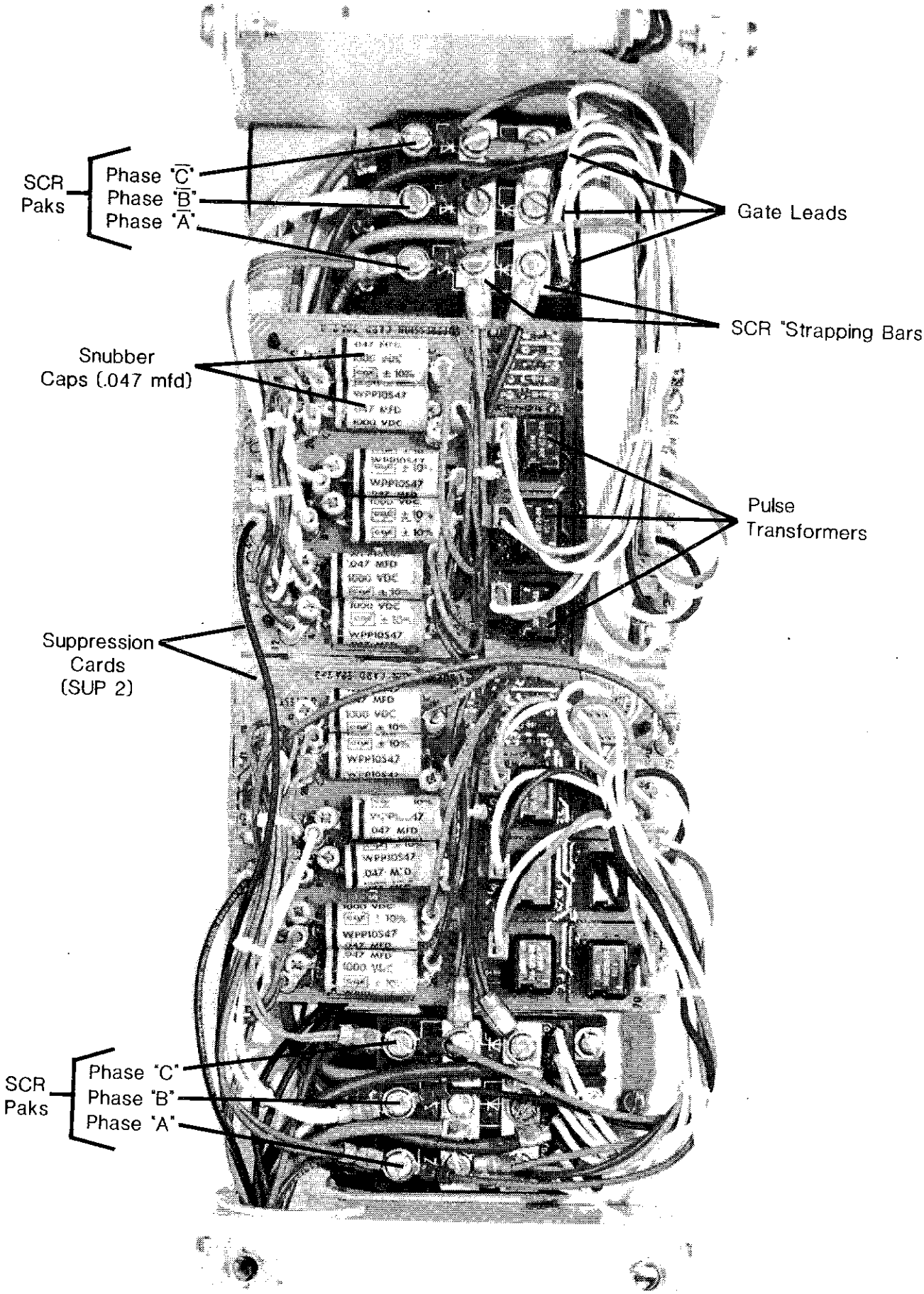


FIGURE 2
HPA (OX) AMPLIFIER (OPEN, SHOWING POWER SECTION)

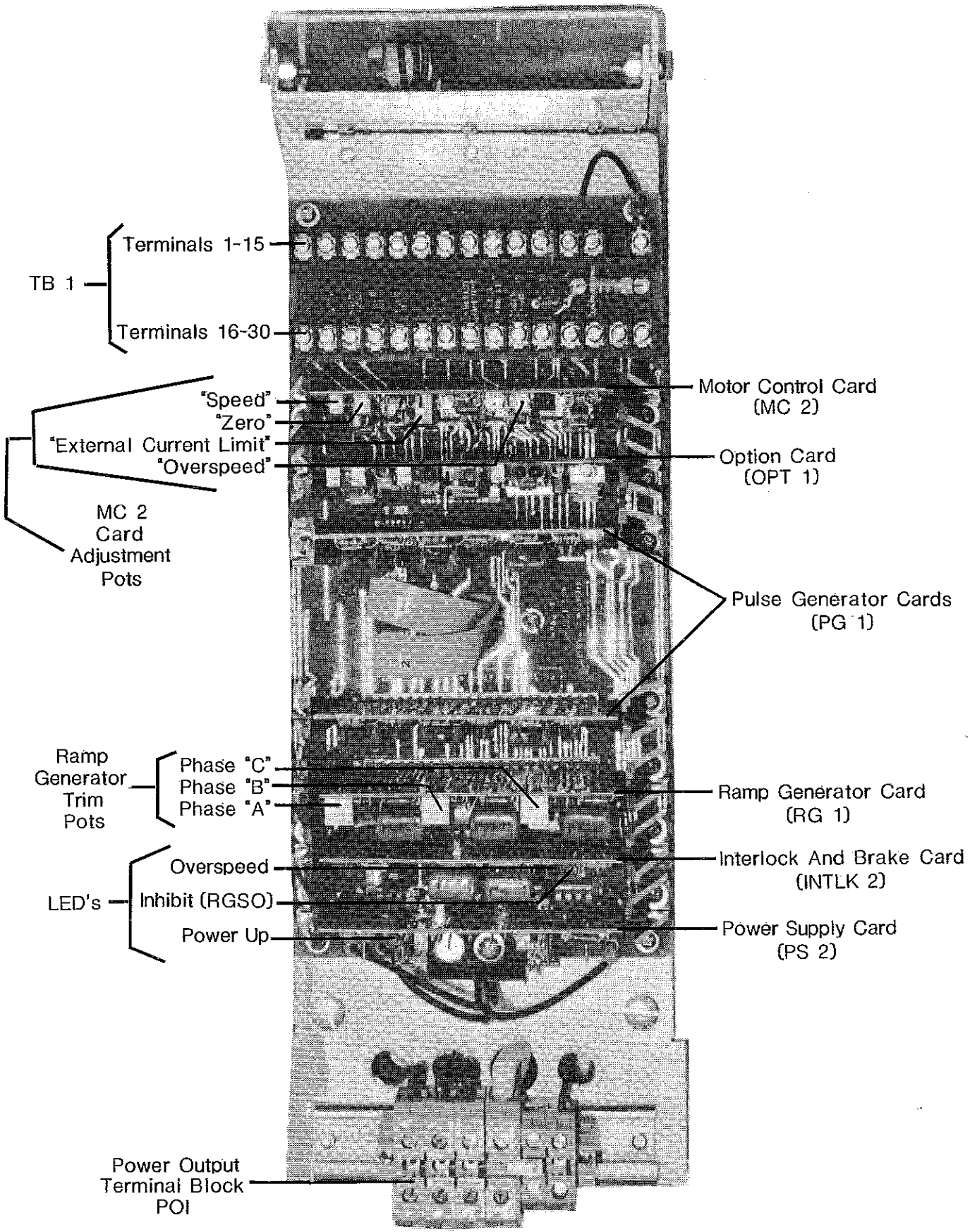


FIGURE 3

HPA01-(X12, X13) AMPLIFIER

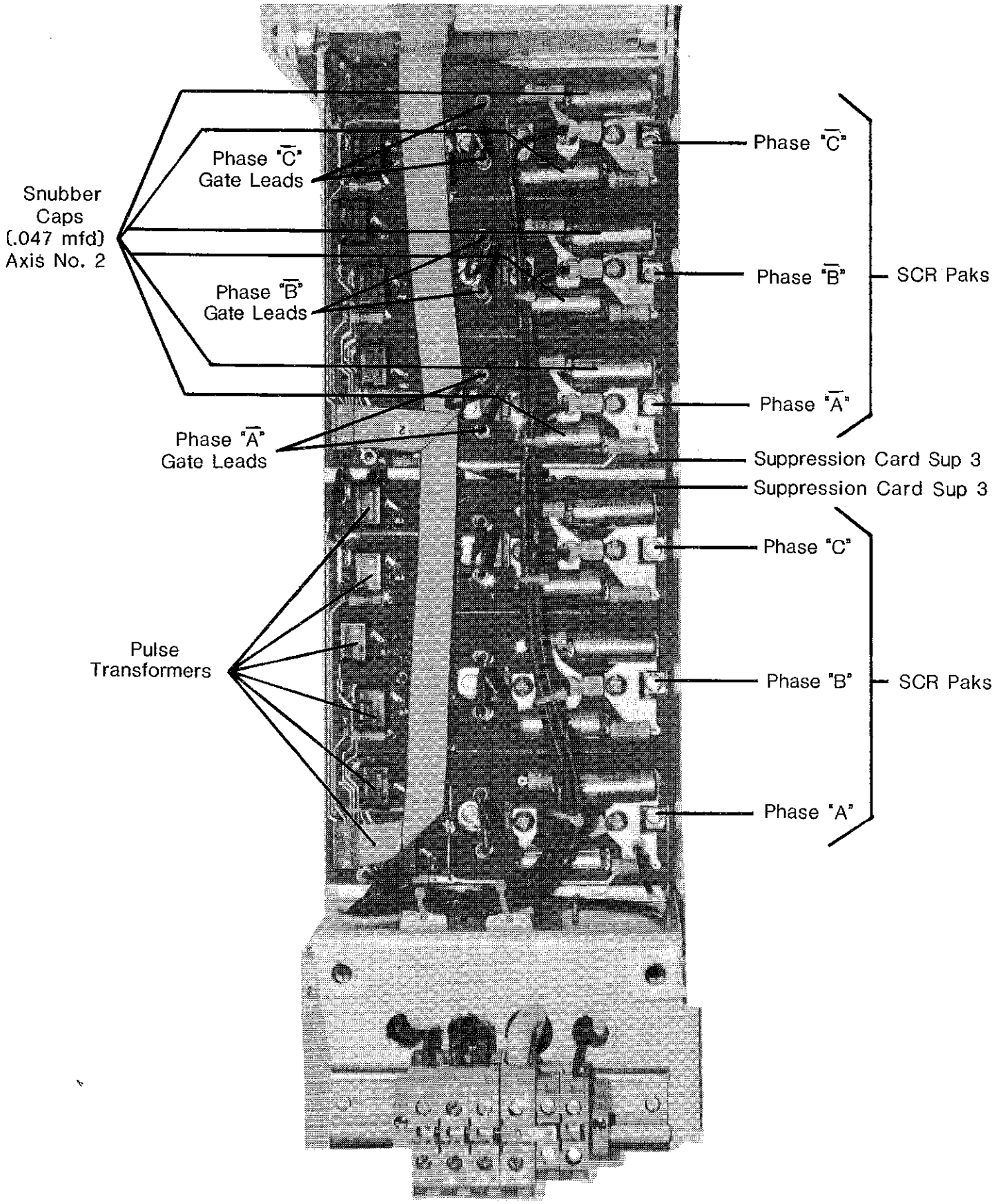


FIGURE 4

HPA01-(X12, X13) AMPLIFIER
(Open, Showing Power Section)

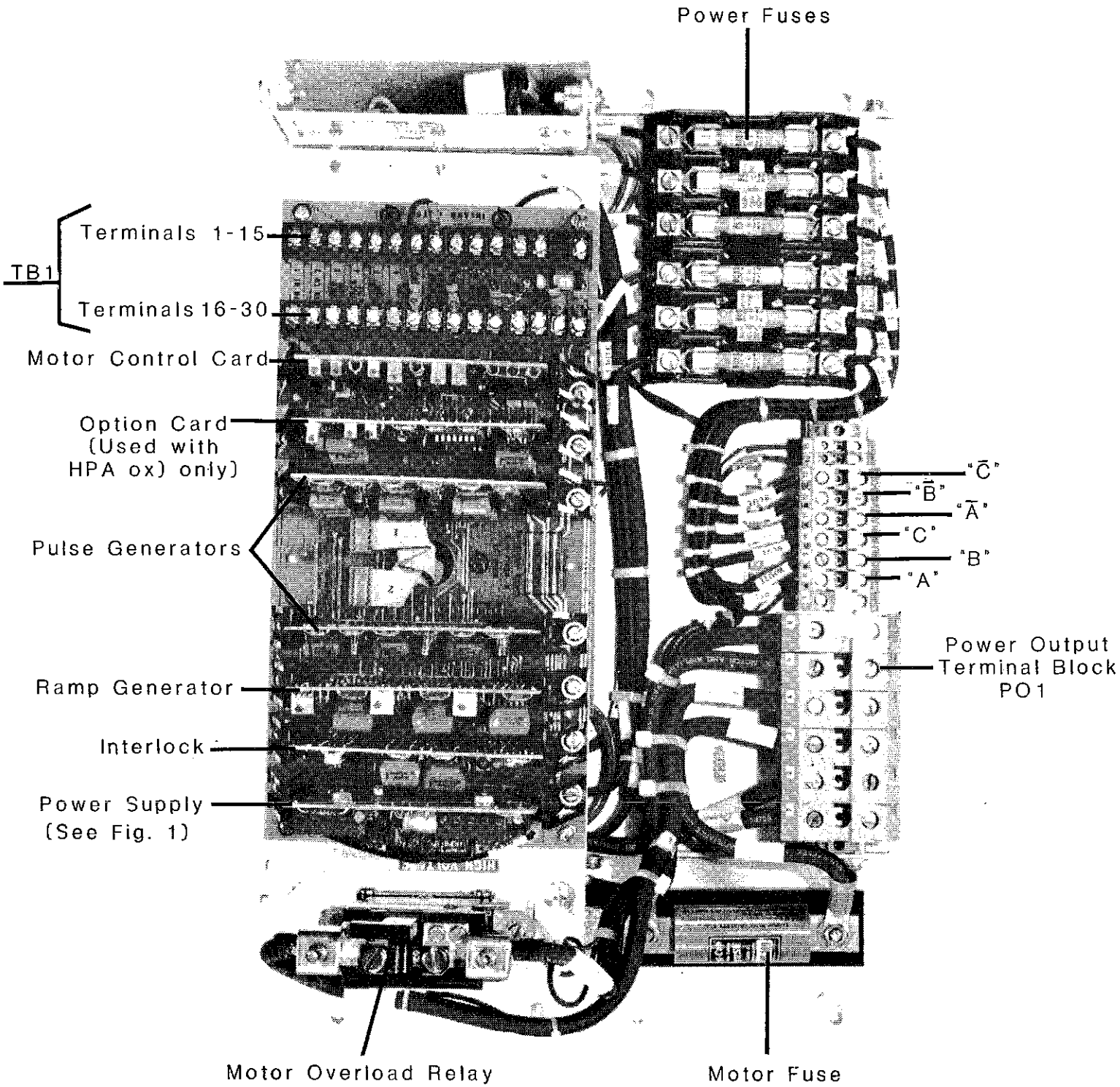


FIGURE 5
HPA OX/100 AMPLIFIER

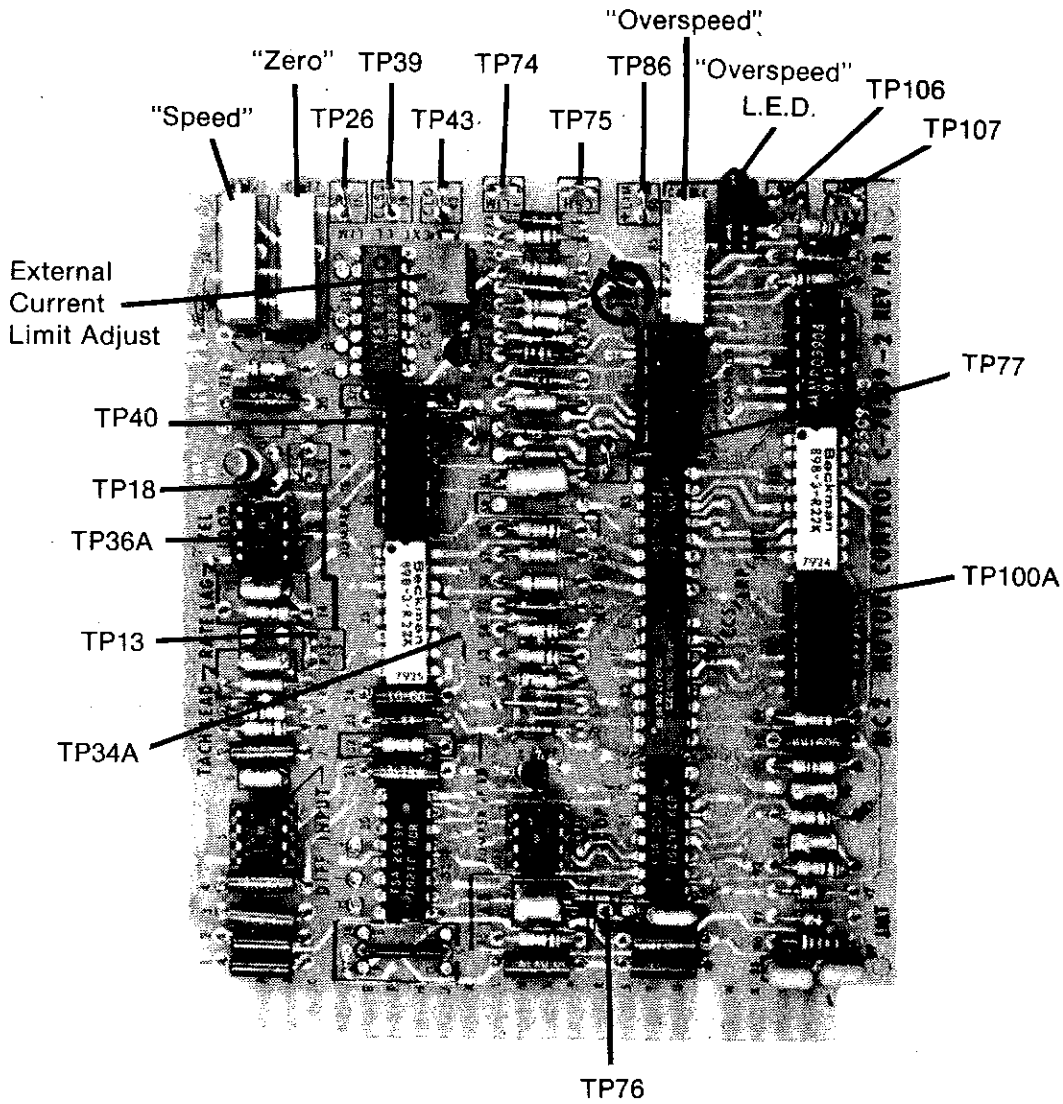


FIGURE 6
MOTOR CONTROL CARD (MC 2)

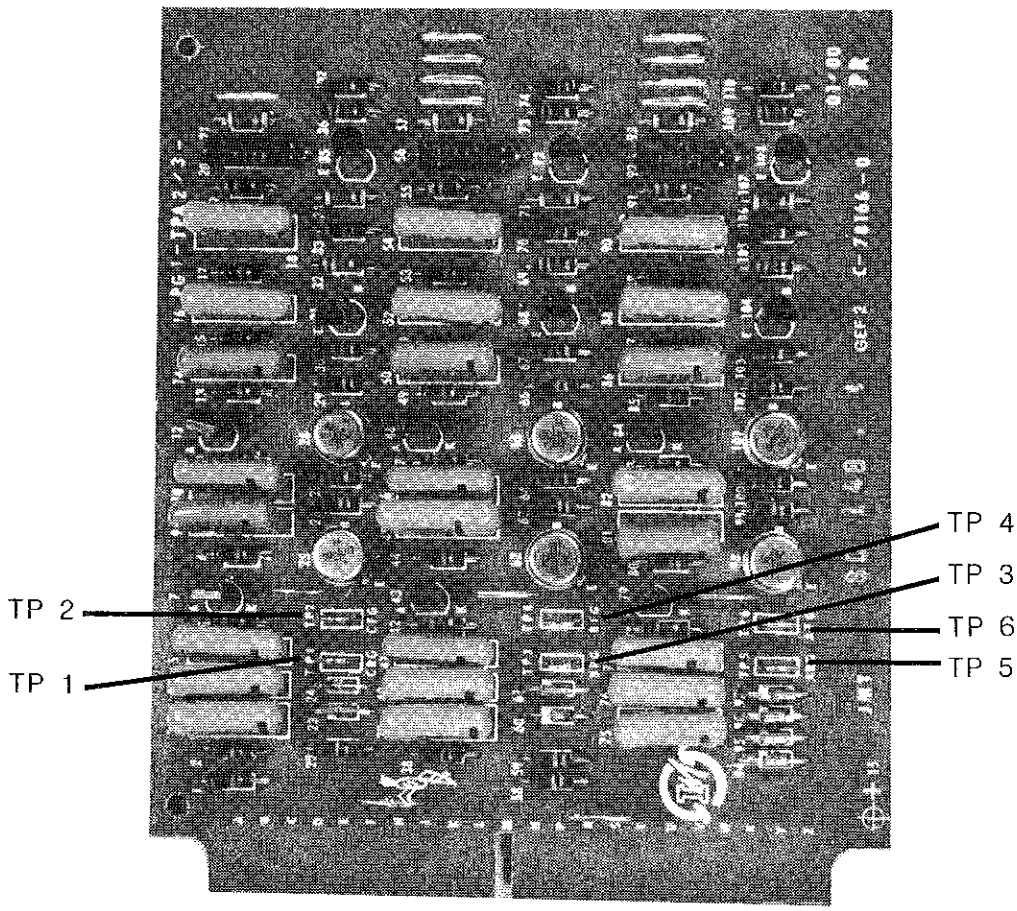


FIGURE 7
PULSE GENERATOR CARD (PG 1)

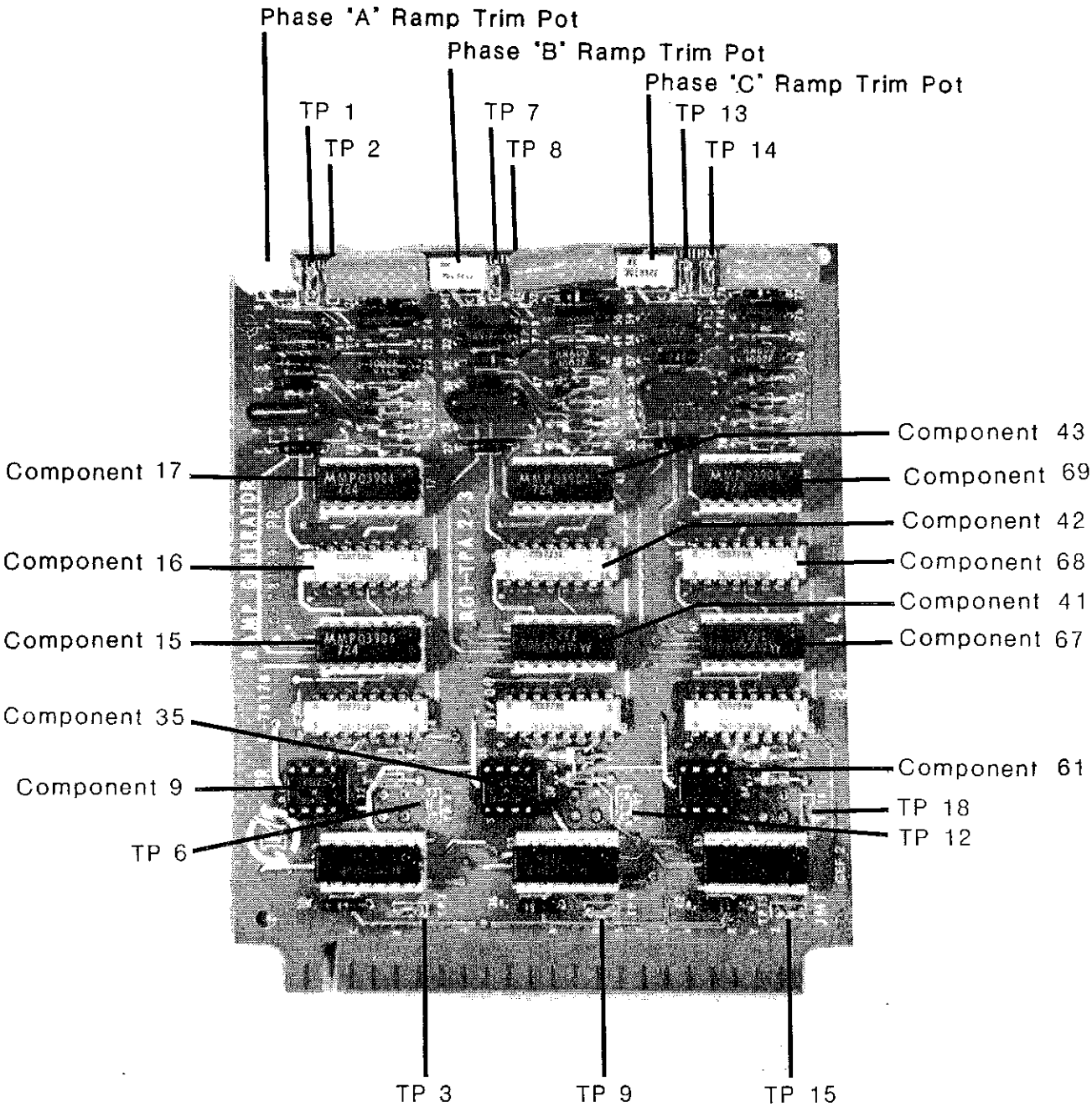


FIGURE 8

RAMP GENERATOR (RG 1)

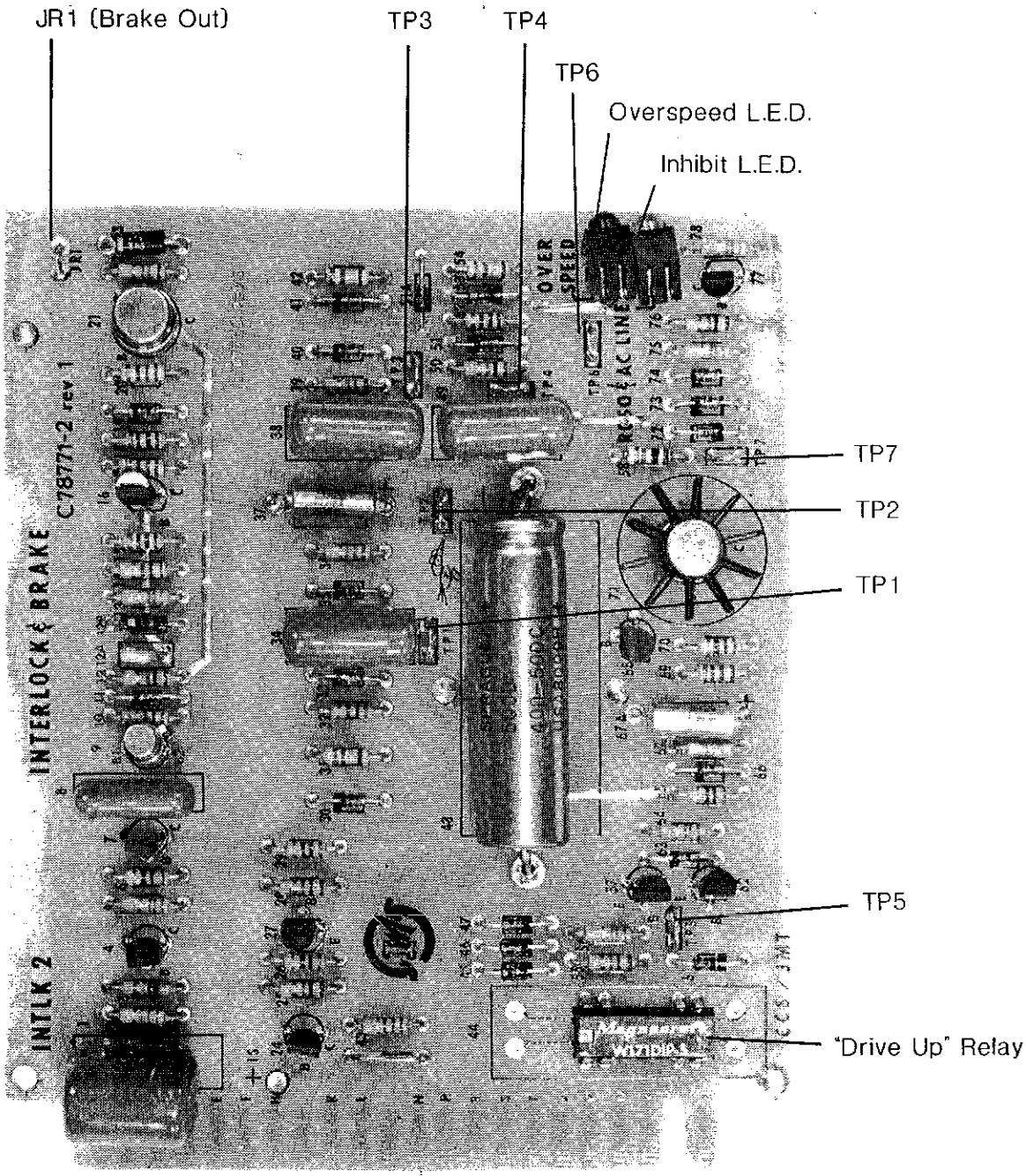


FIGURE 9
INTERLOCK AND BRAKE CARD
(INTLK 2)

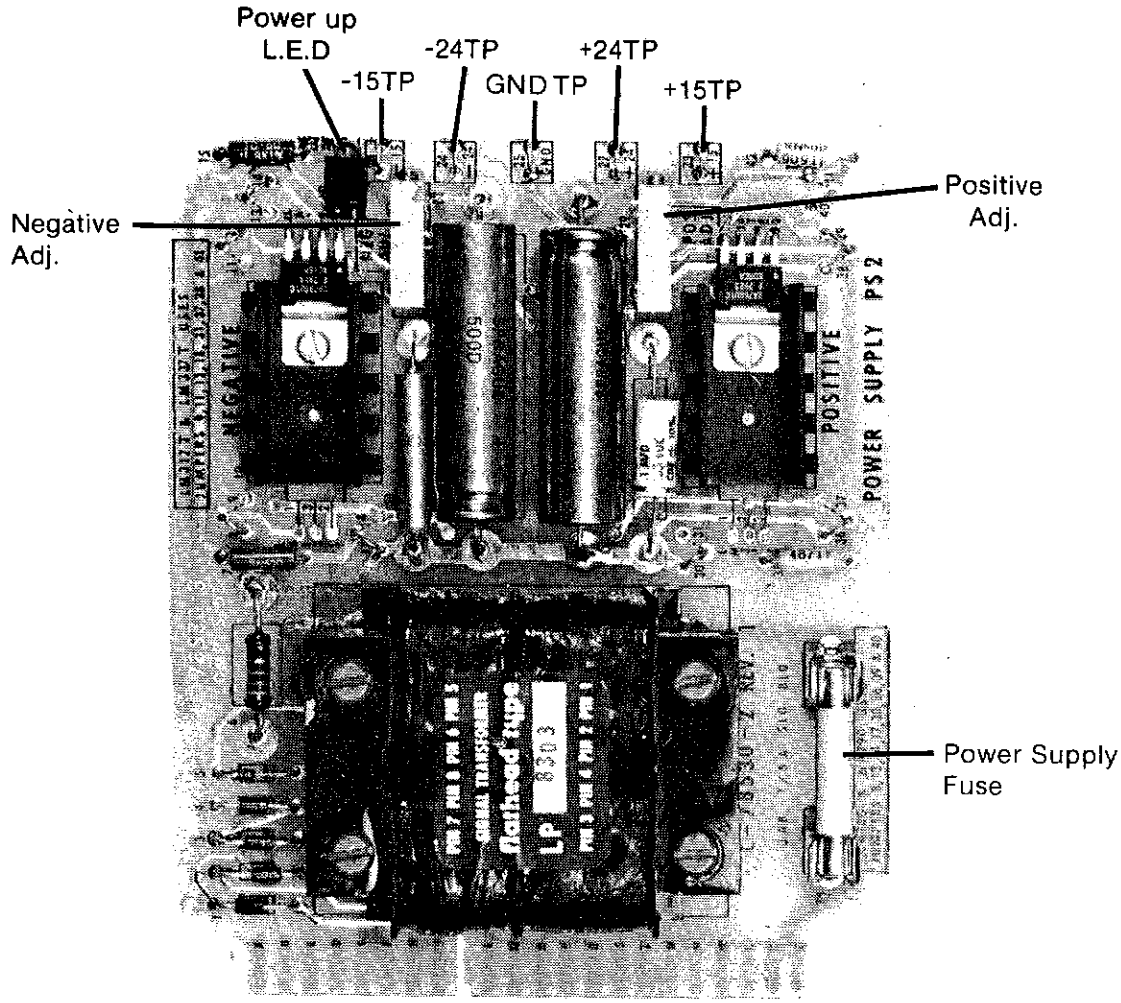


FIGURE 10
POWER SUPPLY CARD (PS 2)

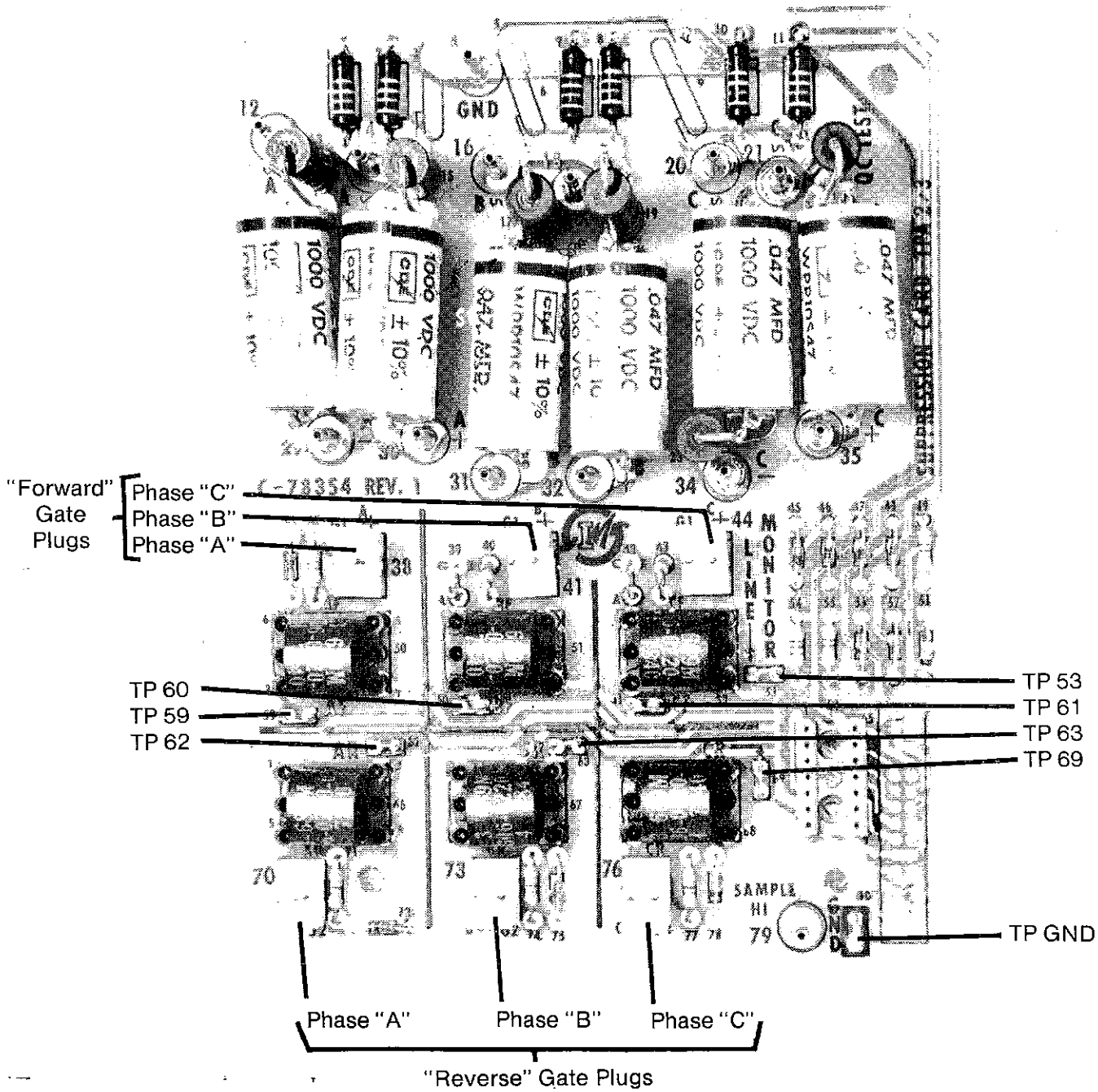


FIGURE 11

SUPPRESSION CARD (SUP 2)

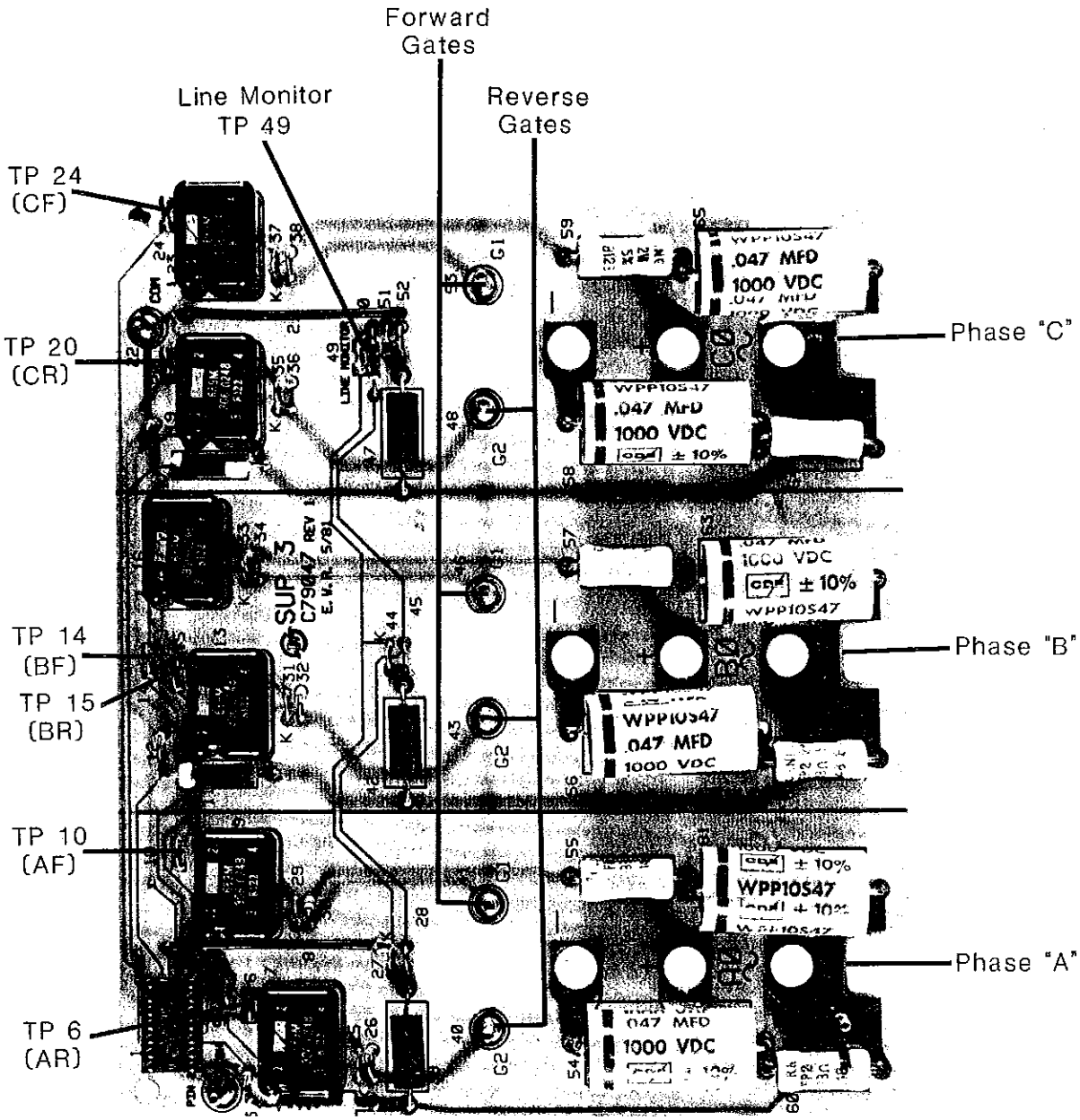


FIGURE 12
SUPPRESSION CARD SUP 3

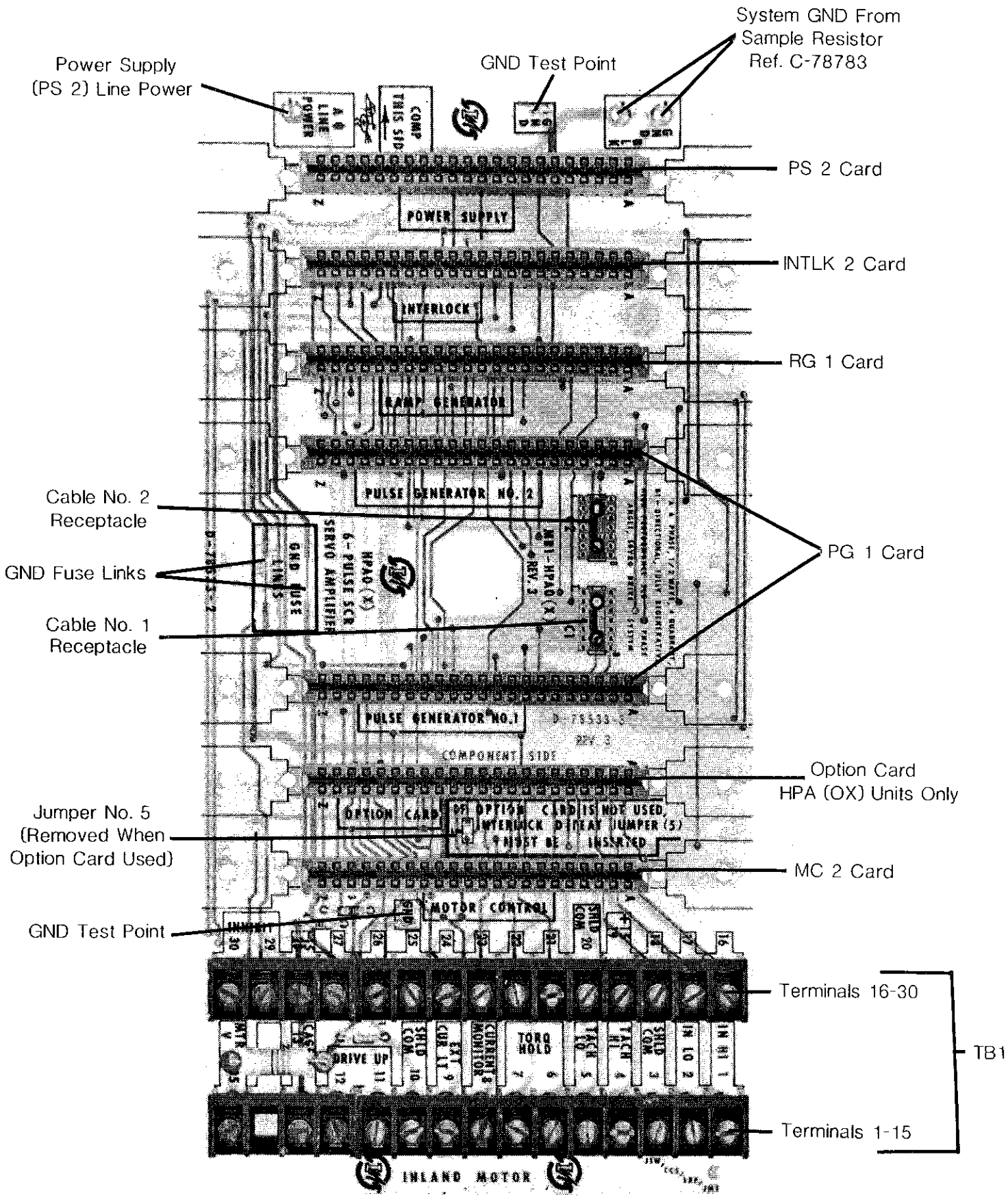
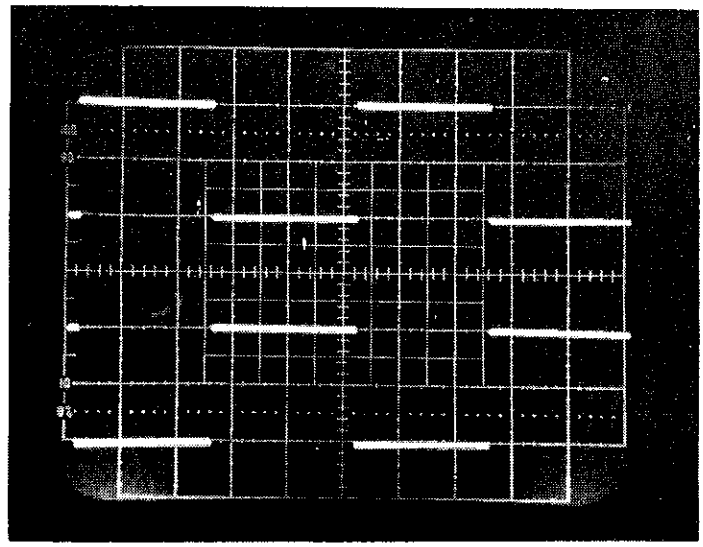


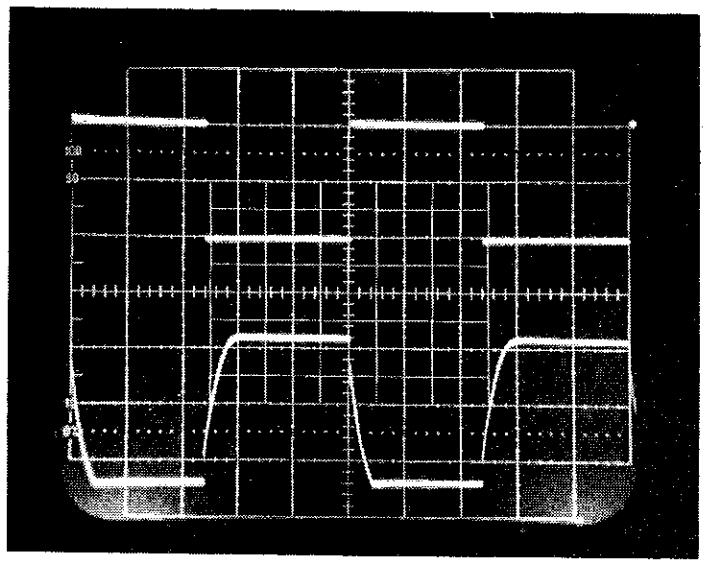
FIGURE 13
MOTHER BOARD MB1-HPA(OX)

a. 20 Volt Peak to Peak 1 Hz. squarewave from signal generator applied at terminals 1 & 2 of TB1 terminal strip. (10V/Div., 0.2 Sec/Div.)



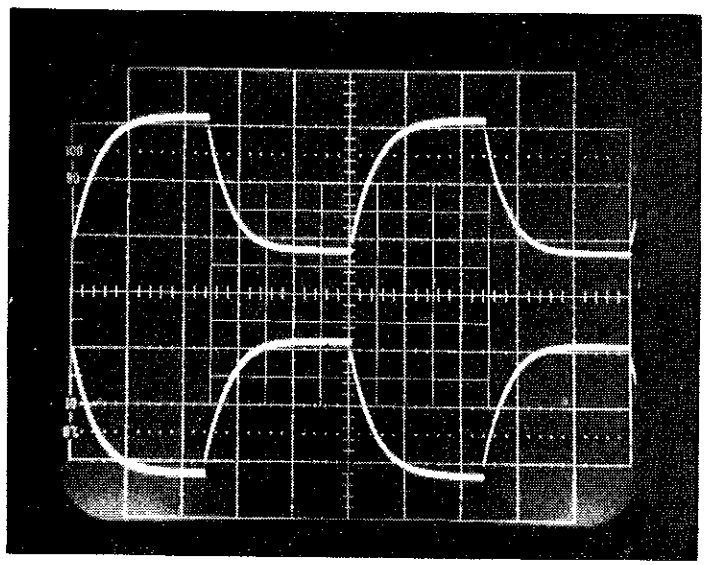
b. Output at TP26 and TP36A of MC 2 Card. (10V/Div., 0.2 Sec/Div.)

c. Output at TP18 and TP34A of MC 2 Card. (10V/Div., 0.2 Sec/Div.)



d. Output at TP43 of MC 2 Card. (5V/Div., 0.2 Sec/Div.)

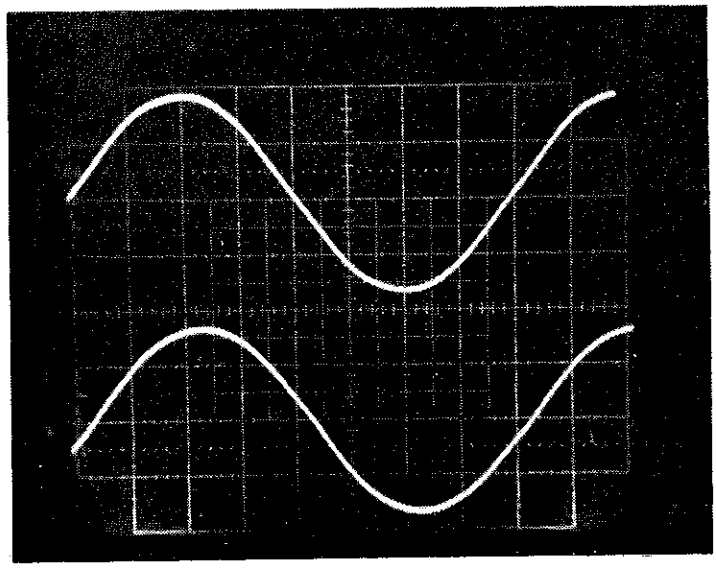
e. Output at TP40 of MC 2 Card. (5V/Div., 0.2 Sec/Div.)



f. Output at TP76 of MC 2 Card. (5V/Div., 0.2 Sec/Div.)

FIGURE 14
MOTOR CONTROL CARD (MC 2)
(REF. CHART #3(e) FOR TEST CONDITIONS)

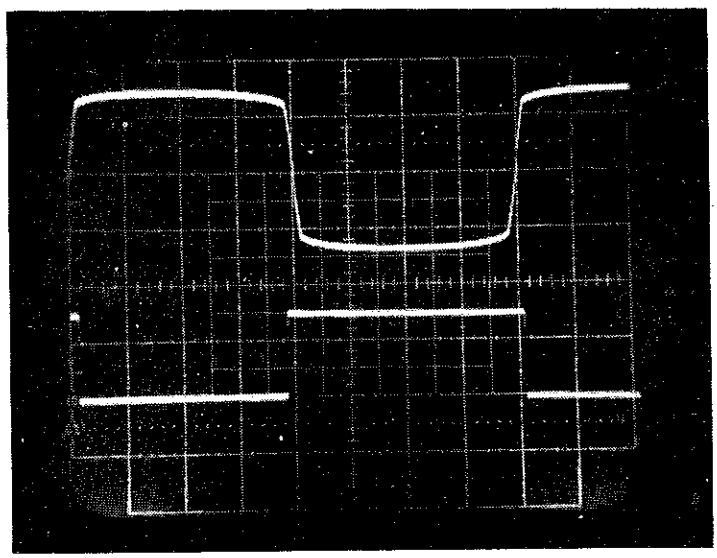
a. Reference Phase
Line Phase "A", "B", or "C" at
Fuse Block No. 1.
(100V/Div., Time base adjusted to give
45°/Div.)



b. Line Phase reduced and shifted 15°.
Seen at TP2, TP8, or TP14 of RG 1 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	(RG 1 Card)
(1V/Div., 45°/Div.)	± 1.4V

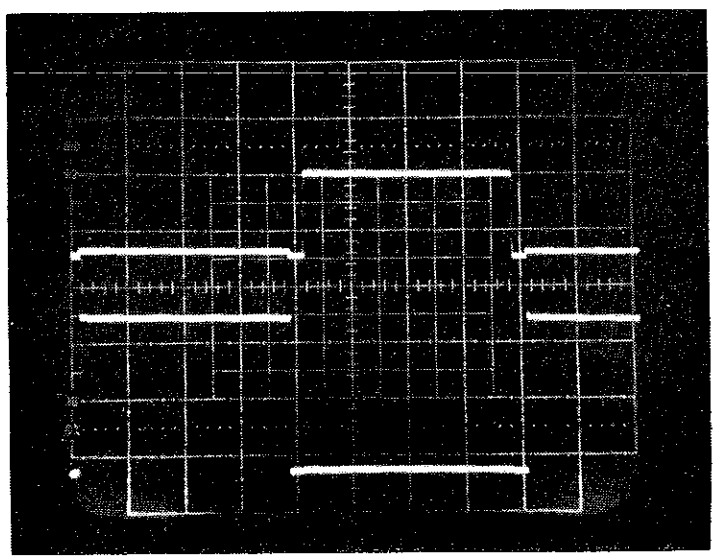


d. Waveform seen at component location:

17-14 for "A" phase	
43-14 for "B" phase	(RG 1 Card)
69-14 for "C" phase	0 to
(10V/Div., 45°/Div.)	+ 15V

e. Waveform seen at component location:

15-7 for phase "A"	
41-7 for phase "B"	(RG 1 Card)
67-7 for phase "C"	0 to
(10V/Div., 45°/Div.)	- 15V



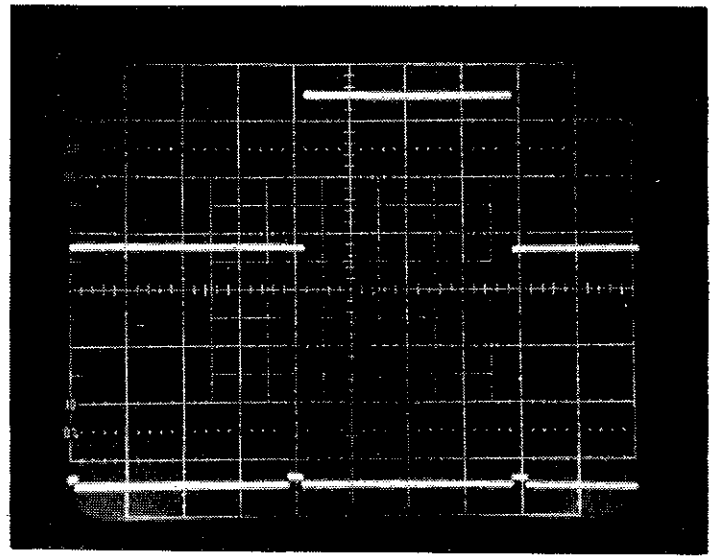
f. Waveform seen at component location:

9-7 for phase "A"	
35-7 for phase "B"	
61-7 for phase "C"	(RG 1 Card)
(10V/Div., 45°/Div.)	± 15V

FIGURE 15
RAMP GENERATOR CARD (RG 1)
(REF. CHART #3(d) FOR TEST CONDITIONS)

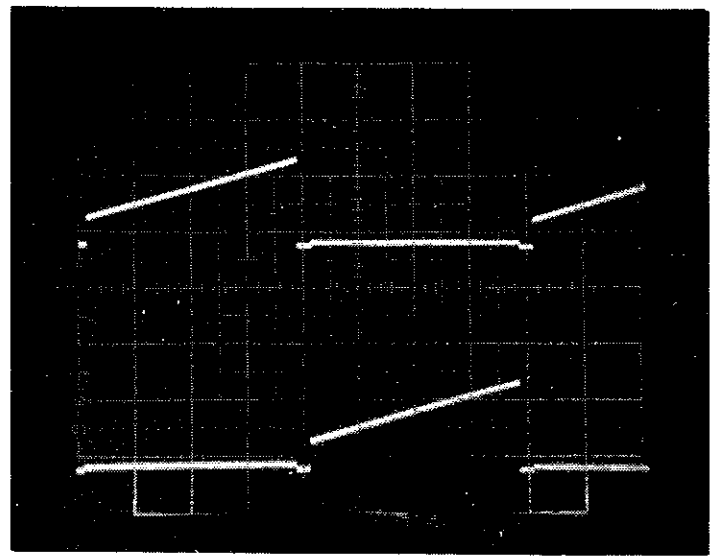
g. Waveform seen at component location:
9-1 for phase "A"
35-1 for phase "B"
61-1 for phase "C" (RG 1 Card)
(10V/Div., 45°/Div.) ±15V

h. Waveform seen at component location:
16-6 for phase "A"
42-6 for phase "B"
68-6 for phase "C" (RG 1 Card)
(10V/Div., 45°/Div.) - 15V



i. Forward Ramp seen at TP6, TP12 or TP18
(10V/Div., 45°/Div.) (RG 1 Card)

j. Reverse Ramp seen at TP3, TP9, or TP15
(10V/Div.. 45°/Div.) (RG 1 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.)

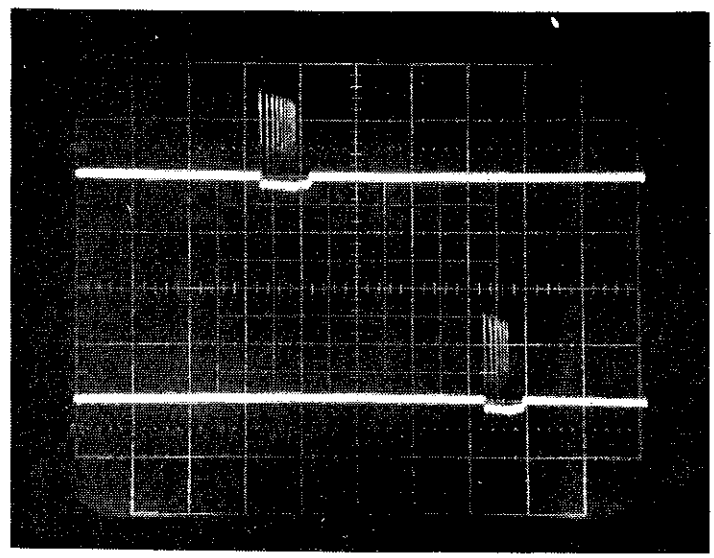
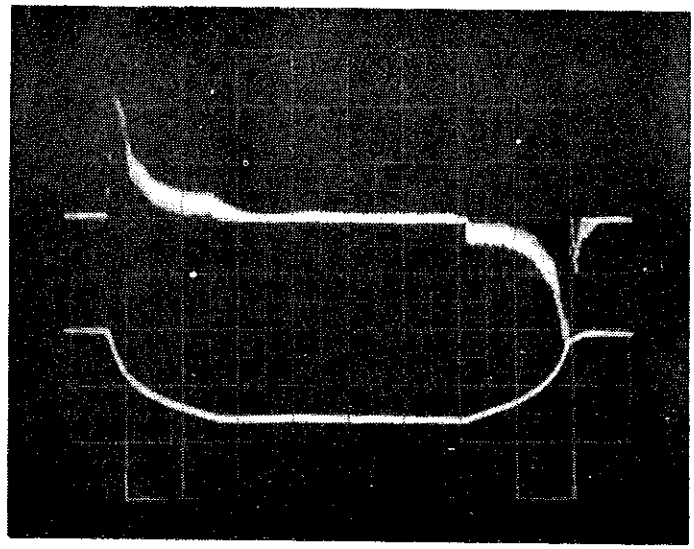


FIGURE 15
RAMP GENERATOR CARD (RG 1) AND PULSE GENERATOR CARD (PG 1)
(REF. CHART #3(c), 3(d) FOR TEST CONDITIONS)

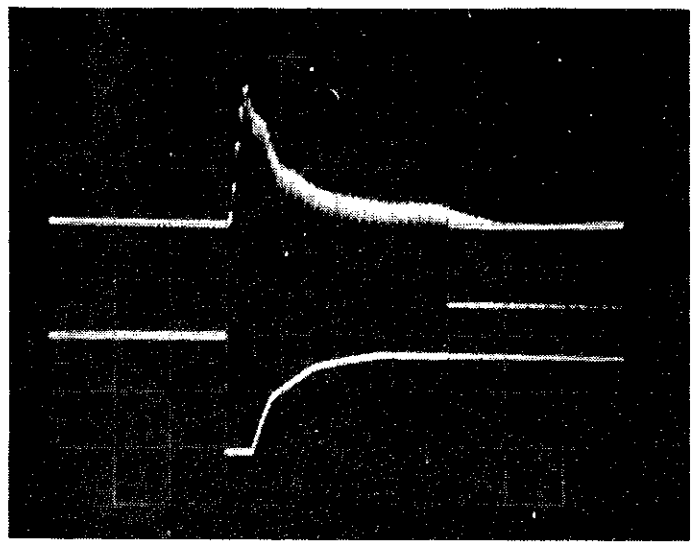
a. Typical Current Profile seen at TP75 of MC 2 Card for systems having horsepower-based current limits. Ref. enclosed TL sheet for specific peak current levels.

b. Typical tach feedback voltage profile seen at TP106 of MC 2 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 MC 2 card.



e. Current Waveform seen at TP75 of MC 2 Card, indicating slight Velocity Loop offset in Forward Direction (seen at Zero Speed). Adjust Pot in Position 25 for near-zero peaks.

f. Current Waveform seen at TP75 of MC 2 Card, indicating slight Velocity Loop offset in Reverse Direction (seen at Zero Speed). Adjust Pot in Position 25 for near-zero peaks.

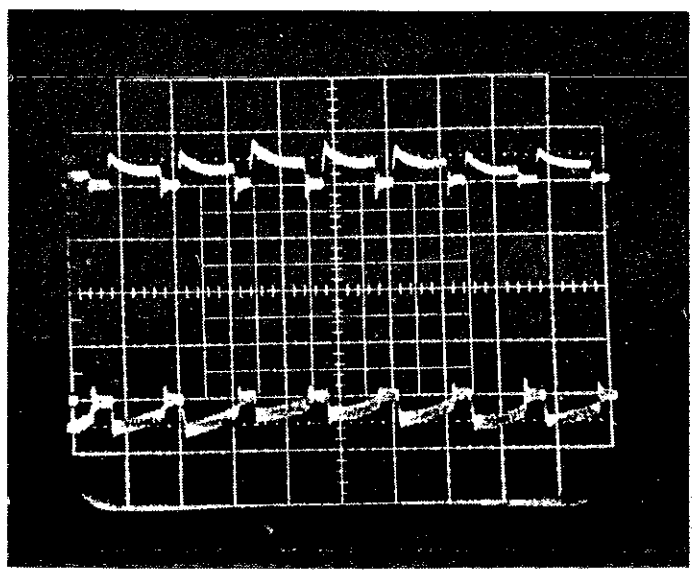
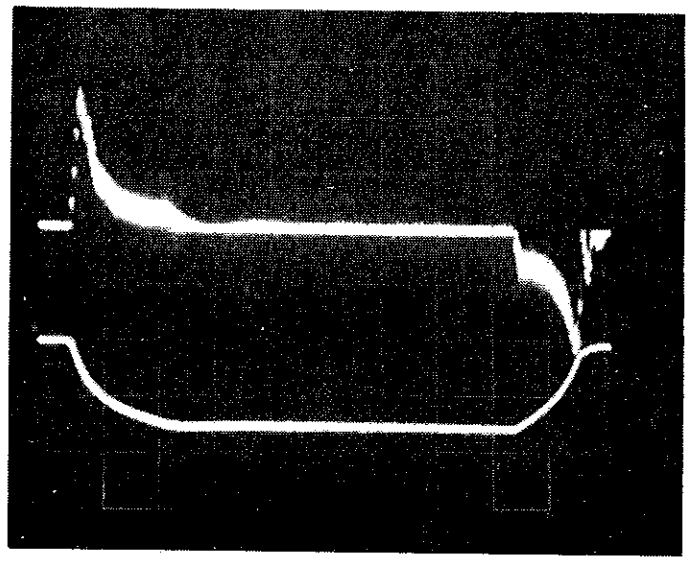


FIGURE 16
CURRENT WAVEFORMS FOR MC 2

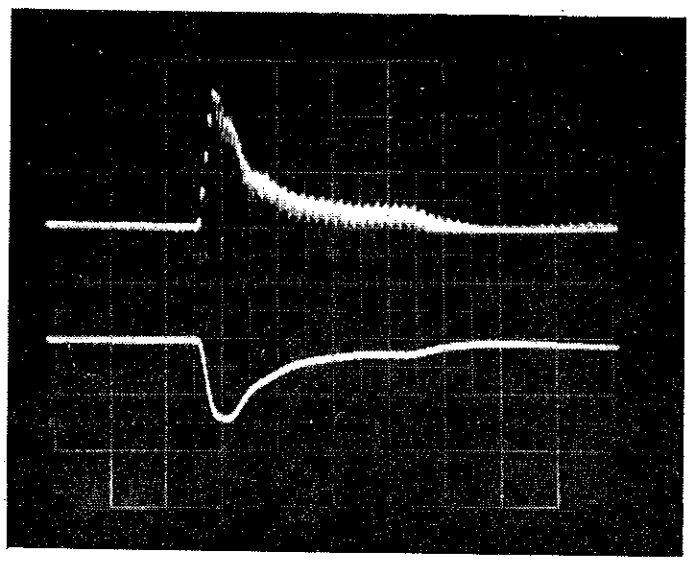
g. Typical Current profile seen at TP75 of MC 2 Card for systems having standard horsepower-based current limits for acceleration, and, using "Hi-Decel" circuit, increased horsepower-based current limits for deceleration.

h. Typical Tach feedback voltage profile seen at TP106 of MC 2 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 TB1 terminal strip with the current profile shown in i. or c.



k. Typical motor current waveform seen at TP75 of MC 2 Card while motor is running.

m. Typical tach ripple voltage as seen at TP106 of MC 2 Card while motor is running.

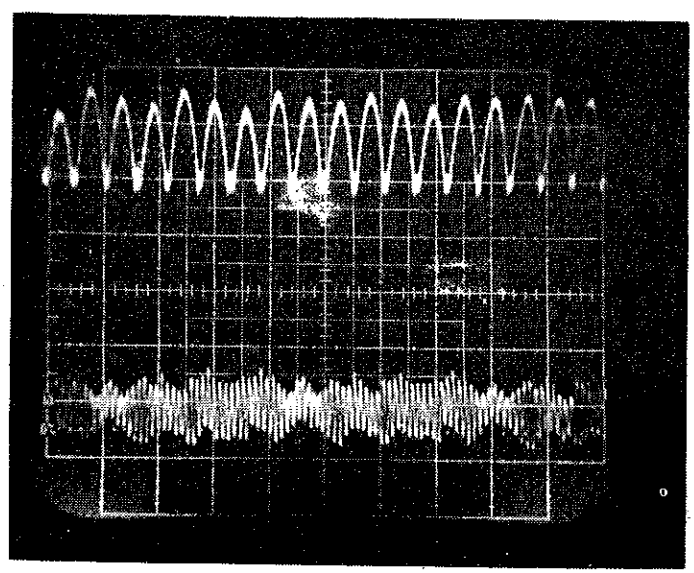
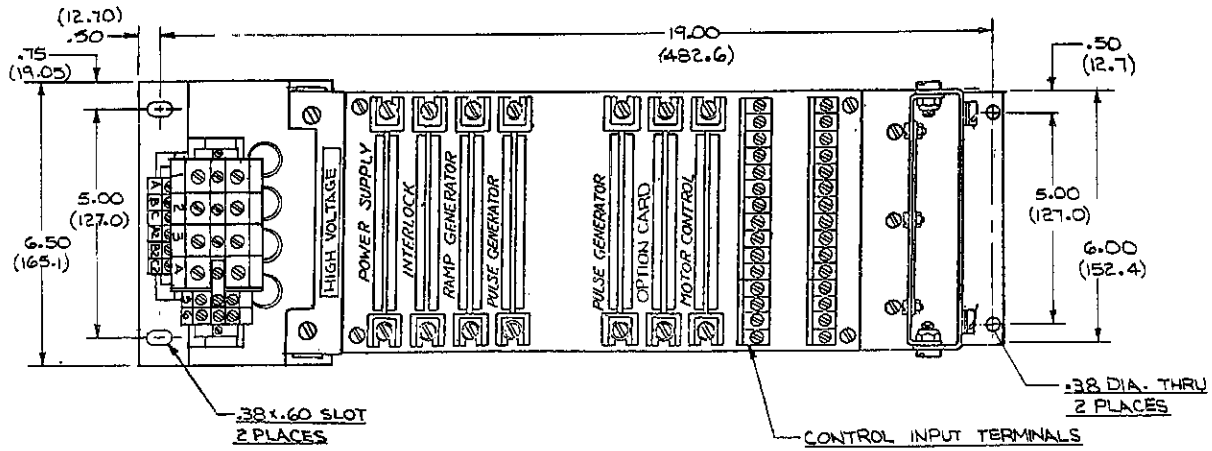
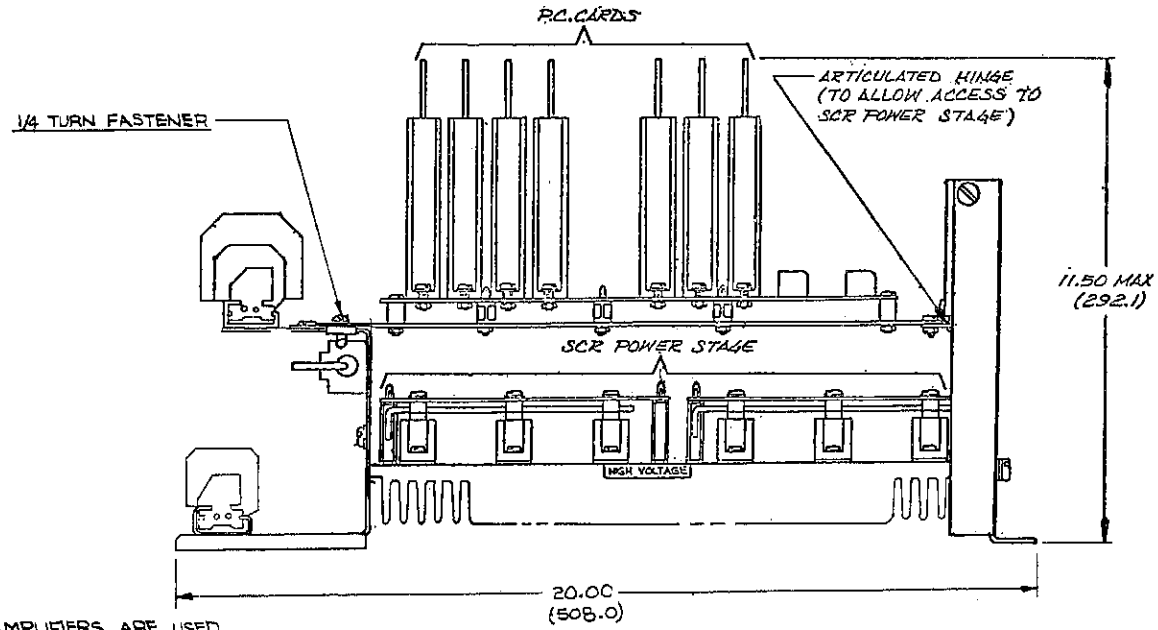


FIGURE 16
CURRENT WAVEFORMS FOR MC 2

NOTES

DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED	UNLESS OTHERWISE SPECIFIED XX DEC. PLACES ± .010 .XXX DEC. PLACES ± .005 ANG. DIM ± 1°	UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES	DWG. SIZE C	DWG. NO. 79489	ISSUE 1





NOTES:
1)-WHEN TWO(2) OR MORE AMPLIFIERS ARE USED, ALLOW MINIMUM OF ONE(1) INCH DISTANCE BETWEEN AMPLIFIERS.
2)-DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.

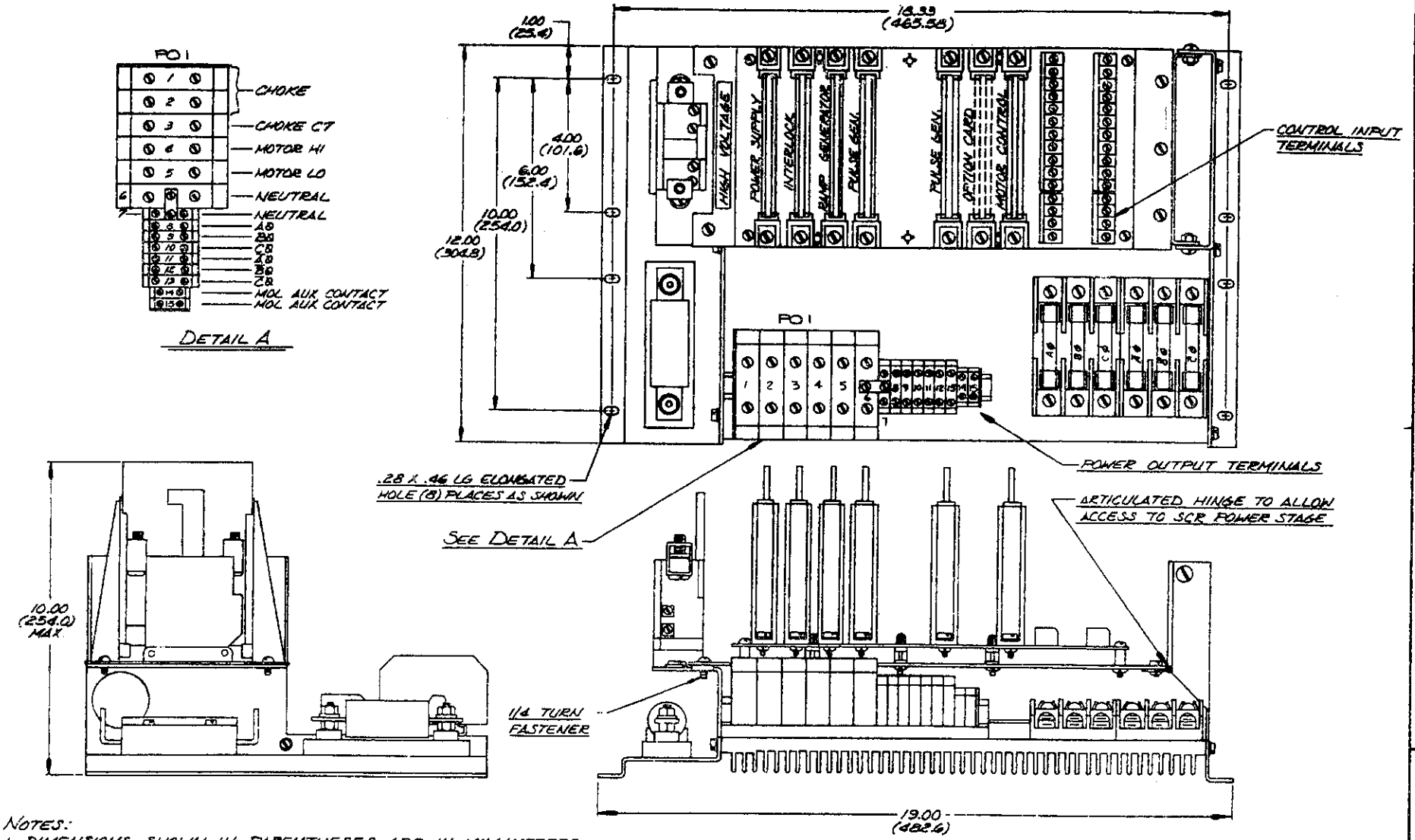
MATERIAL:				HEAT TREAT:				FINISH:				DWN BY FDO 4/29/82
NO.	ECN NO.	DATE	APP'D	NO.	ECN NO.	DATE	APP'D	NO.	ECN NO.	DATE	APP'D	CHK'D BY
												APP'D BY KLM 4/30
												JOB NO.
												P.O. NO.

KOLLMORGEN CORP.
INLAND MOTOR INDUSTRIAL DRIVES DIV.
RADFORD, VIRGINIA

OUTLINE AND DIMENSION
HPA/XXXXX-X12 & X13

SCALE: NA | PART LIST NO.

DWG. SIZE C | DWG. NO. 79489 | ISSUE 1



NOTES:

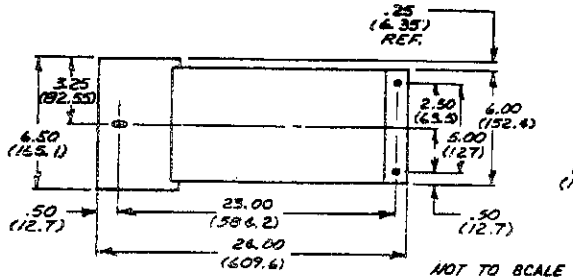
1. DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.
2. WHEN TWO (2) OR MORE AMPLIFIERS ARE USED, ALLOW A MINIMUM OF ONE (1) INCH DISTANCE BETWEEN AMPLIFIERS.
3. DO NOT MOUNT HEAVY MAGNETICS CLOSE TO THIS PANEL, SUCH AS INDUCTORS OR TRANSFORMERS.

INLAND MOTOR
INDUSTRIAL DIV. VE DIVISION
KOLLMORGEN CORPORATION

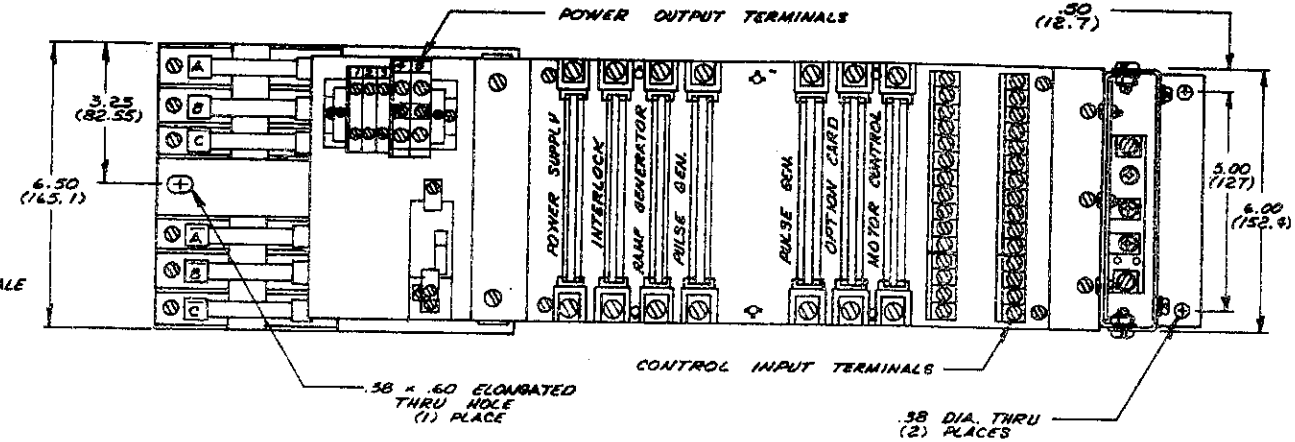
OUTLINE & DIMENSION
HPAQX/100-X11

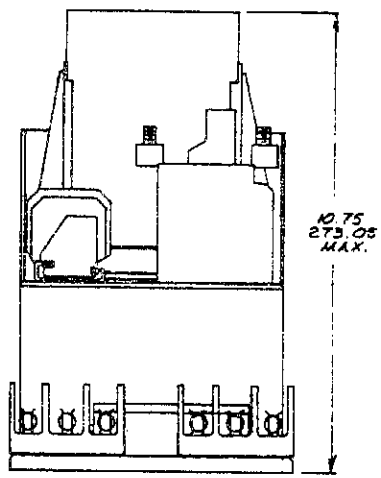
SCALE 1:2

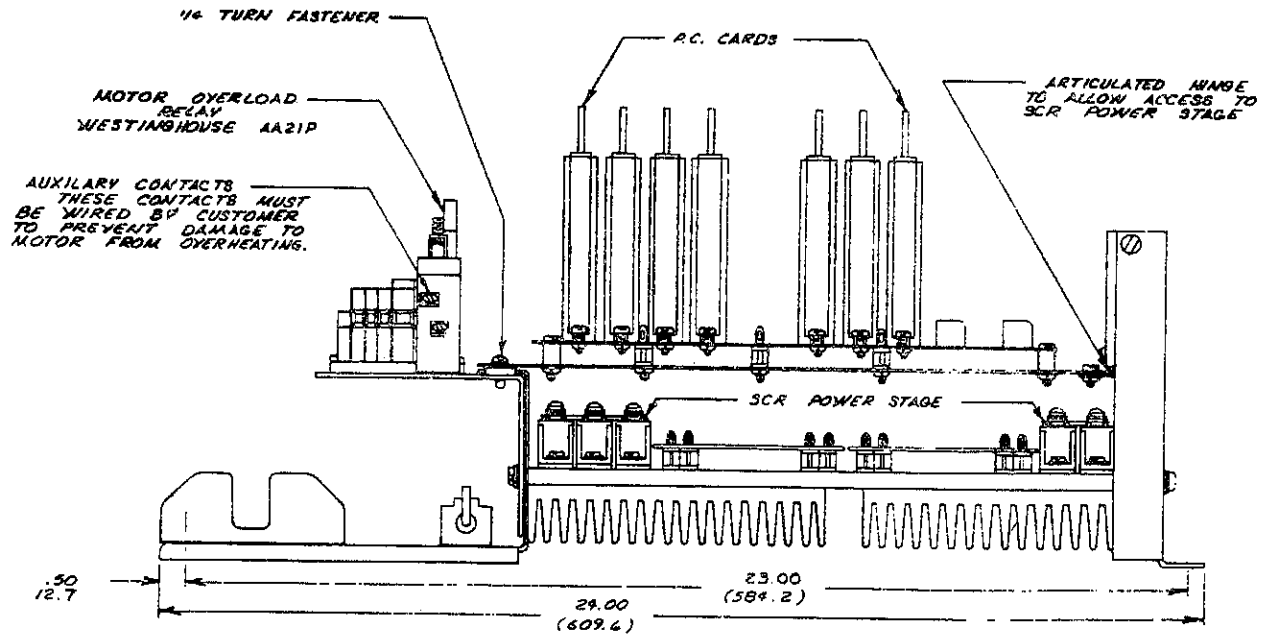
SIZE C | DWG NO 79044 | ISSUE 2



RECOMMENDED MOUNTING DIMENSIONS







NOTES:

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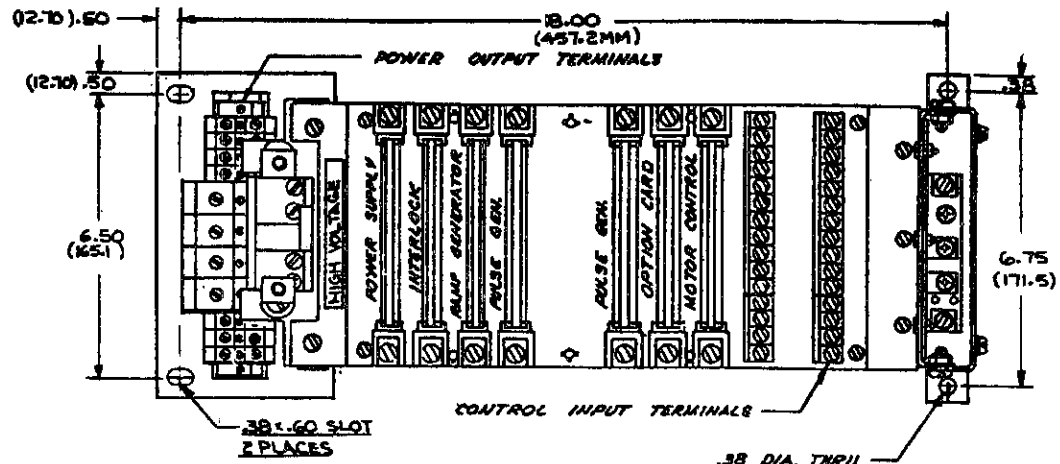
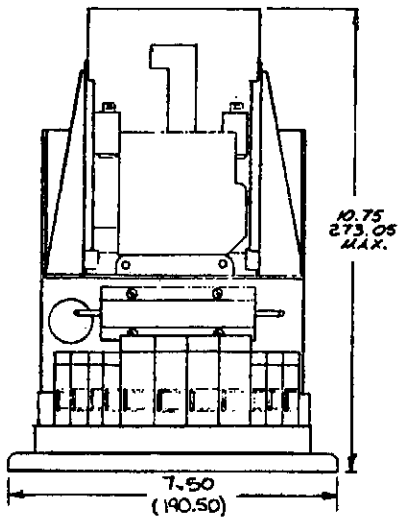
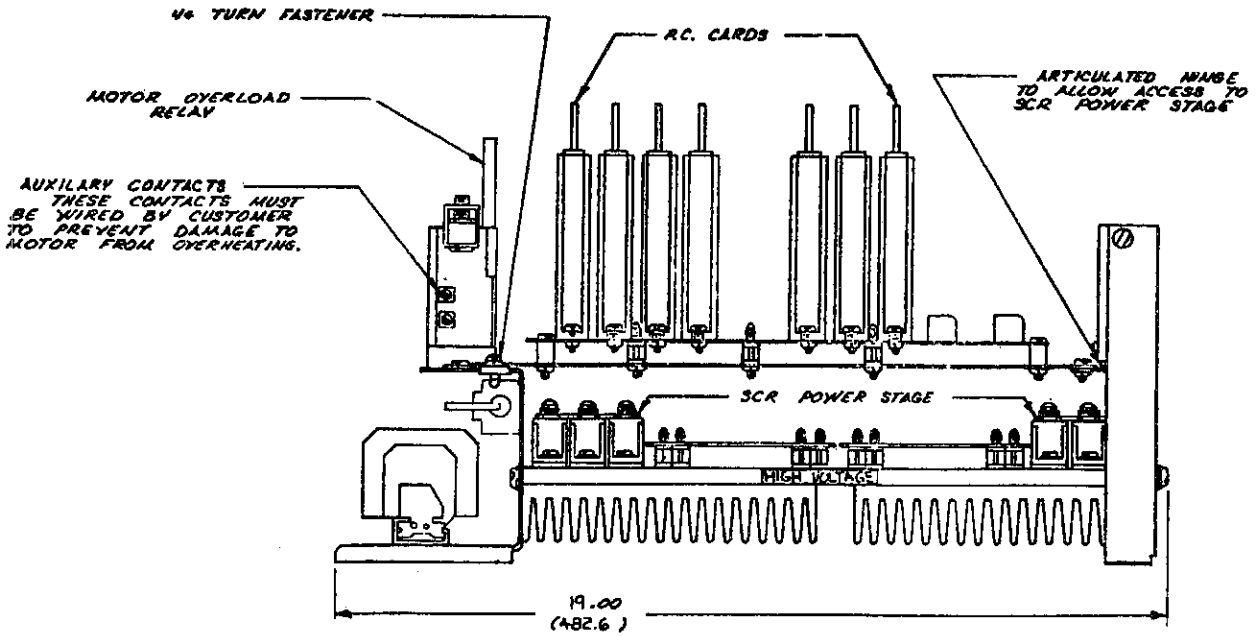
2- DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.
3- DO NOT MOUNT HEAVY MAGNETICS CLOSE TO THIS PANEL, SUCH AS INDUCTORS OR TRANSFORMERS.

INLAND MOTOR INDUSTRIAL DRIVE DIVISION KOLLMORGEN CORPORATION			
OUTLINE AND DIMENSION HPA/45-01,02,03 SERIES			
SCALE 1:2	PART LIST NO PL-78541		
DWG SIZE C	DWG NO 78542		SHEET 2







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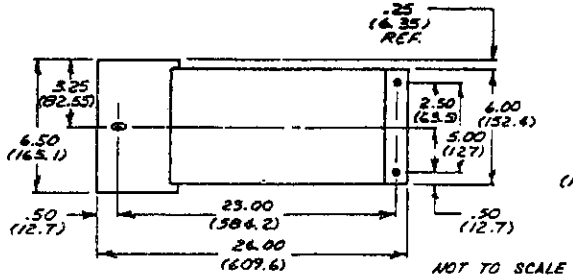
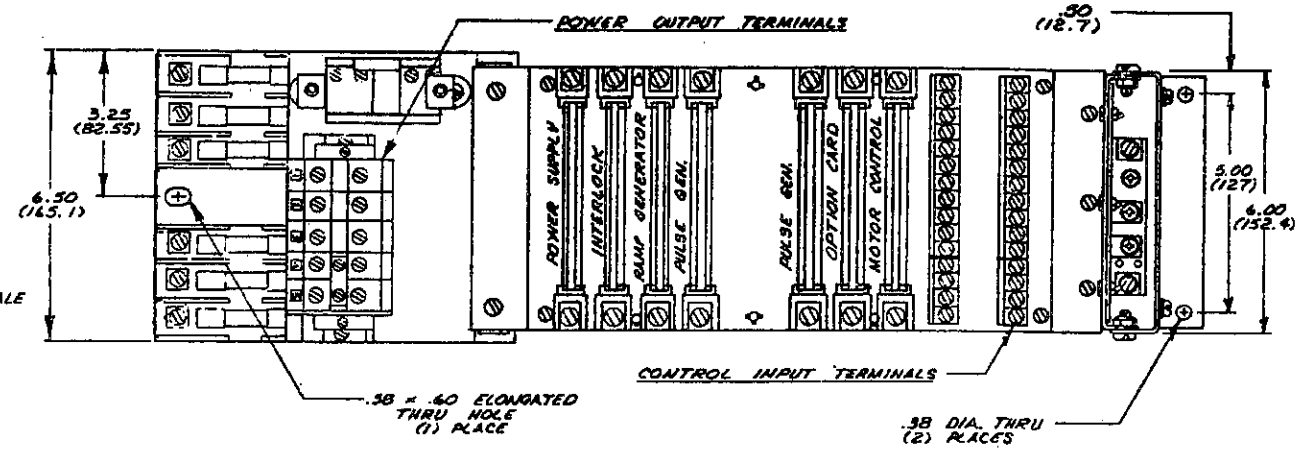
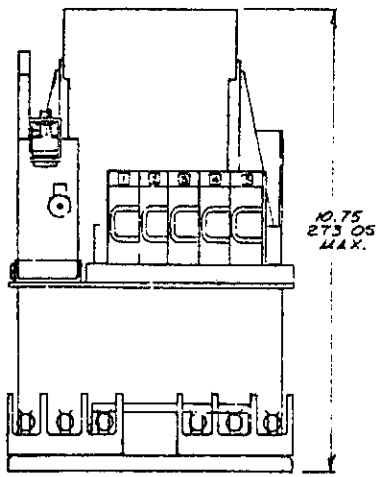
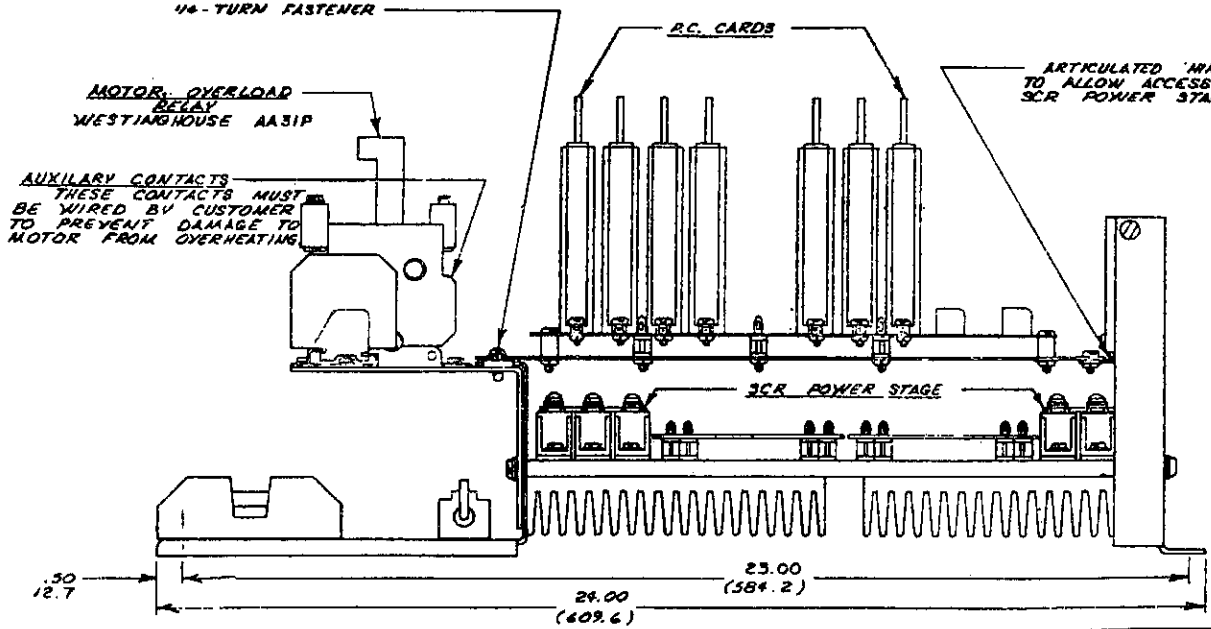
INLAND MOTOR INDUSTRIAL DRIVE DIVISION KOLLMORGEN CORPORATION 300 ROCK ROAD RADFORD VIRGINIA 24141			
OUTLINE AND DIMENSION			
HPA 01/45 & 85-08,09			
SCALE NONE	PART LIST NO.		
SIZE C	DWG. NO. 78895		ISSUE 1



RECOMMENDED MOUNTING DIMENSIONS







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2 - DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.

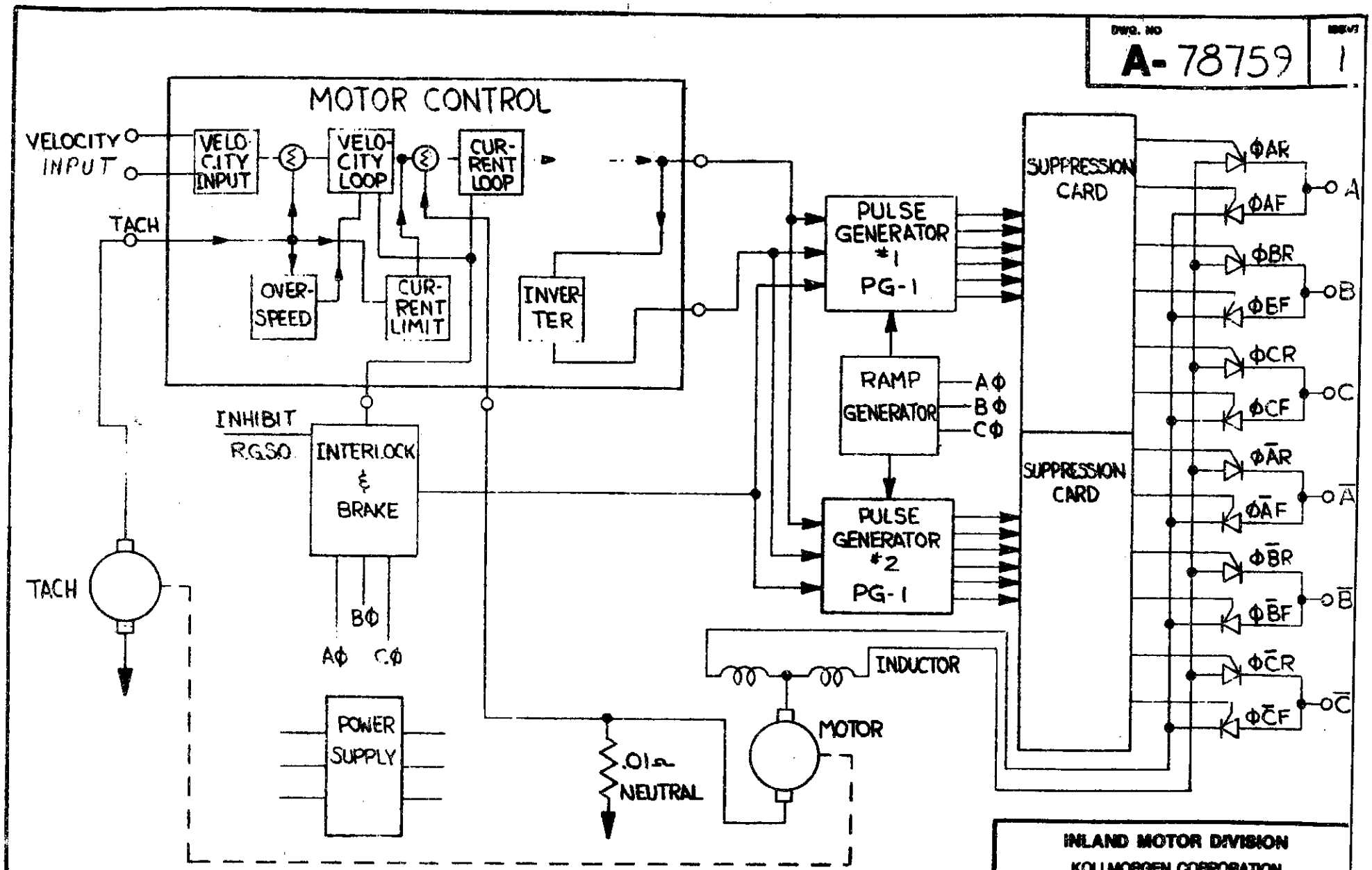
MATERIAL	HEAT TREAT	FINISH
NO. / ECN NO. / DATE / APP'D	NO. / ECN NO. / DATE / APP'D	NO. / ECN NO. / DATE / APP'D
		2 / 78977 / 5/23/89

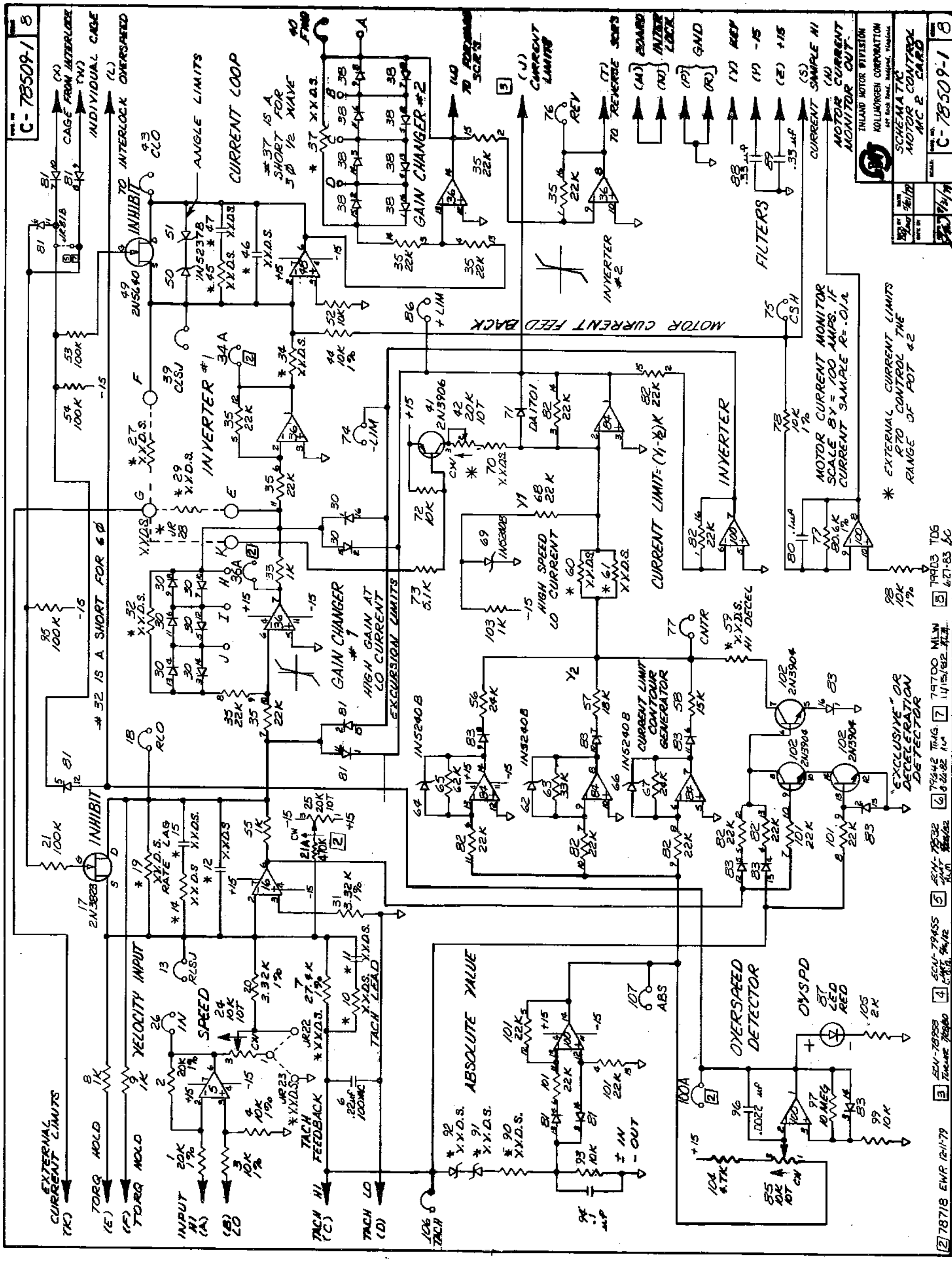
INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
295 BRUCE ROAD
BRADFORD, VIRGINIA 24141

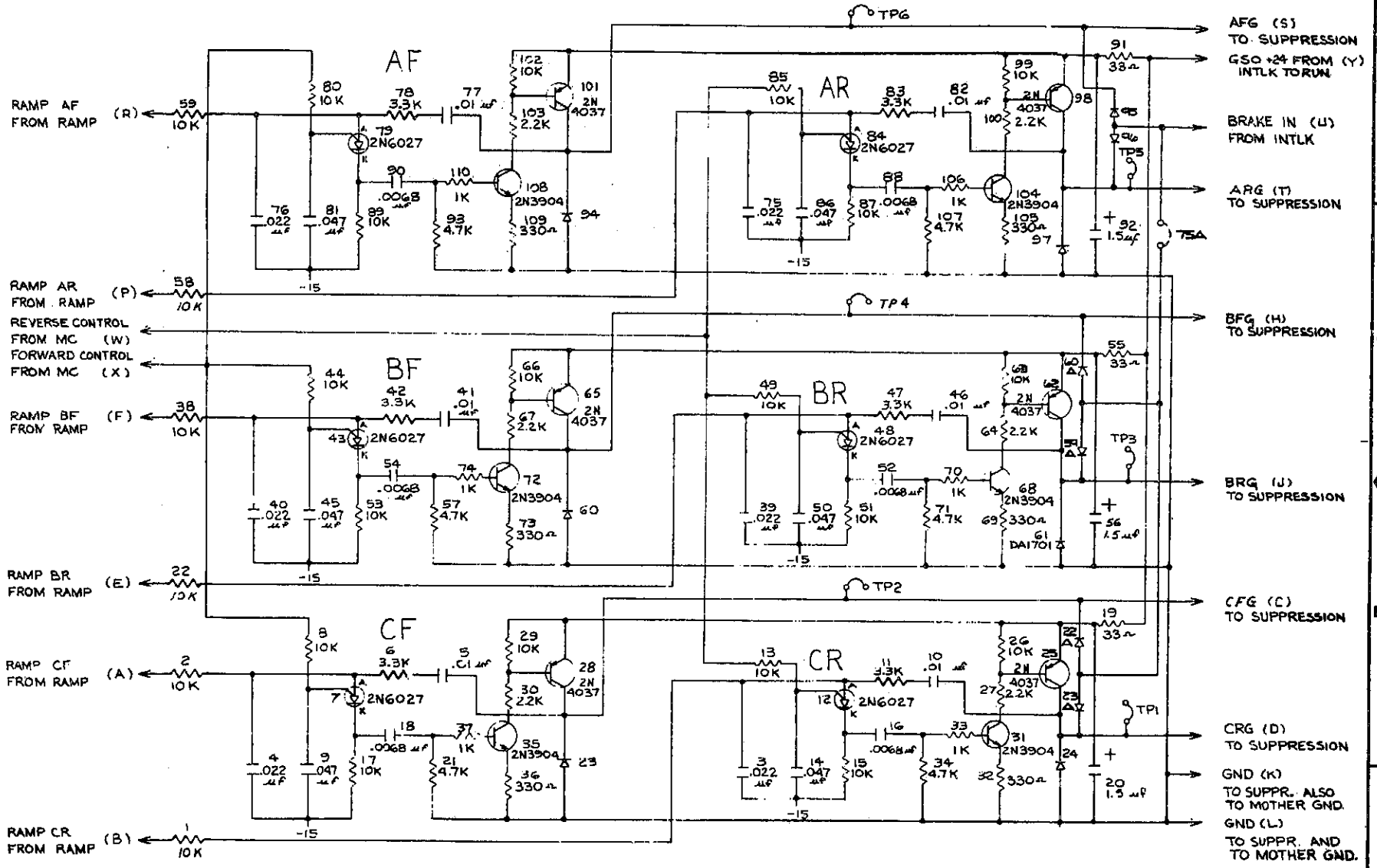
OUTLINE AND DIMENSION
HPA/85-01,-02-03 SERIES

SCALE 1:2 | PART UNIT NO. PL-75586

SIZE C | DRG. NO. 78586 | SHEET 2


DWG. NO
A-78759
REV
1
MOTOR CONTROL
VELOCITY INPUT
VELO-CITY INPUT
VELO-CITY LOOP
CUR-RENT LOOP
TACH
OVER-SPEED
CUR-RENT LIMIT
INVER-TER
INHIBIT
R.G.S.O.
INTERLOCK & BRAKE
PULSE GENERATOR #1 PG-1
RAMP GENERATOR
AΦ
BΦ
CΦ
PULSE GENERATOR #2 PG-1
SUPPRESSION CARD
SUPPRESSION CARD
ΦAR
ΦAF
A
ΦBR
ΦBF
B
ΦCR
ΦCF
C
ΦĀR
ΦĀF
Ā
ΦB̄R
ΦB̄F
B̄
ΦC̄R
ΦC̄F
C̄
TACH
BΦ
AΦ
CΦ
POWER SUPPLY
.01Ω
NEUTRAL
INDUCTOR
MOTOR
UNLESS OTHERWISE SPECIFIED
XX DEC. PLACES ±.01
XXX DEC. PLACES ±.005
ANGS. BNS. ±1°
DO NOT SCALE DWG. USE DIMENSIONS ONLY
ALL DIMENSIONS ARE INCHES
MIN. RADIUS SPECIFIED
NO.
ECN NO.
DATE
APP'D.
NO.
ECN NO.
DATE
APP'D.
DW'N BY EWR
DATE 3 19 80
CH'K BY
APP'D BY
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
501 FIRST ST. RADFORD, VIRGINIA
SYSTEM BLOCK DIAGRAM
HPA SERIES
SCALE:
DWG. NO.
A-78759
REV
1


C-78509-1
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
SCHEMATIC MOTOR CONTROL MC 2 CARD
CURRENT LOOP
ANGLE LIMITS
INVERTER #1
GAIN CHANGER #1
HIGH GAIN AT LO CURRENT EXCURSION LIMITS
GAIN CHANGER #2
INVERTER #2
INVERTER
FILTERS
MOTOR CURRENT FEED BACK
CURRENT LIMIT CONTOUR GENERATOR
HIGH SPEED LO CURRENT
ABSOLUTE VALUE
OVERSPEED DETECTOR
VELOCITY INPUT
SPEED
TACH FEEDBACK
TACH LEAD
EXTERNAL CURRENT LIMITS
INHIBIT
"EXCLUSIVE" OR DECELERATION DETECTOR
32 IS A SHORT FOR 6Ø
37 IS A SHORT FOR 3Ø 1/2 WAVE
MOTOR CURRENT MONITOR SCALE BY = 100 AMPS. IF CURRENT SAMPLE R=.01Ω
* EXTERNAL CURRENT LIMITS R70 CONTROL THE RANGE OF POT 42
CAGE FROM INTERLOCK
INDIVIDUAL CAGE
INTERLOCK OVERSPEED
CURRENT LIMITS
CURRENT SAMPLE HI
MOTOR CURRENT MONITOR OUT



NOTE: ALL DIODES ALL A-78537

INLAND MOTOR DIVISION
RADFORD VIRGINIA
PULSE GENERATOR
3 PG 1
PART LIST NO PL-3725
DWG NO 78169
ISSUE 4

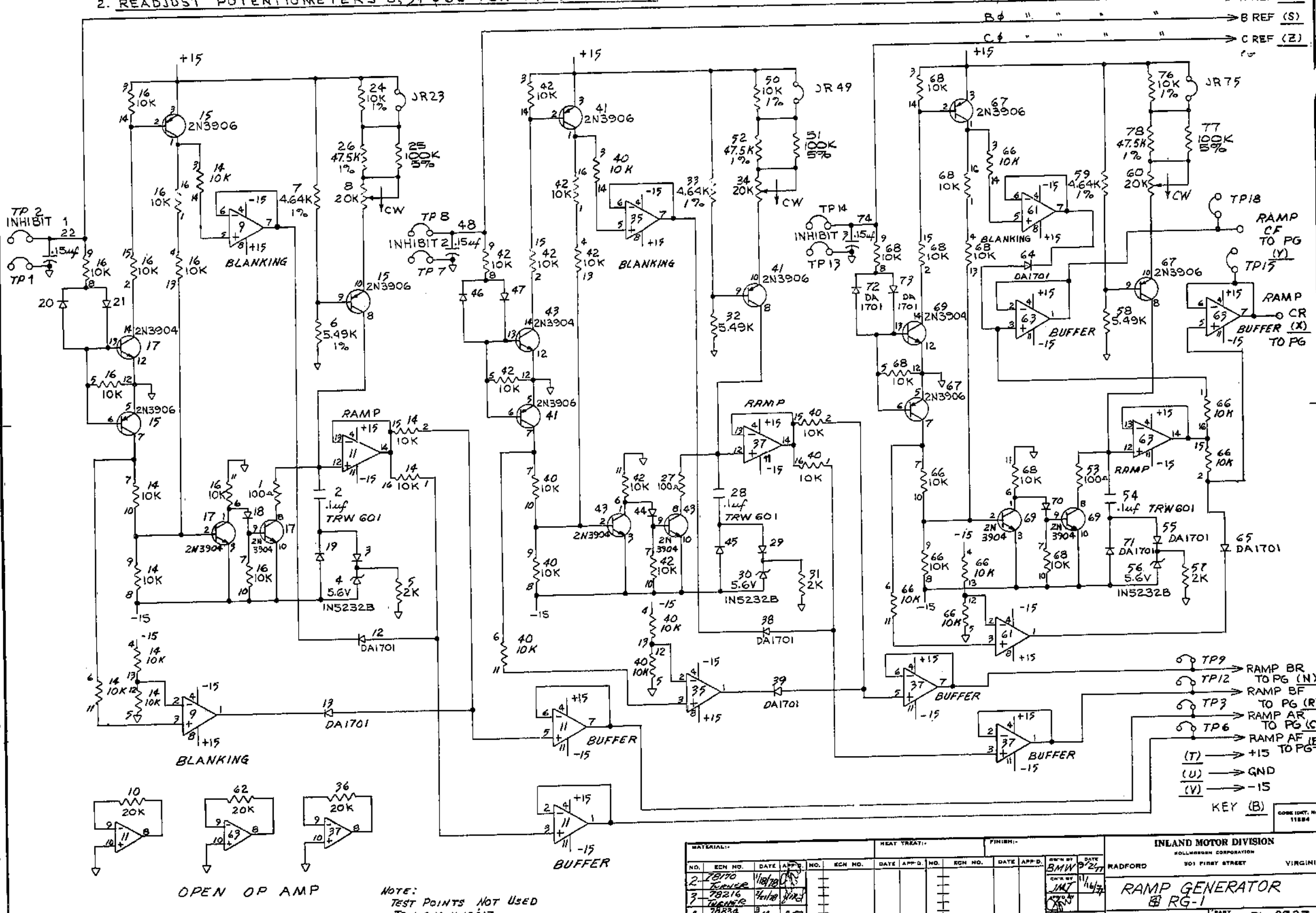
NOTE: 50Hz OPERATION
1. REMOVE JUMPERS JR 23, 49 & 75.
2. READJUST POTENTIOMETERS 8, 34 & 60 FOR PROPER BIAS.

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

UNLESS OTHERWISE SPECIFIED XX DEC. PLACES ± .015 XXX DEC. PLACES ± .005 ANG. DIM. ± 1°

UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE C DWG. NO. 78181 ISSUE 5



NO.	ECN NO.	DATE	APP'D.
2	78170 Turner	1/18/78	
3	78216 Turner	3/21/78	
4	78834 Reynolds	3/14/80	RFD
5	79739 M. Wilson	12/83	RLM

DRAWN BY BMW 9/2/77
CHK'D BY JMT 11/16/77

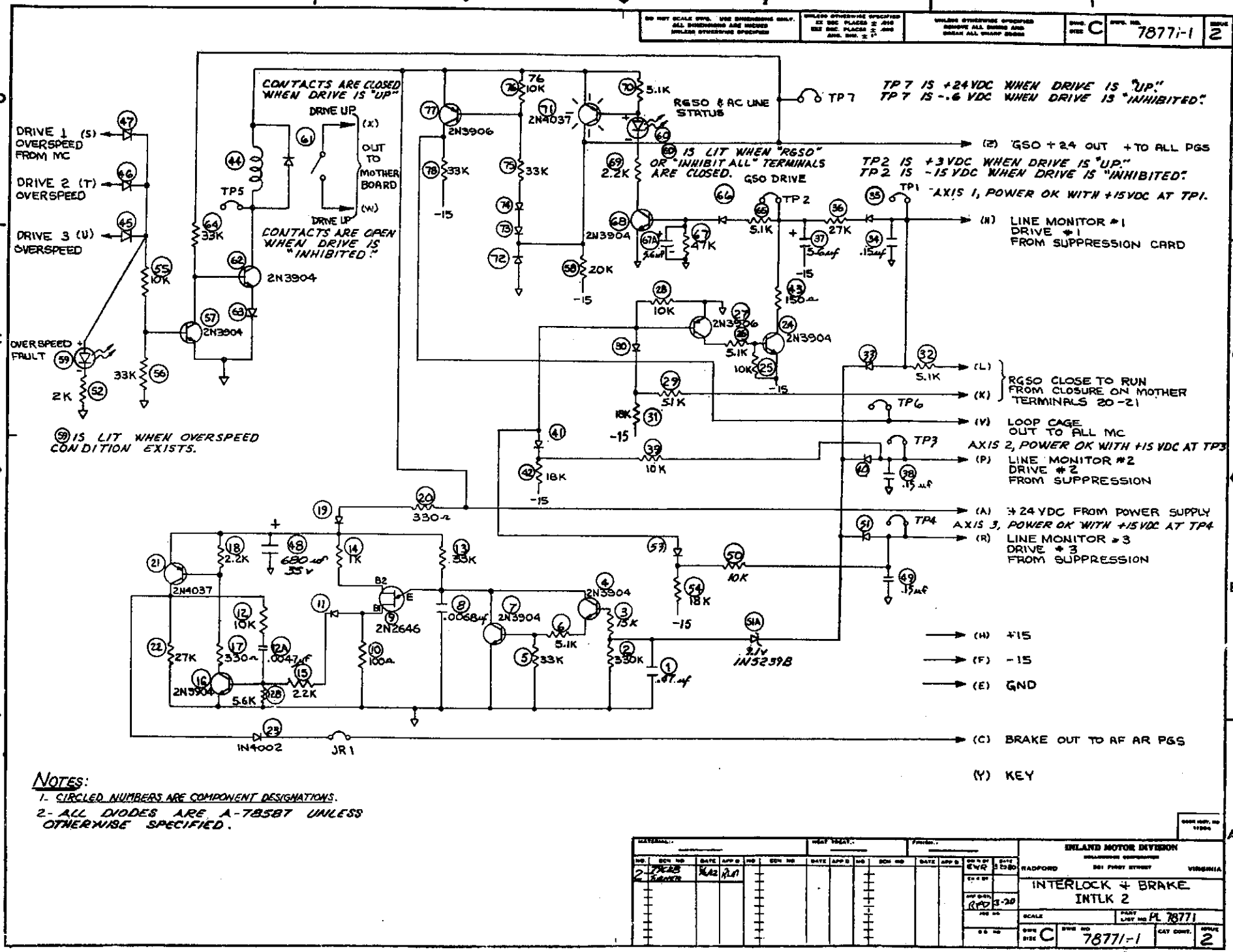
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

RAMP GENERATOR
RG-1

PART LIST NO. PL-3727

CODE IDENT. NO. 11884

DWG. SIZE C DWG. NO. 78181 ISSUE 5



NOTES:

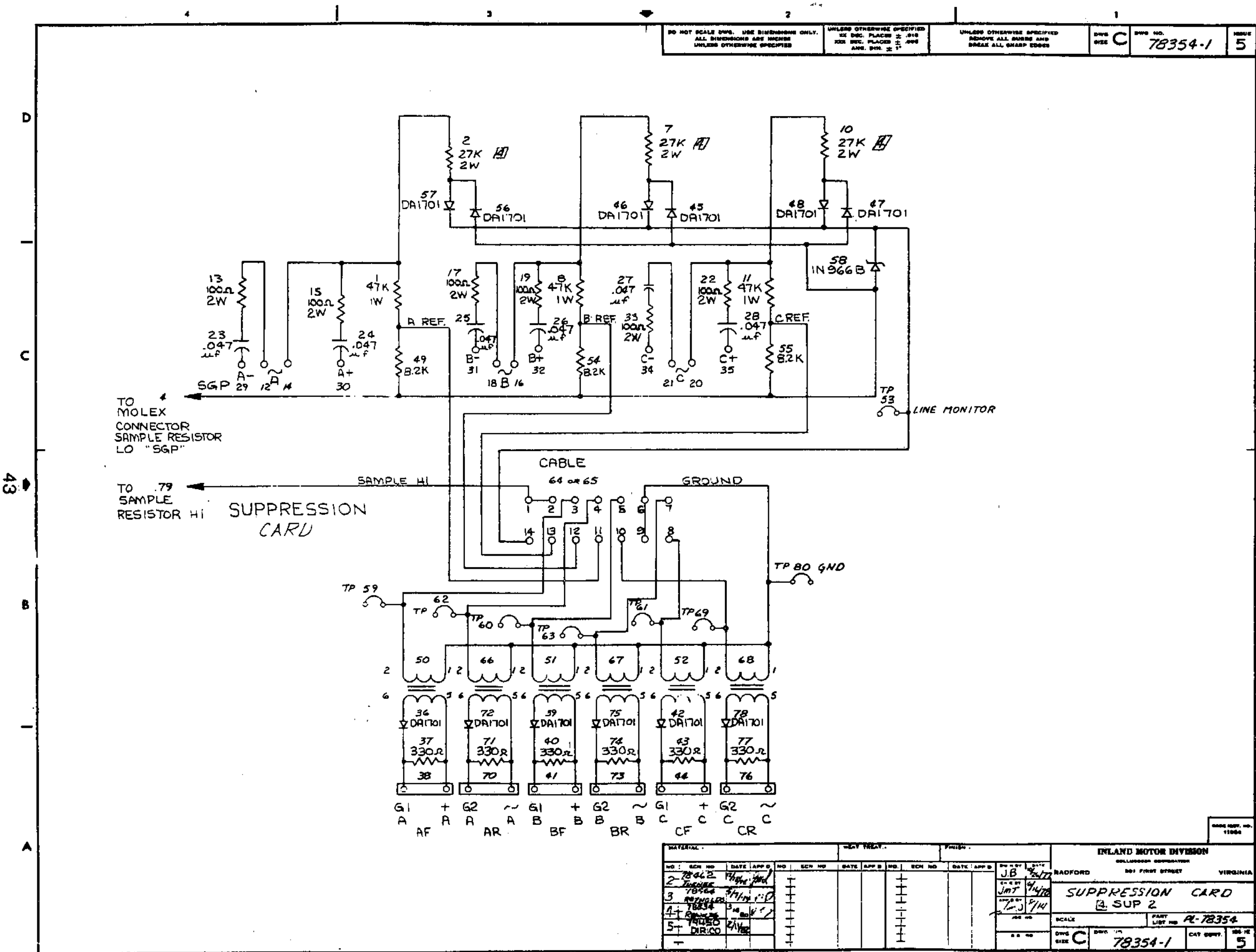
1. CIRCLED NUMBERS ARE COMPONENT DESIGNATIONS.
2. ALL DIODES ARE A-78587 UNLESS OTHERWISE SPECIFIED.

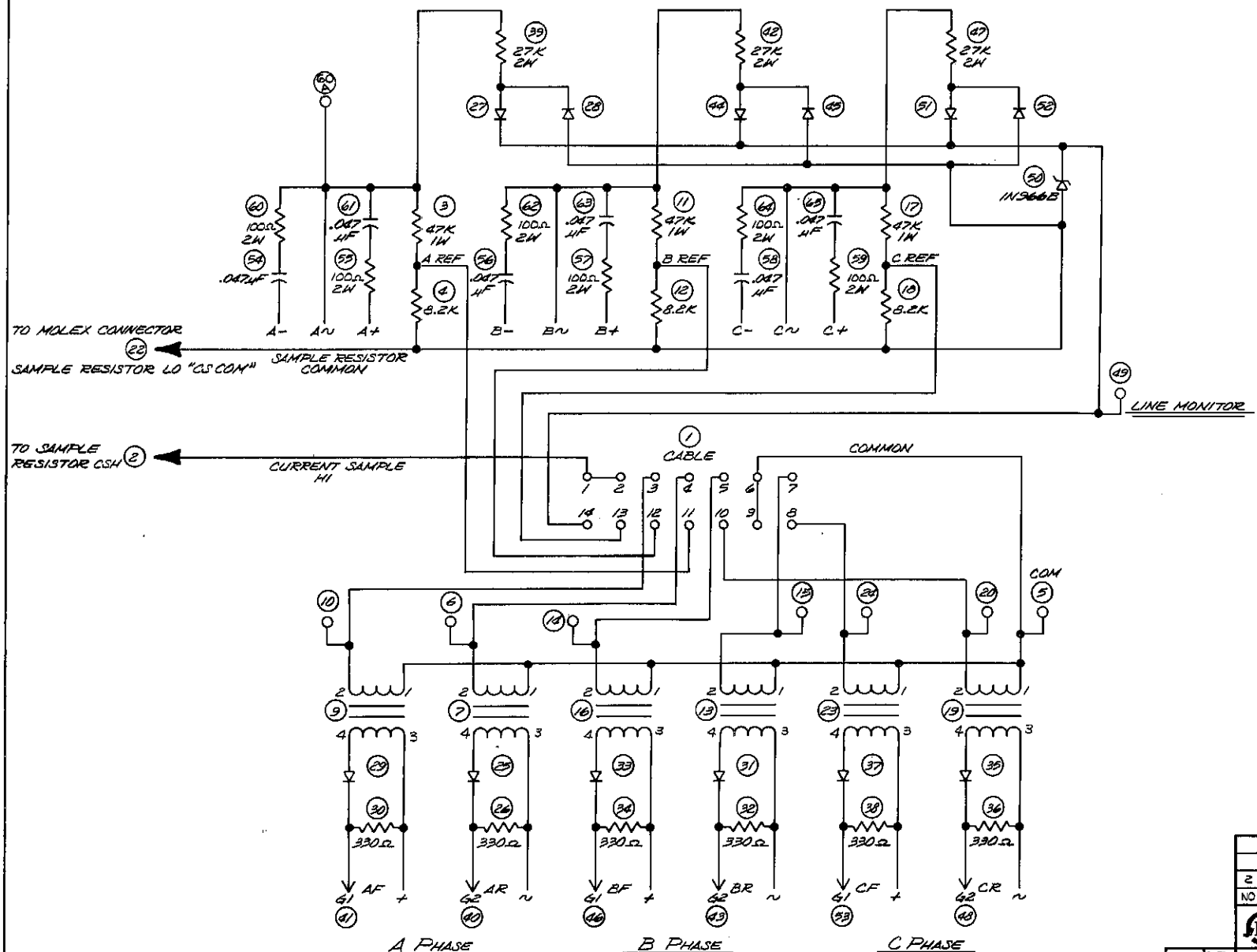
INLAND MOTOR DIVISION
RADFORD 501 FIRST STREET VIRGINIA

INTERLOCK & BRAKE
INTLK 2

SCALE
PART LIST NO PL 78771

SIZE C DWG NO 7877/-1 CAT CONT. ISSUE 2


DWG SIZE C
DWG NO. 78354-1
ISSUE 5
2 27K 2W
7 27K 2W
10 27K 2W
57 DA1701
56 DA1701
46 DA1701
45 DA1701
48 DA1701
47 DA1701
58 1N966B
13 100Ω 2W
15 100Ω 2W
1 47K 1W
17 100Ω 2W
19 100Ω 2W
8 47K 1W
27 .047 µf
22 100Ω 2W
11 47K 1W
23 .047 µf
24 .047 µf
A REF.
25 .047 µf
26 .047 µf
B REF.
33 100Ω 2W
28 .047 µf
C REF.
49 8.2K
54 8.2K
55 8.2K
A- 29
12 A 14
A+ 30
B- 31
18 B 16
B+ 32
C- 34
21 C 20
C+ 35
SGP
TP 53
LINE MONITOR
TO 4 MOLEX CONNECTOR SAMPLE RESISTOR LO "SGP"
CABLE 64 or 65
SAMPLE HI
GROUND
TO 79 SAMPLE RESISTOR HI
SUPPRESSION CARD
TP 80 GND
TP 59
TP 62
TP 60
TP 63
TP 61
TP 69
50
66
51
67
52
68
36 DA1701
72 DA1701
59 DA1701
75 DA1701
42 DA1701
78 DA1701
37 330Ω
71 330Ω
40 330Ω
74 330Ω
43 330Ω
77 330Ω
38
70
41
73
44
76
G1 A
+ A
G2 A
~ A
G1 B
+ B
G2 B
~ B
G1 C
+ C
G2 C
~ C
AF
AR
BF
BR
CF
CR
INLAND MOTOR DIVISION
RADFORD
VIRGINIA
SUPPRESSION CARD
SUP 2
PART LIST NO PL-78354
78354-1
5



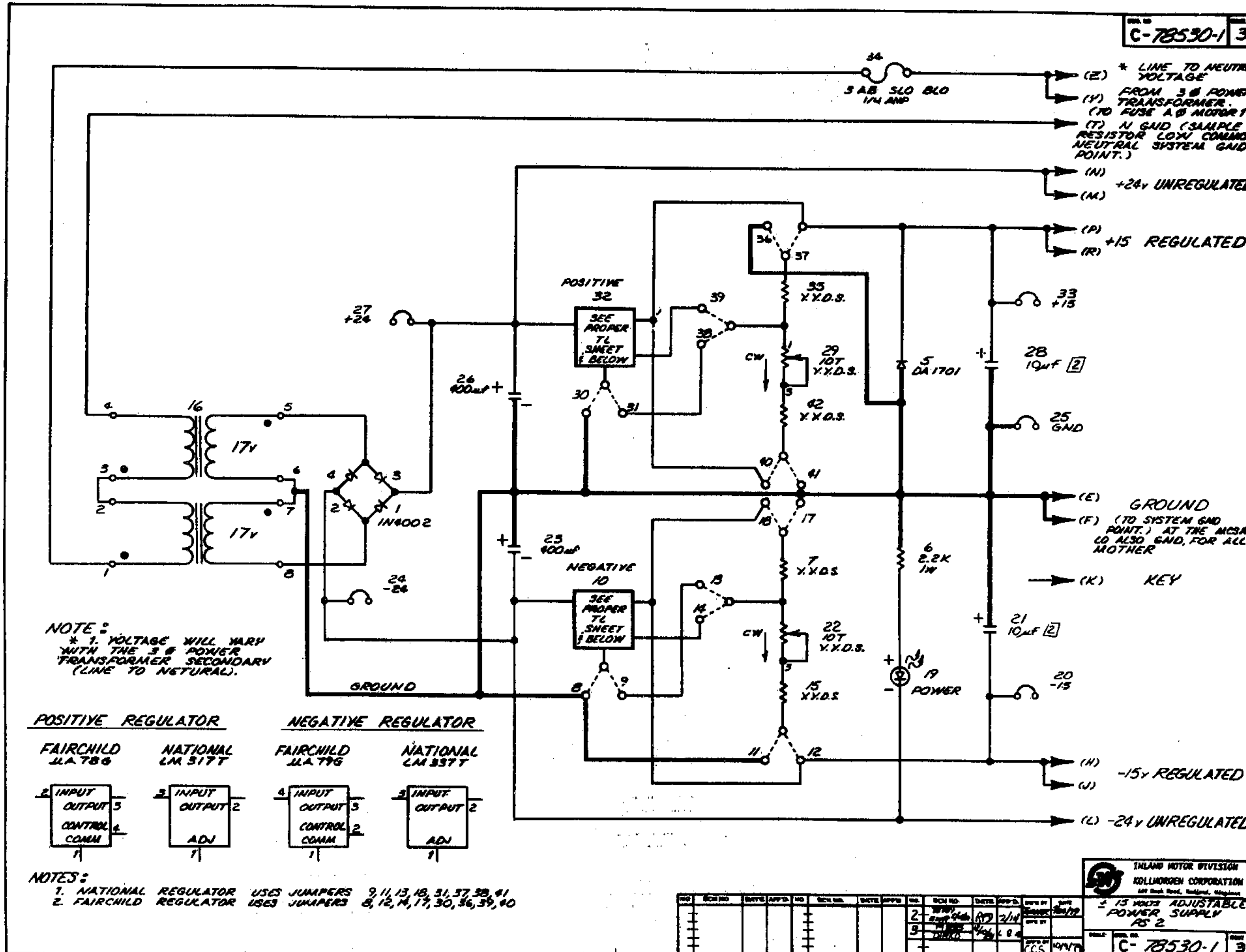
NO	ECN NO	BY	DATE	APP'D
2	79450	SDD	2/11/82	L.G.G.

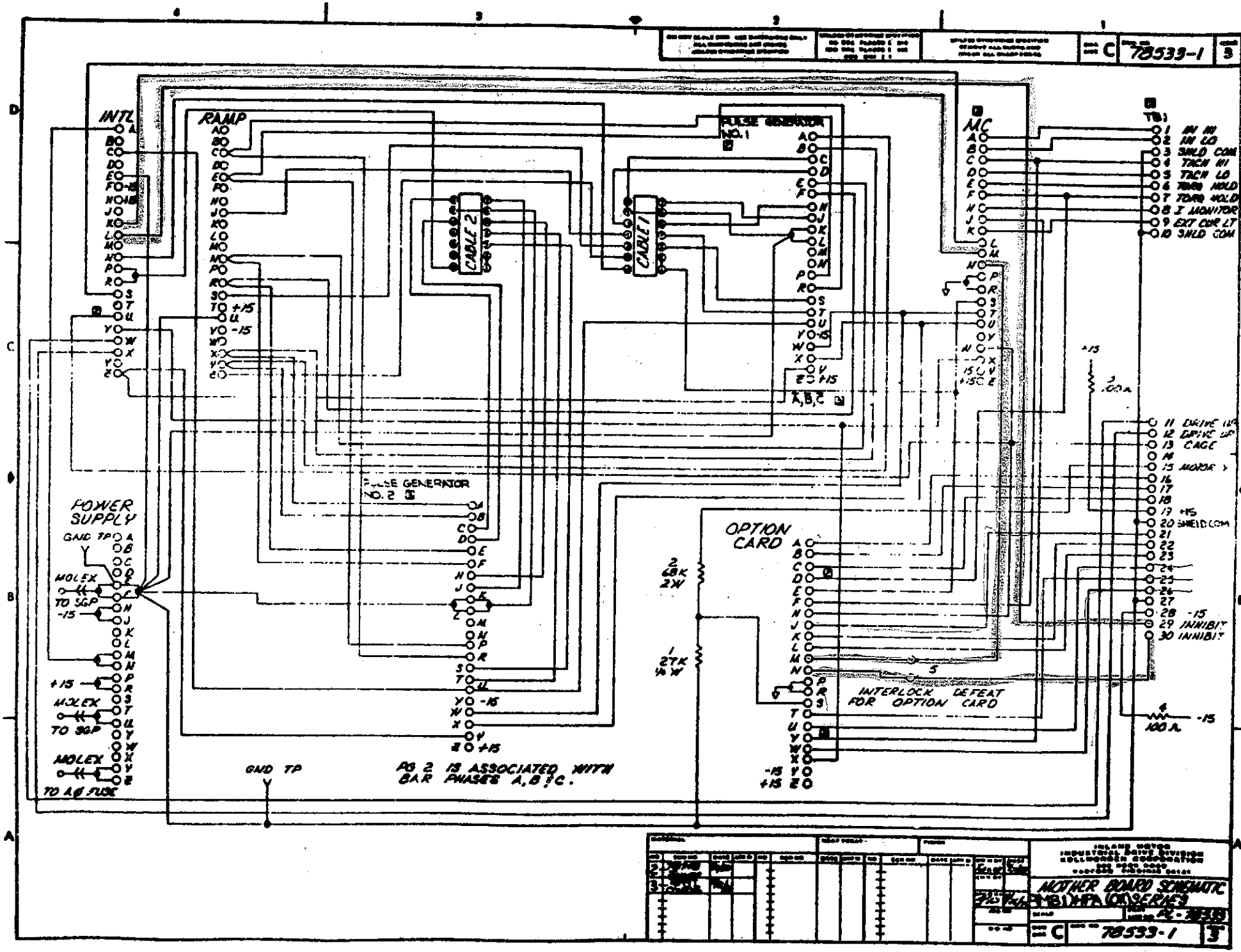
INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
600 Rock Road, Radford, Virginia

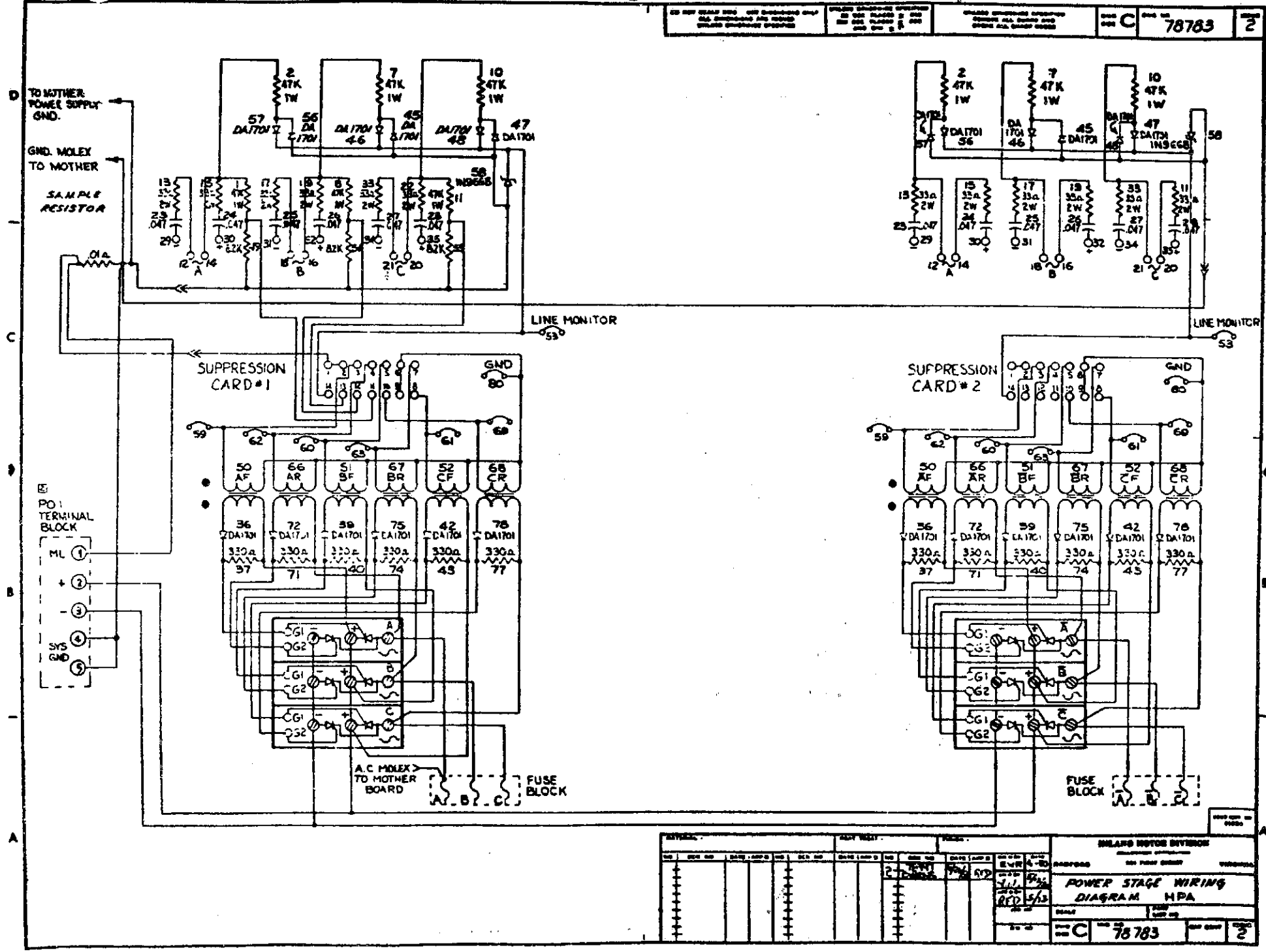
DWN BY TMG DATE 2/21
CH'K BY
APP'D RFD 7/23

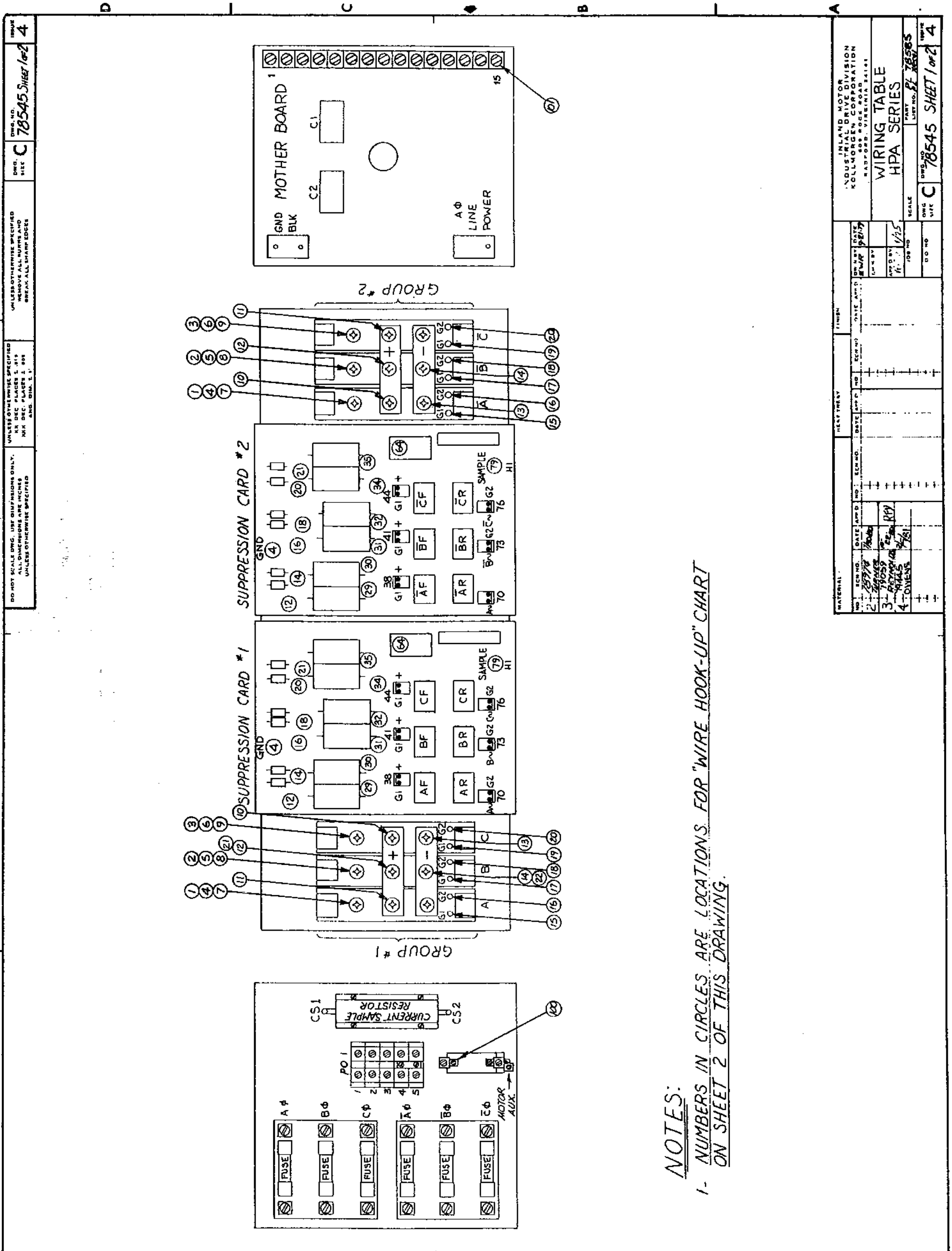
SUPPRESSION CARD
SUP 3

SCALE: N/A DWG. NO. C-79047-1 ISSUE 2


C-78530-1 3
* LINE TO NEUTRAL VOLTAGE
FROM 3 Ø POWER TRANSFORMER. (TO FUSE A Ø MOTOR 1)
(T) N GND (SAMPLE RESISTOR LOW COMMON NEUTRAL SYSTEM GND POINT.)
34
3 AB SLO BLO 1/4 AMP
(E)
(Y)
(N)
(M)
+24v UNREGULATED
(P)
(R)
+15 REGULATED
POSITIVE 32
SEE PROPER TL SHEET & BELOW
27 +24
26 400μf
30
31
39
38
36
37
35 Y.X.D.S.
29 10T Y.X.D.S.
42 Y.X.D.S.
CW
40
41
5 DA1701
28 10μf 2
33 +15
25 GND
(E)
GROUND
(F) (TO SYSTEM GND POINT.) AT THE MCSR CO ALSO GND, FOR ALL MOTHER
(K) KEY
16
17v
17v
1 IN4002
24 -24
25 400μf
NEGATIVE 10
SEE PROPER TL SHEET & BELOW
13
14
16
17
7 Y.X.D.S.
22 10T Y.X.D.S.
15 X.X.D.S.
6 2.2K 1W
19 POWER
21 10μf 2
20 -15
8
9
11
12
(H)
(J)
-15v REGULATED
(L) -24v UNREGULATED
GROUND
NOTE:
* 1. VOLTAGE WILL VARY WITH THE 3 Ø POWER TRANSFORMER SECONDARY (LINE TO NETURAL).
POSITIVE REGULATOR
FAIRCHILD μA786
INPUT OUTPUT CONTROL COMM
NATIONAL LM317T
INPUT OUTPUT ADJ
NEGATIVE REGULATOR
FAIRCHILD μA796
INPUT OUTPUT CONTROL COMM
NATIONAL LM337T
INPUT OUTPUT ADJ
NOTES:
1. NATIONAL REGULATOR USES JUMPERS 9,11,13,18,31,37,38,41
2. FAIRCHILD REGULATOR USES JUMPERS 8,12,14,17,30,36,39,40
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
± 15 VOLTS ADJUSTABLE POWER SUPPLY PS 2
C-78530-1 3
CCS


INTL
RAMP
PULSE GENERATOR NO. 1
CABLE 2
CABLE 1
MC
TB1
1 AV IN
2 AV LO
3 SHLD COM
4 TACH HI
5 TACH LO
6 TORQ HOLD
7 TORQ HOLD
8 I MONITOR
9 EXT CUR LT
10 SHLD COM
POWER SUPPLY
GND TP
MOLEX
TO SGP
-15
+15
MOLEX
TO SGP
MOLEX
TO AC FUSE
PULSE GENERATOR NO. 2
OPTION CARD
2 68K 2W
1 27K 1/4 W
INTERLOCK DEFEAT FOR OPTION CARD
GND TP
PG 2 IS ASSOCIATED WITH BAR PHASES A, B & C.
11 DRIVE UP
12 DRIVE UP
13 CAGE
15 MOTOR
17 +15
20 SHIELD COM
28 -15
29 INHIBIT
30 INHIBIT
100 A
-15
+15
MOTHER BOARD SCHEMATIC
78533-1


TO MOTHER POWER SUPPLY GND.
GND. MOLEX TO MOTHER
SAMPLE RESISTOR
LINE MONITOR
SUPPRESSION CARD #1
SUPPRESSION CARD #2
GND
PO1 TERMINAL BLOCK
ML
SYS GND
A.C MOLEX TO MOTHER BOARD
FUSE BLOCK
POWER STAGE WIRING DIAGRAM HPA
78783



MOTHER BOARD
GND BLK
AΦ LINE POWER
C1
C2
GROUP #2
GROUP #1
SUPPRESSION CARD #2
SUPPRESSION CARD #1
SAMPLE
CURRENT SAMPLE RESISTOR
CS1
CS2
PO 1
MOTOR AUX.
AΦ
BΦ
CΦ
FUSE
NOTES:
1- NUMBERS IN CIRCLES ARE LOCATIONS FOR "WIRE HOOK-UP" CHART ON SHEET 2 OF THIS DRAWING.
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
WIRING TABLE
HPA SERIES
C 78545 SHEET 1 OF 2
ISSUE 4

LIGHT WIRING (40 & 85 AMP UNITS)

(GATE LEADS & SNUBBERS - #20 AWG, GROUNDS & POWER - #18 AWG)

FUNCTION		COLOR	NO. OF WIRES	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
GATE LEADS (12) TWISTED PAIRS	SCR GROUP #1 & SC #1 AF	WHT	1	10	SCR A - 15	SCR GATE PIN	SC 38 G1	NOTE 1
		ORNG	1	10	(+) BUS - 11	R4161GS *	SC 38 +	
	BF	WHT	1	10	SCR B -17	SCR GATE PIN	SC 41 G1	NOTE 1
		GRN	1	10	(+) BUS - 11	R4161GS *	SC 41 +	
	CF	WHT	1	11	SCR C -19	SCR GATE PIN	SC 44 G1	NOTE 1
		GRY	1	11	(+) BUS - 11	R4161GS *	SC 44 +	
	AR	WHT	1	10	SCR A - 16	SCR GATE PIN	SC 70 G2	NOTE 1
		RED	1	10	SCR A - 7	R4268SF *	SC 70 A~	
	BR	WHT	1	11	SCR B - 18	SCR GATE PIN	SC 73 G2	NOTE 1
		BLK	1	11	SCR B - 8	R4268SF *	SC 73 B~	
	CR	WHT	1	12	SCR C - 20	SCR GATE PIN	SC 76 G2	NOTE 1
		BLU	1	12	SCR C - 9	R4268SF *	SC 76 C~	
	SCR GROUP #2 & SC #2 AF	WHT	1	10	SCR A - 15	SCR GATE PIN	SC 38 G1	NOTE 1
		ORNG	1	10	(+) BUS - 11	R4161GS *	SC 38 +	
	BF	WHT	1	10	SCR B -17	SCR GATE PIN	SC 41 G1	NOTE 1
		GRN	1	10	(+) BUS - 11	R4161GS *	SC 41 +	
	CF	WHT	1	11	SCR C - 19	SCR GATE PIN	SC 44 G1	NOTE 1
		GRY	1	11	(+) BUS - 11	R4161GS *	SC 44 +	
	AR	WHT	1	10	SCR A - 16	SCR GATE PIN	SC 70 G2	NOTE 1
		RED	1	10	SCR A - 7	R4268SF *	SC 70 A~	
	BR	WHT	1	11	SCR B - 18	SCR GATE PIN	SC 73 G2	NOTE 1
		BLK	1	11	SCR B - 8	R4268SF *	SC 73 B~	
	CR	WHT	1	12	SCR C - 20	SCR GATE PIN	SC 76 G2	NOTE 1
		BLU	1	12	SCR C - 9	R4268SF *	SC 76 C~	
SNUBBERS	SCR GROUP #1 & SC #1	RED	1	12½	SCR A - 4	R4161GS *	SC 12	NOTE 2
		RED	1	12½	SCR A - 4		SC 14	
		WHT	1	12	SCR B - 5	R4161GS *	SC 16	
		WHT	1	12	SCR B - 5		SC 18	
		BLU	1	12	SCR C - 6	R4161GS *	SC 20	
		BLU	1	12	SCR C - 6		SC 21	
		ORNG	1	7½	(+) BUS - 10	HDR-63 *	SC 30	
		ORNG	1	7½	(+) BUS - 10		SC 32	
		ORNG	1	7½	(+) BUS - 10		SC 35	
		GRN	1	7½	(-) BUS - 13	HDR-63 *	SC 29	
		GRN	1	7½	(-) BUS - 13		SC 31	
		GRN	1	7½	(-) BUS - 13		SC 34	
	SCR GROUP #2 & SC #2	RED	1	12½	SCR A - 4	R4161GS *	SC 12	
		RED	1	12½	SCR A - 4		SC 14	
		WHT	1	12	SCR B - 5	R4161GS *	SC 16	
		WHT	1	12	SCR B - 5		SC 18	
		BLU	1	12	SCR C - 6	R4161GS *	SC 20	
		BLU	1	12	SCR C - 6		SC 21	
		ORNG	1	7½	(+) BUS - 10	HDR-63 *	SC 30	
		ORNG	1	7½	(+) BUS - 10		SC 32	
		ORNG	1	7½	(+) BUS - 10		SC 35	
		GRN	1	7½	(-) BUS - 13	HDR-63 *	SC 29	
		GRN	1	7½	(-) BUS - 13		SC 31	
		GRN	1	7½	(-) BUS - 13		SC 34	
GROUND		BLK	1	52	CS - 1	SOLDER	MB - GND	
		BLK	1	52	CS - 1		MB - GND	
		BLK	1	12	CS - 1		SC1 - 4	
		BLK	1	16	CS - 1		SC2 - 4	
CURRENT SAMPLE HIGH		RED	1	24	CS - 2		SC1 - 79	
POWER		RED	1	60	A Φ FUSE	FUSE BLOCK	MB - A Φ LINE PWR	
RIBBON CABLE (A-78376)		VARIES	14	28	SC1 - 64	MALE DIP PLUG	MB - C1	MALE DIP PLUG
		VARIES	14	23	SC2 - 64	MALE DIP PLUG	MB - C2	MALE DIP PLUG
		WHT	1(=20)	54	MOL - 100	R4268SF *	MB - (15) 101	BS41552F *

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

UNLESS OTHERWISE SPECIFIED: XX DEC. PLACES ± .01; XXX DEC. PLACES ± .005; ANG. DIM. ± 1°

UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE C | DWG. NO. 78545 Sheet 2 of 2 | REV. 4

HEAVY WIRING - 40 AMP UNIT

FUNCTION	COLOR	NO. OF WIRES	GAGE	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
A Φ	RED	1	12	12	SCR A - 1	HDR-63 *	A Φ FUSE	FUSE BLOCK
B Φ	WHT	1	12	12	SCR B - 2		B Φ FUSE	
C Φ	BLU	1	12	12	SCR C - 3		C Φ FUSE	
Ā Φ	RED	1	12	29	SCR Ā - 1		Ā Φ FUSE	
B̄ Φ	WHT	1	12	29	SCR B̄ - 2		B̄ Φ FUSE	
C̄ Φ	BLU	1	12	29	SCR C̄ - 3		C̄ Φ FUSE	
(+) OUT	ORNG	1	10	15	(+) BUS 21 GROUP 1		PO1 - 2	SAK 35 * *
(-) OUT	GRN	1	10	15	(-) BUS 22 GROUP 1		PO1 - 3	SAK 35 * *
MOTOR LO	BLK	1	10	9	CS - 2	SOLDER	PO1 - 1	SAK 35 * *
GROUND	BLK	1	10	9	CS - 1	SOLDER	PO1 - 5	SAK 35 * *
(+) BUS INTERCONNECT	ORNG	1	10	17½	(+) BUS 12 GROUP 1	HDR-63 *	(+) BUS 12 GROUP 2	HDR-63 *
(-) BUS INTERCONNECT	GRN	1	10	18½	(-) BUS 14 GROUP 1	HDR-63 *	(-) BUS 14 GROUP 2	HDR-63 *

HEAVY WIRING - 85 AMP UNIT

FUNCTION	COLOR	NO. OF WIRES	GAGE	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
A Φ	RED	1	10	12	SCR A - 1	HDR-63 *	A Φ FUSE	FUSE BLOCK
B Φ	WHT	1	10	12	SCR B - 2		B Φ FUSE	
C Φ	BLU	1	10	12	SCR C - 3		C Φ FUSE	
Ā Φ	RED	1	10	29	SCR Ā - 1		Ā Φ FUSE	
B̄ Φ	WHT	1	10	29	SCR B̄ - 2		B̄ Φ FUSE	
C̄ Φ	BLU	1	10	29	SCR C̄ - 3		C̄ Φ FUSE	
(+) OUT	ORNG	2	8	15 EACH	(+) BUS 21 GROUP 1	(2) R3031 BF *	PO1 - 2	SAK 35 * *
(-) OUT	GRN	2	8	15 EACH	(-) BUS 22 GROUP 1	(2) R3031 BF *	PO1 - 3	SAK 35 * *
MOTOR LOW	BLK	2	8	9 EACH	CS - 2	SOLDER	PO1 - 1	SAK 35 * *
GROUND	BLK	2	8	9 EACH	CS - 1	SOLDER	PO1 - 5	SAK 35 * *
(+) BUS INTERCONNECT	ORNG	1	8	17½	(+) BUS 12 GROUP 1	R3031 BF *	(+) BUS 12 GROUP 2	R3031 BF *
(-) BUS INTERCONNECT	GRN	1	8	18½	(-) BUS 14 GROUP 1	R3031 BF *	(-) BUS 14 GROUP 1	R3031 BF *

* - HOLLINGSWORTH OR EQUIVALENT

** - WEIDMULLER OR EQUIVALENT

NOTES:

1- EACH ASSEMBLY REQUIRES: (2) MOLEX TERM. #08-56-0106
(1) MOLEX CONN. #09-50-3021

2- EACH WIRE REQUIRES: (1) MOLEX PIN (FEMALE) #1381
(1) MOLEX HOUSING #1691R

3- SC - SUPPRESSION CARD, MB - MOTHER BOARD, CS - CURRENT SAMPLE RESISTOR
MOL = MOTOR OVERLOAD RELAY

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.

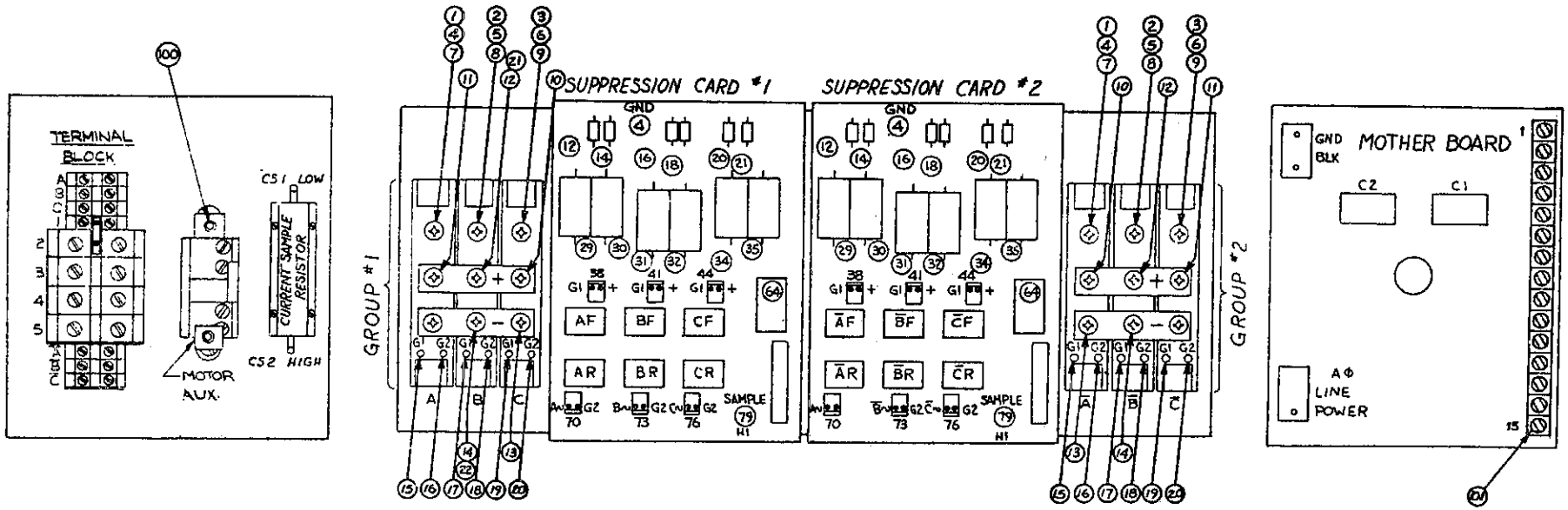
DWN BY | DATE
CHK'D BY
APP'D BY
JOB NO.
D.O. NO.

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
209 ROCK ROAD
RADFORD, VIRGINIA 24141

SEE SHEET #1

SCALE: | PART LIST NO.

DWG SIZE C | DWG. NO. 78545 Sheet 2 of 2 | REV. 4



NOTES:

1- NUMBERS IN CIRCLES ARE LOCATIONS FOR "WIRE HOOK-UP" CHART ON SHEET 2 OF THIS DRAWING.

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
WIRING TABLE
HPA SERIES
DWG SIZE C 78871 SHEET 1 of 2 ISSUE 2

LIGHT WIRING (45 & 85 AMP UNITS)

(GATE LEADS & SNUBBERS - #20 AWG, GROUNDS & POWER - #18 AWG)

FUNCTION			COLOR	NO. OF WIRES	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
GATE LEADS (12) TWISTED PAIRS	SCR GROUP #1 & SC #1	AF	WHT	1	10	SCR A - 15	SCR GATE PIN	SC 38 G1	NOTE 1
			ORNG	1	10	(+) BUS - 11	R4161GS *	SC 38 +	
		BF	WHT	1	10	SCR B - 17	SCR GATE PIN	SC 41 G1	NOTE 1
			GRN	1	10	(+) BUS - 11	R4161GS *	SC 41 +	
		CF	WHT	1	11	SCR C - 19	SCR GATE PIN	SC 44 G1	NOTE 1
			GRY	1	11	(+) BUS - 11	R4161GS *	SC 44 +	
		AR	WHT	1	10	SCR A - 16	SCR GATE PIN	SC 70 G2	NOTE 1
			RED	1	10	SCR A - 7	R4268SF *	SC 70 A~	
		BR	WHT	1	11	SCR B - 18	SCR GATE PIN	SC 73 G2	NOTE 1
			BLK	1	11	SCR B - 8	R4268SF *	SC 73 B~	
		CR	WHT	1	12	SCR C - 20	SCR GATE PIN	SC 76 G2	NOTE 1
			BLU	1	12	SCR C - 9	R4268SF *	SC 76 C~	
	SCR GROUP #2 & SC #2	AF	WHT	1	10	SCR A - 15	SCR GATE PIN	SC 38 G1	NOTE 1
			ORNG	1	10	(+) BUS - 11	R4161GS *	SC 38 +	
		BF	WHT	1	10	SCR B - 17	SCR GATE PIN	SC 41 G1	NOTE 1
			GRN	1	10	(-) BUS - 11	R4161GS *	SC 41 +	
		CF	WHT	1	11	SCR C - 19	SCR GATE PIN	SC 44 G1	NOTE 1
			GRY	1	11	(+) BUS - 11	R4161GS *	SC 44 +	
		AR	WHT	1	10	SCR A - 16	SCR GATE PIN	SC 70 G2	NOTE 1
			RED	1	10	SCR A - 7	R4268SF *	SC 70 A~	
		BR	WHT	1	11	SCR B - 18	SCR GATE PIN	SC 73 G2	NOTE 1
			BLK	1	11	SCR B - 8	R4268SF *	SC 73 B~	
		CR	WHT	1	12	SCR C - 20	SCR GATE PIN	SC 76 G2	NOTE 1
			BLU	1	12	SCR C - 9	R4268SF *	SC 76 C~	
SNUBBERS	SCR GROUP #1 & SC #1		RED	1	12½	SCR A-4	R4161GS *	SC 12	NOTE 2
			RED	1	12½	SCR A-4		SC 14	
			WHT	1	12	SCR B-5	R4161GS *	SC 16	
			WHT	1	12	SCR B-5		SC 18	
			BLU	1	12	SCR C-6	R4161GS *	SC 20	
			BLU	1	12	SCR C-6		SC 21	
			ORNG	1	7½	(+) BUS -10	HDR-63 *	SC 30	
			ORNG	1	7½	(+) BUS -10		SC 32	
			ORNG	1	7½	(+) BUS -10		SC 35	
			GRN	1	7½	(-) BUS -13	HDR-63 *	SC 29	
			GRN	1	7½	(-) BUS -13		SC 31	
			GRN	1	7½	(-) BUS -13		SC 34	
	SCR GROUP #2 & SC #2		RED	1	12½	SCR A-4	R4161GS *	SC 12	
			RED	1	12½	SCR A-4		SC 14	
			WHT	1	12	SCR B-5	R4161GS *	SC 16	
			WHT	1	12	SCR B-5		SC 18	
			BLU	1	12	SCR C-6	R4161GS *	SC 20	
			BLU	1	12	SCR C-6		SC 21	
			ORNG	1	7½	(+) BUS -10	HDR-63 *	SC 30	
			ORNG	1	7½	(+) BUS -10		SC 32	
			ORNG	1	7½	(+) BUS -10		SC 35	
			GRN	1	7½	(-) BUS -13	HDR-63 *	SC 29	
			GRN	1	7½	(-) BUS -13		SC 31	
			GRN	1	7½	(-) BUS -13		SC 34	
GROUND			BLK	1	52	CS - 1	SOLDER	MB - GND	
			BLK	1	52	CS - 1		MB - GND	
			BLK	1	12	CS - 1		SC1 - 4	
			BLK	1	16	CS - 1		SC2 - 4	
CURRENT SAMPLE HIGH			RED	1	24	CS - 2		SC1 - 79	
POWER			RED	1	60	A Φ TERM.	DWG B-78877-2	MB - A Φ LINE PWR	MALE DIP PLUG
RIBBON CABLE (A-78375)			VARIES	14	28	SC1 - 64	MALE DIP PLUG	MB - C1	MALE DIP PLUG
			VARIES	14	23	SC2 - 64	MALE DIP PLUG	MB - C2	MALE DIP PLUG
			WHT	1(#20)	54	MOL - 100	R-1268SF *	MB - (15) 101	BS41552F *

HEAVY WIRING - 45 AMP UNIT

FUNCTION	COLOR	NO. OF WIRES	GAGE	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
A Φ	RED	1	12	12	SCR A - 1	HDR-63 *	A Φ TERM.	DWG B-78877-2
B Φ	WHT	1	12	12	SCR B - 2		B Φ TERM.	
C Φ	BLU	1	12	12	SCR C - 3		C Φ TERM.	
Ā Φ	RED	1	12	29	SCR Ā - 1		Ā Φ TERM.	
B̄ Φ	WHT	1	12	29	SCR B̄ - 2		B̄ Φ TERM.	
C̄ Φ	BLU	1	12	29	SCR C̄ - 3		C̄ Φ TERM.	
(+) OUT	ORNG	1	10	15	(+) BUS 21 GROUP 1		TERM. - 4	DWG. B-78877-1
(-) OUT	GRN	1	10	15	(-) BUS 22 GROUP 1		TERM - 3	
MOTOR LO	BLK	1	10	9	CS - 2	SOLDER	TERM - 5	
NEUTRAL	BLK	1	10	9	CS - 1	SOLDER	TERM. - 2	
(+) BUS INTERCONNECT	ORNG	1	10	17½	(+) BUS 12 GROUP 1	HDR-63 *	(+) BUS 12 GROUP 2	HDR-63 *
(-) BUS INTERCONNECT	GRN	1	10	18½	(-) BUS 14 GROUP 1	HDR-63 *	(-) BUS 14 GROUP 2	HDR-63 *

HEAVY WIRING - 85 AMP UNIT

FUNCTION	COLOR	NO. OF WIRES	GAGE	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
A Φ	RED	1	10	12	SCR A - 1	HDR-63 *	A Φ TERM.	DWG. B-78877-2
B Φ	WHT	1	10	12	SCR B - 2		B Φ TERM	
C Φ	BLU	1	10	12	SCR C - 3		C Φ TERM	
Ā Φ	RED	1	10	29	SCR Ā - 1		Ā Φ TERM	
B̄ Φ	WHT	1	10	29	SCR B̄ - 2		B̄ Φ TERM	
C̄ Φ	BLU	1	10	29	SCR C̄ - 3		C̄ Φ TERM	
(+) OUT	ORNG	2	8	15 EACH	(+) BUS 21 GROUP 1	(2) R3031BF *	TERM. - 4	DWG. B-78877
(-) OUT	GRN	2	8	15 EACH	(-) BUS 22 GROUP 1	(2) R3031BF *	TERM - 3	
MOTOR LOW	BLK	2	8	9 EACH	CS - 2	SOLDER	TERM - 5	
NEUTRAL	BLK	2	8	9 EACH	CS - 1	SOLDER	TERM - 2	
(+) BUS INTERCONNECT	ORNG	1	8	17½	(+) BUS 12 GROUP 1	R3031BF *	(+) BUS 12 GROUP 2	R3031BF *
(-) BUS INTERCONNECT	GRN	1	8	18½	(-) BUS 14 GROUP 1	R3031BF *	(-) BUS 14 GROUP 1	R3031BF *

* - HOLLINGSWORTH OR EQUIVALENT

** - WEIDMULLER OR EQUIVALENT

NOTES:

1- EACH ASSEMBLY REQUIRES: (2) MOLEX TERM. #08-56-0106
(1) MOLEX CONN. #09-50-3021

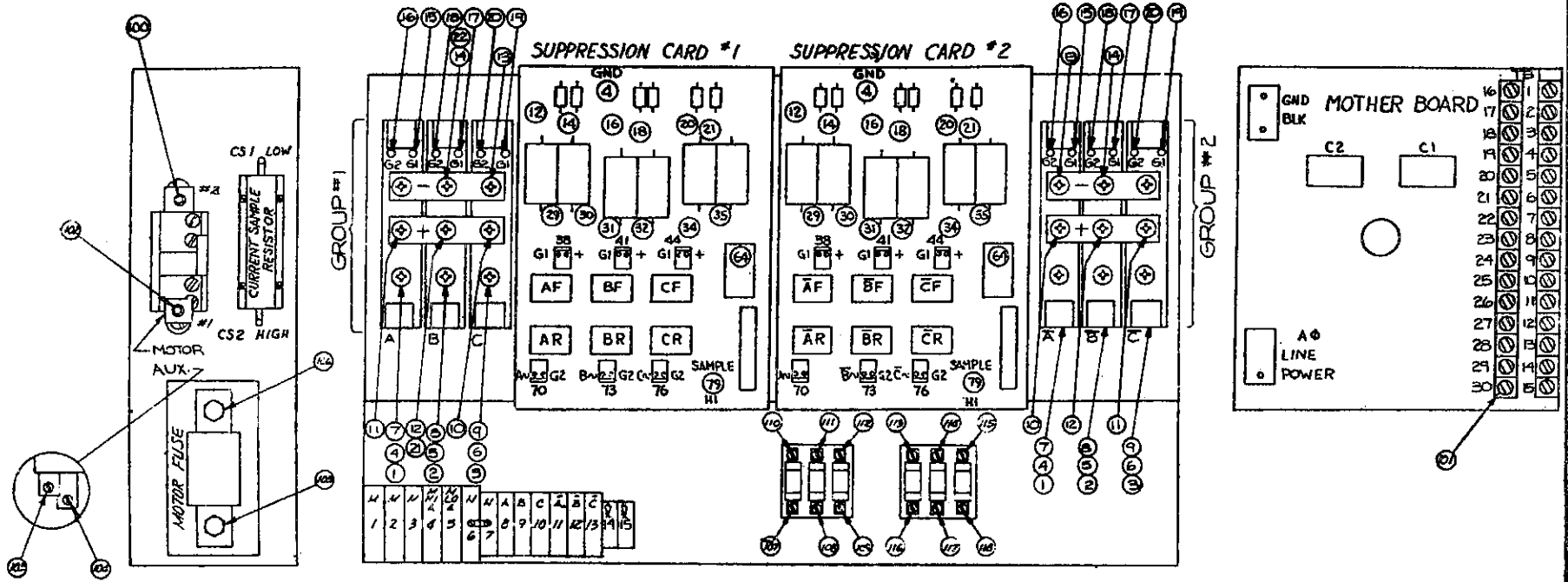
2- EACH WIRE REQUIRES: (1) MOLEX PIN (FEMALE) #1381
(1) MOLEX HOUSING #1691R

3- SC - SUPPRESSION CARD, MB - MOTHER BOARD, CS - CURRENT SAMPLE RESISTOR
MOL = MOTOR OVERLOAD RELAY

SEE SHEET #1

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
535 ROCK ROAD
RADFORD VIRGINIA 24141

DWG NO. 78871 SHEET 2 OF 2 REV 2



NOTES:

1. NUMBERS IN CIRCLES ARE LOCATIONS FOR "WIRE HOOK-UP" CHART ON SHEET 2 OF THIS DRAWING.

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
WIRING TABLE
HPAOX-100-X11
SCALE N.T.S.
C 79041 SHT. 1 OF 2 REV 2

LIGHT WIRING (100 AMP UNITS)

(GATE LEADS & SNUBBERS - #20 AWG, GROUNDS & POWER - #18 AWG)

FUNCTION			COLOR	NO. OF WIRES	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
GATE LEADS (12) TWISTED PAIRS	SCR GROUP #1 & SC#1	AF	WHT	1	10	SCR A-15	SCR GATE PIN	SC 38 G1	NOTE 1
			ORNG	1	10	(+) BUS-11	R4161GS *	SC 38 +	
		BF	WHT	1	10	SCR B-17	SCR GATE PIN	SC 41 G1	NOTE 1
			GRN	1	10	(+) BUS-11	R4161GS *	SC 41 +	
		CF	WHT	1	11	SCR C-19	SCR GATE PIN	SC 44 G1	NOTE 1
			GRY	1	11	(+) BUS-11	R4161GS *	SC 44 +	
		AR	WHT	1	10	SCR A-16	SCR GATE PIN	SC 70 G2	NOTE 1
			RED	1	10	SCR A-7	R42683F *	SC 70 A~	
		BR	WHT	1	11	SCR B-18	SCR GATE PIN	SC 73 G2	NOTE 1
			BLK	1	11	SCR B-8	R4268SF *	SC 73 B~	
		CR	WHT	1	12	SCR C-20	SCR GATE PIN	SC 76 G2	NOTE 1
			BLU	1	12	SCR C-9	R42683F *	SC 76 C~	
	SCR GROUP #2 & SC#2	AF	WHT	1	10	SCR $\bar{A}$-15	SCR GATE PIN	SC 38 G1	NOTE 1
			ORNG	1	10	(+) BUS-11	R4161GS *	SC 38 +	
		BF	WHT	1	10	SCR $\bar{B}$-17	SCR GATE PIN	SC 41 G1	NOTE 1
			GRN	1	10	(+) BUS-11	R4161GS *	SC 41 +	
		CF	WHT	1	11	SCR $\bar{C}$-19	SCR GATE PIN	SC 44 G1	NOTE 1
			GRY	1	11	(+) BUS-11	R4161GS *	SC 44 +	
		AR	WHT	1	10	SCR $\bar{A}$-16	SCR GATE PIN	SC 70 G2	NOTE 1
			RED	1	10	SCR $\bar{A}$-7	R42683F *	SC 70 A~	
		BR	WHT	1	11	SCR $\bar{B}$-18	SCR GATE PIN	SC 73 G2	NOTE 1
			BLK	1	11	SCR $\bar{B}$-8	R4268SF *	SC 73 B~	
		CR	WHT	1	12	SCR $\bar{C}$-20	SCR GATE PIN	SC 76 G2	NOTE 1
			BLU	1	12	SCR $\bar{C}$-9	R4268SF *	SC 76 C~	
SNUBBERS	SCR GROUP #1 & SC#1		RED	1	12½	SCR A-4	R4161GS *	SC 12	NOTE 2
			RED	1	12½	SCR A-4		SC 14	
			WHT	1	12	SCR B-5	R4161GS *	SC 16	
			WHT	1	12	SCR B-5		SC 18	
			BLU	1	12	SCR C-6	R4161GS *	SC 20	
			BLU	1	12	SCR C-6		SC 21	
			ORNG	1	7½	(+) BUS-10	HDR-63 *	SC 30	
			ORNG	1	7½	(+) BUS-10		SC 32	
			ORNG	1	7½	(+) BUS-10		SC 35	
			GRN	1	7½	(-) BUS-13	HDR-63 *	SC 29	
			GRN	1	7½	(-) BUS-13		SC 31	
			GRN	1	7½	(-) BUS-13		SC 34	
	SCR GROUP #2 & SC#2		RED	1	12½	SCR $\bar{A}$-4	R4161GS *	SC 12	
			RED	1	12½	SCR $\bar{A}$-4		SC 14	
			WHT	1	12	SCR $\bar{B}$-5	R4161GS *	SC 16	
			WHT	1	12	SCR $\bar{B}$-5		SC 18	
			BLU	1	12	SCR $\bar{C}$-6	R4161GS *	SC 20	
			BLU	1	12	SCR $\bar{C}$-6		SC 21	
			ORNG	1	7½	(+) BUS-10	HDR-63 *	SC 30	
			ORNG	1	7½	(+) BUS-10		SC 32	
			ORNG	1	7½	(+) BUS-10		SC 35	
			GRN	1	7½	(-) BUS-13	HDR-63 *	SC 29	
			GRN	1	7½	(-) BUS-13		SC 31	
			GRN	1	7½	(-) BUS-13		SC 34	
GROUND			BLK	1	52	CS-1	SOLDER	MB-GND	
			BLK	1	52	CS-1		MB-GND	
			BLK	1	12	CS-1		SC1-4	
			BLK	1	16	CS-1		SC2-4	
CURRENT SAMPLE HIGH			RED	1	24	CS-2		SC1-79	
POWER			RED	1	60	A0 TERM.	DWG B-78877-2	MB-A0 LINE PWR	
RIBBON CABLE (A-78376)			VARIES	14	28	SC1-64	MALE DIP PLUG	MB-C1	MALE DIP PLUG
			VARIES	14	23	SC2-64	MALE DIP PLUG	MB-C2	MALE DIP PLUG
			WHT	1	54	MOL-100	R4268SF *	MB-(15)101	BS41552F *
MOL AUX CONTACT			WHT	1		MOL-103	R4161GS *	TERM-14	B78477-2
			WHT	1		MOL-106	R4161GS *	TERM 15	B78477-2

HEAVY WIRING - 100 AMP UNIT

FUNCTION	COLOR	NO. OF WIRES	GAGE	LENGTH (INCHES)	FROM LOCATION	FROM TERMINATION	TO LOCATION	TO TERMINATION
A0	RED	1	10		FUSE-107	SCREW TERM	A0 TERM 8	DWG B-78877-2
B0	WHT	1	10		FUSE-108		B0 TERM 9	
C0	BLU	1	10		FUSE-109		C0 TERM 10	
$\bar{A}$0	RED	1	10		FUSE-116		$\bar{A}$0 TERM 11	
$\bar{B}$0	WHT	1	10		FUSE-117		$\bar{B}$0 TERM 12	
$\bar{C}$0	BLU	1	10		FUSE-118		$\bar{C}$0 TERM 13	DWG B-78877-2
	RED	1	10		FUSE-110		SCR A-1	HDR-63 *
	WHT	1	10		FUSE-111		SCR B-2	
	BLU	1	10		FUSE-112		SCR C-3	
	RED	1	10		FUSE-113		SCR $\bar{A}$-1	
	WHT	1	10		FUSE-114		SCR $\bar{B}$-2	
	BLU	1	10		FUSE-115	SCREW TERM	SCR $\bar{C}$-3	HDR-63 *
(+) OUT	ORN	1	6		(+)BUS 21, GROUP 1	R4001BF *	TERM-1	DWG B-78877
(-) OUT	GRN	1	6		(-)BUS 21, GROUP 1	R4001BF *	TERM-2	DWG B-78877
CHOKE CT	ORN	1	6		MOTOR FUSE 105	R4002BF **	TERM-3	DWG B-78877
	GRN	1	6		MOTOR FUSE 106	R4002BF **	MOL-102	SCREW TERM
MOTOR H1	GRN	1	6		MOL-100	SCREW TERM	TERM-4	DWG B-78877
MOTOR L0	BLK	1	6		CS-2	SOLDER	TERM-5	DWG B-78877
NEUTRAL	BLK	1	6		CS-1	SOLDER	TERM-6	DWG B-78877
(+) BUS INTERCONNECT	ORN	1	8	17½	(+) BUS 12, GROUP 1	R3031BF **	(+) BUS 12, GROUP 2	R3031BF **
(-) BUS INTERCONNECT	GRN	1	8	18½	(-) BUS 14, GROUP 1	R3031BF **	(-) BUS 14, GROUP 1	R3031BF **
JUMPER	BLK	1	20	2½	TB-1(8)	SPADE	TB-1(22)	SPADE
JUMPER	BLK	1	20	2	TB-1(24)	SPADE	TB-1(26)	SPADE
JUMPER	BLK	1	20	?	TB-1(29)	SPADE	TB-1(30)	SPADE

SEE NOTE #4

* - HOLLINGSWORTH OR EQUIVALENT

** - WEIDMULLER OR EQUIVALENT

NOTES:

1- EACH ASSEMBLY REQUIRES: (2) MOLEX TERM. #08-56-0106
(1) MOLEX CONN. #09-50-3021

2- EACH WIRE REQUIRES: (1) MOLEX PIN (FEMALE) #1381
(1) MOLEX HOUSING #1691R

3- SC = SUPPRESSION CARD, MB = MOTHER BOARD, CS = CURRENT SAMPLE RESISTOR
MOL = MOTOR OVERLOAD RELAY

4- REQUIRED ONLY WHEN OPTION CARD #3 (OPT. #3) IS USED.

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

UNLESS OTHERWISE SPECIFIED: .XX DEC. PLACES ± .015; .XXX DEC. PLACES ± .005; ANG. DIM. ± 1°

UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE C | DWG. NO. 79041 SHT 2 OF 2 | ISSUE 2

MATERIAL | HEAT TREAT | FINISH

NO.	ECN NO.	DATE	APP'D

DWN BY 7/16/82 | CHK'D BY | APP'D BY | JOB NO. | D.O. NO.

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
601 ROCA ROAD
RADFORD VIRGINIA 24141

SEE SHT #1

SCALE | PART LIST NO.

DWG. SIZE C | DWG. NO. 79041 SHT 2 OF 2 | ISSUE 2

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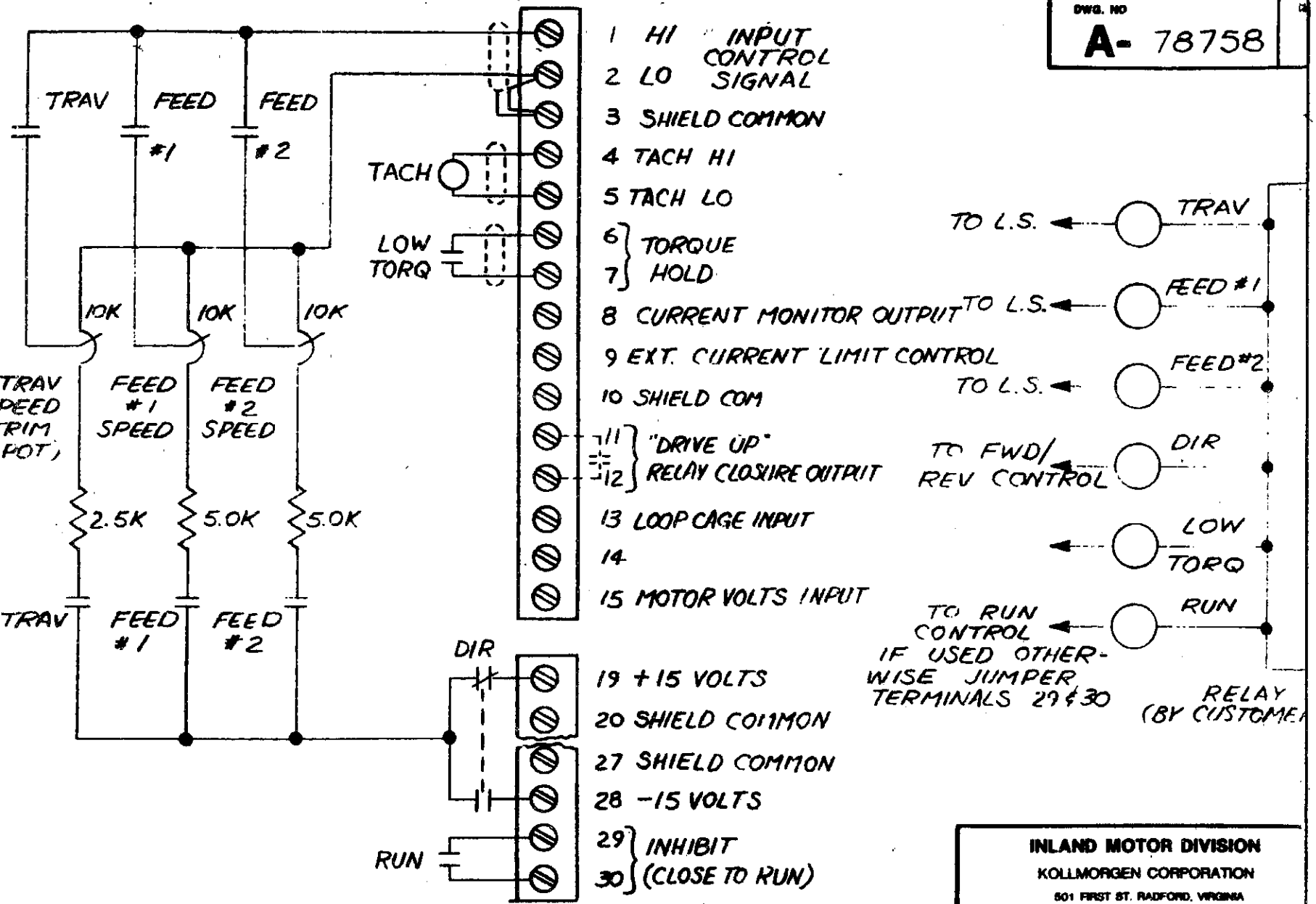
DWG. NO
A- 78758



UNLESS OTHERWISE SPECIFIED
XX DEC. PLACES ±.015
XXX DEC. PLACES ±.005
ANG. DIM. ±1°

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	EWR
DATE	2 22 80
CH'K BY	
APP'D BY	

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

INPUT CIRCUITRY
HPA SERIES

SCALE:

DWG. NO.
A- 78758

VOLTAGE AND CURRENT DATA				
AMPLIFIER MODEL	A-B	A-N	"A"	"B"
HPA 15845	275 V	158 V	30 A	15 A
HPA 15885	275 V	158 V	40 A	85 A

C 78543 2

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

6 PHASE STAR ISOLATION TRANSFORMER

3 Ø INPUT 50 OR 60 HZ

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

[2] EACH SECONDARY PHASE WIRE (A, B, C, A, B, C) MUST BE CONNECTED AS SHOWN.

NOTE: A MUST BE 180° OUT OF PHASE WITH A, B TO BE 180° OUT OF PHASE WITH B AND C TO BE 180° OUT OF PHASE WITH C.

TO NUMERICAL CONTROL OR MACHINE GROUND

THIS IS THE ~~ONLY~~ GROUND TO BE APPLIED TO THE SYSTEM WITH THE ONE EXCEPTION OF TB1 - TERMINAL 2 WHICH CONNECTS TO N/C LO. CONSULT FACTORY FOR OTHER ARRANGEMENTS.

AC POWER INPUT

FUSE BLOCK #1

FUSE BLOCK #2

DIFF INPUT

SHIELD COMMON

TACH

TORQUE HOLD

CURRENT MONITOR OUTPUT

EXTERNAL CURRENT LIMIT CONTROL

SHIELD COMMON

"DRIVE UP" [3] OPEN WHEN DRIVE INHIBITED

LOOP CAGE INPUT

MOTOR VOLTS INPUT

[3] (INTERNALLY WIRED AT FACTORY)

6 PHASE, 12 WAVE, 4 QUADRANT, BI-DIRECTIONAL, FULLY REGENERATIVE, HIGH PERFORMANCE SCR PHASE ANGLE, SERVO DRIVE SYSTEM

VELOCITY INPUT OR POSITION ERROR INPUT (SIGNAL)

+15 OUTPUT FOR CUSTOMER USE

SHIELD COMMON

-15 OUTPUT FOR CUSTOMER USE

INHIBIT (CLOSE TO RUN)

P01

N

MOTOR

MOTOR LO

MOTOR OVERLOAD RELAY

SEE NOTE 4

MOTOR

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

AUXILIARY OVERLOAD CONTACTS LOCATED ON THE ABOVE OVERLOAD RELAY.

FUSE BLOCK #1

FUSE BLOCK #2

P01

1 2 3 4 5

MOL

MOTOR AUX.

NOTES:

1- IMPORTANT- TO AVOID RUNAWAY BEFORE APPLYING POWER, MEASURE 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 TB1 - 6 FOR THE TACH AND TERMINAL POINTS ACROSS THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND (NOT - 6 OR 5).

2- USE TWISTED, SHIELDED WIRE (#15-20 GA) FOR ALL INPUTS ON TB1 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

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

4- RECOMMENDED SLOW-BLOW FUSE (CUSTOMER SUPPLIED AND MOUNTED) SIZED FOR 115VAC. CONT. MOTOR CURRENT RATING TO PROVIDE ADDED MOTOR PROTECTION.

INLAND MOTOR INDUSTRIAL DRIVE DIVISION KOLLMORGEN CORPORATION

SYSTEM WIRING DIAGRAM HPA SERIES (-101,102,-103)

C 78543 2

55

VOLTAGE AND CURRENT DATA				
AMPLIFIER MODEL	A-B	A-N	"A"	"B"
MPA 15845	275V	159V	30A	15A
MPA 15855	275V	159V	40A	25A

* SHIELDS ARE TO BE TERMINATED TO EITHER THE A/C GROUND OR TERMINAL 1, BUT NOT TO BOTH. ONE END OF SHIELD TO BE OPEN AND INSULATED.

6 PHASE STAR ISOLATION TRANSFORMER

3 Ø INPUT 60 OR 60 HZ

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

EACH SECONDARY PHASE (A,B,C,A,B,C MUST BE CONNECTED AS SHOWN.

NOTE: A MUST BE 180° OUT OF PHASE WITH A, B TO BE 180° OUT OF PHASE WITH B AND C TO BE 180° OUT OF PHASE WITH C.

TO NUMERICAL CONTROL OR MACHINE GROUND

THIS IS THE ONLY GROUND TO BE APPLIED TO THE SYSTEM WITH THE ONE EXCEPTION OF TB1 - TERMINAL 2 WHICH CONNECTS TO A/C LO. CONSULT FACTORY FOR OTHER ARRANGEMENTS.

6 PHASE 1/2 WAVE 4 QUADRANT, BI-DIRECTIONAL, FULLY REGENERATIVE, HIGH PERFORMANCE SCR PHASE ANGLE, SERVO DRIVE SYSTEM

DIFF INPUT

HI — VELOCITY INPUT OR POSITION ERROR INPUT SIGNAL

LO

SHIELD COMMON

TACH

TORQUE HOLD

CURRENT MONITOR OUTPUT

EXTERNAL CURRENT LIMIT CONTROL

SHIELD COMMON

"DRIVE UP" RELAY CLOSURE OUTPUT

LOOP CAGE INPUT

MOTOR VOLTS INPUT FROM POINT "X" (INTERNALLY WIRED AT FACTORY)

+15 OUTPUT FOR CUSTOMER USE

SHIELD COMMON

SHIELD COMMON

-15 OUTPUT FOR CUSTOMER USE

INHIBIT (CLOSE TO RUN)

MOTOR

MOTOR LO

MOTOR OVERLOAD RELAY

SEE NOTE 4

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

AUXILIARY OVERLOAD CONTACTS LOCATED ON THE ABOVE OVERLOAD RELAY.

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 TB1-4 FOR THE TACH AND TERMINAL POINT PD1-3 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND (PDT-1 OR 2).

2- USE TWISTED, SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON TB1 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

3- ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN AC TYPE SUPPRESSOR AS A AND 1 AT IS SUGGESTED.

4- RECOMMENDED SLOW-BLOW FUSE (CUSTOMER SUPPLIED AND MOUNTED) SIZED FOR APPROX. CONT. MOTOR CURRENT RATING TO PROVIDE ADDED MOTOR PROTECTION.

INLAND MOTOR INDUSTRIAL DRIVE DIVISION KOLLMORGEN CORPORATION

SYSTEM WIRING DIAGRAM MPA (108,109)

C 78872 1

VOLTAGE AND CURRENT DATA				
AMPLIFIER MODEL	A-B	A-N	"A"	"B"
HPA 158100	275 V	158 V	45A	100A

EACH SECONDARY PHASE (A,B,C,$\bar{A}$,$\bar{B}$,$\bar{C}$) MUST BE CONNECTED AS SHOWN.

* 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.

6 PHASE STAR ISOLATION TRANSFORMER

3Ø INPUT 50 OR 60 HZ

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

NOTE: $\bar{A}$ MUST BE 180° OUT OF PHASE WITH A, $\bar{B}$ TO BE 180° OUT OF PHASE WITH B AND $\bar{C}$ TO BE 180° OUT OF PHASE WITH C.

TO NUMERICAL CONTROL OR MACHINE GROUND

THIS IS THE ONLY GROUND TO BE APPLIED TO THE SYSTEM WITH THE ONE EXCEPTION OF TB1 - TERMINAL 2 WHICH CONNECTS TO NC LO. CONSULT FACTORY FOR OTHER ARRANGEMENTS.

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

HPA AMPLIFIER

DIFF INPUT

TB1

P01

- 1 CHOKE
- 2
- 3 CHOKE CT
- 4 MOTOR HI
- 5 MOTOR LO
- 6 NEUTRAL
- 7
- 8 AØ
- 9 BØ
- 10 CØ
- 11 $\bar{A}$Ø
- 12 $\bar{B}$Ø
- 13 $\bar{C}$Ø
- 14
- 15

MOTOR FUSE

MOL

TB1

- 1 HI — VELOCITY INPUT OR
- 2 LO — POSITION ERROR INPUT (SIGNAL)
- 3 SHIELD COMMON
- 4 TACH
- 5
- 6 TORQUE HOLD
- 7
- 8 CURRENT MONITOR OUTPUT
- 9 EXTERNAL CURRENT LIMIT CONTROL
- 10 SHIELD COMMON
- 11 "DRIVE UP"
- 12 OPEN WHEN DRIVE INHIBITED
- 13 LOOP CAGE INPUT
- 14
- 15
- 16

(INTERNALLY WIRED AT FACTORY)

- 17
- 18
- 19 +15 OUTPUT FOR CUSTOMER USE
- 20 SHIELD COMMON
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28 SHIELD COMMON
- 29 -15 OUTPUT FOR CUSTOMER USE
- 30
- 31 INHIBIT (CLOSE TO RUN)
- 32

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 TB1-4 FOR THE TACH AND TERMINAL POINT P01-1 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND (P01-6 OR 7).

2- USE TWISTED, SHIELDED WIRE (#18 - 20 GA) FOR ALL INPUTS ON TB-1 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

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

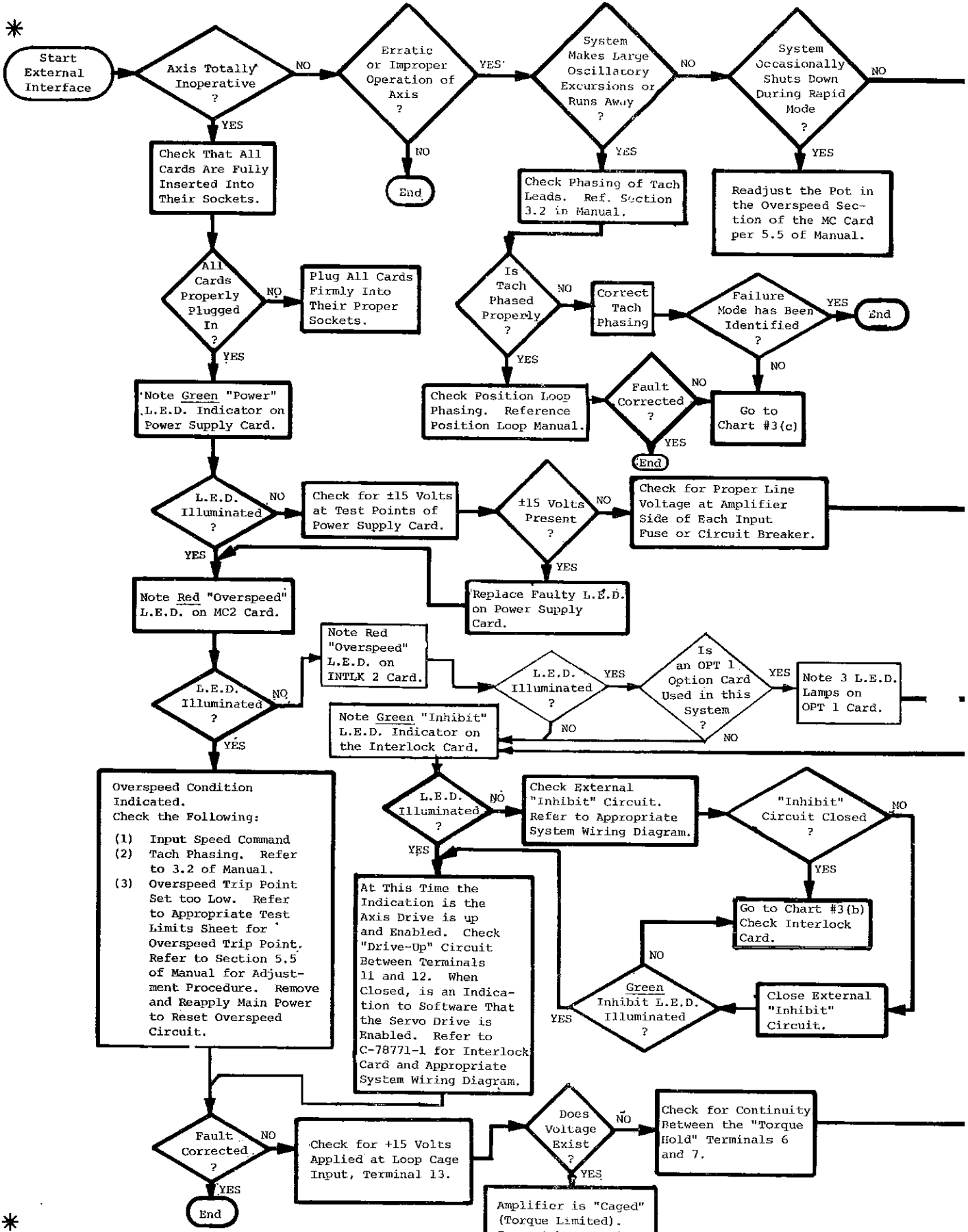
DRAWN BY	MLW	3-6-81	
CHK'D BY	FMJ	3-9-81	
ENG APP'D	[illegible]	3-11-81	

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION

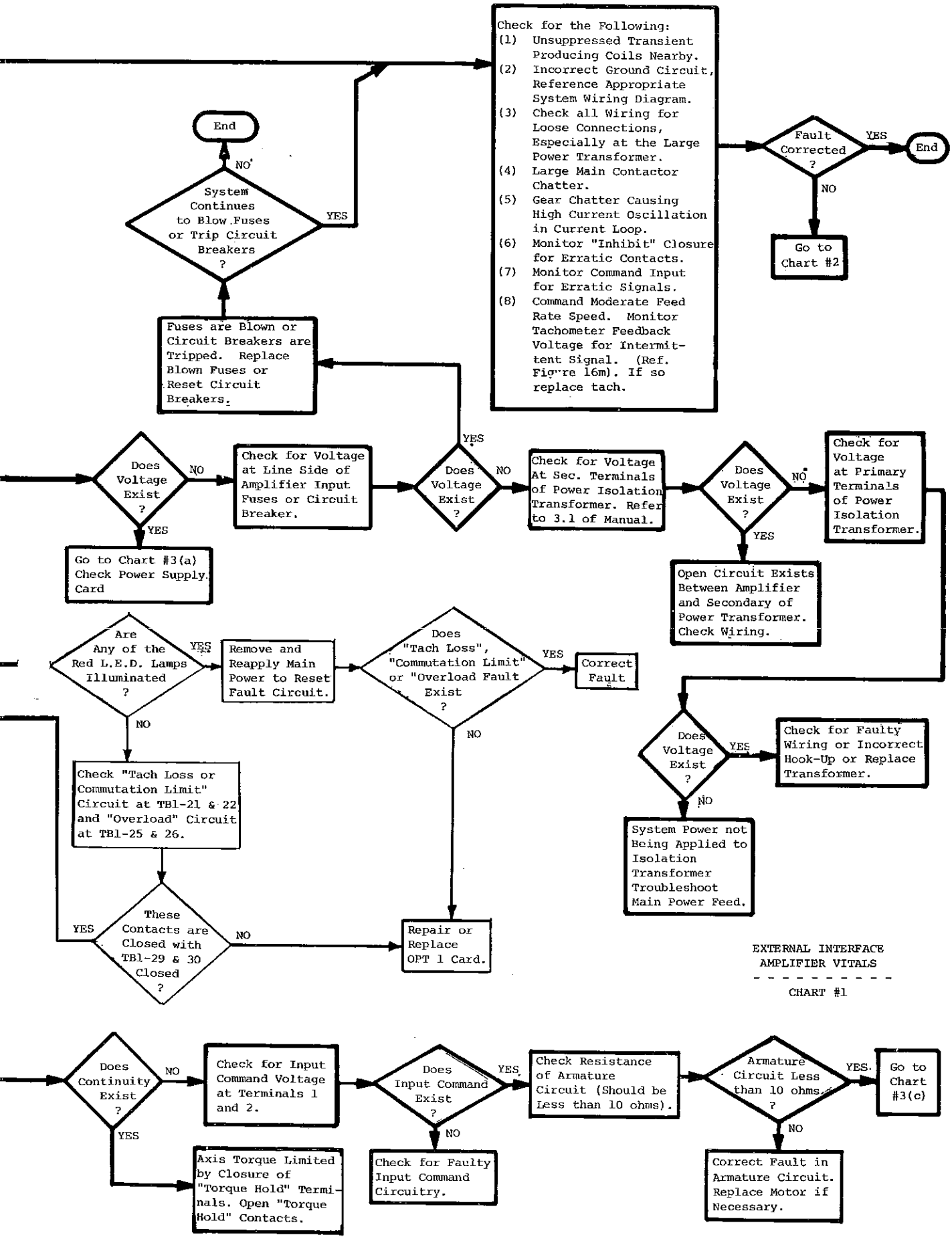
SYSTEM WIRING DIAGRAM HPA 0X-X11

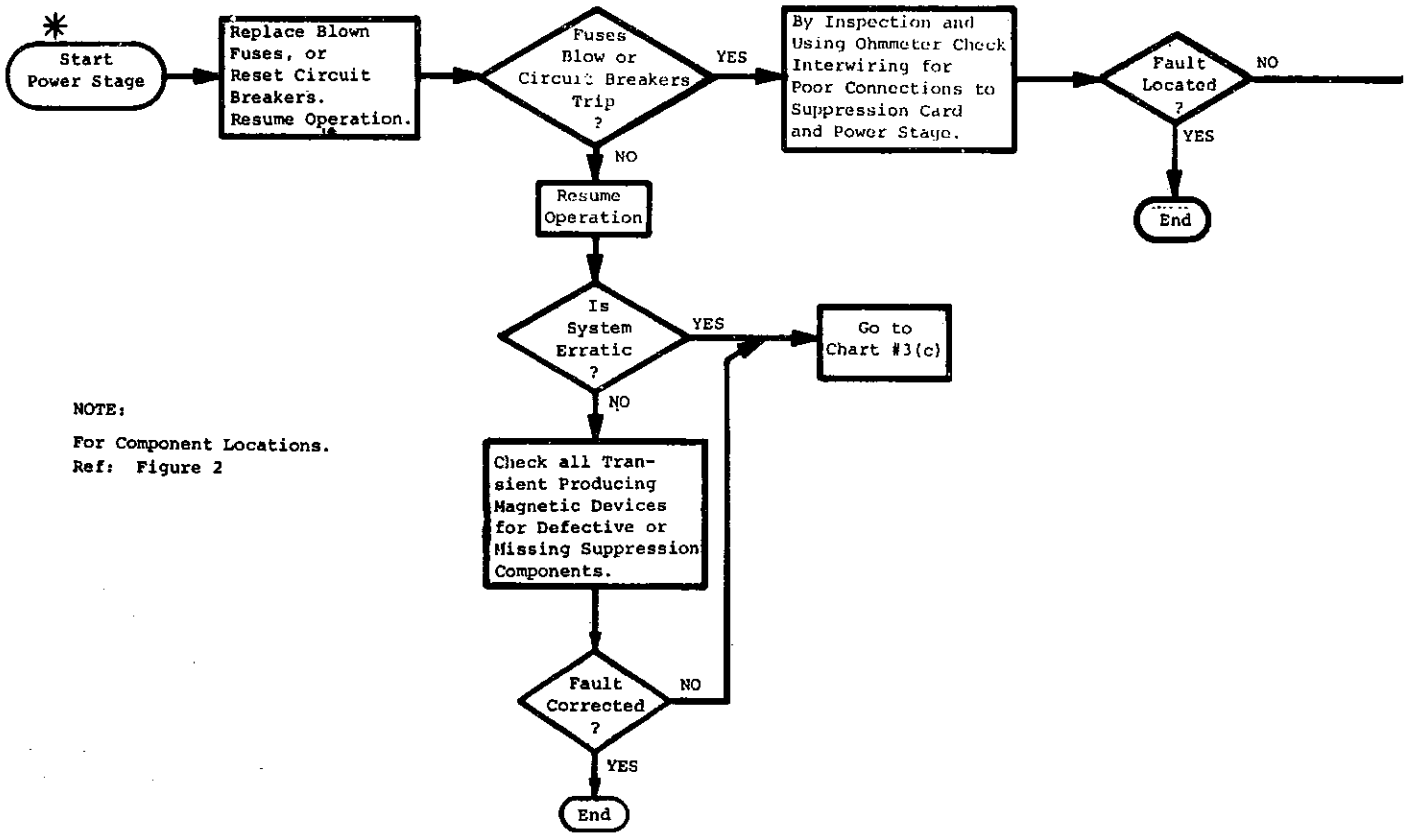
SIZE C — DWG. NO. 79043 — REV 1

SIZE C — DWG. NO. 79043 — REV 1



✳ Refer to Page 10 for "Instructions for Using Flow Charts".

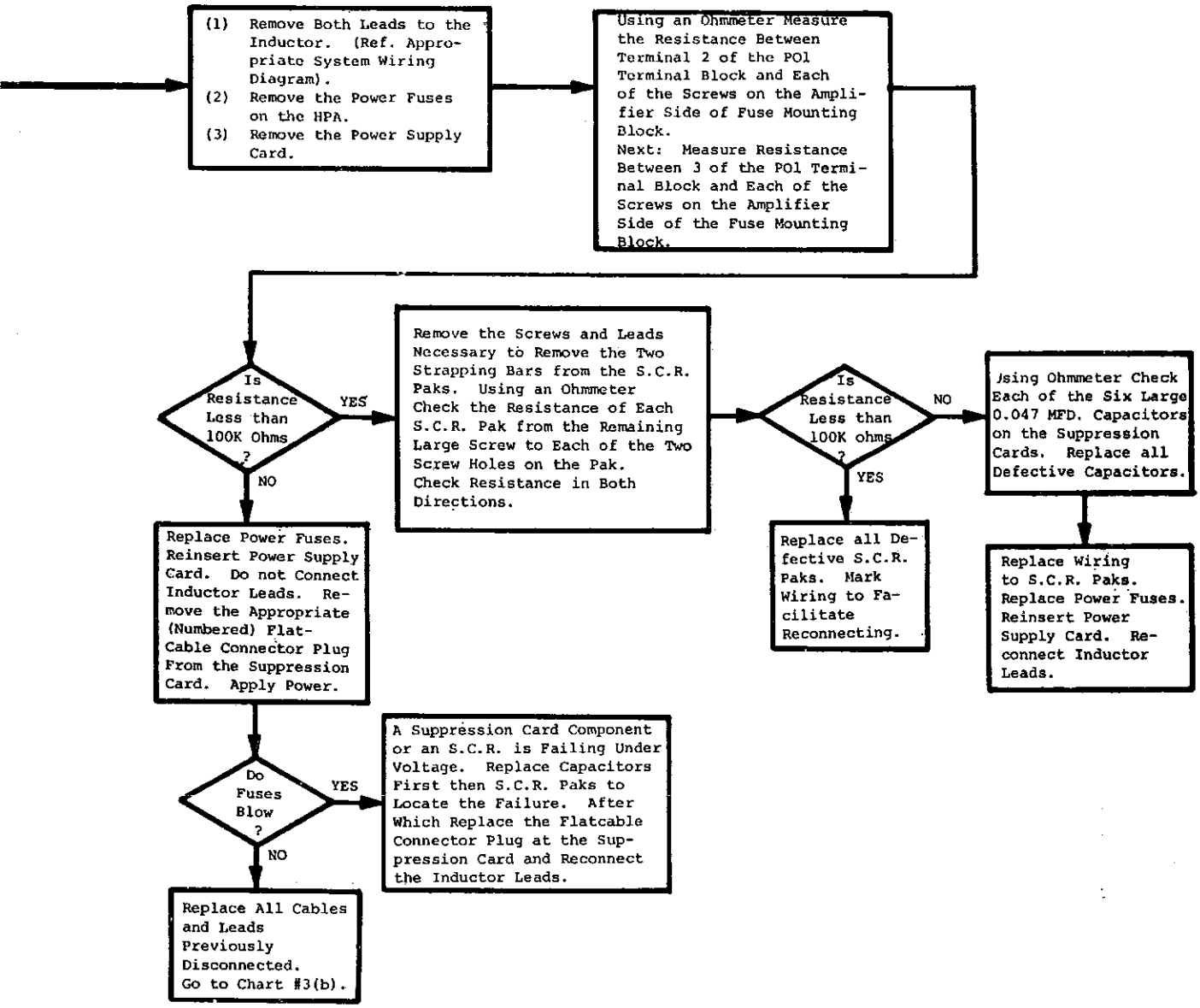

Check for the Following:
(1) Unsuppressed Transient Producing Coils Nearby.
(2) Incorrect Ground Circuit, Reference Appropriate System Wiring Diagram.
(3) Check all Wiring for Loose Connections, Especially at the Large Power Transformer.
(4) Large Main Contactor Chatter.
(5) Gear Chatter Causing High Current Oscillation in Current Loop.
(6) Monitor "Inhibit" Closure for Erratic Contacts.
(7) Monitor Command Input for Erratic Signals.
(8) Command Moderate Feed Rate Speed. Monitor Tachometer Feedback Voltage for Intermittent Signal. (Ref. Figure 16m). If so replace tach.
Fault Corrected ?
YES
End
NO
Go to Chart #2
End
System Continues to Blow Fuses or Trip Circuit Breakers ?
NO
YES
Fuses are Blown or Circuit Breakers are Tripped. Replace Blown Fuses or Reset Circuit Breakers.
Does Voltage Exist ?
NO
YES
Check for Voltage at Line Side of Amplifier Input Fuses or Circuit Breaker.
Does Voltage Exist ?
YES
NO
Check for Voltage At Sec. Terminals of Power Isolation Transformer. Refer to 3.1 of Manual.
Does Voltage Exist ?
NO
YES
Check for Voltage at Primary Terminals of Power Isolation Transformer.
Open Circuit Exists Between Amplifier and Secondary of Power Transformer. Check Wiring.
Go to Chart #3(a) Check Power Supply Card
Are Any of the Red L.E.D. Lamps Illuminated ?
YES
NO
Remove and Reapply Main Power to Reset Fault Circuit.
Does "Tach Loss", "Commutation Limit" or "Overload Fault Exist ?
YES
Correct Fault
NO
Check "Tach Loss or Commutation Limit" Circuit at TB1-21 & 22 and "Overload" Circuit at TB1-25 & 26.
These Contacts are Closed with TB1-29 & 30 Closed ?
YES
NO
Repair or Replace OPT 1 Card.
Does Voltage Exist ?
YES
NO
Check for Faulty Wiring or Incorrect Hook-Up or Replace Transformer.
System Power not Being Applied to Isolation Transformer Troubleshoot Main Power Feed.
EXTERNAL INTERFACE
AMPLIFIER VITALS
CHART #1
Does Continuity Exist ?
NO
YES
Check for Input Command Voltage at Terminals 1 and 2.
Axis Torque Limited by Closure of "Torque Hold" Terminals. Open "Torque Hold" Contacts.
Does Input Command Exist ?
YES
NO
Check for Faulty Input Command Circuitry.
Check Resistance of Armature Circuit (Should be Less than 10 ohms).
Armature Circuit Less than 10 ohms. ?
YES
NO
Go to Chart #3(c)
Correct Fault in Armature Circuit. Replace Motor if Necessary.



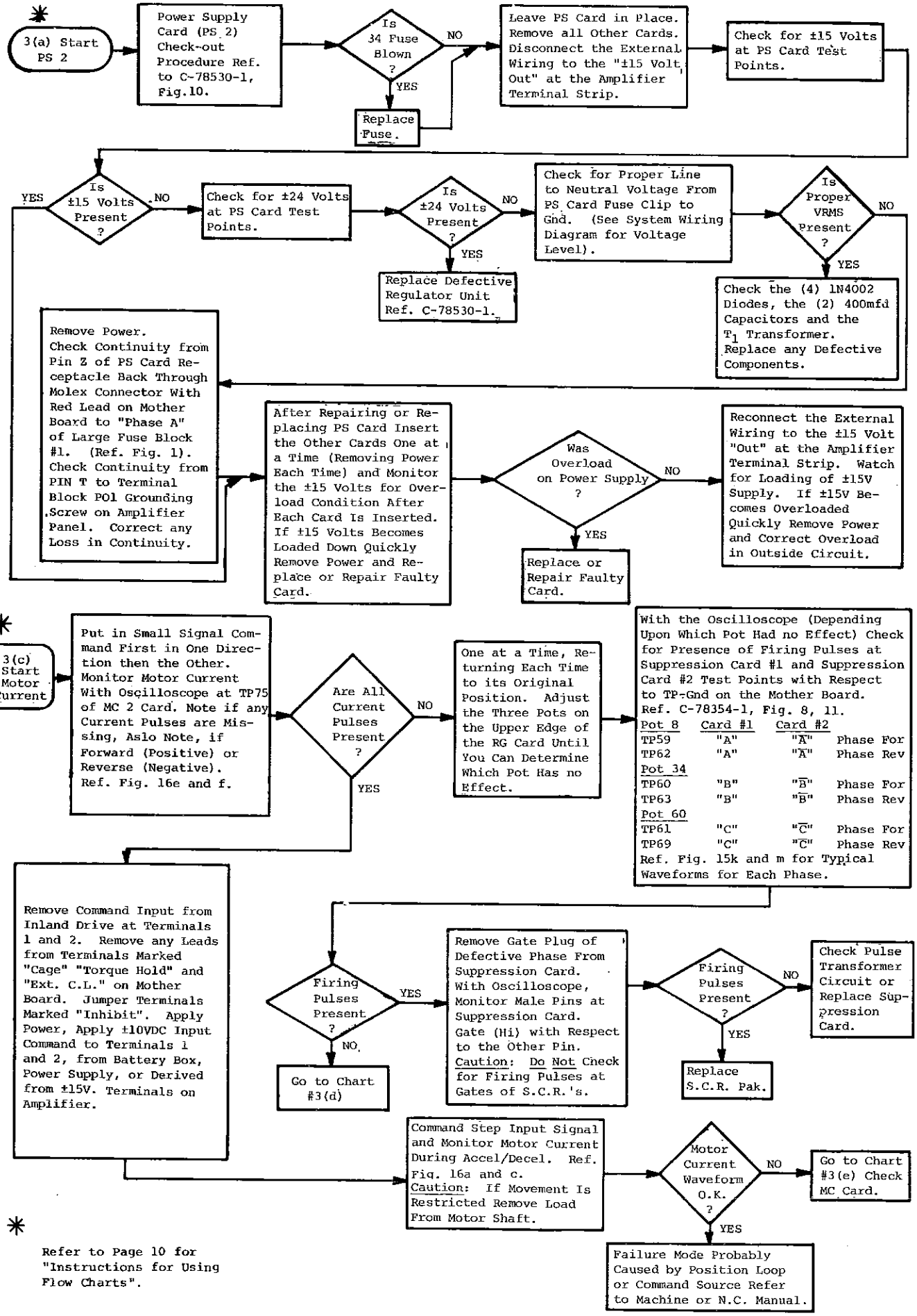
NOTE:

For Component Locations.
Ref: Figure 2

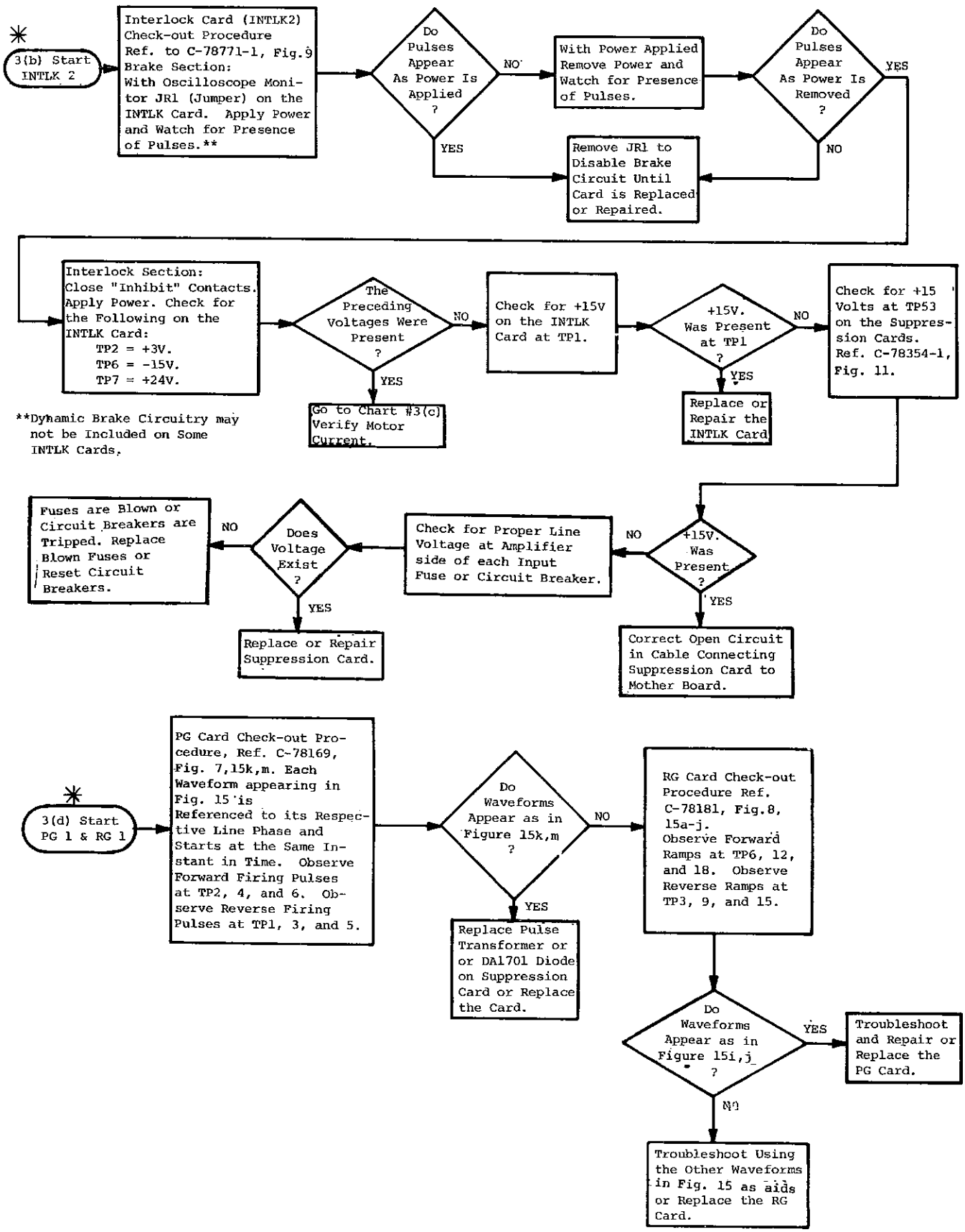
✳ Refer to Page 10 for "Instructions for Using Flow Charts".



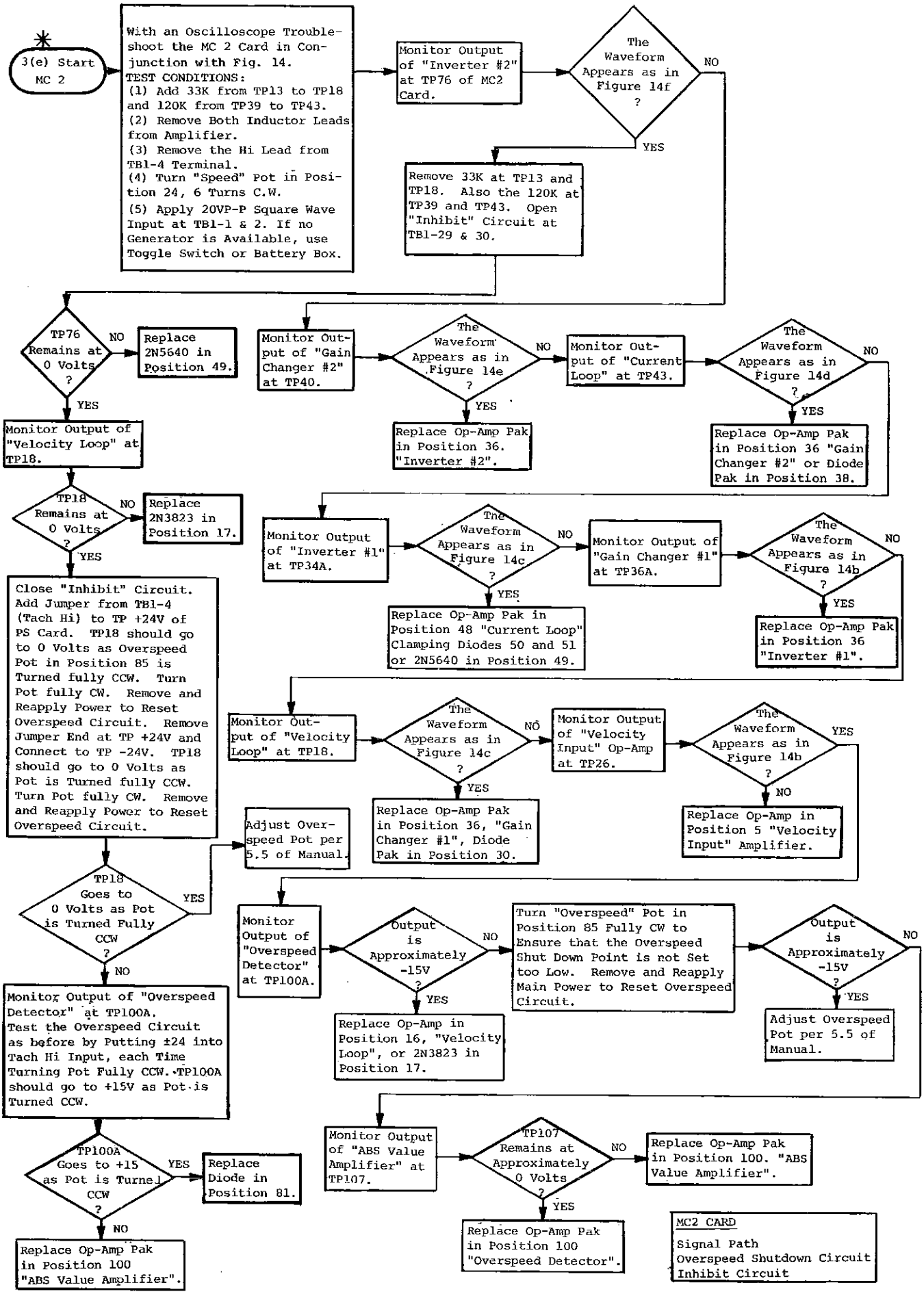
POWER STAGE
CHART #2

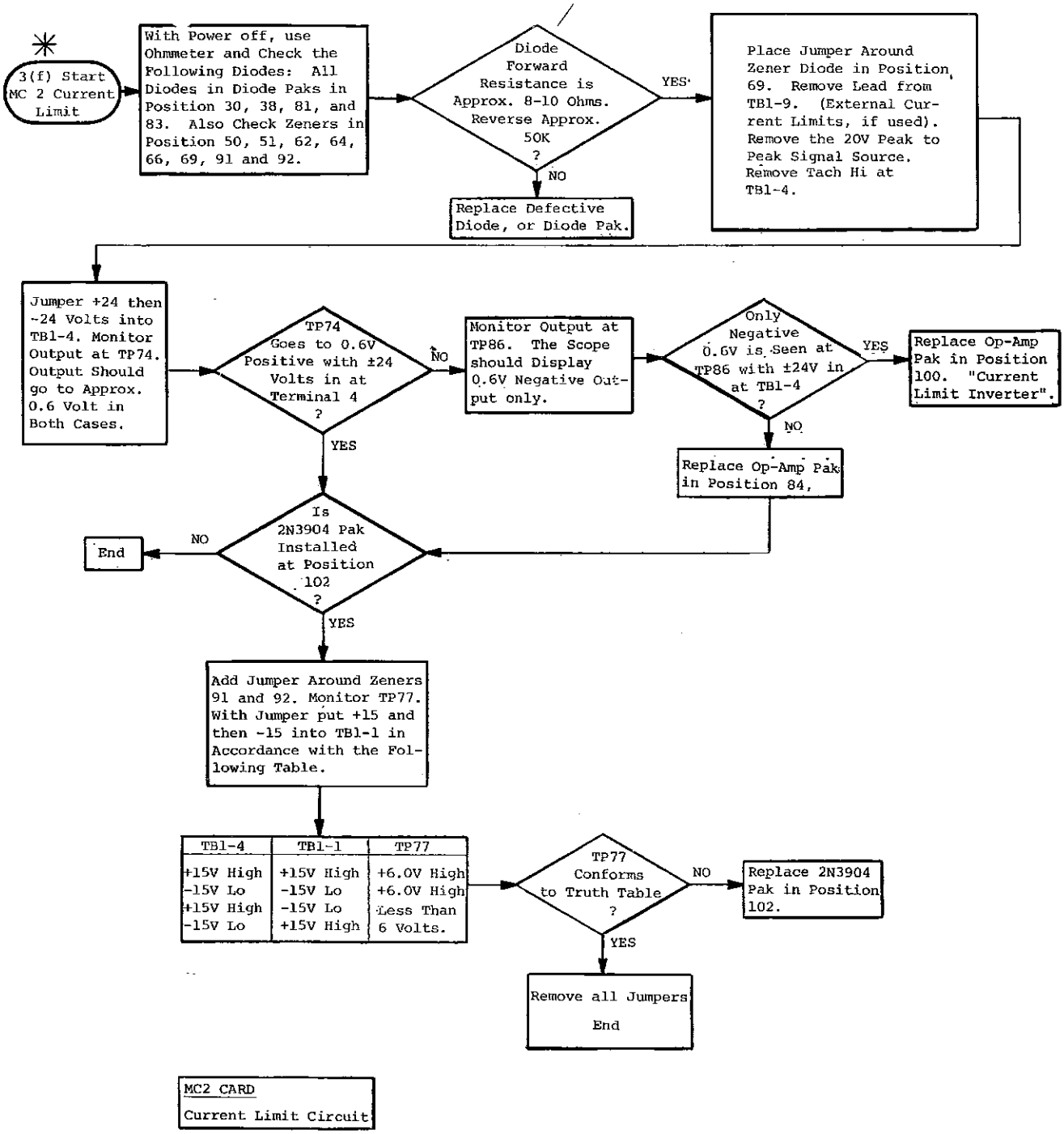


Refer to Page 10 for "Instructions for Using Flow Charts".



CONTROL SECTION
CHART #3
SHEET 1 OF 2


3(e) Start MC 2
With an Oscilloscope Trouble-shoot the MC 2 Card in Con-junction with Fig. 14.
TEST CONDITIONS:
(1) Add 33K from TP13 to TP18 and 120K from TP39 to TP43.
(2) Remove Both Inductor Leads from Amplifier.
(3) Remove the Hi Lead from TB1-4 Terminal.
(4) Turn "Speed" Pot in Posi-tion 24, 6 Turns C.W.
(5) Apply 20VP-P Square Wave Input at TB1-1 & 2. If no Generator is Available, use Toggle Switch or Battery Box.
Monitor Output of "Inverter #2" at TP76 of MC2 Card.
The Waveform Appears as in Figure 14f ?
NO
YES
Remove 33K at TP13 and TP18. Also the 120K at TP39 and TP43. Open "Inhibit" Circuit at TB1-29 & 30.
TP76 Remains at 0 Volts ?
NO
Replace 2N5640 in Position 49.
YES
Monitor Output of "Velocity Loop" at TP18.
TP18 Remains at 0 Volts ?
NO
Replace 2N3823 in Position 17.
YES
Close "Inhibit" Circuit. Add Jumper from TB1-4 (Tach Hi) to TP +24V of PS Card. TP18 should go to 0 Volts as Overspeed Pot in Position 85 is Turned fully CCW. Turn Pot fully CW. Remove and Reapply Power to Reset Overspeed Circuit. Remove Jumper End at TP +24V and Connect to TP -24V. TP18 should go to 0 Volts as Pot is Turned fully CCW. Turn Pot fully CW. Remove and Reapply Power to Reset Overspeed Circuit.
TP18 Goes to 0 Volts as Pot is Turned Fully CCW ?
YES
NO
Adjust Over-speed Pot per 5.5 of Manual.
Monitor Output of "Overspeed Detector" at TP100A.
Test the Overspeed Circuit as before by Putting ±24 into Tach Hi Input, each Time Turning Pot Fully CCW. TP100A should go to +15V as Pot is Turned CCW.
TP100A Goes to +15 as Pot is Turned CCW ?
YES
Replace Diode in Position 81.
NO
Replace Op-Amp Pak in Position 100 "ABS Value Amplifier".
Monitor Output of "Gain Changer #2" at TP40.
The Waveform Appears as in Figure 14e ?
NO
YES
Replace Op-Amp Pak in Position 36. "Inverter #2".
Monitor Output of "Current Loop" at TP43.
The Waveform Appears as in Figure 14d ?
NO
YES
Replace Op-Amp Pak in Position 36 "Gain Changer #2" or Diode Pak in Position 38.
Monitor Output of "Inverter #1" at TP34A.
The Waveform Appears as in Figure 14c ?
NO
YES
Replace Op-Amp Pak in Position 48 "Current Loop" Clamping Diodes 50 and 51 or 2N5640 in Position 49.
Monitor Output of "Gain Changer #1" at TP36A.
The Waveform Appears as in Figure 14b ?
NO
YES
Replace Op-Amp Pak in Position 36 "Inverter #1".
Monitor Output of "Velocity Loop" at TP18.
The Waveform Appears as in Figure 14c ?
NO
YES
Replace Op-Amp Pak in Position 36, "Gain Changer #1", Diode Pak in Position 30.
Monitor Output of "Velocity Input" Op-Amp at TP26.
The Waveform Appears as in Figure 14b ?
YES
NO
Replace Op-Amp in Position 5 "Velocity Input" Amplifier.
Monitor Output of "Overspeed Detector" at TP100A.
Output is Approximately -15V ?
NO
YES
Replace Op-Amp in Position 16, "Velocity Loop", or 2N3823 in Position 17.
Turn "Overspeed" Pot in Position 85 Fully CW to Ensure that the Overspeed Shut Down Point is not Set too Low. Remove and Reapply Main Power to Reset Overspeed Circuit.
Output is Approximately -15V ?
NO
YES
Adjust Overspeed Pot per 5.5 of Manual.
Monitor Output of "ABS Value Amplifier" at TP107.
TP107 Remains at Approximately 0 Volts ?
NO
YES
Replace Op-Amp Pak in Position 100. "ABS Value Amplifier".
Replace Op-Amp Pak in Position 100 "Overspeed Detector".
MC2 CARD
Signal Path
Overspeed Shutdown Circuit
Inhibit Circuit



✳ Refer to Page 10 for "Instructions for Using Flow Charts".

CONTROL SECTION
CHART #3
SHEET 2 OF 2

PAGE

9.Ø APPENDICES

Appendix A Option Card OPT1. 67

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3.3 Tach Loss Offset Adjustment 71

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ILLUSTRATIONS

Option Card (OPT1) . . . . . Figure 1A 72

Schematic (OPT1) C-78547-1 73

Schematic (MB1-HPA) C-78533-1 45

System Wiring Diagram HPAØ1-(XØ1-XØ2-XØ3) C-79134 74

System Wiring Diagram (X12, X13). C-79494 75

APPENDIX A

OPTION CARD OPT 1
USED WITH MODEL HPA01

1.0 DESCRIPTION

The OPT 1 (Option Card) when used is inserted into the MB1-HPA(OX) Mother Board at the card receptacle marked "OPTION CARD". This card consists of four separate and independent circuits to provide a ramp input and three types of protection in addition to that normally available in the HPA amplifier. The four circuits contained on the OPT 1 card are:

(1) Ramp Generator
(2) Tach Loss
(3) Commutation Limit
(4) Thermal Limit

2.0 SIMPLIFIED THEORY OF OPERATION (REF. C-78547-1, C-78533-1, FIG. 1 & THE APPROPRIATE SYS. WIRING DIA.)

2.1 Ramp Generator Circuit

The Ramp Generator circuit may be utilized to change a step input, from a command signal source, into a ramp command to accelerate or decelerate the motor at a preselected rate.

When the input signal (a step input not to exceed ±10 volts) is applied to the amplifier at TB1-16 (pin out A) with respect to TB1-17 (pin out B) an adjustable ramp of approximately the same magnitude will appear at TB1-18 (pin out C). The ramp output may then be used as a command source to accelerate or decelerate the motor at a preselected rate when connected to the input of the amplifier at TB1-1 (TB1-2 must be connected to TB1-3).

The slope of the acceleration and deceleration ramps may be adjusted by pot 26 (Ramp A) or pot 25 (Ramp B). The rate of acceleration or deceleration may be selected by changing the ramp select line logic input at TB1-24 (pin out U). A logic level "1" (above 5 volts) into TB1-24 will select the ramp under the influence of adjustment pot 25 (Ramp B). Otherwise a logic level "0" (below 0.8 volt) into TB1-24 will select the ramp under the influence of adjustment pot 26 (Ramp A). Thus, if desired the motor does not necessarily have to be accelerated and decelerated at the same rate.

2.2 Tach Loss Circuit

The Tach Loss circuit provides protection against damage to the servo system or the machine due to a runaway condition and acts to shut the system down in the event the tach feedback is lost, shorted, or hooked up backwards.

The back e.m.f. of the motor (which is proportional to motor speed) is brought (internally) to TB1-15 (pin out S) where it is monitored and compared, through proper scaling, with the Tach Feedback signal (also proportional to motor speed) being monitored at TB1-4 (pin out F). The motor current level is also monitored (direct from the Current Sample resistor at pin out E) and is used to compensate for the IR drop in the motor at high current levels thereby making the motor terminal voltage a more accurate indication of the true motor back e.m.f.

The algebraic sum of the motor back e.m.f. and the Tach Feedback signal is fed by way of an Absolute Value circuit, to the input of a Level Detector and Latch circuit where it is compared to a reference level. If the output of the Absolute Value circuit exceeds that of the reference level the output of the Level Detector will switch from a negative to a positive state and exit the OPT 1 card at pin out H. This positive voltage level will enter the MC 2 card at pin out W where it will turn on the "caging" F.E.T. in position 17, clamp the velocity loop op-amp in position 16, and torque limit the motor to zero, putting the amplifier into an inhibit mode. The output from the Level Detector also enters pin out U of the INTLK 2 card where it will turn on a red OVERSPEED FAULT LED and drop out the closed "DRIVE UP" contacts at TB1-11 and 12 (an indication that the amplifier is inhibited).

The positive voltage level from the output of the Level Detector will also turn on a red Tach Loss LED and drop out the closed "Tach Loss or Commutation Limit" contacts (at TB1-21 and 22) in its output circuit which will indicate to the outside world (software, etc.) that the servo amplifier is in the Tach Loss fault mode.

When the jumper 79 is installed this set of contacts is shared by the Commutation Limit circuit and may also (when open with the Commutation Limit LED turned on) indicate a Commutation Limit fault.

The main power to the amplifier must be removed and (after a time delay of 60 sec.) reapplied to reset the latch circuit in either case.

2.3 Commutation Limit Circuit

The Commutation Limit Circuit provides protection against damage to the servo motor due to excessively high current levels at high speeds which would ordinarily cause flash over or ring fire at the brushes and commutator. The common motor overload relays for example simply cannot react fast enough to protect D.C. servo motors against flash over caused by an increase in load at high speed. The Commutation Limit Circuit however, can recognize this type of short term overload condition and reacts quickly to shut the system down.

The Commutation Limit Circuit monitors the output of the Velocity Loop op-amp at pin out D (from MC 2 card pin out F) and compares it with the Positive Current Limit level being monitored at pin out V (from MC 2 card pin out J). If the Velocity Loop output is sustained in saturation (current limit) for a period of time (selected by the value of resistor 93) capacitor 67 will charge up and be compared to a reference level. When the charge on capacitor 67 becomes greater, the output of the Level Detector will switch from a negative to a positive state and exit the OPT 1 card (by way of jumper 79) at pin out H. This positive voltage level will enter the MC 2 card at pin out W where it will turn on the "caging" F.E.T. in position 17, clamp the Velocity Loop op-amp in position 16, and torque limit the motor to zero putting the amplifier into an inhibit mode. The output from the Level Detector also enters pin out U of the INTLK 2 card where it will turn on a red OVERSPEED FAULT LED and drop out the closed "DRIVE UP" contacts at TB1-11 and 12 (an indication that the amplifier is inhibited). The positive voltage level from the output of the Level Detector will also turn on a red Commutation Limit LED and drop out the closed "Tach Loss or Commutation Limit" contacts (at TB1-21 and 22) in its output circuit which will indicate to the outside world (software, etc.) that the servo amplifier is in the Commutation Limit fault mode. This set of contacts is shared by the Tach Loss Circuit and may also (when open with the Tach Loss LED turned on) indicate a Tach Loss fault.

The main power to the amplifier must be removed and (after a time delay of 60 sec.) reapplied to reset the latch circuit in either case.

2.4 Thermal Limit Circuit

The Thermal Limit Circuit is an inverse time/current monitor and provides protection against damage to the servo motor in the event the current level in the motor exceeds the motor's continuous current rating for a certain time

period. This circuit is also much faster than the normal motor overload relay, especially in the very high current region and acts quickly to shut the system down.

The Thermal Limit circuit monitors the motor current level (direct from the Current Sample resistor at pin out E) through an Absolute Value and scaling circuit. The gain of the circuit is such that +10.0 volts at TP167 indicates maximum motor current under acceleration and deceleration conditions. TP168 when at -0.25 volts represents the nominal continuous load current and is set by pot 135. The outputs at TP168 and TP103 drive the integrator op-amp 162 via diodes 156 and 157. When the capacitor 161 charges up to -8.4 volts the output of the Level Detector (136) will switch from a negative to a positive state, turn on the red OVERLOAD LED and drop out the closed "OVERLOAD" contacts at TB1-25 (pin out T and TB1-26 (pin out W) in its output circuit which will indicate to the outside world (software, etc.) that the amplifier is in the OVERLOAD fault mode.

To reset the Overload circuit remove the main power, wait 60 sec., and re-apply power; then push the Overload Reset switch on the OPT 1 card.

3.0 ADJUSTMENTS (REF. C-78547-1 & FIGURE 1A)

NOTE: Before making adjustments to the OPT 1 card check to determine if all the optional circuits are used.

With exception to the slope adjustments (P25 and P26) in the Ramp Generator circuit all adjustments are factory set and sealed and should never require adjustment. The following procedures are given only in the event of component or card replacement or in the event the seals are unintentionally broken. Reseal all pots after adjustment.

3.1 Ramp Generator Offset Adjustment

Remove Power. Remove the command input leads at TB1-16 and 17. Place a jumper from TB1-16 to 17. Turn Pots 25 and 26 fully CCW. Connect a voltmeter on a sensitive volts DC scale from TP29 with respect to TP "Common" of the Mother Board. Apply power. Adjust Zero Offset pot (9) for zero volts DC on the voltmeter. Remove power, remove jumper from TB1-16 to 17, reconnect the command input leads to TB1-16 and 17.

3.2 Ramp Generator Slope Adjustments

Place a jumper from TB1-24 to TP "Common" of the Mother Board. Monitor TP29 with an oscilloscope or chart recording. Apply a step input command at TB1-16 and 17. Adjust P26 for desired ramp time.

Remove jumper from TB1-24 to TP "Common". Place a jumper from TB1-24 to TB1-19. Adjust P25 for desired ramp time. Remove jumper from TB1-24 to TB1-19.

With a step input command of ±10VDC the slope of the ramps are adjustable from approximately 53V/sec. to less than 1.7 V/sec.

3.3 Tach Loss Offset Adjustment

Remove power. Open the inhibit circuit at TB1-29 and 30. Turn P66 full CCW. Connect a voltmeter on a sensitive volts DC scale from TP31 with respect to TP "Common" of the Mother Board. Apply power. Adjust P85 for 0 VDC on the voltmeter. Remove power. Close the inhibit circuit at TB1-29 and 30.

3.4 Tach Loss Trip Adjustment

Remove power. Place a jumper from TP102 to TP "Common". Turn P66 fully CW. Apply power. While running at 300-400 RPM turn P66 CCW until the red Tach Loss LED just turns on and the system shuts down. Turn P66 1/2 turn CW. Remove power. Remove the jumper from TP102 to TP "Common".

3.5 Thermal Limit Offset Adjustment

Remove power. Open the inhibit circuit at TB1-29 and 30. Connect a voltmeter on a sensitive volts DC scale from TP167 to TP "Common". Apply power. Adjust P149 for 0 VDC on the voltmeter. Jumper TP103 and 168 to TP "Common". Connect a voltmeter on a sensitive volts DC scale from TP166 to TP "Common". Adjust P163 for 0 VDC on the voltmeter. Remove the jumpers and meter. Close the inhibit circuit at TB1-29 and 30.

3.6 Thermal Limit Trip Adjustment

Remove power. Open the inhibit circuit at TB1-29 and 30. Place a jumper from TP167 to TP "Common". Connect a voltmeter on a sensitive volts DC scale from TP168 to TP "Common". Apply power. Adjust P135 for the amount of voltage specified on the Test Limits sheet (TL) for the system.

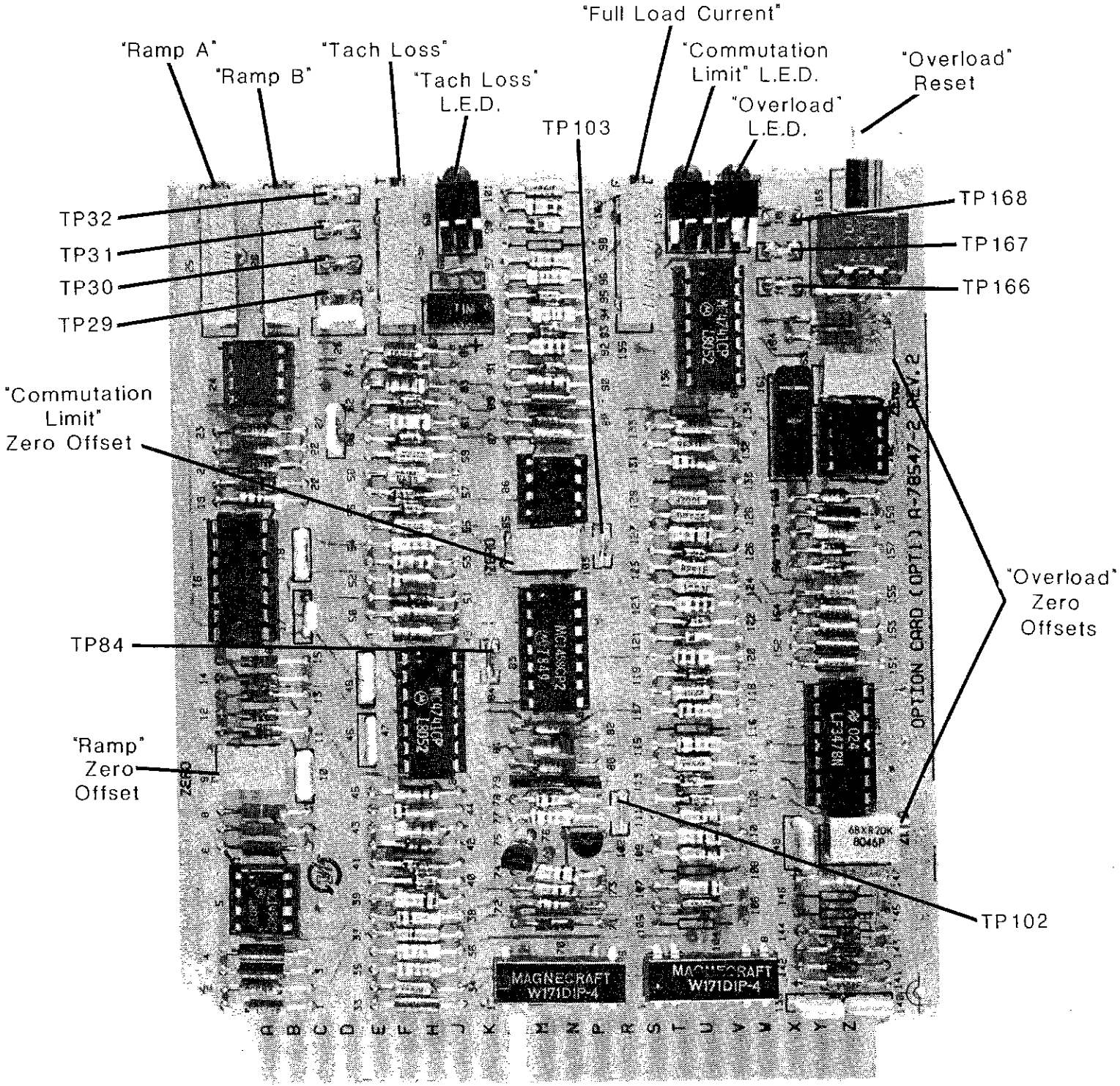
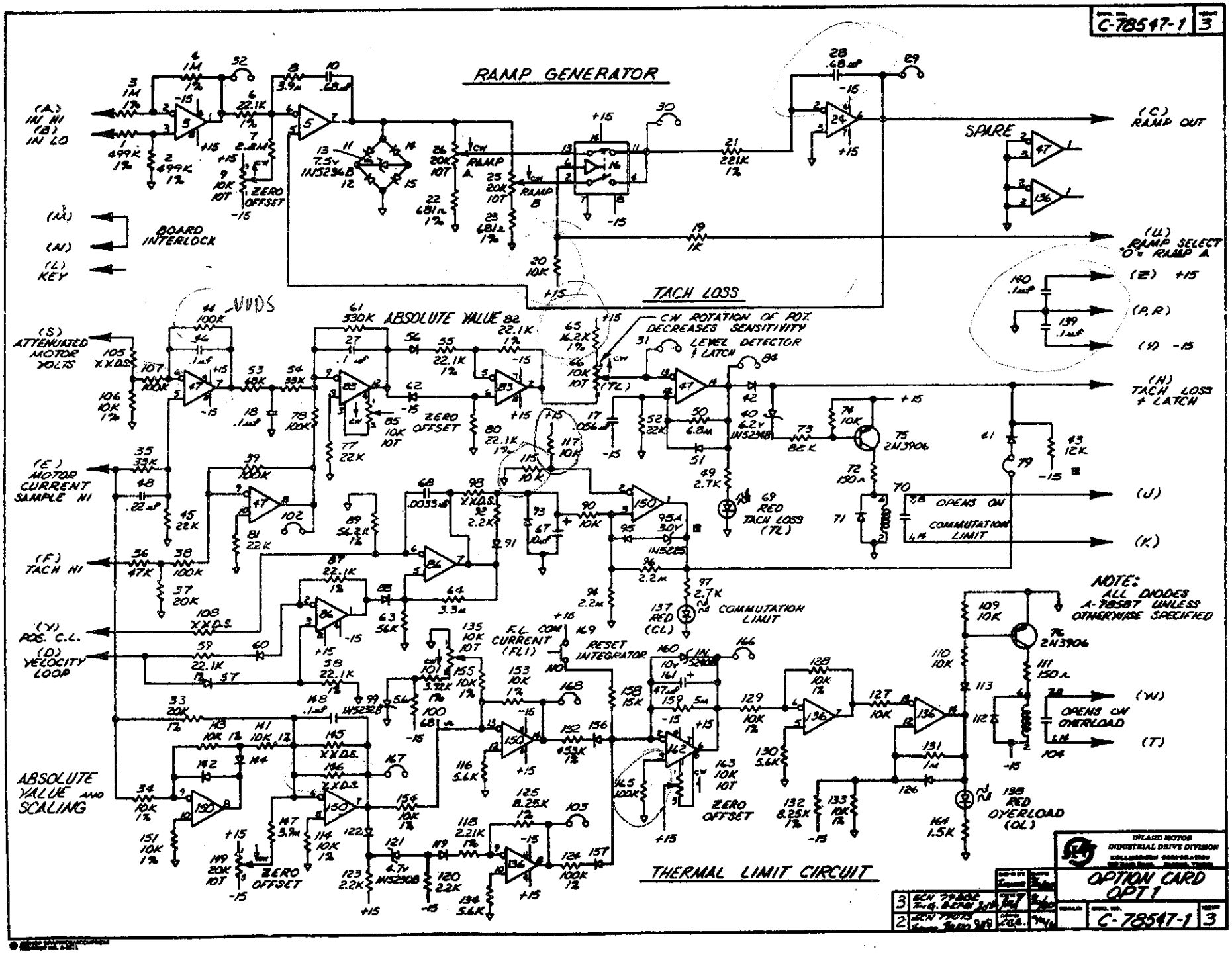
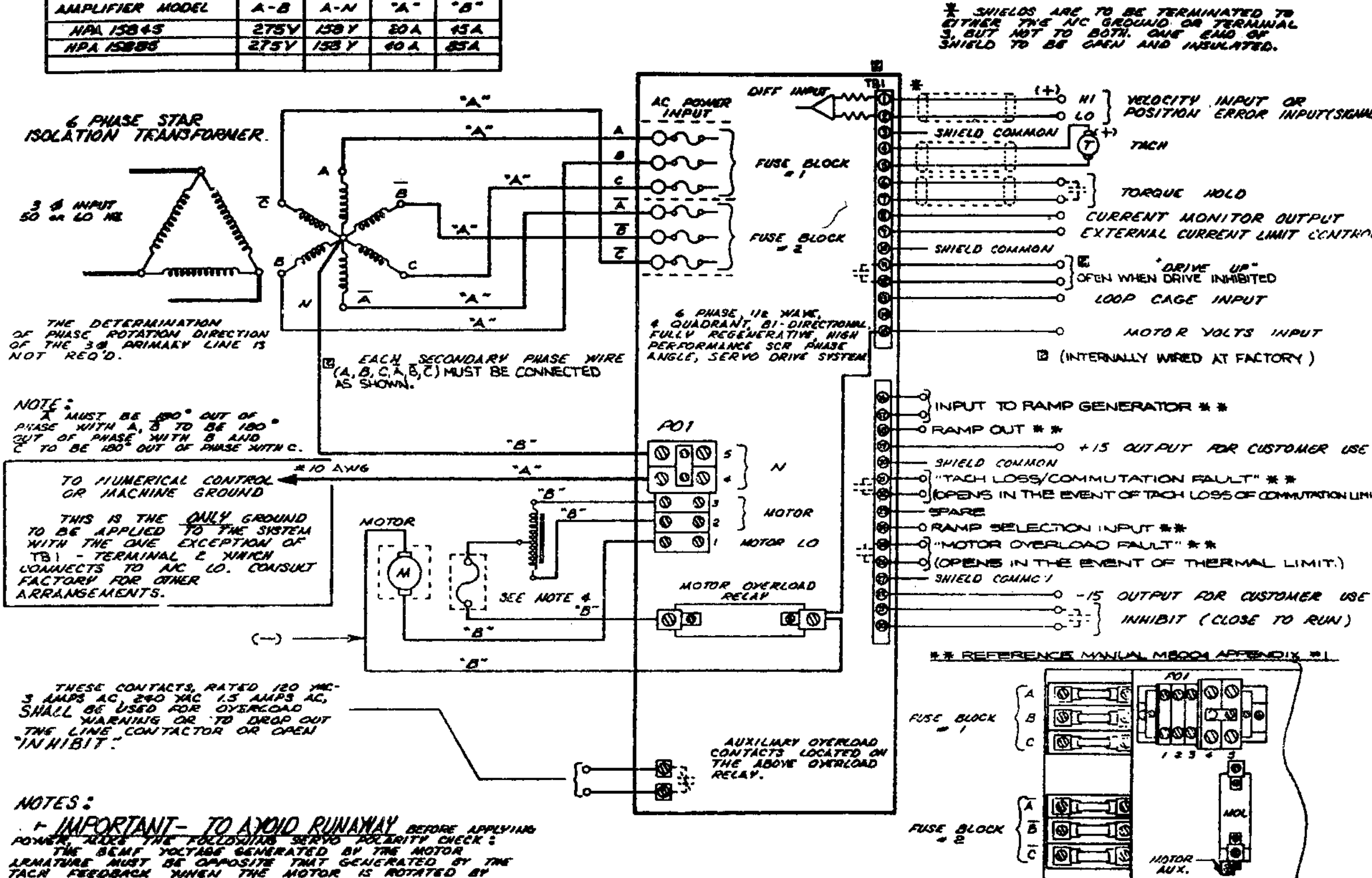


FIGURE 1-A
OPTION CARD (OPT 1)


RAMP GENERATOR
(A) IN HI
(B) IN LO
BOARD INTERLOCK
(M)
(N)
(L) KEY
ZERO OFFSET
RAMP A
RAMP B
SPARE
(C) RAMP OUT
(U) RAMP SELECT "0" = RAMP A
TACH LOSS
(E) +15
(P, R)
(V) -15
(N) TACH LOSS + LATCH
VVDS
ABSOLUTE VALUE
CW ROTATION OF POT DECREASES SENSITIVITY
LEVEL DETECTOR + LATCH
(S) ATTENUATED MOTOR VOLTS
(E) MOTOR CURRENT SAMPLE HI
(F) TACH HI
(Y) POS. C.L.
(D) VELOCITY LOOP
ZERO OFFSET
RED TACH LOSS (TL)
OPENS ON COMMUTATION LIMIT
(J)
(K)
F.L. COM CURRENT (FL)
RESET INTEGRATOR
COMMUTATION LIMIT
RED (CL)
NOTE: ALL DIODES A-78587 UNLESS OTHERWISE SPECIFIED
OPENS ON OVERLOAD
(W)
(T)
ABSOLUTE VALUE AND SCALING
ZERO OFFSET
RED OVERLOAD (OL)
THERMAL LIMIT CIRCUIT
OPTION CARD OPT 1
C-78547-1 | 3

YOLTAGE AND CURRENT DATA				
AMPLIFIER MODEL	A-B	A-N	"A"	"B"
HPA 15845	275V	158Y	20A	15A
HPA 15886	275V	158Y	60A	85A



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 TB1-4 FOR THE TACH AND TERMINAL POINT P01-3 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND (P01-4 OR 5).

2- USE TWISTED, SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON TB1 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

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

4- RECOMMENDED SLOW-BLOW FUSE (CUSTOMER SUPPLIED AND MOUNTED) SIZED FOR APPROX. CONT. MOTOR CURRENT RATINGS TO PROVIDE ADDED MOTOR PROTECTION.

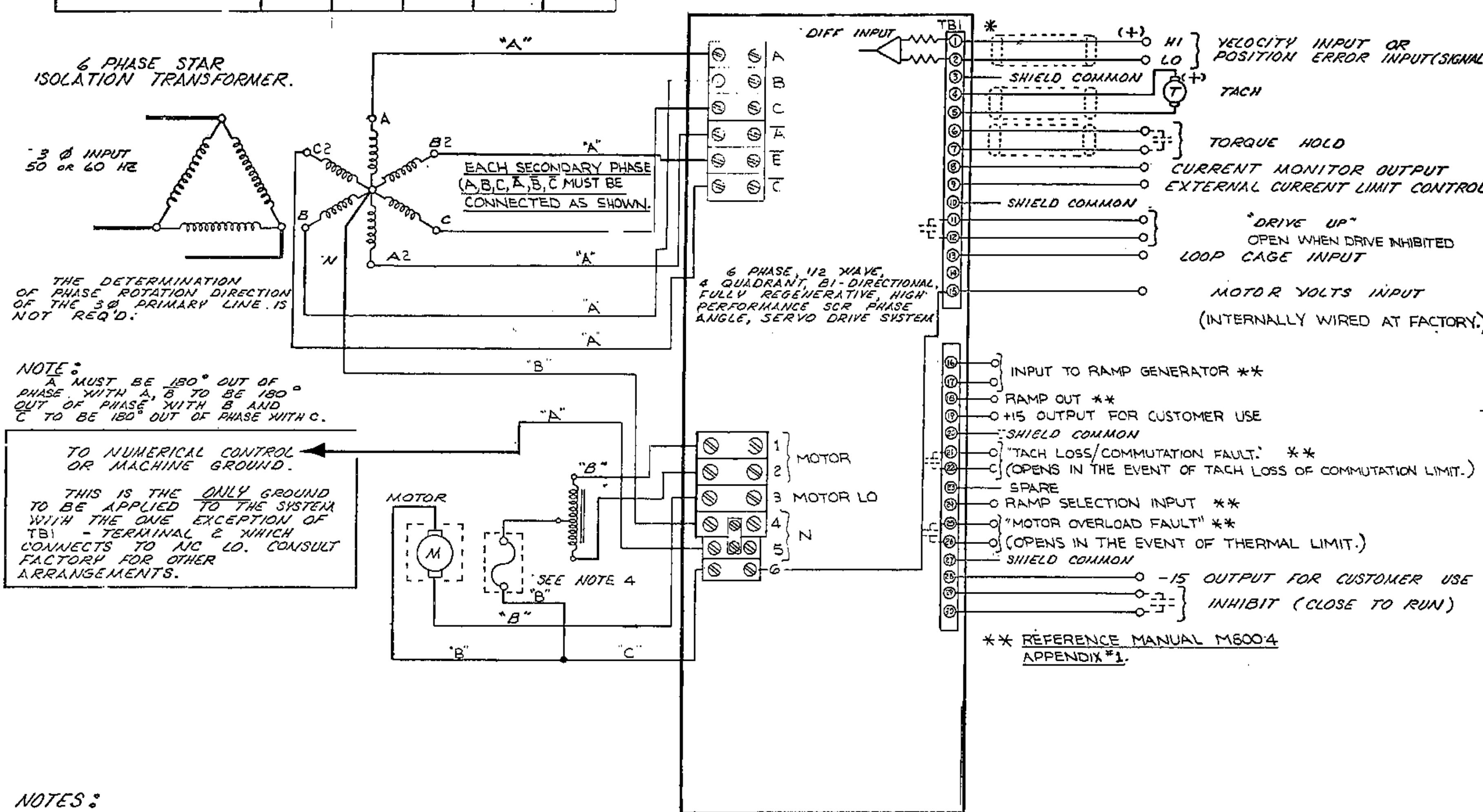
INLAND MOTOR INDUSTRIAL DRIVE DIVISION KOLLMORGEN CORPORATION

SYSTEM WIRING DIAGRAM HPA01-X01, X02, X03

C 79134 1

YOLTAGE AND CURRENT DATA					
AMPLIFIER MODEL	A-B	A-N	"A"	"B"	"C"
HPA 15845	275V	158Y	20A	45A	.1A
HPA 15885	275V	158Y	40A	85A	.1A

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



6 PHASE STAR ISOLATION TRANSFORMER.
3 Ø INPUT 50 or 60 HZ
THE DETERMINATION OF PHASE ROTATION DIRECTION OF THE 3Ø PRIMARY LINE IS NOT REQ'D.
NOTE: Ā MUST BE 180° OUT OF PHASE WITH A, B̄ TO BE 180° OUT OF PHASE WITH B AND C̄ TO BE 180° OUT OF PHASE WITH C.
TO NUMERICAL CONTROL OR MACHINE GROUND.
THIS IS THE ONLY GROUND TO BE APPLIED TO THE SYSTEM WITH THE ONE EXCEPTION OF TB1 - TERMINAL 2 WHICH CONNECTS TO N/C LO. CONSULT FACTORY FOR OTHER ARRANGEMENTS.
EACH SECONDARY PHASE (A,B,C,Ā,B̄,C̄) MUST BE CONNECTED AS SHOWN.
"A"
"B"
"C"
A
B2
C2
B
C
A2
N
6 PHASE, 1/2 WAVE, 4 QUADRANT, BI-DIRECTIONAL, FULLY REGENERATIVE, HIGH PERFORMANCE SCR PHASE ANGLE, SERVO DRIVE SYSTEM
DIFF INPUT
TB1
MOTOR
SEE NOTE 4
1 MOTOR
2
3 MOTOR LO
4 N
5
6
(+) HI LO VELOCITY INPUT OR POSITION ERROR INPUT(SIGNAL)
SHIELD COMMON
(+) TACH
TORQUE HOLD
CURRENT MONITOR OUTPUT
EXTERNAL CURRENT LIMIT CONTROL
SHIELD COMMON
"DRIVE UP"
OPEN WHEN DRIVE INHIBITED
LOOP CAGE INPUT
MOTOR VOLTS INPUT
(INTERNALLY WIRED AT FACTORY.)
INPUT TO RAMP GENERATOR **
RAMP OUT **
+15 OUTPUT FOR CUSTOMER USE
SHIELD COMMON
"TACH LOSS/COMMUTATION FAULT." **
(OPENS IN THE EVENT OF TACH LOSS OF COMMUTATION LIMIT.)
SPARE
RAMP SELECTION INPUT **
"MOTOR OVERLOAD FAULT" **
(OPENS IN THE EVENT OF THERMAL LIMIT.)
SHIELD COMMON
-15 OUTPUT FOR CUSTOMER USE
INHIBIT (CLOSE TO RUN)

** REFERENCE MANUAL M6004 APPENDIX #1.

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 TB1-4 FOR THE TACH AND TERMINAL POINT PO1-1 FOR THE MOTOR. ALL VOLTAGES ARE WITH RESPECT TO GROUND (PO1-4 OR 5).

2- USE TWISTED, SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON TB1 AS INDICATED. ALL THE OTHERS CAN BE NON-SHIELDED.

*3- ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR 10Ω AND .47µf IS SUGGESTED.

4- RECOMMENDED SLOW-BLOW FUSE (CUSTOMER SUPPLIED AND MOUNTED) SIZED FOR APPROX. CONT. MOTOR CURRENT RATING TO PROVIDE ADDED MOTOR PROTECTION.

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

UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE C DWG. NO. 79494 SHEET 2

INLAND MOTOR
INDUSTRIAL DRIVE DIVISION
KOLLMORGEN CORPORATION
RADFORD, VIRGINIA

SYSTEM WIRING DIAGRAM
HPAC1 - (X12 , X13)

DWG. SIZE C DWG. NO. 79494 SHEET 2