Manual and Applications Guide

1 Phase and 3 Phase SCR Servo Amplifier
SPA, SPAR, TPA, AND TPAR SERIES

M-037201

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1.0 DESCRIPTION

The Inland Motor SPA and SPAR series are single-phase, full-wave four-quadrant fully regenerative SCR "Rate Loop" servo amplifiers.

The Inland Motor TPA and TPAR series are three phase, half-wave four-quadrant fully regenerative SCR "Rate Loop" servo amplifiers.

Except for minor component changes on the Rate Loop, Current Loop and possibly the Interlock, the basic modules of these amplifiers are interchangeable and the operation of the modules is identical whether used in the SPA, SPAR, TPA, or TPAR series.

Due to the interchangeability of the modules, spare parts costs can be minimized. The learning process is essentially cut in half on those systems utilizing both single- and three-phase drives.

Modular construction and the liberal use of test points assure easy field maintenance and trouble-shooting.

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

Other features are: Fail Safe Dynamic Braking (Patent No. 3,786,329)

Programmable Torque

I^2t Fusing for Semiconductor Protection, or Circuit Breakers

Overspeed Protection

Motor Overload Protection

3 Phase Unit Not Sensitive to Line Phasing

1.1 Simplified Theory of Operation

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

The amplifier consists of seven basic modules as shown in the System Block Diagram (A-32396) found in the back of this manual:

1. Rate Loop Card
2. Current Loop Card
3. Interlock Card
4. Pulse Generators (2 or 3)
5. Mother Board Containing Items 1 - 4
6. SCR PAKS (2 or 3) (SPA and TPA only)
7. Mounting Panel (SPA and TPA only)

The Rate Loop Card serves the basic function of comparing the commanded speed to the actual speed, as recorded by the tachometer, and emitting a signal commanding more current or less current as necessary to speed up or slow down the motor.

The Current Loop Card serves the basic function of comparing the current command output of the Rate Loop Card to the actual current to the motor and ordering more or less current to agree with the Rate Loop Card command vs. speed ratios to avoid commutation problems.

The Interlock Card monitors the line voltage and shuts down the firing pulses upon loss of a line phase. It also delays turn-on until transients have settled at start-up. In addition, it controls the Fail Safe Dynamic Brake, contains the circuit which removes pulses in case of overspeed of the motor, and performs the RGSO (Remote Gate Shut-Off) function.

The Pulse Generator Cards accept the Current Loop Card output and convert it to a pulse whose position, with respect to line zero crossover, depends on the value of the input signal. As the pulse position advances, current in the motor increases.

The Mother Board serves as a receptacle for all plug-in cards and contains the DC Power Supply as well.

The SCR PAKS are the basic power amplifier section of the amplifier. They control the switching of current into the motor and are in turn switched on by the pulses from the pulse generators.

The Mounting Panel contains all elements of the amplifier named above plus circuit breakers or fuses, the current sample resistor, a termination board for heavy leads, and the motor overload relay.

The SPAR / TPAR series does not have SCR PAKS or a separate mounting panel as do the TPA or SPA series; rather, the SCR's are mounted on individual heat sinks which are mounted on angle support brackets. These brackets form legs which enable the SPAR / TPAR to be mounted in the equipment enclosure. In addition, the SPAR / TPAR system does not include circuit breakers or fuses, or the motor overload relay. These items are available at a slight additional cost but must be mounted external to the SPAR / TPAR unit. Consult the factory for prices.

2.0 INSTALLATION AND ALIGNMENT

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.

On SPA and TPA models, unwrap the plug-in boards (if shipped separately) and install them in the proper connector. The boards are all "keyed," so locate the proper slot and do not force a board into the wrong connector. The component side of the board goes toward the right. SPAR and TPAR models are shipped with the cards in place.

2.1 Mounting

The amplifier is not position sensitive but it should be mounted to allow vertical circulation of air through the SCR heat sinks if possible. SPAR and TPAR models should be mounted at least one inch apart to provide electrical clearances and adequate air flow. SPA and TPA models can be butted together.

2.2 Preliminary Testing

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

2.2.1 Equipment Required

Adjustable Signal Source 0 - $\pm$ 10 VDC @ 15 ma ($\pm$ 15 VDC is available from the amplifier at TB1-7 and TB1-8)

Volt-Ohmmeter (Simpson or Triplett, etc.)

Dual Trace Oscilloscope

Clip-On RMS Ammeter

2.2.2 Wiring Check

Double check all wiring to insure that it is properly installed, securely connected, well soldered, etc., and is wired per the appropriate system wiring diagram found in the back of this manual. Observe the following precautions:

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

Avoid running tachometer leads and signal leads in close proximity to power leads, armature leads, or other sources of electromagnetic noise.

Minimize lead lengths as much as practical.

After wiring is completed, carefully inspect all connections to insure tightness, good solder joints, no stray clippings, etc., especially in the tachometer leads.

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

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

In other words, don't turn the power off and reapply it before the motor comes to a complete stop.

2.2.3 Initial Conditions

NOTE: With the exception of the Speed Scale Factor Pot (P1) and the Stability Pot (P3) on the Rate Loop Card (see B-32111 in back of manual), all adjustments on this amplifier are preset at the factory and should be left as adjusted during initial turn-on.

Set initial conditions as follows:

With primary power OFF, open the leads between TB1 terminals

9 and 10 (RGSO). With the volt-ohmmeter on a sensitive VDC scale, place the positive lead on the choke center-tap (or TB2-1 for SPA/TPA models, "+" mounting stud for SPAR / TPAR models) and the negative lead on TP GND on the mother board or TB1-4.

Manually rotate the motor shaft sharply CW as viewed from the large shaft end. Note the direction of meter needle deflection. Place the positive volt-ohmmeter lead on TB1-3, leaving the negative lead on TP GND or TB1-4. Rotate the motor shaft sharply CW. The meter should now deflect in the opposite direction from the previous step.

2.2.4 Power Application

Remove the command input wires from TB1-1 and 2. On initial turn-on, it is advisable to have the load disconnected from the motor shaft. Turn on the primary power, being ready to switch it off quickly if runaway occurs. If runaway occurs, refer to Section 3.0 of this manual. If the motor sits still, proceed. Close the RGSO (TB1-9 to 10). The motor will either sit still or run up to a very high speed and get stopped by the over-speed control. If runaway occurs, it is probable that the tach leads are improperly phased. Turn off power and reverse the leads on TB1-3 and 4. Leave the shield ground on TB1-4.

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

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

2.2.5 Speed Scale Factor (P1 on Rate Loop Card; See B-32111 in back of manual)

Since driving signals vary considerably, it is a good idea to check the speed scale factor. Proceed as follows:

Connect the D.C. signal source "Hi" to TB1-1. Connect its "Lo" to TB1-2. If the $\pm$ 15 VDC supply on the amplifier is used, connect a jumper from TB1-2 to TB1-4.

Connect the scope between TB1-3 and 4.

Turn the speed scale factor pot, P1, on the Rate Loop Card fully CCW.

Compute the necessary tachometer voltage as follows:

Desired Voltage = (Speed in RPM) (Tach Sensitivity, $\frac{\text{Volts}}{\text{RPM}}$), where tach sensitivity = speed scale factor of tach.

EXAMPLE:

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

CAUTION: IN NO CASE MUST YOU RUN THE MOTOR FASTER THAN THE SPEED ALLOWED PER THE TL SHEET ENCLOSED.

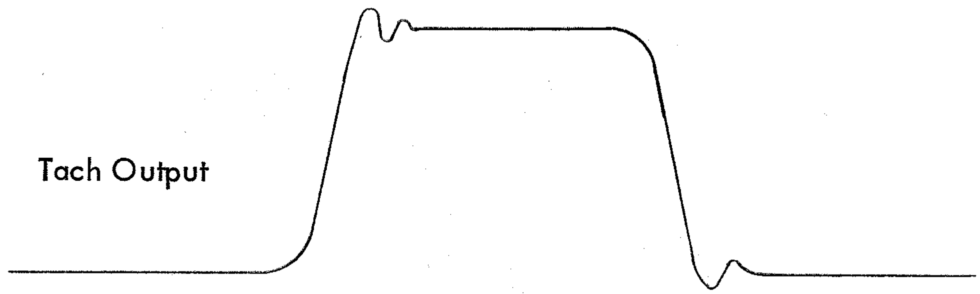
Apply primary power, beginning with a small input command signal, and drive the system backward and forward to familiarize yourself with directions, speed, time you can run, etc. If no response is obtained, rotate the speed scale factor pot, P1, five (5) turns CW and repeat.

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

While running the system, observe the scope and read the tach voltage. If the voltage is too low, adjust P1 (Scale Factor) on the Rate Loop Card to obtain the proper match of input signal vs. desired speed. Remove primary power. After the speed scale factor pot has been set and the system is functioning properly, the load may be reconnected to the motor shaft if it was removed previously.

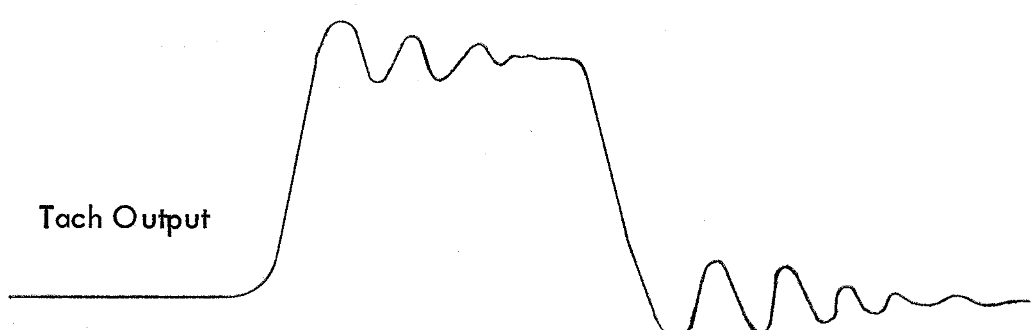
2.2.6 Stability Adjust (P3 on Rate Loop Card, Ref. B-32111 in back of manual)

Once speed is set the system stability may be set. Connect the scope to observe the tachometer and set the input command signal to obtain about 200 - 300 RPM motor speed. Accelerate the motor and observe that the motor accelerates to speed with a tach voltage as follows:



Stability Pot Properly Adjusted
Figure I

Start and stop the system and adjust P3, stability pot, on the Rate Loop Card CW to obtain the wave form shown in Figure I. As this pot is adjusted, the system may begin to oscillate as shown in Figure II. If it does, turn off power immediately and turn P3 about three (3) turns CCW. The system should now be stable and ready for connection to the control command.



Stability Pot Adjusted Too Far CW
Figure II

2.2.7 Current Check

TURN OFF POWER and connect the scope ground to TP GND and the scope Hi to TP MC Hi.

The scale factor on this point is as follows:

Current Sense Resistance	Scale Factor
.01 Ohm	100 Amps / Volt
.005 Ohm	200 Amps / Volt
.003 Ohm	333 Amps / Volt

Set the DC input signal to the maximum expected value, then be sure it is turned off.

Turn on power, then close RGSO. Using the signal source, command speed and observe the current on the scope. With a step input command, the wave form should be as indicated below for the EM-2, EM-10 current loop cards. For the current profile with the EM-12 current loop card, refer to Appendix "B" in the back of this manual.

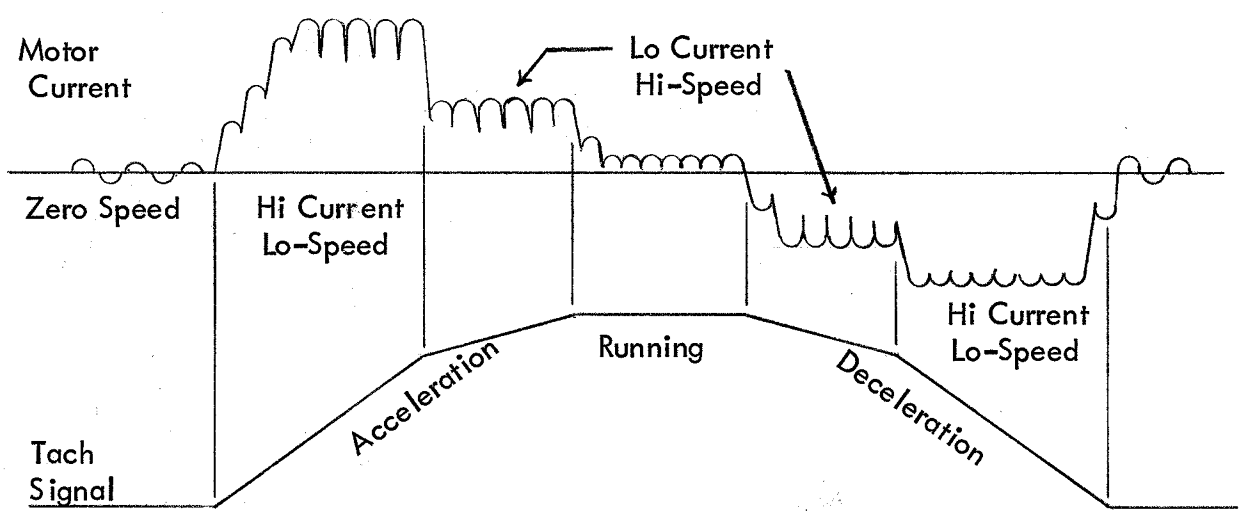


Figure III
Motor Current Waveform

2.3 Connection to the Control Command Output

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

2.3.1 Connection to the N/C

Remove the D.C. signal source. Remove the jumper from TB1-2 to TB1-4 if installed.

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

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

1. Figure out the proper phasing by analyzing the feedback based on the design of the complete machine. Then attach the N/C output to the amplifier and turn on the power.

2. Insert a 47K (33K to 68K is o.k.) ohm resistor in series with the N/C Hi output and TB1-1 on the amplifier. Then with one hand on the start button and one hand on the emergency stop button, apply power and observe the action of the machine.

If it sits still, have someone attempt to rotate the lead screw. If it opposes the attempt to be moved, we may assume that the loop is properly phased.

If the servo tends to help move the axis when turned by hand, or actually runs away when the screw is turned, the position loop phasing is wrong and should be corrected. In most cases, if the phasing is wrong the motor will accelerate to some reasonable speed of about 500 RPM and then the system will oscillate at a low frequency and produce large excursions. The resistor (47K) insures that when a runaway occurs the speed does not reach dangerous levels.

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

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

The machine may now be exercised by the N/C. The last items to be set are the position loop gain in the N/C and the speed scale factor pot, P1, on the Inland amplifier.

The speed scale factor must be set such that the max N/C output is sufficient to drive the Inland system to about 20% over max traverse speed. That is, if the N/C has a ± 5 VDC max output, the scale factor should be such that about 4 VDC will produce max traverse speed. This may be checked and adjusted by running the system with the N/C in max traverse and measuring the N/C output voltage at TB1-1 and 2. Determine the max swing capability of the controller either by reading the N/C specs or actually measuring the max N/C output swing with the Inland drive disabled. With the machine under N/C control, program max traverse and measure the voltage at terminals TB1-1 and 2. Adjust the speed scale factor pot P1 to obtain about 80% of the N/C max output while the machine is moving.

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

2.3.2 Connection to a Manually-Operated Machine

Should the system be used on a manually-operated machine, some form of DC input signal will be required. Drawing A-70087, in the back of this manual, illustrates one method of doing this.

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

An external power supply may be utilized, provided its common is returned to TB1-4 and it does not exceed 15 VDC. The system connections will be similar to those shown in A-70087, the only exception being the connections to TB1-7 and 8. The connections made to the right side of the DIR relay contacts should go to the $\pm$ 15 VDC external power supply rather than to TB1-7 and 8.

This system will operate as follows:

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

2.4 Other Adjustments

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

2.4.1 Common Mode Balance (P4 on the Rate Loop Card; Ref. B-32111 in back of manual)

The Common Mode Balance adjustment is factory set and sealed and should never require adjustment. The following procedure is given only in the event that the seal is unintentionally broken. The potentiometer should be re-sealed after it has been adjusted.

Remove the jumper across JR1 (if installed), or between TB1-2 and TB1-4, on the Mother Board. Jumper TB1-1 to TB1-2 and apply + 1 VDC between this jumper and TB1-4. Close RGSO and adjust P4 (CM Bal) for no change in the voltage at TP2 on the Rate Loop Card when the input signal polarity is changed from + 1 VDC to - 1 VDC.

2.4.2 Zero Adjust (P2 on Rate Loop Card; Ref. B-32111 in back of manual)

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

Jumper TB1-1 to TB1-2. Connect a voltmeter on a sensitive volts DC scale from TP MC Hi to TP GND. Apply power, close RGSO, and adjust P2 (Zero Adjust) on the Rate Loop Card for 0 VDC on the voltmeter.

2.4.3 Automatic Gain Changer Adjustment (Ref. Appendix "A" in back of manual)

This adjustment applies to systems having a GAIN adjustment on the EM-10 and EM-12 Current Loop Cards. This adjustment is not required on systems incorporating the EM-2 Current Loop Card.

2.4.4 Bias Adjustment (P1 on Current Loop Card; Ref. appropriate drawing for your system in back of manual)

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

Turn OFF power and remove the input wire from TB1-1. Jumper TB1-5 to TB1-6 to prevent friction effects in the machine from affecting the bias reading. On the SPA and SPAR series connect the clip-on RMS ammeter around either wire going to the choke. On the TPA and TPAR series connect the clip-on RMS ammeter around one of the leads to the motor. Turn ON power, close RGSO (TB1-9 to 10), and observe the current on the clip-on AC ammeter. It should be at the value indicated on the enclosed TL. If it is not, adjust P1 (bias current) on the Current Loop Card until the correct current is obtained. Turn OFF power and remove the jumper from TB1-5 and 6.

2.4.5 Pulse Generator Adjustment

There are two adjustments on each pulse generator. These are factory set and sealed and should never be touched. In the event that the motor current as shown in Figure III (Sheet 11) or in Figure 2 in Appendix "B" has uneven peaks, such as one current pulse much higher than the two other current pulses in three-phase systems, or one current pulse much higher than the other current pulse in single-phase systems, readjustment may be required. The end result should be that all current pulses under acceleration and deceleration are fairly even. A small variation ($\pm$ 20% from average) in pulse height is acceptable. Should readjustment be required, be sure to reseal the adjustments when completed.

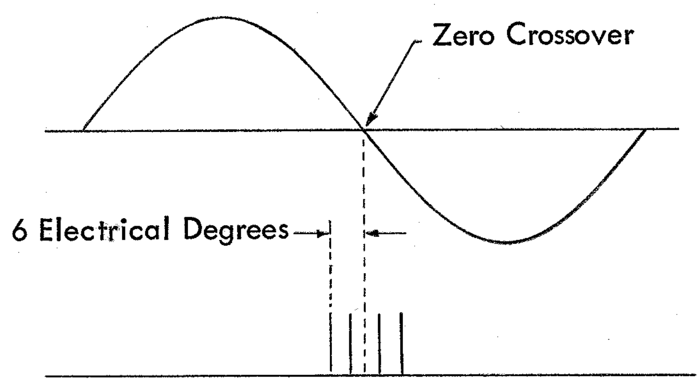
Remove power, remove the SCR PAK plugs along the top edge of the Mother Board, and ground the IN F and IN R test points to the GND test point on the right side of the Mother Board.

For accessibility to the adjustment potentiometers, each card will be adjusted in the extreme right-hand card receptacle. After each card is adjusted, exchange it with an unadjusted pulse generator card and repeat the adjustment procedure. Continue until all EM-4 cards (three for TPA and TPAR models, two for SPA and SPAR models) are adjusted.

NOTE: All cards must be properly inserted into the Mother Board receptacles or the drive will be inoperative.

Using a dual-trace oscilloscope, connect one channel to TP-3 on the right-hand pulse generator, and connect the other channel to the bottom terminal on the line input block for the TPA or SPA model, or the bottom bolt on the right-hand mounting foot on the TPAR or SPAR model.

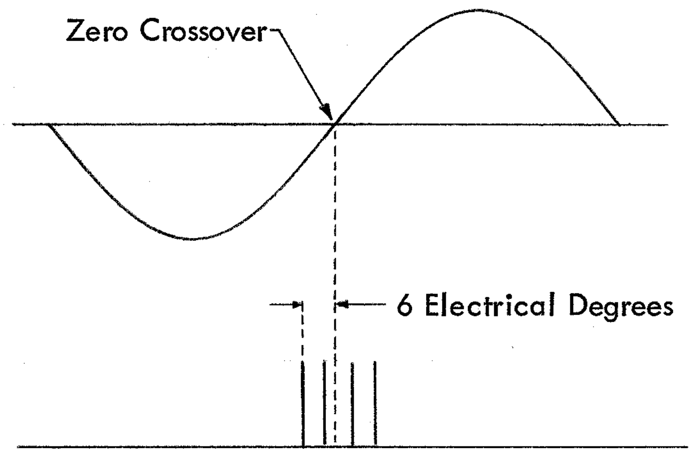
Insure that all cards are in place, apply power, and close RGSO. The waveforms should appear as in Figure IV.



Pulse Generator Timing
Figure IV

There should appear between 3 and 7 pulses on TP3, and the first pulse should be at 6° before zero crossover. If it is not, adjust P1, FWD TRIM, on the right-hand Pulse Generator Card until it is. (The oscilloscope can be calibrated for 6 major divisions between zero crossings on the line input sine wave so that each major division is 30 electrical degrees. Then if each major division is divided into 5 divisions, each of these divisions is 6 electrical degrees.)

When this adjustment is complete, open RGSO and remove power. Move the scope probe from TP3 to TP4 on the same Pulse Generator Card. (Leave the other channel connected as is.) Apply power and close RGSO. The waveforms should appear as in Figure V.



Pulse Generator Timing
Figure V

If the pulses are not 6 electrical degrees as shown, adjust P2, REV TRIM, on the right-hand Pulse Generator Card until it is.

Open RGSO and remove power. Follow the above procedure for the adjustment of the remaining EM-4 card or cards, using in each case the right-hand receptacle. Don't forget to reseal the adjustments on the Pulse Generator Cards. A touch of glyptol or red fingernail polish will do.

The adjustment procedure is now complete. The jumpers on the IN F and IN R test points may be removed, and the SCR PAK plugs may be reconnected. The BIAS adjustment should be rechecked per Section 2.4.4 at this point.

CAUTION: Dangerous voltages exist in this equipment. Do not attempt maintenance or troubleshooting probing and hookup with power on.

3.1 Maintenance

The amplifier should be kept free of excessive dust and grime, especially accumulations of oil. Low pressure compressed air may be used to blow off dust. Freon is a good cleaner for grime. Be very careful not to break fragile parts when cleaning.

Periodically, check all wiring to make sure no connections have worked loose or become frayed.

3.2 Troubleshooting

If trouble is suspected in the rate loop portion of the system and the system is not dangerously erratic or out of control, the procedure outlined in Section 3.2 should be followed.

Below is a chart of typical minor problems that occur and their usual cause. Check each "possible problem" step in sequence until the fault is located.

Symptom	Possible Problem	Refer to Section
Nothing happens	1. Is power present at F1, F2 and F3?	
	2. Is RGSO closed? Are all cards properly inserted?	

Symptom	Possible Problem	Refer to Section
	3. Any fuses blown?	3.2.1 - 3.2.4
	4. Inhibit applied due to overspeed.	Remove and re-apply primary power to reset overspeed circuit.
	5. Is unit wired properly? Does an input command exist at TB1-1, TB1-2?	2.2.2
	6. Check the + and - 15 volt power supplies at TP-15 and TP+15 on the right-hand side of the Mother Board.	3.2.5
	7. Are all cards functioning properly?	3.3
Motor takes off when power is applied	1. Is a large signal present at TB1-1?	
	2. Are tach leads in good condition?	
	3. Is tach phased properly?	2.2.3
Unit is erratic	1. Is all wiring in good condition, screws tight, good solder joints?	
	2. Is stability pot set too far CW?	2.2.6
Unit makes large oscillatory excursions	1. Is position loop properly phased?	2.3.1

Symptom	Possible Problem	Refer to Section
Unit is blowing fuses	1. Are all leads secure with no loose connections?	2.2.2
	2. Is the system properly grounded?	2.2.2
	3. Is there a shorted SCR or faulty component on the suppression card?	3.2.1 - 3.2.4
	4. Check for faulty pulse generator card (EM-4)	3.3.4
	5. If unit is blowing fuses on turn-on, check brake circuit.	3.3.1.1

If the problem cannot be found through the above suggestions, contact the factory.

3.2.1 Preliminary Steps

If the amplifier has SCR PAKS, notice that there is a lamp mounted on the top of each PAK. If the amplifier is a SPAR or TPAR, notice that there are lamps on the right end of the thick support board. These lamps are wired to the line input power and will light when line voltage is applied to the amplifier. If one or all of these lamps are extinguished, line voltage is not present, one or more of the amplifier fuses are blown, or the circuit breaker has tripped. The fact that a lamp is lighted does not guarantee that a transformer primary fuse has not blown. A transformer may couple enough voltage into the secondary windings to light all the lamps. If these lamps light when power is applied, it is safe to assume that the SCR's are not shorted and the tests in 3.2.2 through 3.2.4 may be skipped. Proceed to 3.2.5 to resume testing.

If the system is blowing fuses, proceed as follows:

Turn off power.

Disconnect PAK1 and PAK2 (and PAK3 if present) plugs from the Mother Board.

Remove the connections from TB2-1 and 2 on the SPA or TPA, or + and - on the SPAR or TPAR.

Remove and check the three small power supply fuses on the Mother Board.

Do not replace yet.

3.2.2 Fuse and SCR PAK Static Tests, TPA / SPA Series

Remove the large power fuses. Using the volt-ohmmeter measure the impedance between TB2-1 and each of the "left-hand" screws on the fuse mounting block. Repeat this check for TB2-2 and each of the "left-hand" screws on the fuse mounting block. If either shows a low impedance (less than 100K ohms), the failure of an SCR or suppression component is indicated.

To check the SCR PAKS remove all three leads from the PAK. Use the volt-ohmmeter and check the impedance from L to +, and then from L to -. If either reads less than 100K ohms, check the PAK for a failed component or replace the PAK.

3.2.3 Fuse and SCR Static Tests, TPAR / SPAR Series

To check the SCR's in the SPAR or TPAR, remove the bolt at the + terminal and separate the two or three large leads under the bolt.

Measure the impedance between either left side heat sink and the two or three right side heat sinks in succession. If any reading is below 100K ohms, a bad SCR is indicated in one of the left side heat sinks, or a faulty component on the suppression board.

Measure the impedance from any one of the two or three large leads to the two or three right side heat sinks in succession. If any reading is below 100K ohms, a bad SCR is indicated in the associated right side heat sink, or a faulty component on the suppression board. Repeat the procedure for the remaining one or two large leads.

If all tests are passed, re-install the three large leads on the bolt removed above and tighten it securely.

3.2.4 Fuse and SCR Dynamic Tests

If the above tests indicate no failure, check the fuses and replace any blown ones. Reconnect any wires removed from the SCR PAKS except the leads to the Mother Board PAK 1 and PAK 2 plugs (and PAK 3 if unit is a TPA or TPAR).

Turn on power for a second or so. Turn off power and recheck power fuses to make sure they are not blown. If any are blown, one of the components is failing under voltage. Replace one item at a time to locate the failure.

Upon completion of Step 3.2.4, turn off power and replace the small power supply fuses on the Mother Board.

3.2.5 Power Supply Tests

Disengage all plug-in cards from their connectors.

CAUTION: DO NOT REINSERT ANY CARDS WITH POWER ON. YOU MAY RECEIVE A SEVERE OR FATAL SHOCK SINCE HIGH VOLTAGE IS PRESENT ON SOME CARDS.

Remove any connections from TB1-7 and 8 and TB1-1 and 2. Turn on the power and check for +15 VDC on TB1-7 with respect to TB1-4. Also check for -15 VDC on TB1-8 with respect to TB1-4. If either is missing, the power supply must be troubleshot. The $\pm$ 15 VDC may not be exactly numerically equal.

The primary input of the transformer will accept any one of several input voltages since the primary is multi-tapped. The appropriate jumper on the primary must be connected. Here is a chart of the jumpers versus line to line input voltage; check to see that the proper jumper is closed to match the input voltage between F1 and F2.

RMS Volts F1 & F2	SPA Connected Jumper (JR)	TPA / TPAR Connected Jumper (JR)
460	3-5-7	
340	3-6-10	
230	3-5-8	
208		3-5-8
330		3-6-9
275		3-6-10

In any case the raw DC voltage at the large filter caps C1 and C2 should be between 20 - 30 VDC.

After the power supply has been repaired, insert the plug-in cards one at a time, quickly monitoring the + and - 15 volt test points after each individual card has been reinserted. If it is observed, after a specific card has been reinserted and primary power applied, that the power supply can no longer maintain + and - 15 volts, quickly remove power and troubleshoot that card and replace the faulty component.

3.3 Troubleshooting Individual Card Functions

Before proceeding with troubleshooting of individual cards, turn off power, remove all PAK plugs from the Mother Board, and disconnect one of the motor armature leads (reference appropriate system wiring diagram).

3.3.1 Interlock Card, EM-3-XX (Ref. B-32114 in back of manual)

With power OFF, connect scope Hi to TP-1 of the Interlock (B-32114) and Lo to TP GND (Dwg. B-33462). Open the connection between TB1-9 and 10. Turn on power and observe that the scope deflects -15 volts. Jumper TB1-9 to 10 and observe that the scope deflects positive at least +2.0 volts. If this point does not go to +2.0 volts, check the voltage at the junction of R11, C3, and R13 (upper side of R13). If this voltage is approximately +15 VDC, the Overspeed section can be assumed to be faulty. (The jumper between TP4 and TP5 can be removed to disable the Overspeed function.)

Remove power and connect the scope to Interlock TP2. Turn on power and observe that the voltage at this point is -15 VDC. Remove the jumper between TB1-9 and 10 and observe that TP2 goes to +15 VDC. Remove power. Connect the scope to Interlock TP3. Reapply power and observe that the voltage at this point is at 0 volts. Jumper TB1-9 to 10 and observe that TP3 goes to +15 volts. Remove power.

3.3.1.1 Brake Circuit

Turn off power and connect scope Hi to Interlock TP6. Observe the scope carefully as power is turned on. No deflection should occur on the scope and TP6 should remain at ground. Observe the scope carefully as power is turned off. A string of pulses should occur with the first about +7 VDC in magnitude and subsequent pulses decreasing in magnitude. No pulses should occur on TP6 during normal operation. They should be present only when power is lost. (The brake function may be disabled by removing the jumper between TP6 and 7 if necessary.)

3.3.2 Rate Loop Card, EM-1-XX (Ref. B-32111 in back of manual)

Turn off power and set up as follows:

Connect a 10K resistor between TB1-5 and 6. Connect the scope Lo to TP GND on the Mother Board and Hi to TP-2 (Rate Loop Card). Apply primary power. With TB1-1 connected alternately to TP -15 and TP +15, a deflection of at least $\pm$ 7 VDC should be observed on the scope. If this does not happen, in either case, troubleshoot the rate loop card. AR1, AR2, and Q1 are the components most likely to fail (Q1 is a FET).

3.3.3 Current Loop Card, EM-2-XX (Ref. B-33712), EM-10-XX (Ref. B-35426), EM-12-XX (Ref. B-70525)

3.3.3.1 Current Loop and Current Limiting Circuitry

Turn off power. Install alligator clips on each end of a 120K ohm, $\frac{1}{2}$ watt, resistor (insulating the leads) and clip the resistor between TP1 and TP2 of the current loop card. Reinstall the card in its socket. Ensure that the Rate Loop and Interlock cards are operating properly and are installed.

Connect the scope Lo to TP GND on the Mother Board and Hi to TP3 on the current loop card. Apply primary power. With TB1-1 connected alternately to TP -15 and TP +15, a deflection of from $\pm$ 3 to $\pm$ 7 VDC should be observed on the scope. Remove primary power.

Remove the tach lead from TB1-3. Connect a jumper between TB1-3 and either TP -15 or TP +15 (to simulate the tach). On EM-2 or EM-10 cards apply a jumper between the left-hand side of R18 and the top side of CR5. On EM-12 cards apply a jumper around CR30 and CR31 if they are installed. (This will be from the right-hand side of CR31 to the bottom side of CR30.)

Reapply primary power. Now as TB1-1 is connected alternately between TP -15 and TP +15, TP3 should be observed to swing ± some lower voltage than in the previous step. This checks the current limiting function of the card. Remove primary power. Remove all jumpers, scope leads, and reinstall the tach lead to TB1-3.

3.3.3.2 Automatic Gain Changing Circuitry (Found on EM-10-XX and EM-12-XX Current Loop Cards)

The object of this circuit is to reduce the AC gain of the current loop at the point where motor current changes from being discontinuous to continuous (lower edges or "valleys" of motor current pulses no longer drop all the way back to zero or "baseline"). This is done by introducing a new set of compensation values around the current loop.

Troubleshoot as follows:

Make sure that the PAK plugs and one motor lead are disconnected! Connect the Hi scope lead to TP4 on the current loop card and Lo to TP GND on the Mother Board. Apply primary power. The voltage at TP4 should be approximately -15 volts. Remove power. Connect a jumper from the junction of R23 and R25 of the EM10 card (R18 & R20 of EM-12) to TB1-8. Reapply power. The voltage at TP4 should be approximately +15 volts. Remove power. Remove jumper from TB1-8 and connect to TB1-7. Reapply power. The voltage at TP4 should again be approximately +15 volts.

If the results of the above test are negative, turn P_2 to one extreme and perform the test again. If the results are still negative turn P_2 to the other extreme and try again. If the test is positive, readjust P_2 per Appendix A-1.

If desired, the functioning of Q7 (on EM-10) or Q2 (on EM-12) can be checked as follows:

While applying either + or - 15 volts to the resistor junction as in the above step, monitor with an ohmmeter the 330K ohm resistor around the Q7 or Q2 FET. Place one lead of the ohmmeter on each side of R40 for checking EM-10 cards, or R33 for EM-12 cards, and observe that the resistance here goes from approximately 330K ohms to nearly zero when the circuit is activated.

Remove power, scope leads, and any remaining jumpers.

3.3.4 Pulse Generator Cards, EM-4-XX (Ref. B-32115 in back of manual)

Turn off power. Be sure PAK plugs are disconnected and one motor armature lead is removed. Jumper TB1-1 to TB1-2; TB1-9 to TB1-10.

Connect a 10K resistor between TB1-5 and TB1-6. Install alligator clips on each end of a 120K ohm, $\frac{1}{2}$ watt resistor (insulating the leads) and clip the resistor between TP1 and TP2 on the current loop card. Using a dual-trace oscilloscope, connect one channel to TP1 on the first pulse generator card, and connect the other channel to the top terminal on the line input block for the TPA or SPA model, or the top bolt on the right-hand mounting foot on the TPAR or SPAR model. Connect the scope Lo to TP GND on the Mother Board. Adjust the Bias pot (P1) on the current loop card fully CCW to set the bias current at zero.

Apply power. The waveform at TP1 should appear as shown in Figure VI for "zero input." Remove power. Move the scope probe from TP1 to TP3 on the same pulse generator card. Reapply power. The waveform at TP3 should appear as shown in Figure VI for "zero input." Remove power. Now following the same procedure as above, monitor the waveforms at TP2 and then at TP4. The waveform at TP2 should be like that at TP1 except shifted 180° in phase. The waveform at TP4 should be like that at TP3 except shifted 180° in phase. Remove power.

Remove the jumper from TB1-1 to TB1-2. Apply a jumper from TB1-2 to TB1-4 and another jumper from TB1-7 to TB1-1. Monitor TP1, TP3, and TP2, TP4 on the pulse generator card to confirm that one set of waveforms displays the fully saturated waveform as shown in Figure VII while the other set of waveforms displays the condition as shown for fully retarded in Figure VIII. Depending upon the actual configuration of the specific amplifier, either TP1 / TP3 or TP2 / TP4 may be the fully saturated side.

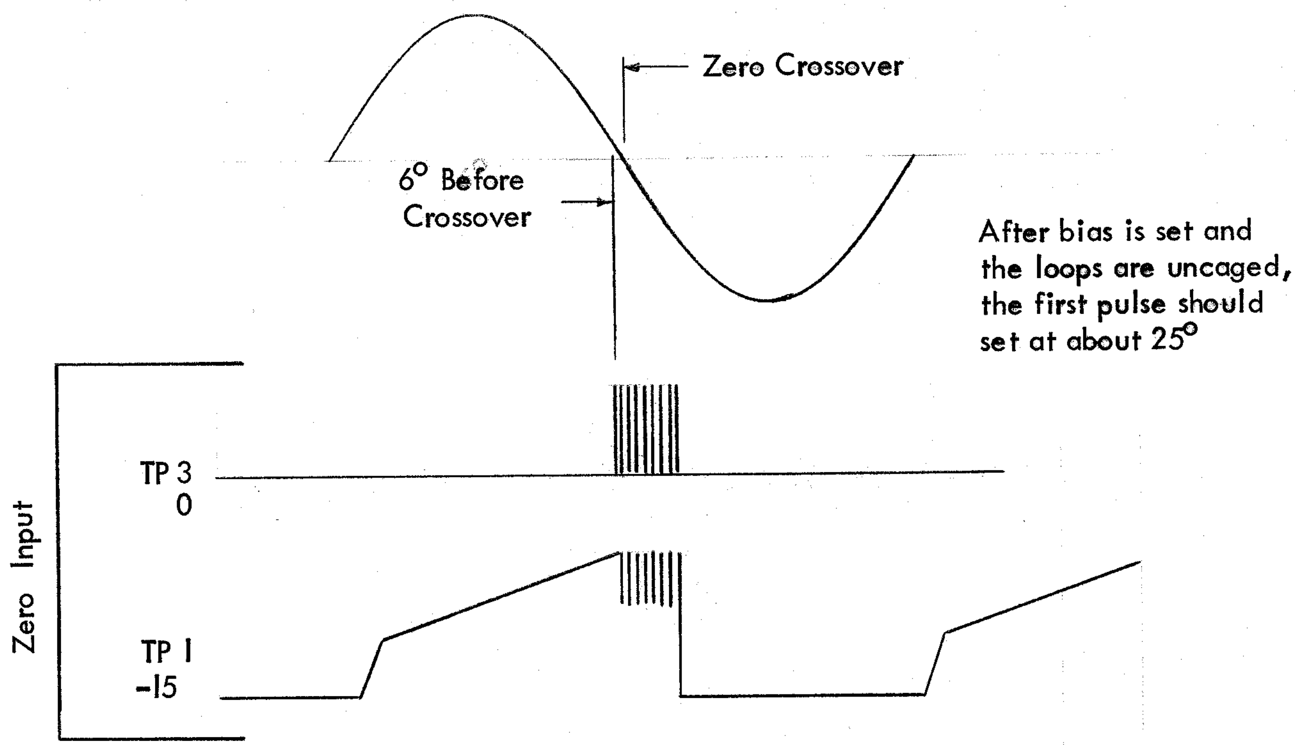


Figure VI

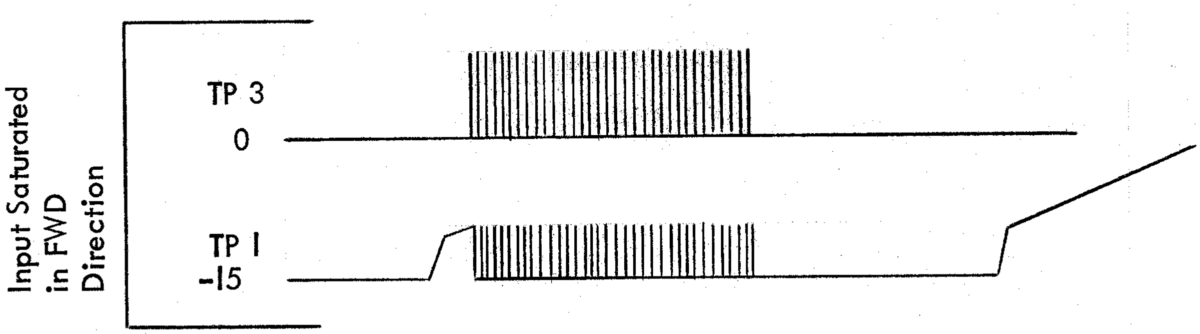


Figure VII

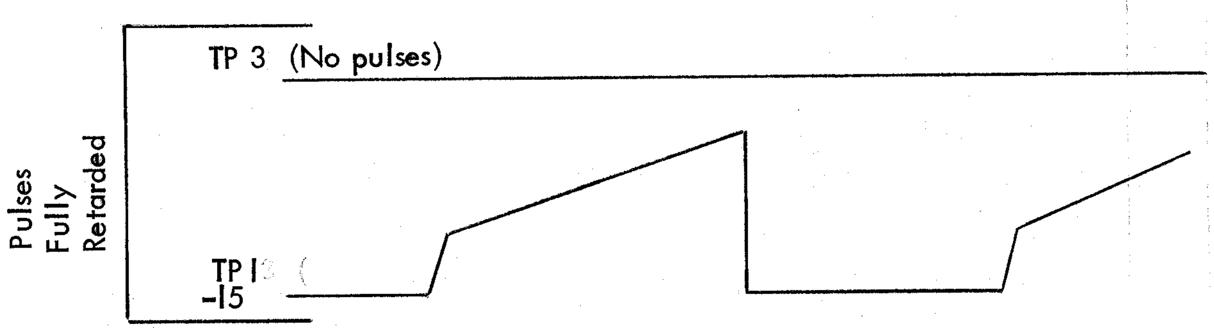


Figure VIII

The important thing is that they swing in opposite directions.

Remove power and move the jumper from TB1-1 and TB1-7 to TB1-1 and TB1-8. Reapply power and confirm that the waveforms now appearing at TP1 / TP3 and TP2 / TP4 are the opposite from those in the previous step. Remove power. Remove the jumper from TB1-1 to TB1-8 and reapply the jumper from TB1-1 to TB1-2.

Repeat the above testing sequence for each of the remaining pulse generator cards, referencing now the second line input block terminal for the second card (third, or bottom, line input block terminal for the third card, if applicable) for SPA and TPA models; third bolt (LB) for the second pulse generator card (fourth, or bottom, bolt (LC) for the third card, if applicable) for SPAR and TPAR models.

If a fault is found in one or more cards, troubleshoot and repair or simply replace the faulty card. Spare or replacement cards are immediately available from the factory.

If the above tests indicate all cards are functioning but it is determined from observing the motor current waveform that an SCR is not firing or being fired, an open circuit may exist between the card output and the SCR gate, or an open SCR may exist.

Remove power, all jumpers, and all resistors; reconnect PAK plugs and motor armature lead; and rewire the entire system into its normal configuration. Recheck per system wiring diagram.

BE CERTAIN THE TACH IS RECONNECTED.

Now follow the Bias Adjustment procedure as found in Section 2.4.4 to reset the bias level, resealing the pot after the adjustment is complete.

4.0 RECOMMENDED SPARE PARTS LIST - SPA / SPAR & TPA / TPAR SCR SERVO AMPLIFIER

10 Fuses, Chase Shawmut A25x150 Form 101 (Not required if the unit contains circuit breakers)

1 SCR PAK, EA 1-XX (SPA or TPA models only)

2 SCR's for SPAR or TPAR models (consult factory for correct SCR part number)

2 Operational Amplifiers, Fairchild U5B7741393

1 Transistor, Silicon, 2N4037

1 Transistor, Silicon, 2N3053

1 Diode, Zener, 1N966B

2 Capacitors, Tant., 100 microfarad, 50 VDC, Sprague

1 Diode, Zener, 1N5243B

5 Diodes, DA 1701

3 Fuses, 3AG, 1 Amp

1 Transformer, ASK-6266

1 Rate Loop, EM-1-XX

1 Current Loop, EM-2-XX (or EM-10-XX or EM-12-XX if applicable)

1 Interlock, EM-3-XX

1 Pulse Generator, EM-4-XX

(Appropriate EM cards must be used, since these cards differ from system to system.)

APPENDIX A

General Procedure for Field Adjustment of the Automatic Gain Circuit

I. EM-10 A.G.C. Adjustment Procedure

The A.G.C. adjustment is factory set and sealed and should never require adjustment. The following procedure is given only in the event that the seals are unintentionally broken. The adjustments should be resealed after they have been set.

Automatic gain changer adjustment (ref. P2 on current loop card; B-35426 in back of manual).

1. Remove primary power from the unit. Disconnect one of the motor armature leads. Remove the "Pak" Plugs on the mother board.

2. Place a jumper in series with a 390K ohm resistor (if a 30 amp system), a 750K ohm resistor (if a 40 or 80 amp system) or a 1.2 megohm resistor (if a 150 amp system). Connect the jumper resistor combination from the junction of R23 and R25 on the EM-10 card to the +15 volt test point on the mother board.

3. With an oscilloscope monitor TP4 on the EM-10 card. Apply power and turn P2 in the direction which will cause TP4 to read approximately -15 volts. Now adjust P2 so that TP4 just saturates to +15 volts.

The EM-10 gain adjustment procedure is complete. Remove power. Remove jumper and resistor. Reinstall the "Pak" plugs and reconnect the motor armature.

II. EM-12 A.G.C. Adjustment Procedure

Automatic gain changer adjustment (ref. P2 on current loop card; B-70525 in back of manual).

1. Remove primary power from the unit. Disconnect one of the motor armature leads. Remove the "Pak" plugs on the mother board.

2. Place a jumper in series with a 390K ohm resistor (if a 30 amp system), a 750K ohm resistor (if a 40 or 80 amp system), or a 1.2 megohm resistor (if a 150 amp system). Connect the jumper resistor combination from the junction of R18 and R20 on the EM-12 card to the +15 volt test point on the mother board.

3. With an oscilloscope monitor TP4 on the EM-12 card. Apply power and turn P2 in the direction which will cause TP4 to read approximately -15 volts. Now adjust P2 so that TP4 just saturates to +15 volts.

The EM-12 gain adjustment procedure is complete. Remove power. Remove jumper and resistor. Reinstall the "Pak" plugs and reconnect the motor armature.

APPENDIX B

General Procedure for Field Adjustments of Horsepower Based Current Limits

I. EM-12 H.B.C.L. Adjustment Procedure

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

The speed at which current limit reduction starts is set by the values of zener diodes CR30 and CR31. If these zeners are replaced by jumpers, the reduction starts immediately. Most motors can withstand a fixed high current for about $\frac{1}{4}$ of their operating speed range. Therefore, the components usually installed will be 7 to 10 volt zeners to establish a fixed current limit for about $\frac{1}{4}$ of the motor speed range (Fig. 1).

CAUTION: Refer to the test limits sheet (T.L.) provided with the system. Under no circumstances should the motor speed exceed the maximum value stated on the test limit sheet.

Under no circumstances should the lo-speed peak current or the hi-speed peak current exceed the maximum values stated on the test limit sheet.

Equipment Required

Small variable DC voltage source 0 - ±15 VDC @ 0.05 A.

Small ±15 VDC voltage source @ 0.05 A.
(One of the above voltage sources may be derived from TB1-7, 8 on the amplifier.)

Dual channel oscilloscope

Procedure

1. Remove primary power from the unit. Disconnect one of the motor armature leads. Remove the "Pak" plugs on the mother board. Remove the tach hi lead from TB1-3. Remove the input command leads at TB1-1 and 2. Turn P4 fully CW on the EM-12 card. Turn P5 fully CW on the EM-12 card. Reapply primary power.

2. Apply ±15 VDC to TB1-3. Adjust P3 for "-A" volts at TP-5 on the EM-12 card. (If so specified on the T.L. sheet, place a jumper around CR30, CR31 on the EM-12 card.) Verify that lowering the voltage applied at TB1-3 lowers the voltage at TP-5 immediately with respect to the change in voltage at TB1-3. Refer to the test limits sheet for value of "A." Remove primary power.

   Remove the voltage at TB1-3 and jumper TB1-3 to TB1-4. (Remove jumper from CR30, CR31 if added.)

3. Temporarily jumper a 68K ohm resistor between TB1-5 and 6 of the amplifier. Connect an adjustable, 0 to ±15 VDC, signal source between TB1-1 and 2 at the input of the amplifier. Reapply primary power to the amplifier and adjust the d.c. signal source for ±10 VDC at TP-8 on the EM-12 card.

4. Adjust P4 on the EM-12 card CCW until the voltage appearing at TP-8 is reduced to "± B" volts. Refer to the test limits sheet for value of "B." Remove primary power and connect the second power supply to TP-5 on the EM-12 card such that -10 volts can be applied directly to TP-5 with respect to terminal TB1-4 (or TP GND on the mother board). Reapply primary power.

5. With "± B" volts appearing at TP-8 on the EM-12 card apply -10 volts d.c. directly to TP-5. Adjust P5 CCW until the "± B" volts at TP-8 is reduced to "± C" volts. Refer to the test limits sheet for value of "C." Remove primary power.

6. Reconnect the motor armature lead. Connect the "pak" plugs to the mother board. Remove the 68K ohm resistor between TB1-5 and TB1-6. Connect the tach Hi lead to TB1-3. Connect the input command to TB1-1 and 2.

7. With a dual channel oscilloscope monitor TP-8 on the EM-12 card. Also monitor the motor current at the "MC-Hi" test point (located on the right-hand side of the mother board) with respect to GND.

Locate the large gold current sensing resistor on the servo drive package and determine its value. It will be .01, .003, or .005 ohm. Next determine the scale factor for the motor current feedback in $\frac{\text{amps}}{\text{volt}}$ at the "MC-Hi" test point.

For Example: (Scope reads 1.5 volt peak, unit has .005 ohm current sensing resistor)

$$\text{Motor Peak Current} = \frac{\text{Peak Voltage at "MC-Hi" Test Point}}{\text{Value of Sensing Resistor}}$$

$$\text{Motor Peak Current} = \frac{1.5 \text{ Volts Peak}}{0.005 \text{ ohm}} = 300 \text{ amps}$$

While monitoring the motor current at the "MC-Hi" test point with the scope, start and stop the motor at the maximum desired system speed (not to exceed the maximum stated on the test limits sheet for the system). The Lo speed peak current should not exceed the maximum value stated on the test limit sheet. The Hi speed peak current should not exceed the maximum value stated on the test limits sheet. The current waveform profile should appear similar to that of the current command profile at TP-8. (Refer to Fig. 1, 2)

8. After the current limit adjustments have been concluded, seal all pots with a touch of Glyptol or fingernail polish.

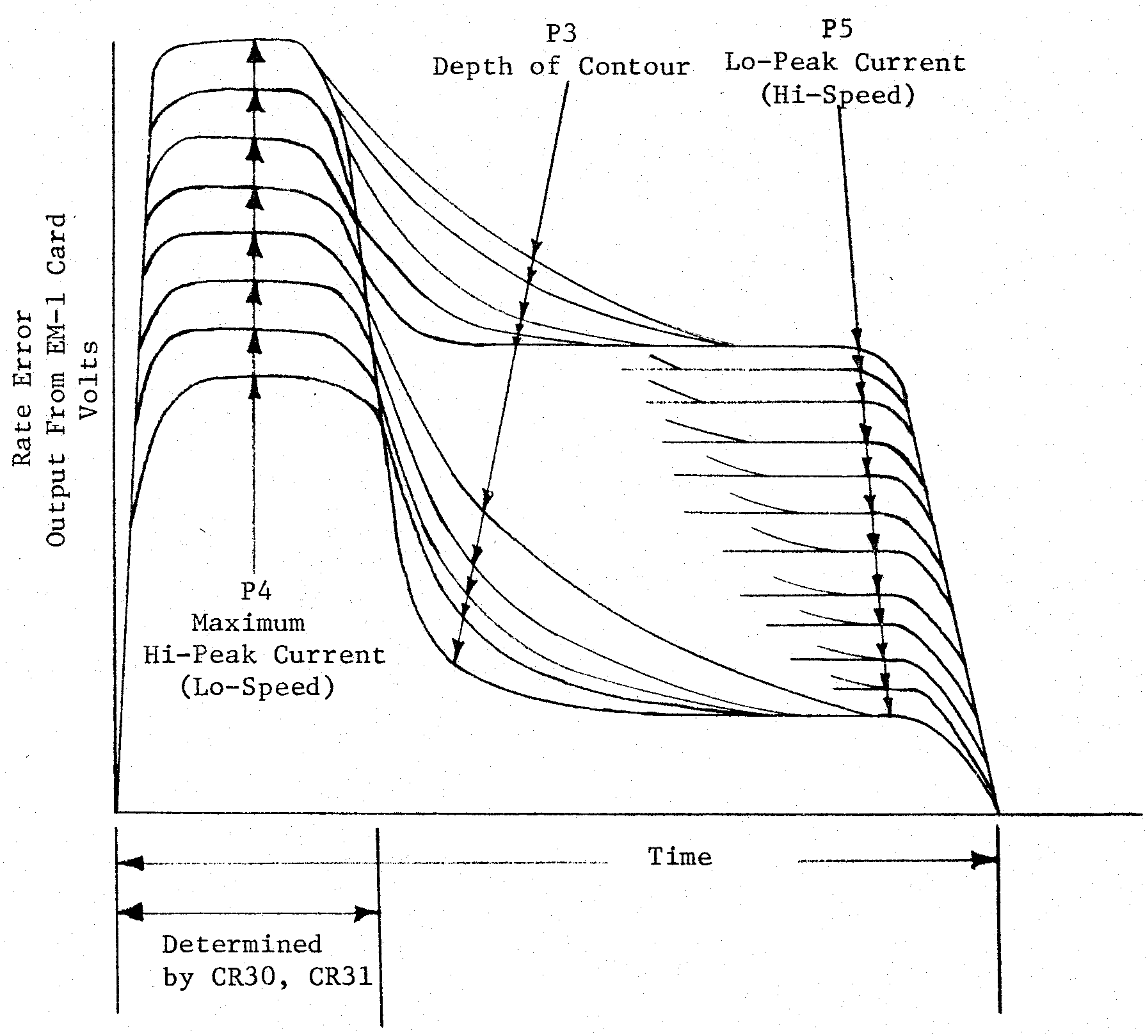


Fig. 1 Current Command Profile at TP-8 (EM-12 Card) During Acceleration from Stall to Max Speed.

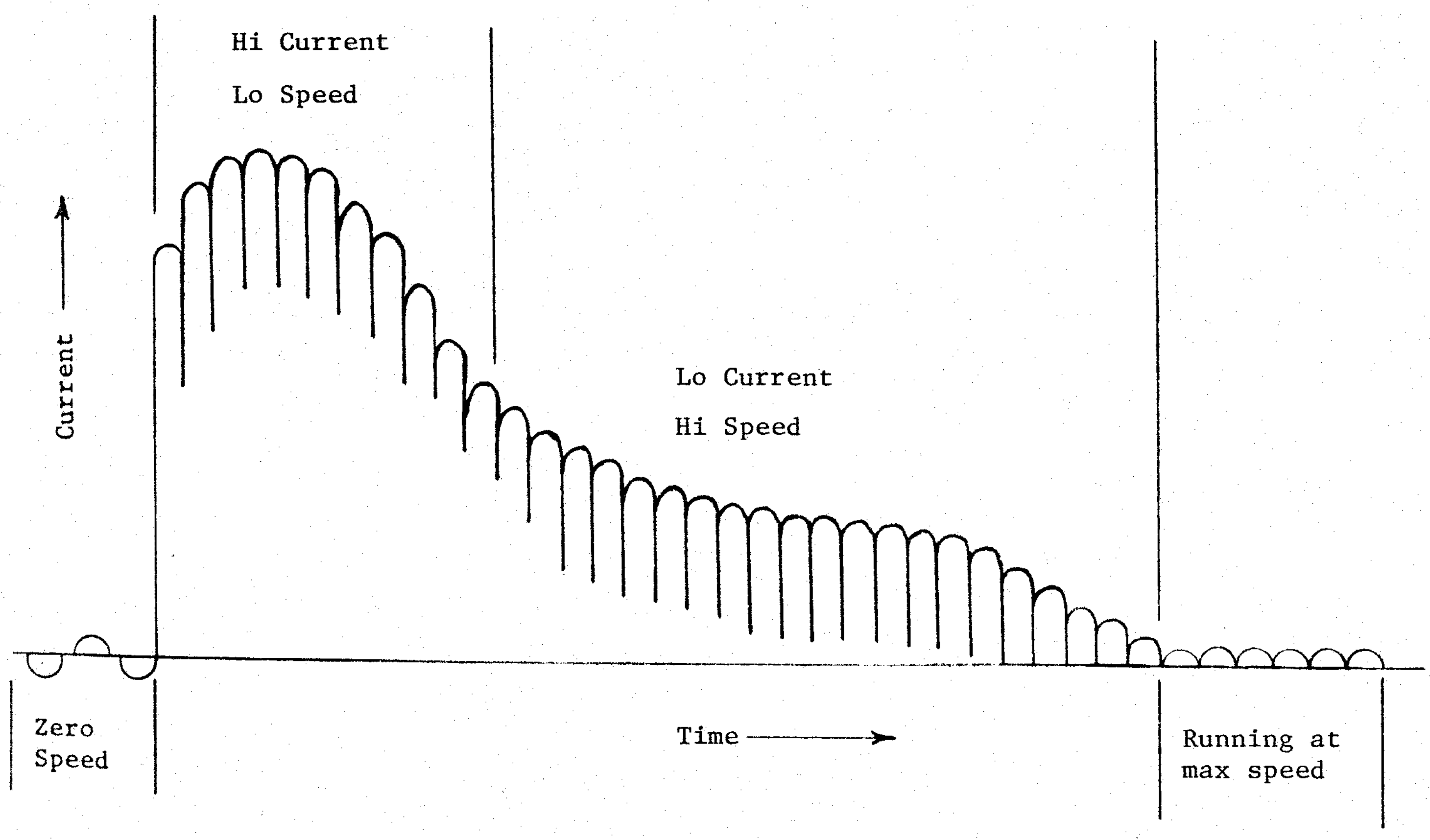
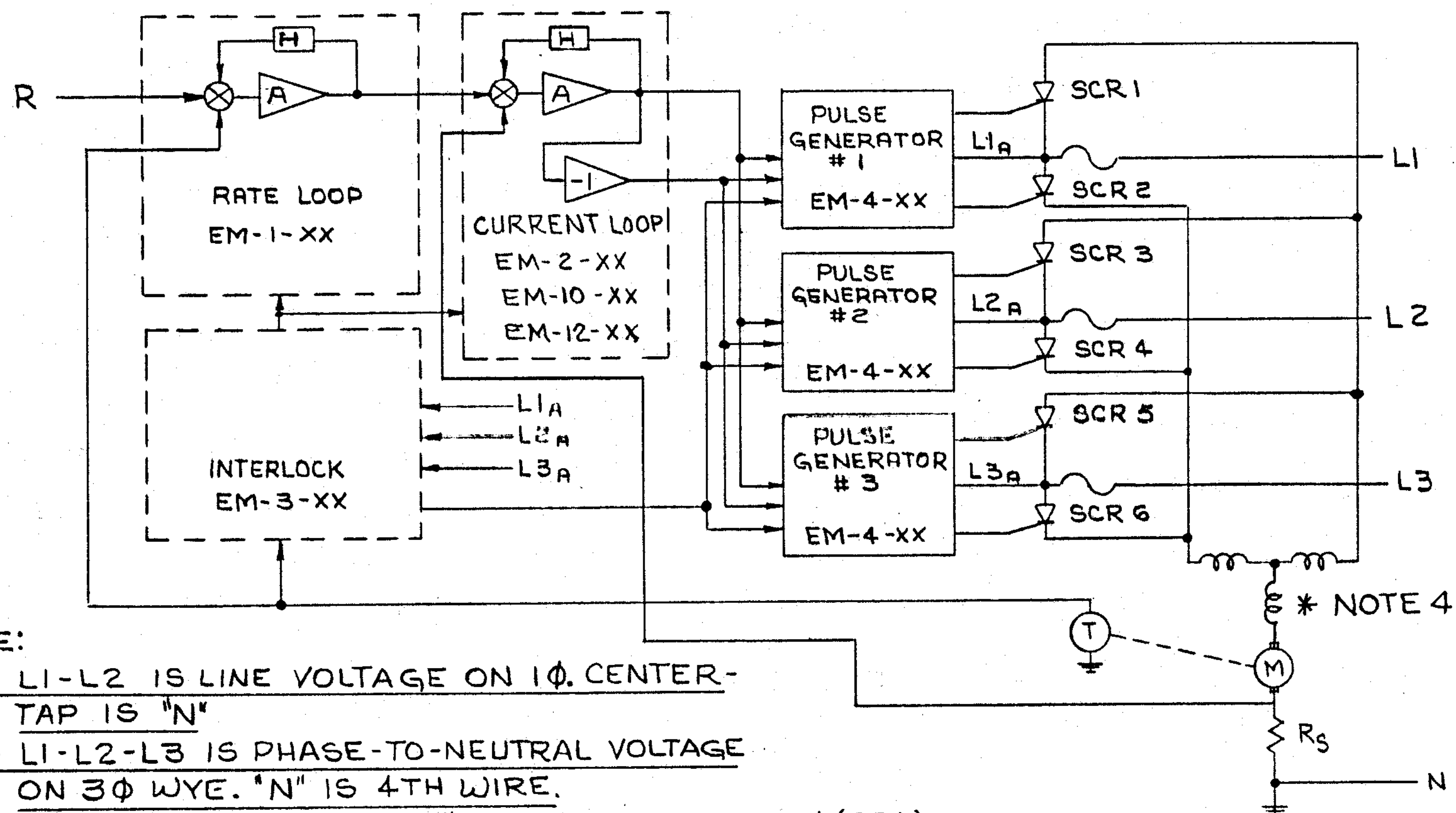


Fig. 2 Acceleration current profile at MC-Hi test point (mother board) stall to max speed.

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 A	DWG. NO. 32396	ISSUE 3



NOTE:

1- L1-L2 IS LINE VOLTAGE ON 1Φ. CENTER-TAP IS "N"

2- L1-L2-L3 IS PHASE-TO-NEUTRAL VOLTAGE ON 3Φ WYE. "N" IS 4TH WIRE.

3- SCR 5-6, F3, PULSE GEN. #3 ARE OMITTED ON 1Φ (SPA)

4- NOT USED ON SOME MODELS.

MATERIAL:-	HEAT TREAT:-	FINISH:-

NO.	ECN NO.	DATE	APP'D.
2	36386 AMJoseph	6-5-72	[illegible]
3	78016 Joseph	4-22-77	RLM

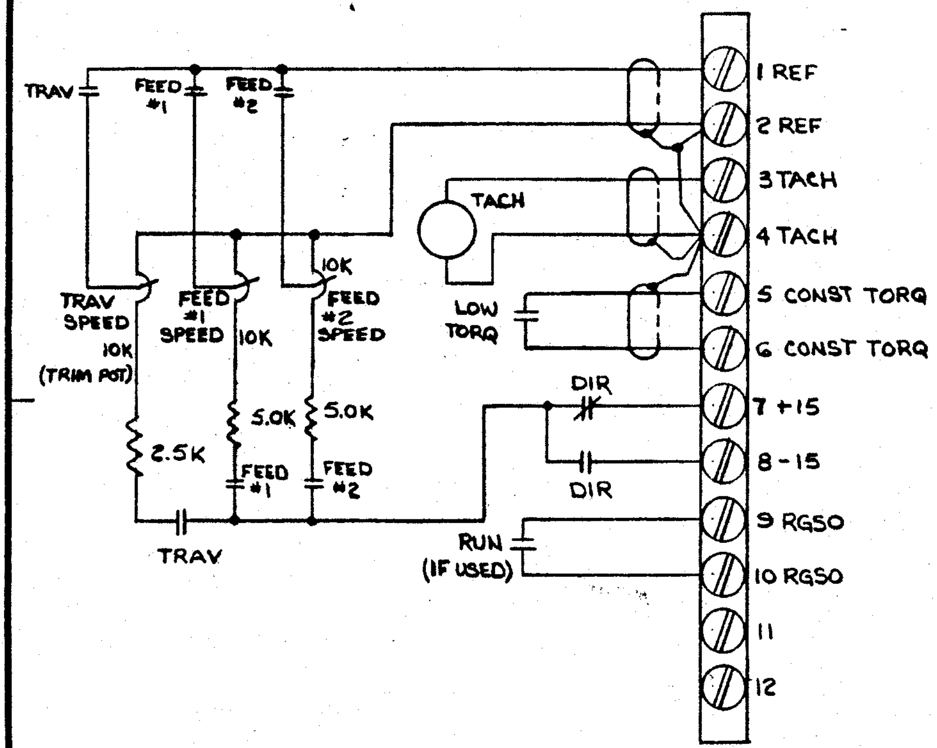
DW'N BY	DATE
AMJ	1-13-72
CH'K BY	
APP'D BY Cws	1-13-72
JOB NO.	
B.O. NO.	

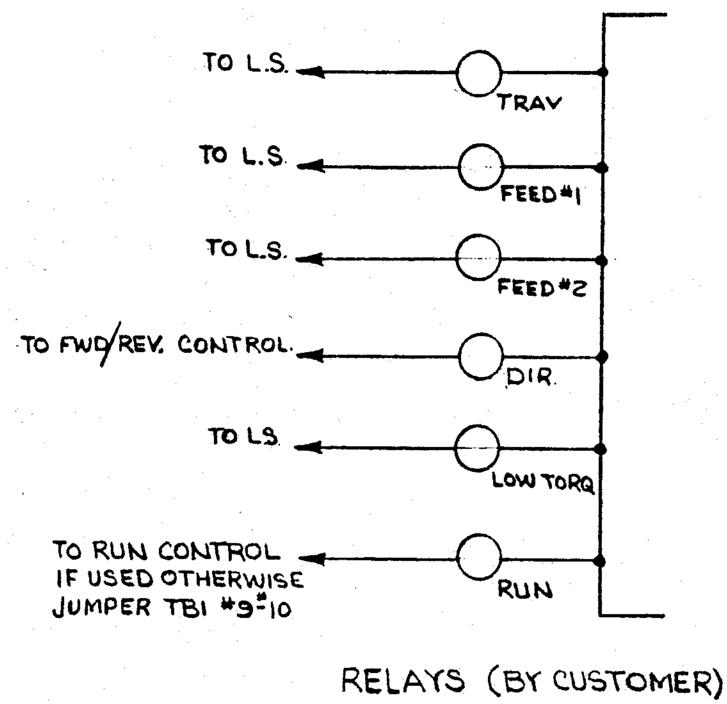
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

BLOCK DIAGRAM
SCR SERVO AMPLIFIER

SCALE:	PART LIST NO.
DWG. SIZE A	DWG. NO. 32396	ISSUE 3

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 A	DWG. NO. 70087	ISSUE 2





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								2	41498 M. Joseph	11/5/74	JKC

DW'N BY	DATE
FMJ	4-20-72
CH'K BY	
APP'D BY JKC	11/5/74
JOB NO. 3-15501	
D.O. NO.	

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

INPUT CIRCUITRY

SCALE: PART LIST NO.

DWG. SIZE A | DWG. NO. 70087 | ISSUE 2

WAS A-SK-6342

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°

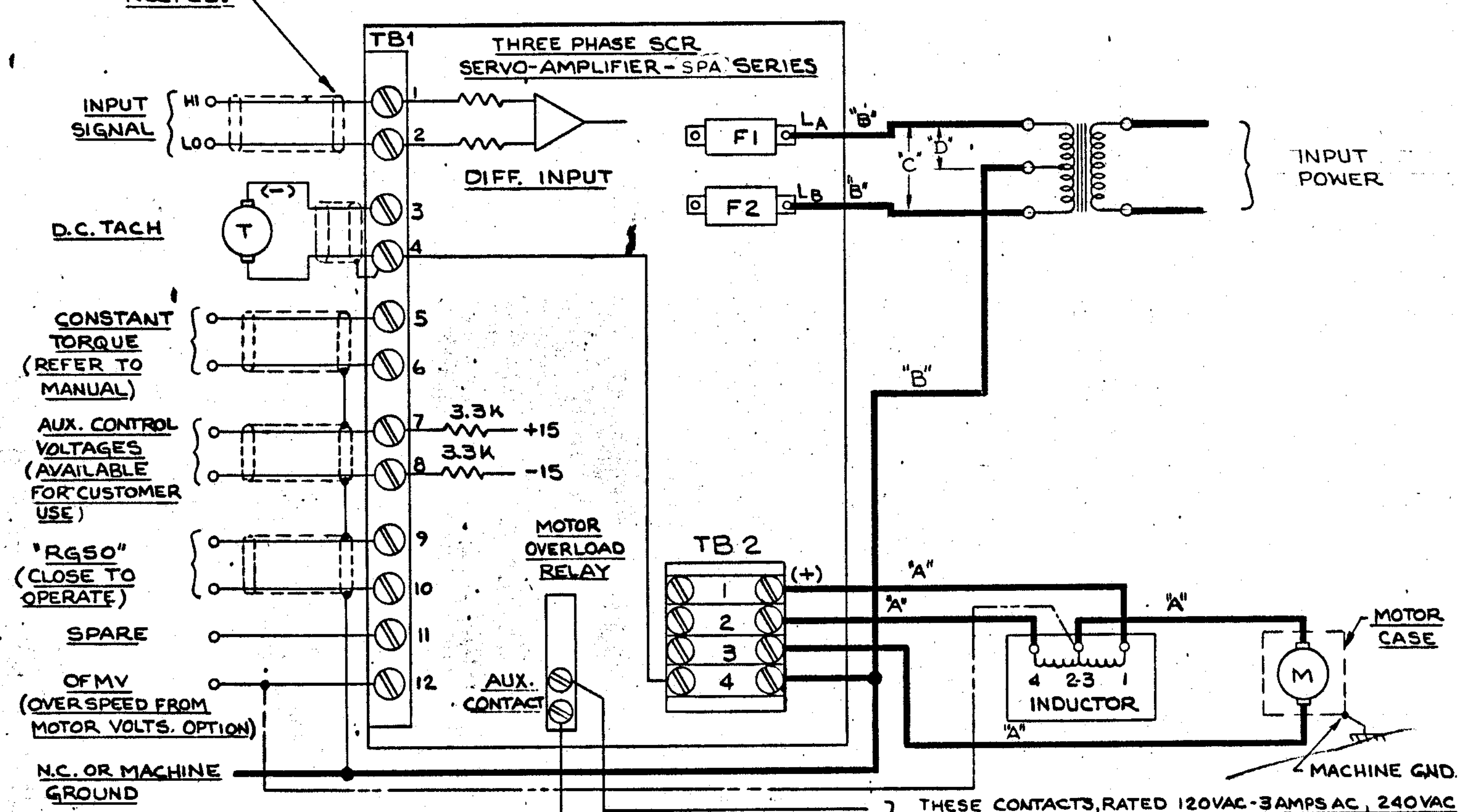
UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE B | DWG. NO. 70216 | ISSUE 1

THIS SHIELD MAY BE CONNECTED TO N.C. GROUND OR TO TB1-4, ONE END SHALL NOT BE CONNECTED.

NOTE: FOR PRIMARY WIRING REFER TO APPROPRIATE TRANSFORMER WIRING DIAGRAM.

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



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

MODEL	A	B	C	D
1330	30 AMPS	30 AMPS	460 L-L	230 L-N
1320	20 AMPS	20 AMPS	460 L-L	230 L-N
1230	30 AMPS	30 AMPS	340 L-L	170 L-N
1220	20 AMPS	20 AMPS	340 L-L	170 L-N
1130	30 AMPS	30 AMPS	230 L-L	115 L-N
1120	20 AMPS	20 AMPS	230 L-L	115V L-N

CODE DATA

NOTE:

1- USE TWISTED, SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON TB1 EXCEPT USE (#18-20GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12).

★ 2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK; CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERMINAL #1 OF TB-2, AND NEGATIVE VOLTAGE AT TERMINAL #3 OF TB-1. ALL VOLTAGES ARE WITH RESPECT TO TERM. #4 OF TB-2.

3- DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

B-70213

MATERIAL: | HEAT TREAT: | FINISH:

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

DW'N BY: Joseph DATE 1/21/75
CH'K BY
APP'D BY [illegible] 2/4/75
JOB NO.
D.O. NO.

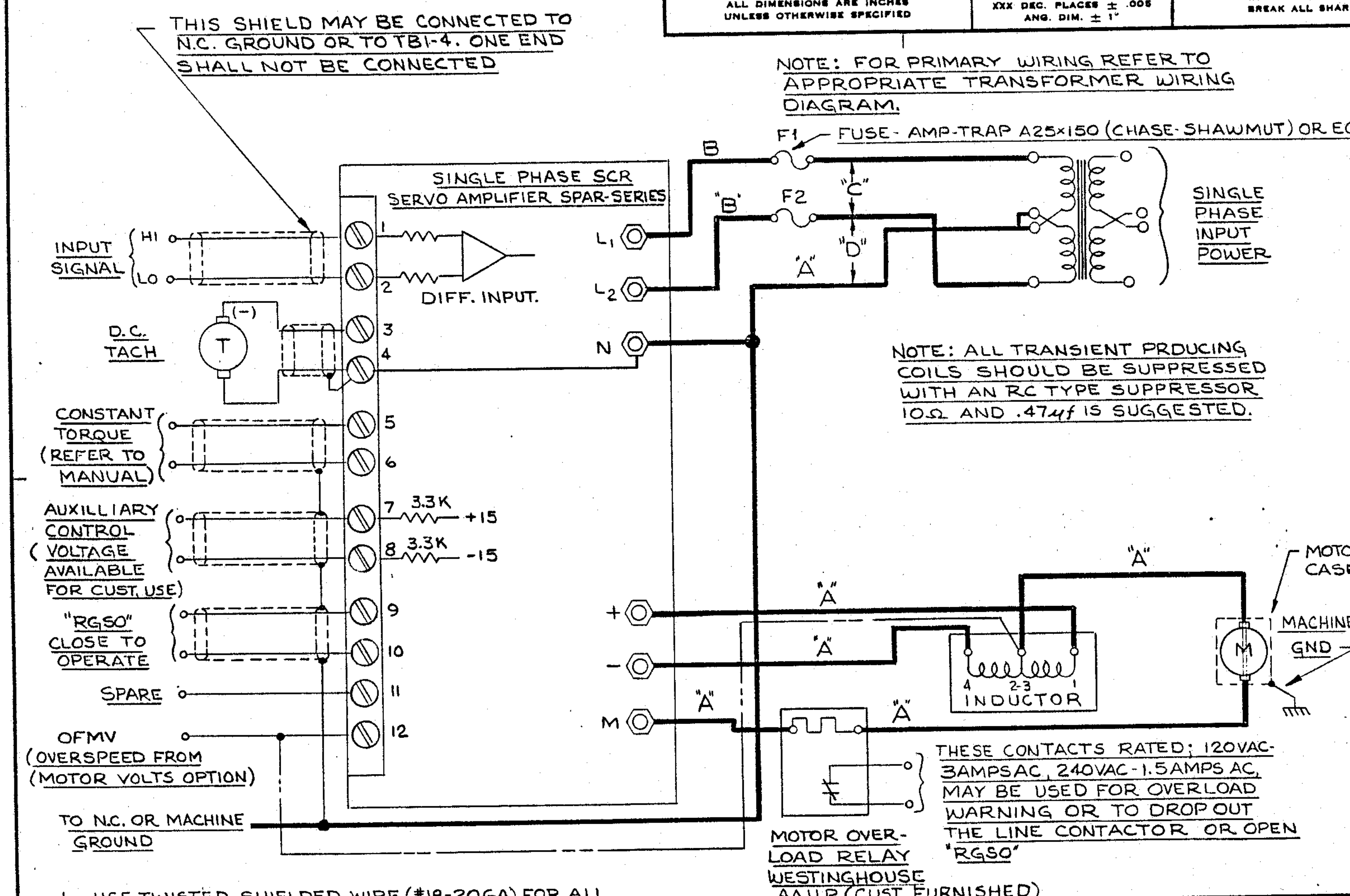
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

SYSTEM WIRING DIAGRAM SPA-SERIES (20A, 30A)

SCALE: | PART LIST NO.

DWG. SIZE B | DWG. NO. 70216 | ISSUE 1

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 B | DWG. NO. 34676 | ISSUE 3



MODEL	A	B	C	D
1330	30 AMPS	30 AMPS	460 L-L	230 L-N
1320	20 AMPS	20 AMPS	460 L-L	230 L-N
1230	30 AMPS	30 AMPS	340 L-L	170 L-N
1220	20 AMPS	20 AMPS	340 L-L	170 L-N
1130	30 AMPS	30 AMPS	230 L-L	115 L-N
1120	20 AMPS	20 AMPS	230 L-L	115V L-N

CODE DATA

1- USE TWISTED, SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON TB1, EXCEPT. USE (#18-20GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12).
2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK; CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERM "+" AND NEGATIVE VOLTAGE AT TERMINAL #3 OF TB1. ALL VOLTAGES ARE WITH RESPECT TO TERM. "N"
3- DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
								3	70085 Joseph	1/27/75	[illegible]

DW'N BY Joseph, DATE 1/25/75
CH'K BY
APP'D BY KLM, 4/16/77
JOB NO.
D.O. NO.

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

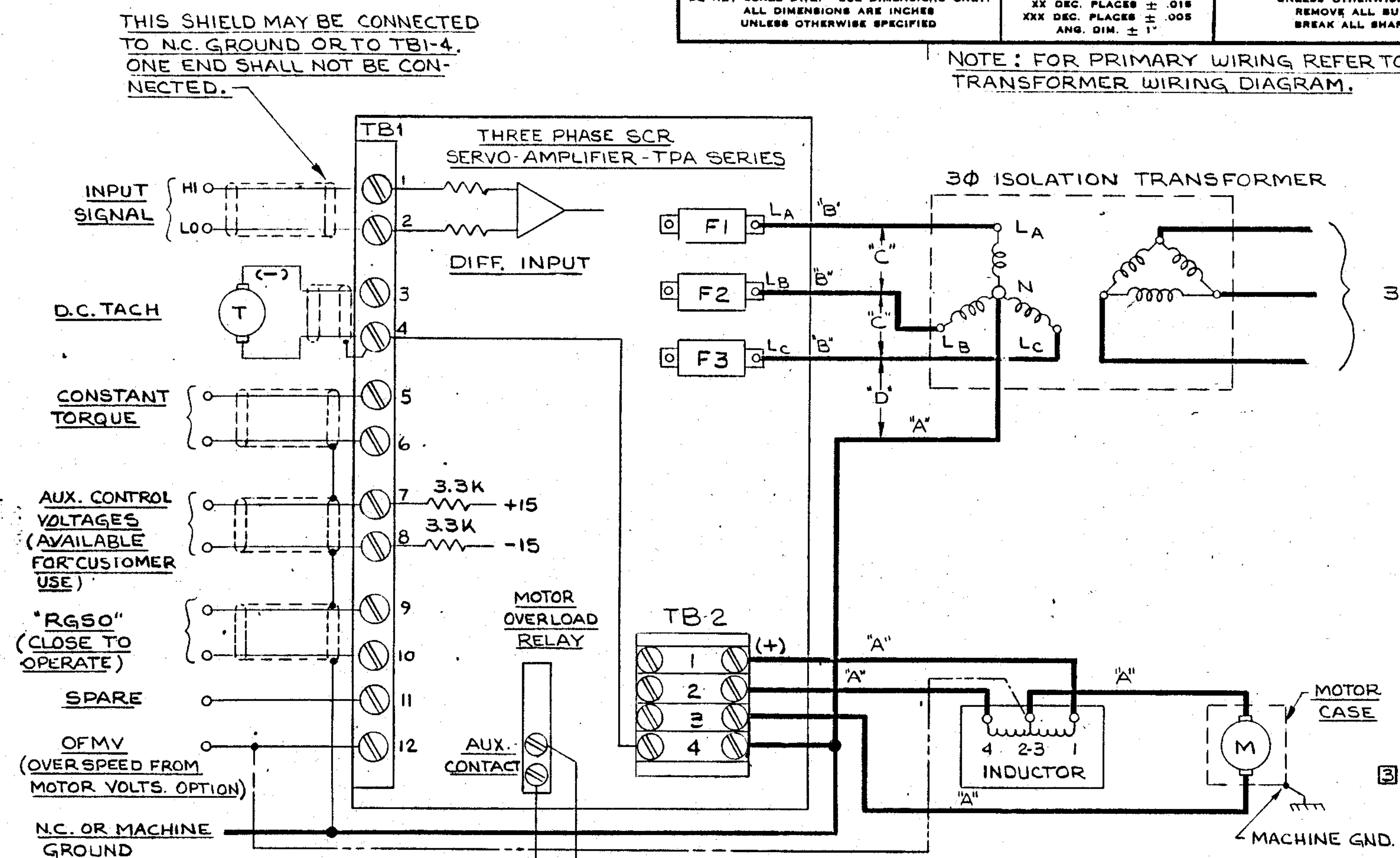
SYSTEM WIRING DIAGRAM
SPAR-SERIES (20A & 30A)

SCALE: | PART LIST NO.

DWG. SIZE B | DWG. NO. 34676 | ISSUE 3

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 B	DWG. NO. 70213	ISSUE 3

NOTE: FOR PRIMARY WIRING REFER TO APPROPRIATE TRANSFORMER WIRING DIAGRAM.



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

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

3

MODEL	A	B	C	D
32.440	40 AMPS	23 AMPS	240V L-L	140V L-N
3440	40 AMPS	23 AMPS	330V L-L	195V L-N
3340	40 AMPS	23 AMPS	275V L-L	160 L-N
3330	30 AMPS	17 AMPS	275V L-L	160 L-N
3230	30 AMPS	17 AMPS	208V L-L	120V L-N

CODE DATA

NOTE:

1 - USE TWISTED, SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON TB1, EXCEPT USE (#18-20GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12)

★2 - BEFORE APPLING POWER MAKE THE FOLLOWING CHECK; CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERMINAL #1 OF TB-2, AND NEGATIVE VOLTAGE AT TERMINAL #3 OF TB-1. ALL VOLTAGES ARE WITH RESPECT TO TERM. #4 OF TB-2.

3 - DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

MATERIAL: HEAT TREAT: FINISH:

NO.	ECN NO.	DATE	APP'D.
2	71000 Joseph	5/20/76	Joseph
3	78134 JOSEPH	10-18-79	RM

DW'N BY: Joseph DATE: 1/21/75
CH'K BY:
APP'D BY: [illegible] 1/4/75
JOB NO.:
D.O. NO.:

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

SYSTEM WIRING DIAGRAM TPA-SERIES (30A, 40A)

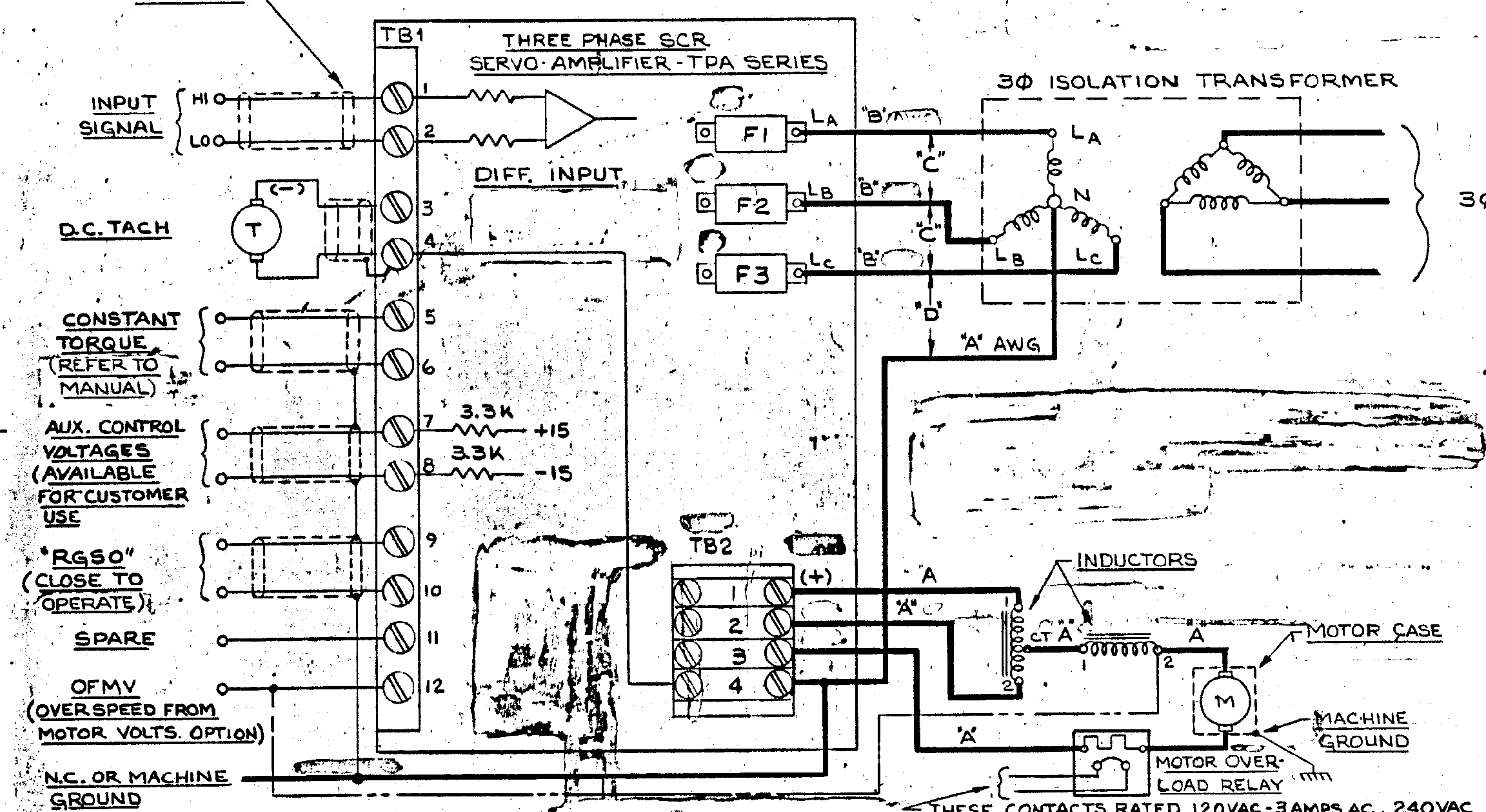
SCALE: PART LIST NO.:

DWG. SIZE B DWG. NO. 70213 ISSUE 3

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 B	DWG. NO. 70214	ISSUE 2

THIS SHIELD MAY BE CONNECTED TO N.C. GROUND OR TO TB1-4. ONE END SHALL NOT BE CONNECTED.

NOTE: FOR PRIMARY WIRING REFER TO APPROPRIATE TRANSFORMER WIRING DIAGRAM.



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

THESE CONTACTS, RATED 120VAC-3AMPS AC, 240VAC 1.5 AMPS AC, MAY BE USED FOR OVERLOAD WARNING OR TO DROP OUT THE LINE CONTACTOR OR OPEN "RGSO". 2

34100	100 AMPS	58 AMPS	330 L-L	195 L-N
33100	100 AMPS	58 AMPS	275 L-L	160 L-N
3480	80 AMPS	46 AMPS	330 L-L	195 L-N
3380	80 AMPS	46 AMPS	275 L-L	160 L-N
MODEL	"A"	"B"	"C"	"D"

CODE DATA

NOTE:

1- USE TWISTED, SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON TB1, EXCEPT USE #18-20GA NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12)

2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK: CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERMINAL #1 OF TB-2, AND NEGATIVE VOLTAGE AT TERMINAL #3 OF TB-1. ALL VOLTAGES ARE WITH RESPECT TO TERM. #4 OF TB-2.

3- DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

B-70213

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
								2	28616 REYNOLDS	8/16/79	

DW'N BY. Joseph DATE 1/21/75
CH'K BY
APP'D BY CHO 2/4/75
JOB NO.
D.O. NO.

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

SYSTEM WIRING DIAGRAM
TPA- SERIES (80 & 100A)

SCALE: | PART LIST NO.

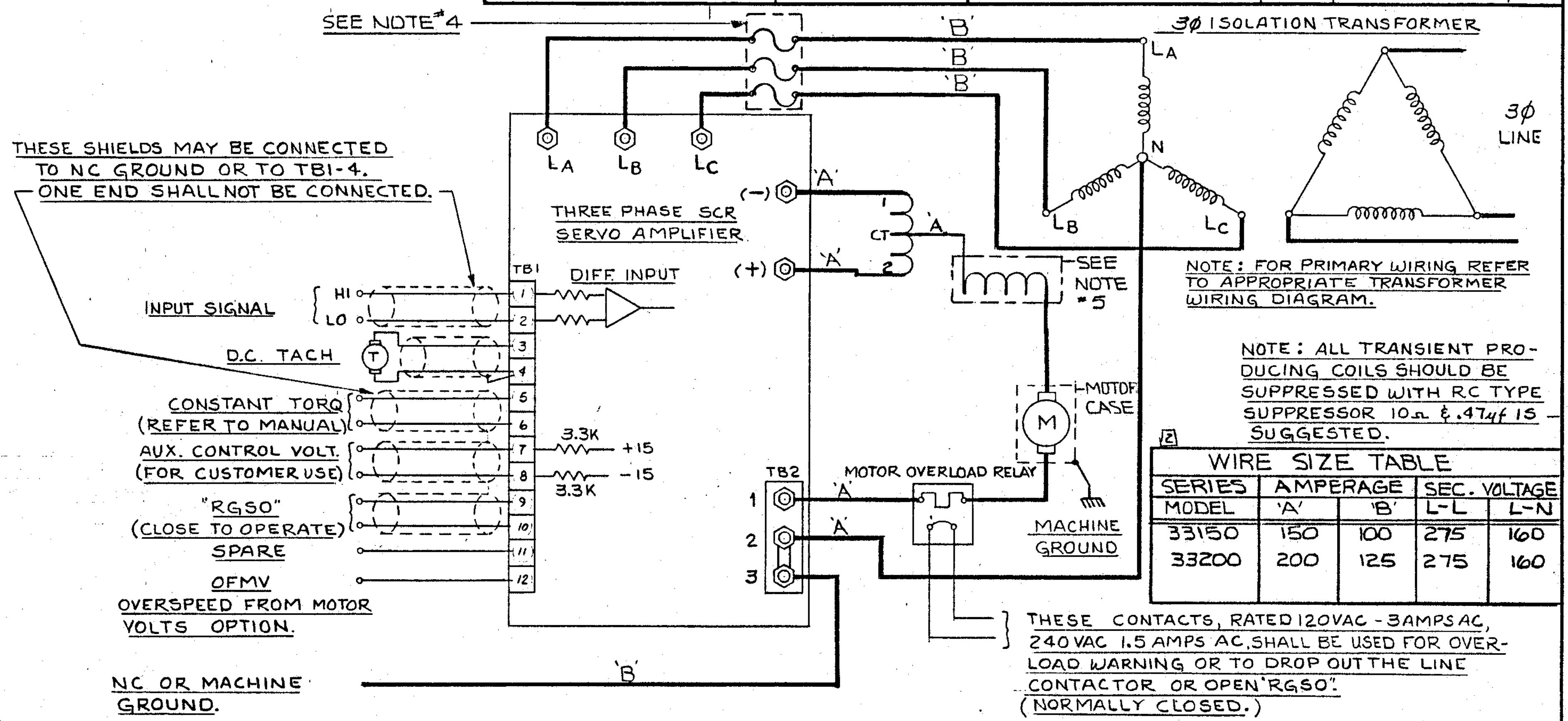
DWG. SIZE B | DWG. NO. 70214 | ISSUE 2

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 B | DWG. NO. 70506 | ISSUE 2



NOTE: FOR PRIMARY WIRING REFER TO APPROPRIATE TRANSFORMER WIRING DIAGRAM.

NOTE: ALL TRANSIENT PRODUCING COILS SHOULD BE SUPPRESSED WITH RC TYPE SUPPRESSOR 10Ω & .47μf IS SUGGESTED.

[2] WIRE SIZE TABLE

SERIES	AMPERAGE		SEC. VOLTAGE	
MODEL	'A'	'B'	L-L	L-N
33150	150	100	275	160
33200	200	125	275	160

NOTE:

1- USE TWISTED, SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON TB1, EXCEPT USE (#18-20 GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12).

★ 2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK; CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT (+) TERMINAL, AND A NEGATIVE VOLT. AT TERM #3 OF TB1. ALL VOLTAGES ARE WITH RESPECT TO TERM. #3 OF TB2.

3- DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

[2] 4- LINE FUSES - CUSTOMER SUPPLIED. TYPE #A-50PXXX OR EQUIVALENT.

[2] 5- SERIES INDUCTOR MAY NOT BE REQUIRED IN ALL APPLICATIONS, CONSULT FACTORY.

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
								2	82445 OWENS	1/7/88	SCM

DW'N BY Joseph DATE 10/30/75
CH'K BY Joseph 11/4/75
APP'D BY R.L. Melton 12/15/75
JOB NO.
D.O. NO.

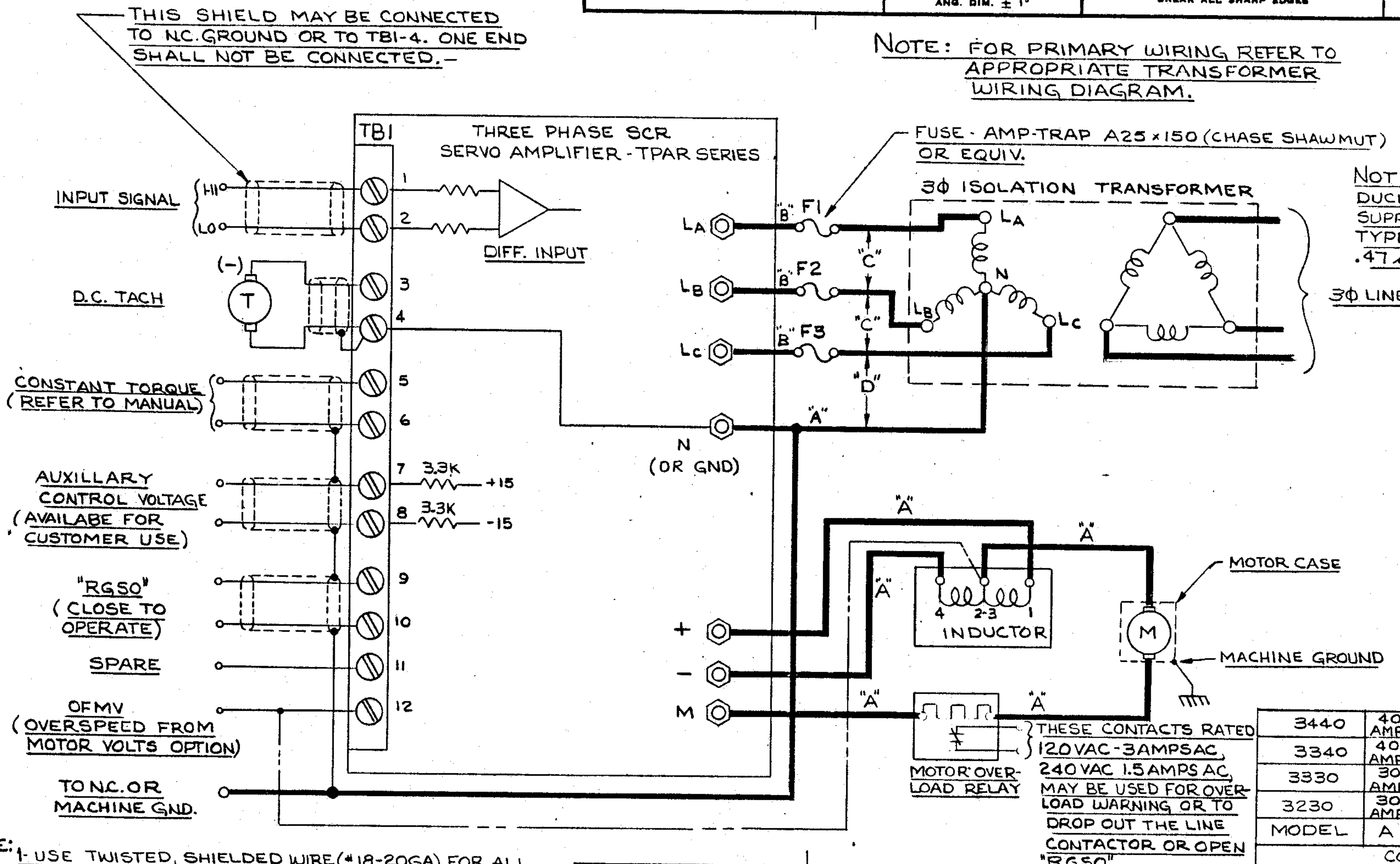
INDUSTRIAL DRIVES
Radford, Virginia
A KOLLMORGEN DIVISION

SYSTEM WIRING DIAGRAM
TPA-33 XXX

SCALE: —— | PART LIST NO. 3634

DWG. SIZE B | DWG. NO. 70506 | ISSUE 2

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 B	DWG. NO. 33255	ISSUE 9



NOTE: ALL TRANSIENT PRO-DUCING COILS SHOULD BE SUPPRESSED WITH AN RC TYPE SUPPRESSOR, 10Ω AND .47μf IS SUGGESTED.

3440	40 AMPS	23 AMPS	330 L-L	195 L-N
3340	40 AMPS	23 AMPS	275 L-L	160 L-N
3330	30 AMPS	17 AMPS	275 L-L	160 L-N
3230	30 AMPS	17 AMPS	208 L-L	120 L-N
MODEL	A	B	C	D

CODE DATA

NOTE:
1- USE TWISTED, SHIELDED WIRE (#18-20GA) FOR ALL INPUTS ON TBI, EXCEPT, USE #18-20GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS. (TBI-12).
2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK; CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERMINAL (+) OF AMPLIFIER AND NEGATIVE AT VOLTAGE AT TBI-3. WITH RESPECT TO N.
3- DO NOT OPERATE SYSTEM WITH MOTOR DIS-CONNECTED.

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.
7	70086 Joseph	1/27/75	[illegible]
8	70227 Joseph	4/30/75	[illegible]
9	70343 YW	7/28/75	RED 8-1

DW'N BY Joseph DATE 1/24/75 | CH'K BY | APP'D BY KLM DATE 5/16/75 | JOB NO. | D.O. NO.

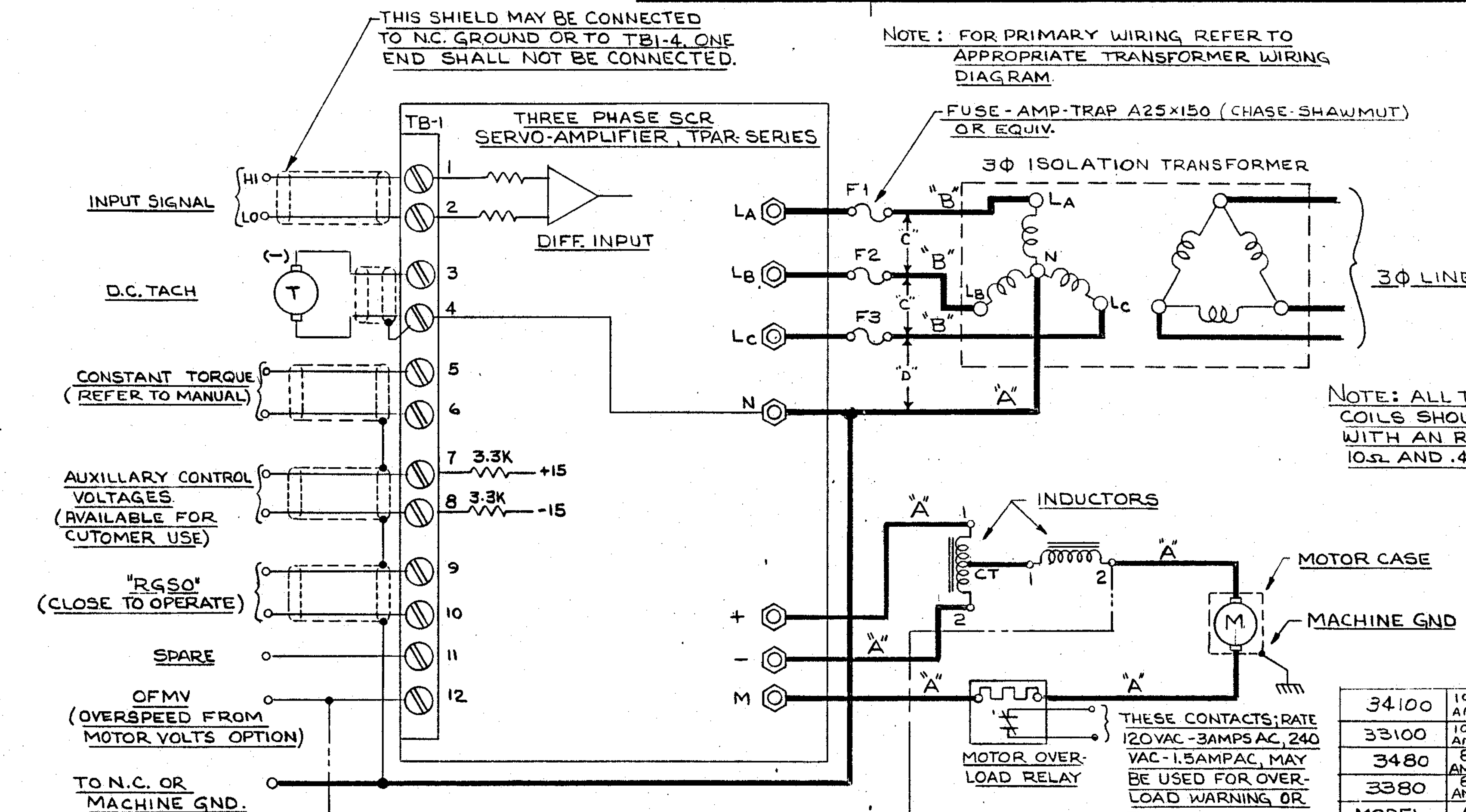
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 301 FIRST STREET VIRGINIA

SYSTEM WIRING DIAGRAM
TPAR - SERIES (30A & 40A)

SCALE: | PART LIST NO.

DWG. SIZE B | DWG. NO. 33255 | ISSUE 9

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 B	DWG. NO. 70215	ISSUE 2



NOTE: FOR PRIMARY WIRING REFER TO APPROPRIATE TRANSFORMER WIRING DIAGRAM.

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

MODEL	A	B	C	D
34100	100 AMPS	58 AMPS	330 L-L	195 L-N
33100	100 AMPS	58 AMPS	275 L-L	160 L-N
3480	80 AMPS	46 AMPS	330 L-L	195 L-N
3380	80 AMPS	46 AMPS	275 L-L	160 L-N

CODE DATA

NOTE:

1- USE TWISTED SHIELDED WIRE (#18-20 GA) FOR ALL INPUTS ON TB1, EXCEPT USE (#18-20 GA) NON-SHIELDED WIRE FOR OVERSPEED FROM MOTOR VOLTS (TB1-12).

2- BEFORE APPLYING POWER MAKE THE FOLLOWING CHECK: CW ROTATION OF MOTOR (LARGE SHAFT END) SHOULD PRODUCE A POSITIVE VOLTAGE AT TERMINAL "+" ON AMPLIFIER AND NEGATIVE VOLTAGE AT TERM. 3 OF TB1. ALL VOLTAGES ARE WITH RESPECT TO TERM. N OF TB2

3- DO NOT OPERATE SYSTEM WITH MOTOR DISCONNECTED.

MATERIAL: HEAT TREAT: FINISH:

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
								2	70342 J.W.	7/25/75	RFD 8-1

DW'N BY Joseph DATE 1/24/75
CH'K BY
APP'D BY [illegible] 7/4/75
JOB NO.
D.O. NO.

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD 501 FIRST STREET VIRGINIA

SYSTEM WIRING DIAG. TPAR-SERIES (80A)

SCALE: PART LIST NO.

DWG. SIZE B DWG. NO. 70215 ISSUE 2

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

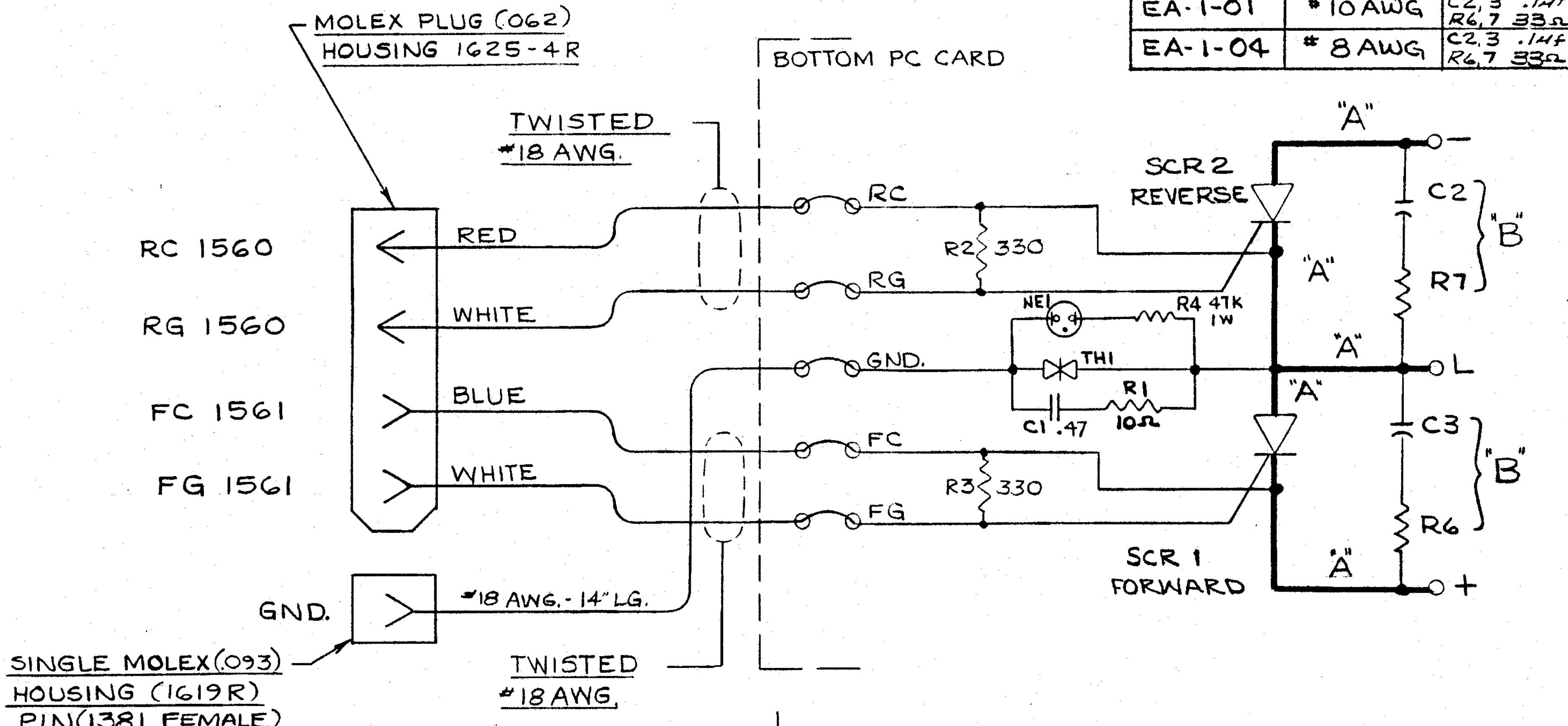
UNLESS OTHERWISE SPECIFIED XX DEC. PLACES ± .015 XXX DEC. PLACES ± .005 ANG. DIM. ± 1°

UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

DWG. SIZE A | DWG. NO. 32098 | ISSUE 5

CODE CHART

MODEL	A	B
EA-1-00	#12 AWG	—
EA-1-01	#10 AWG	C2,3 .1µf R6,7 33Ω
EA-1-04	# 8 AWG	C2,3 .1µf R6,7 33Ω



MATERIAL: NOTED	HEAT TREAT: NONE	FINISH: NONE

NO.	ECN NO.	DATE	APP'D.
2	38025 M. Joseph	1-25-73	DC
3	70099 M. Joseph	2/4/75	QIE
4	70893 Joseph	4-22-7	RLM
5	78016 Joseph	5-13-7	RLM

DW'N BY DET | DATE 11-3-71 | CH'K BY | APP'D BY SHW 1/21 | JOB NO. RD-3062 | D.O. NO.

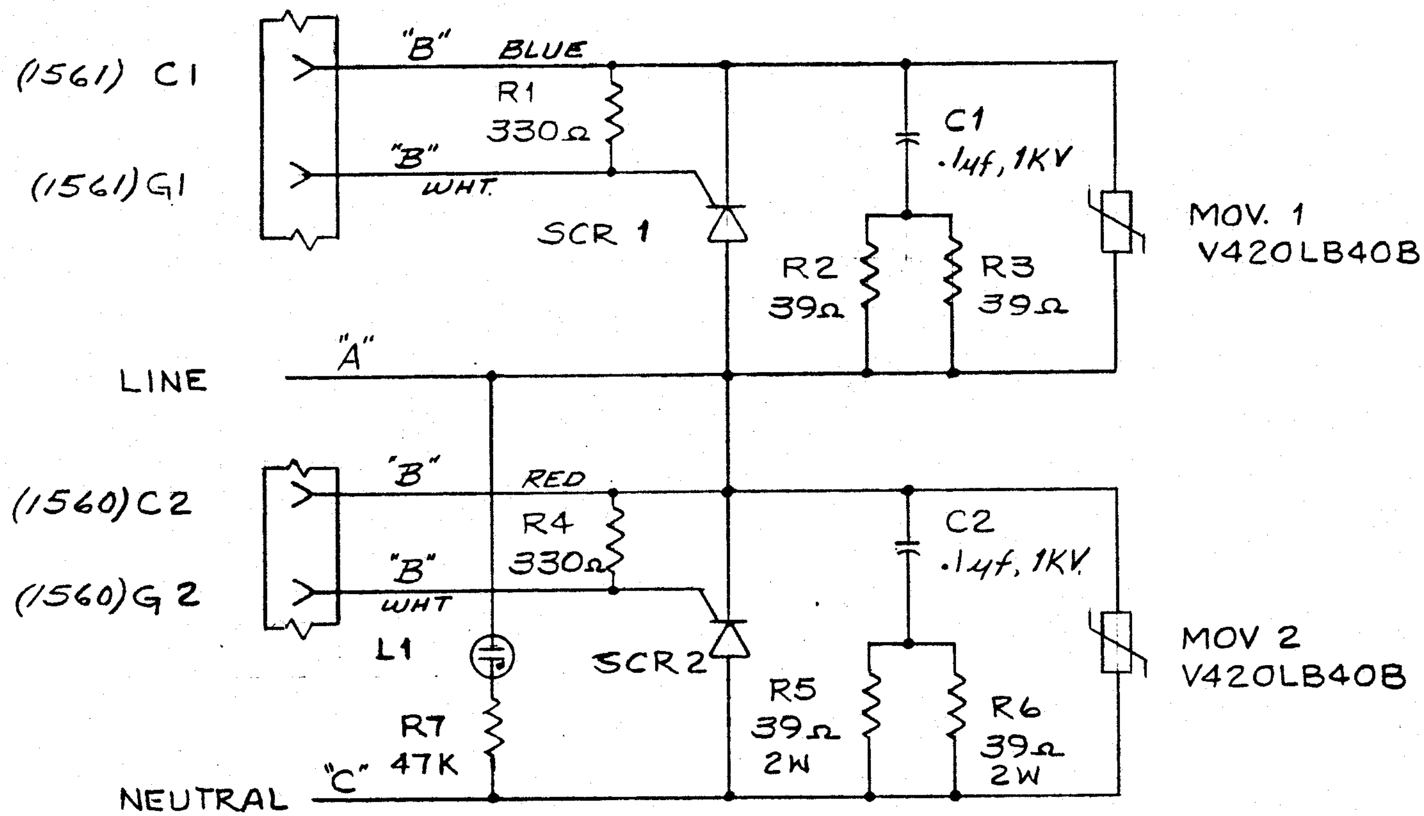
INLAND MOTOR DIVISION KOLLMORGEN CORPORATION
RADFORD VIRGINIA

SCHEMATIC - SCR PAK
EA-1 (SPA & TPA MODELS ONLY)

SCALE: NONE | PART LIST NO. 2799

DWG. SIZE A | DWG. NO. 32098 | ISSUE 5

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 A	DWG. NO. 70512	ISSUE 1



CODE DATA

LTR	DESCRIPTION
"A"	BUS BAR 1" x 1/4
"B"	#18 AWG, TEFLON
"C"	1/0 WELDING CABLE

CODE IDET. NO. 11384

MATERIAL:- HEAT TREAT:- FINISH:-

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

DW'N BY	Joseph	10/28/75
CH'K BY	Joseph	11/4/75
APP'D BY	AL Melan	12/15/75
APP'D BY		
APP'D BY		

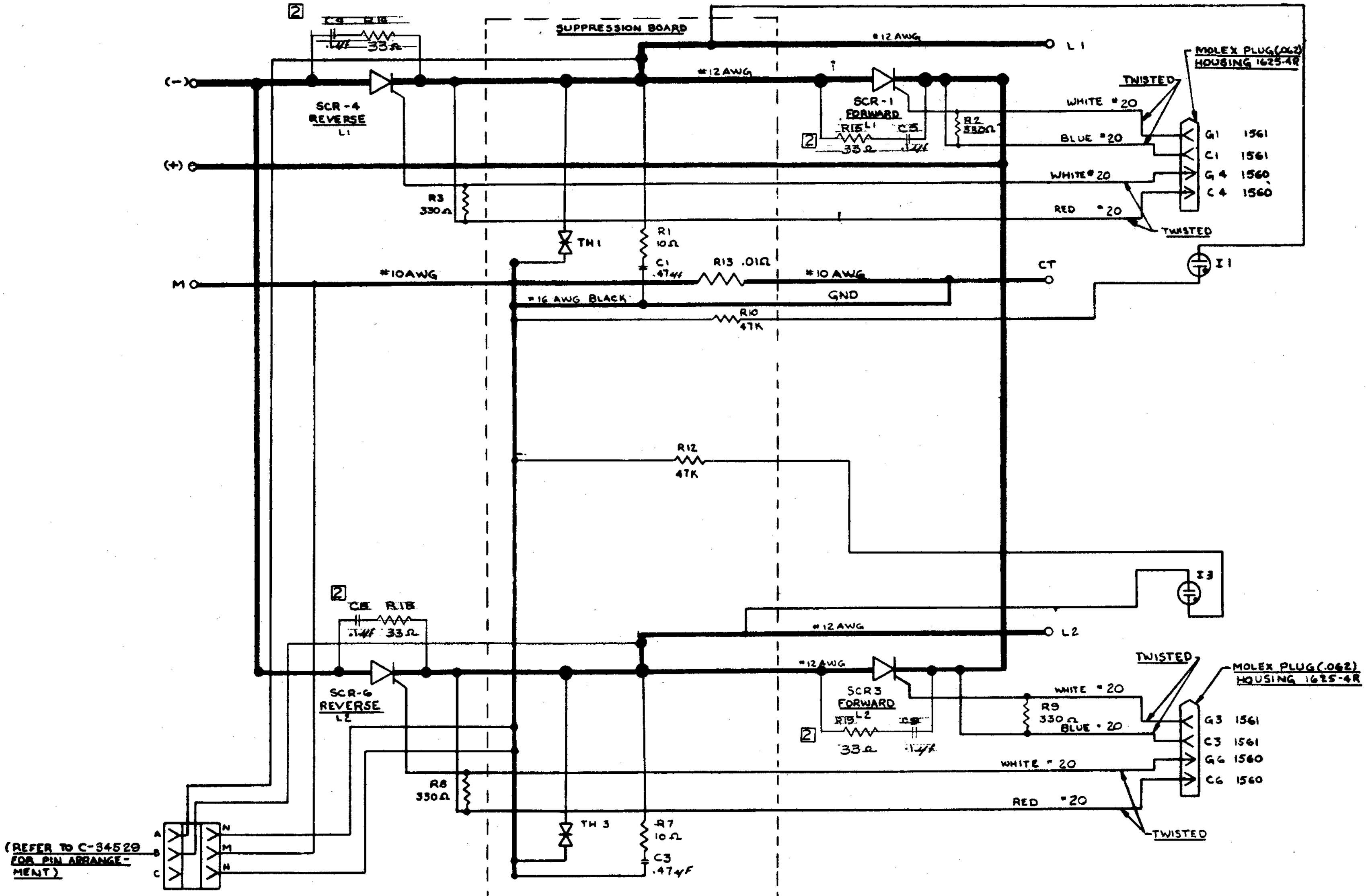
INLAND MOTOR
DIVISION OF KOLLMORGEN CORP.
RADFORD 501 FIRST STREET VIRGINIA

SCR-PAK SCHEMATIC
EA-6-XX

SCALE: D.O. NO. PARTS LIST NO. 3633

DWG. SIZE A | DWG. NO. 1 70512 | CAT. CONT. | ISSUE 1

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. 34533 | 3



REFER TO C-34529

NO	ECN NO	DATE	APP'D	NO	ECN NO	DATE	APP'D	NO	ECN NO	DATE	APP'D
								2	40270 J.DEAN	1-19-74	
								3	70586 Joseph	3/3/76	

MATERIAL: · HEAT TREAT: · FINISH:

DR. BY: JD 8-21-73 · CH. BY: T.W. 9-21-73 · T.W. 9-21-73

INLAND MOTOR
DIVISION OF KOLLMORGEN CORP.
RADFORD · 501 FIRST STREET · VIRGINIA

SCHEMATIC, SCR-PAK ASSY EA-4-XX

SCALE: · PART LIST NO 3039

DWG. SIZE C · DWG. NO. 34533 · 3

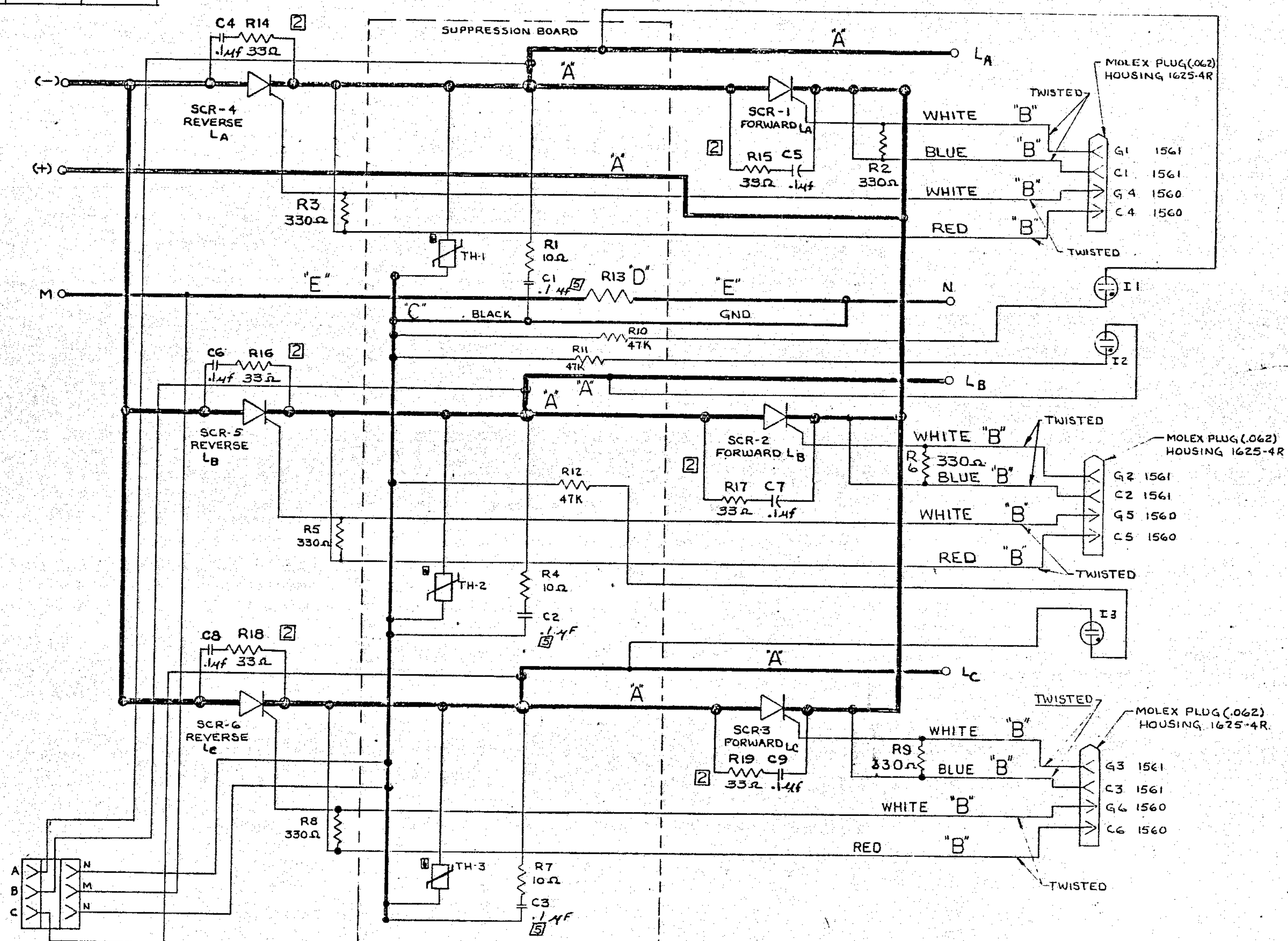
CODE CHART					
MODEL	"A" (AWG)	"B" (AWG)	"C" (AWG)	"D" (R13)	"E" (GND)
EA-3-00	#12	#18	#16	.01Ω	#10
EA-3-01	#12	#18	#16	.01Ω	#10
EA-3-02	#12	#18	#16	.005Ω	#10
EA-5-00	#10	#18	#16	.005Ω	#10

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. 33287 ISSUE 6



NO.	ECN NO.	DATE	APP'D.
2	40681	1-19-72	
3	70100 Joseph	2/5/75	
4	70586 Joseph	3/4	
5	79005 EWR	9/26/78	
6	83793	11-15-90	

MATERIAL: HEAT TREAT: FINISH:

DWN BY RMJ DATE 10-15-72

CHK BY

APP'D BY

JOB NO. RD-3079

G.O. NO.

INLAND MOTOR

DIVISION OF KOLLMORGEN CORP.

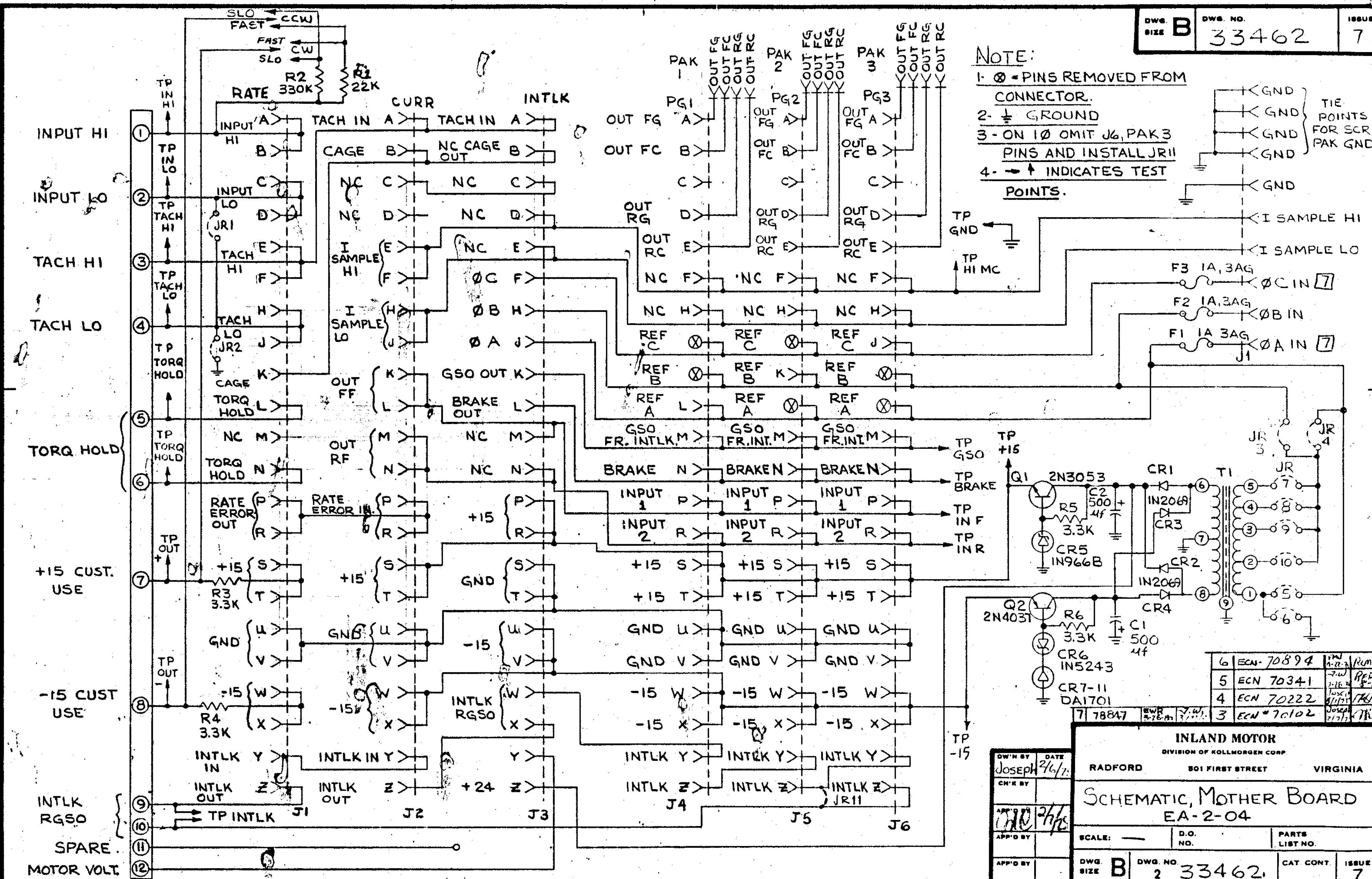
RADFORD 501 FIRST STREET VIRGINIA

SCHEMATIC, SUPPRESSION BOARD EA-3, 5

SCALE:

PART LIST NO.

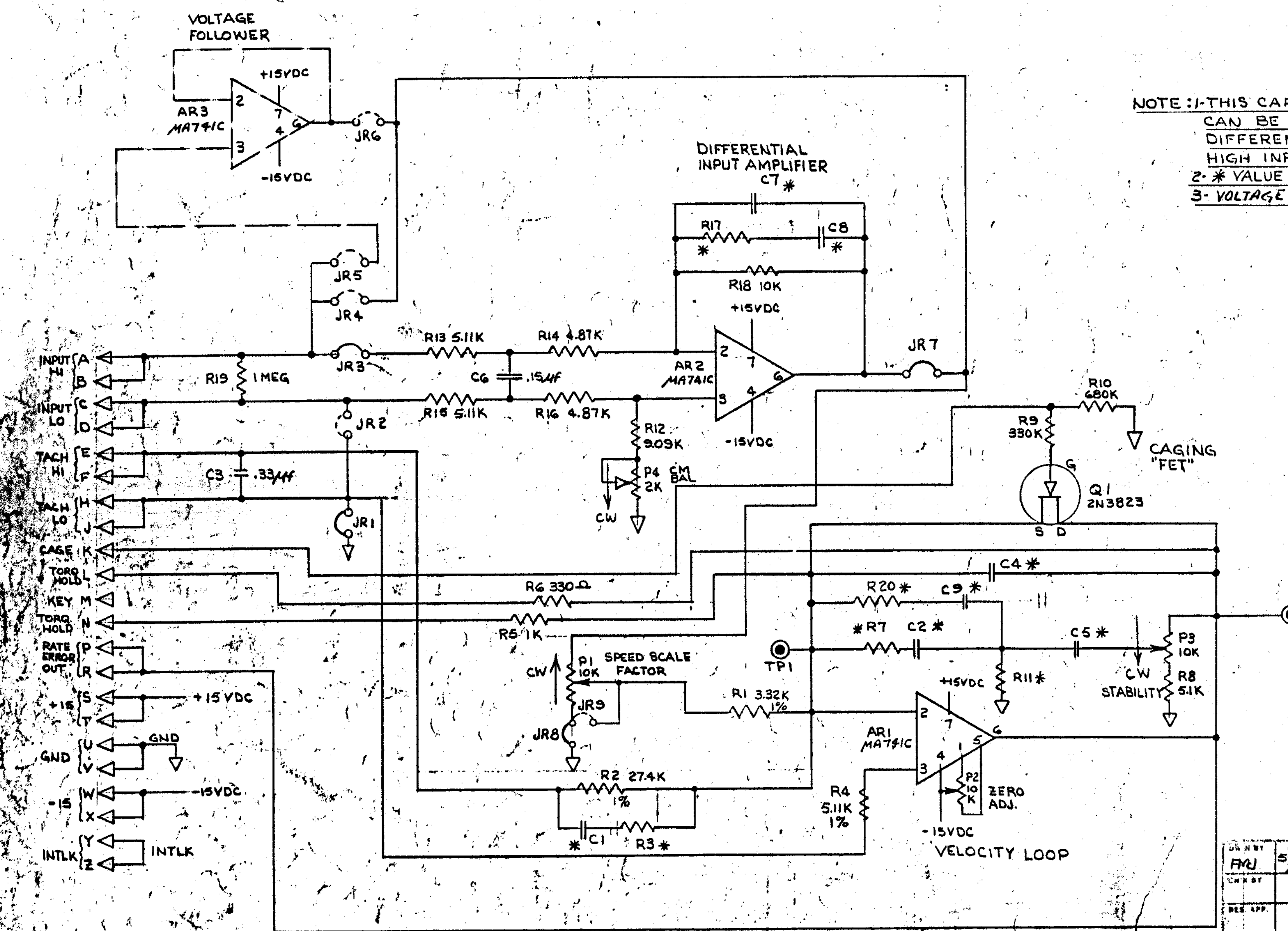
DWG. SIZE C DWG. NO. 33287 ISSUE 6



DWG. SIZE B DWG. NO. 33462 ISSUE 7
NOTE:
1- ⊗ = PINS REMOVED FROM CONNECTOR.
2- ⏚ GROUND
3- ON 1Ø OMIT J6, PAK3 PINS AND INSTALL JR11
4- → INDICATES TEST POINTS.
6 ECN-70894
5 ECN 70341
4 ECN 70222
3 ECN # 70102
7 78847
INLAND MOTOR
DIVISION OF KOLLMORGEN CORP
RADFORD
501 FIRST STREET
VIRGINIA
SCHEMATIC, MOTHER BOARD
EA-2-04
DWG. SIZE B DWG. NO. 2 33462 ISSUE 7

DWG SIZE	DWG NO	ISSUE
B	32111	5

NOTE: 1- THIS CARD REPLACES ISSUE # 1, 2 AND CAN BE USED TO PROVIDE A DIFFERENTIAL INPUT CAPABILITY AND HIGH INPUT IMPEDANCE.
2- * VALUE VARIES DEPENDING ON SYSTEM.
3- VOLTAGE FOLLOWER SUPPLIED AS AN OPTION



NO	REVISION	C.O. NO	CHK	APP
3	ECN-36172 RMJ			
4	ECN 70898 Joseph	4/22/7?		KLH
5	ECN-78016 Joseph	5/16/7?		KLH

DRAWN BY: RMJ — DATE: 5-12-72

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

RATE LOOP-CARD # 1
EM-1

SCALE: | PART LIST NO.

DWG. SIZE B | DWG NO. 32111 | ISSUE 5

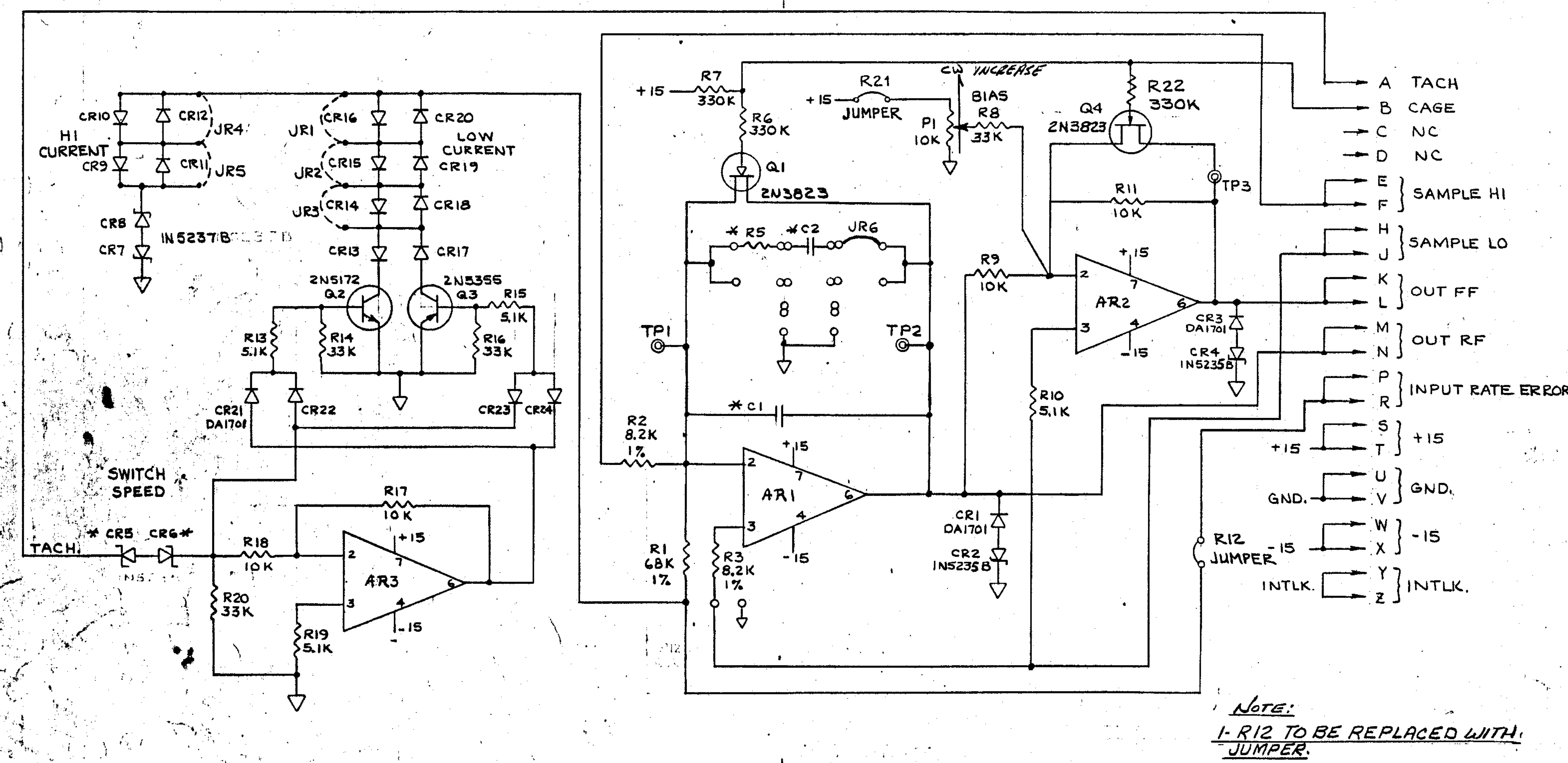
K COPY CODE

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 B | DWG. NO. 33712 | ISSUE 4



NOTE:
1- R12 TO BE REPLACED WITH JUMPER.

* VALUE VARIES DEPENDING ON SYSTEM

MATERIAL: | HEAT TREAT: | FINISH:

NO.	ECN NO.	DATE	APP'D.
2	35457	3/22	CWS
3	36686 A. Joseph	7-5-72	GW
4	78016 Joseph	5-17-7	MO

DW'N BY DET | DATE 11-2-71 | CH'K BY | APP'D BY | 1/21/

JOB NO. RD-3062 | D.O. NO.

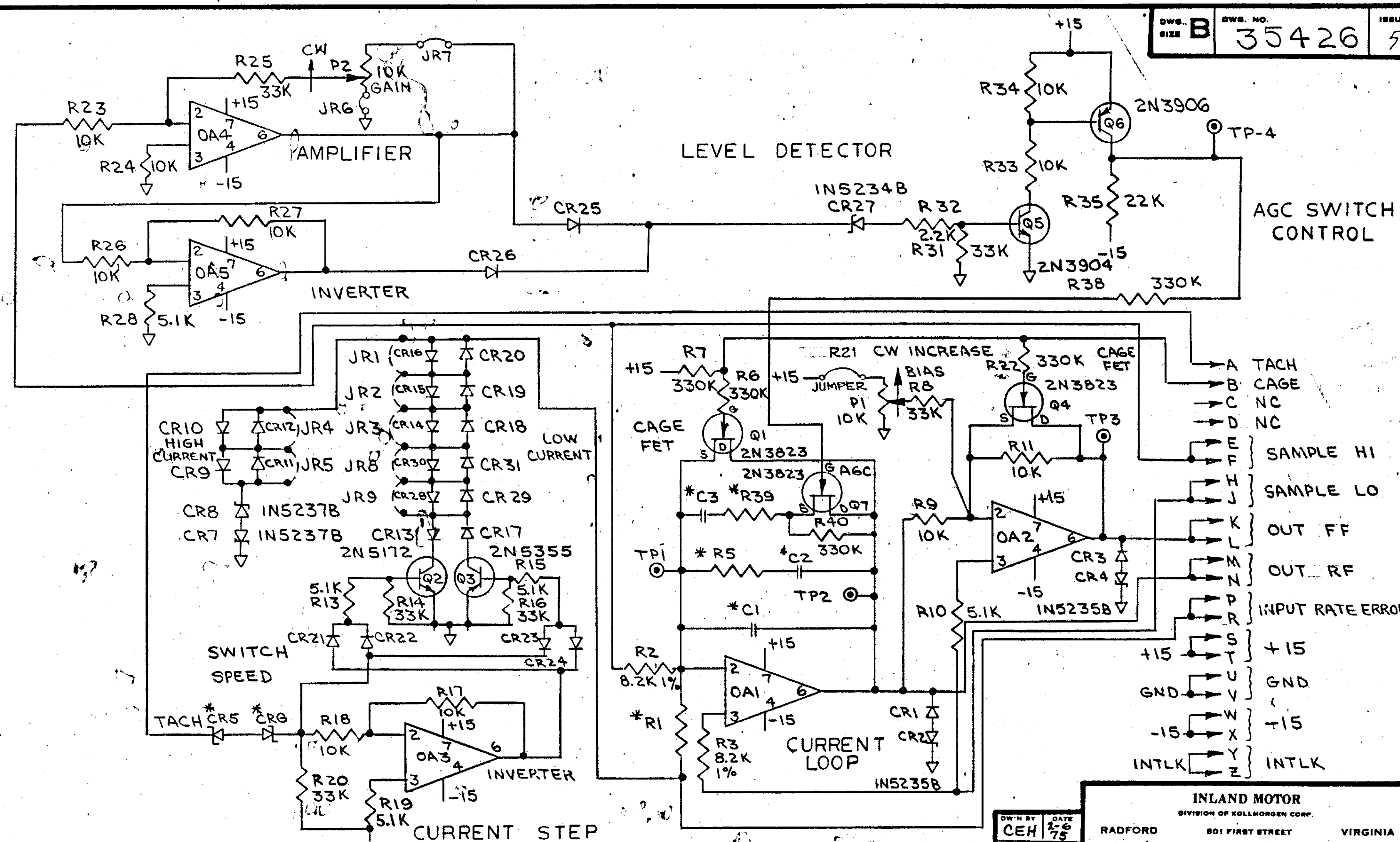
INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

CURRENT LOOP & CURRENT STEP (FIXED)
EM-2

SCALE: | PART LIST NO. 2802

DWG. SIZE B | DWG. NO. 33712 | ISSUE 4

K COPY CODE



NOTE
1. * VALUE VARIES DEPENDING ON SYSTEM
2. R12, 29, 36; CR32; REPLACED WITH JUMPERS
3. ALL DIODES DA1701 EXCEPT WHERE NOTED

5	78016 Joseph	5-13-	RLM
4	70896 Joseph	4-22-	RLM
3	* 70103 Joseph	2/10/75	

DW'N BY CEH — DATE 2-6-75

INLAND MOTOR
DIVISION OF KOLLMORGEN CORP.
RADFORD — 501 FIRST STREET — VIRGINIA

CURRENT LOOP / STEP (FIXED) WITH AGC FOR EM-10-XX

SCALE: — D.O. NO. — PARTS LIST NO. 3135

DWG. SIZE B — DWG. NO. 2 35426 — CAT CONT — ISSUE 5

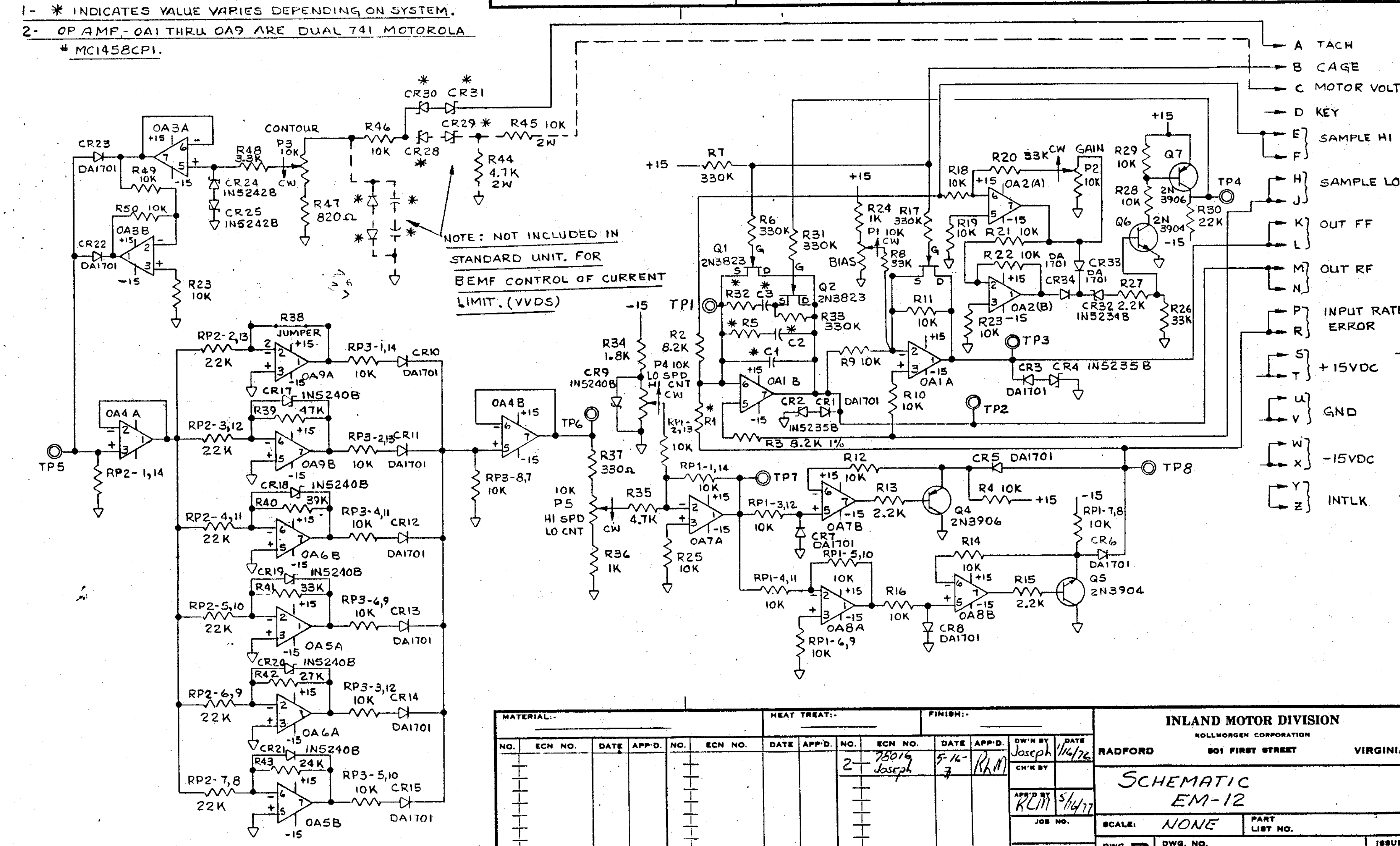
DWG. SIZE B — DWG. NO. 35426 — ISSUE 5

NOTE :

1- ✱ INDICATES VALUE VARIES DEPENDING ON SYSTEM.

2- OP AMP.- OA1 THRU OA9 ARE DUAL 741 MOTOROLA # MC1458CP1.

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 B	DWG. NO. 70525	ISSUE 2



NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
								2	78016 Joseph	5-16-77	RKM

MATERIAL:- HEAT TREAT:- FINISH:-

DW'N BY Joseph DATE 1/16/76

CH'K BY

APP'D BY KLM 5/16/77

JOB NO.

D.O. NO.

INLAND MOTOR DIVISION

KOLLMORGEN CORPORATION

RADFORD 501 FIRST STREET VIRGINIA

SCHEMATIC EM-12

SCALE: NONE PART LIST NO.

DWG. SIZE B DWG. NO. 70525 ISSUE 2

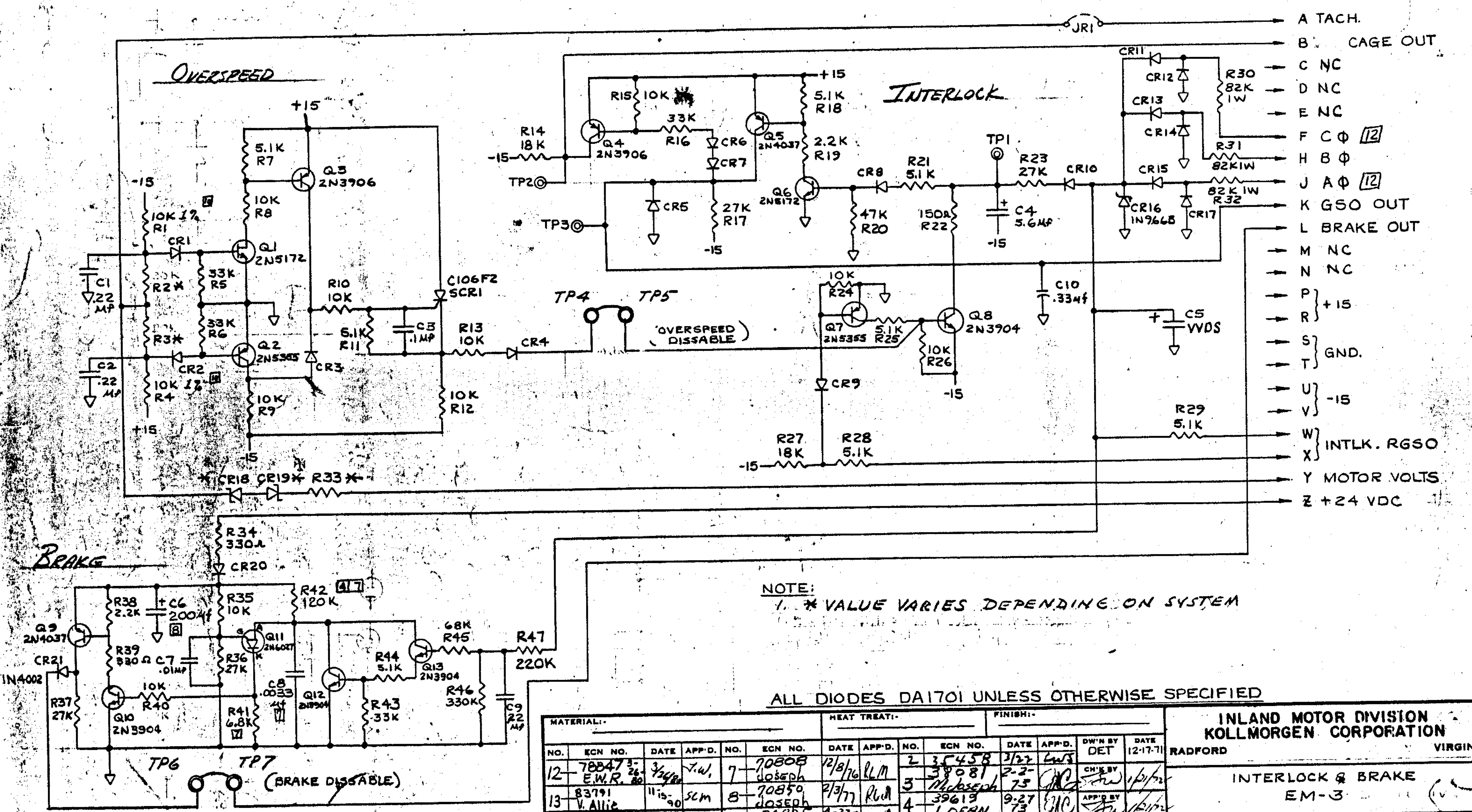
K COPY CODE

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 B DWG. NO. 32114 ISSUE 13



NOTE:
1. * VALUE VARIES DEPENDING ON SYSTEM

ALL DIODES DA1701 UNLESS OTHERWISE SPECIFIED

OVERSPEED TRIP IS SET BY VALUES OF ...

MATERIAL:- HEAT TREAT:- FINISH:-

NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.
12	78847 3-26-80 E.W.R.	3/26/80	T.W.	7	70808 Joseph	12/8/76	RLM	2	35458	3/22	LWS
13	83791 V. Allie	11-15-90	SCM	8	70850 Joseph	2/3/77	RLM	3	38081 M Joseph	2-2-73	[illegible]
				9	70895 Joseph	4-22-77	[illegible]	4	39619 J DEAN	9-27-73	[illegible]
				10	78008 Z.G.	8-2-77	RLM	5	70259 Joseph	5/24/75	[illegible]
				11	78016 Joseph	5-13-77	RLM	6	70344 T.W.	7/25/75	AFD

DW'N BY DET DATE 12-17-71
CH'K BY [illegible] 1/1/72
APP'D BY [illegible] 1/1/72
JOB NO. RD-3062
D.O. NO.

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

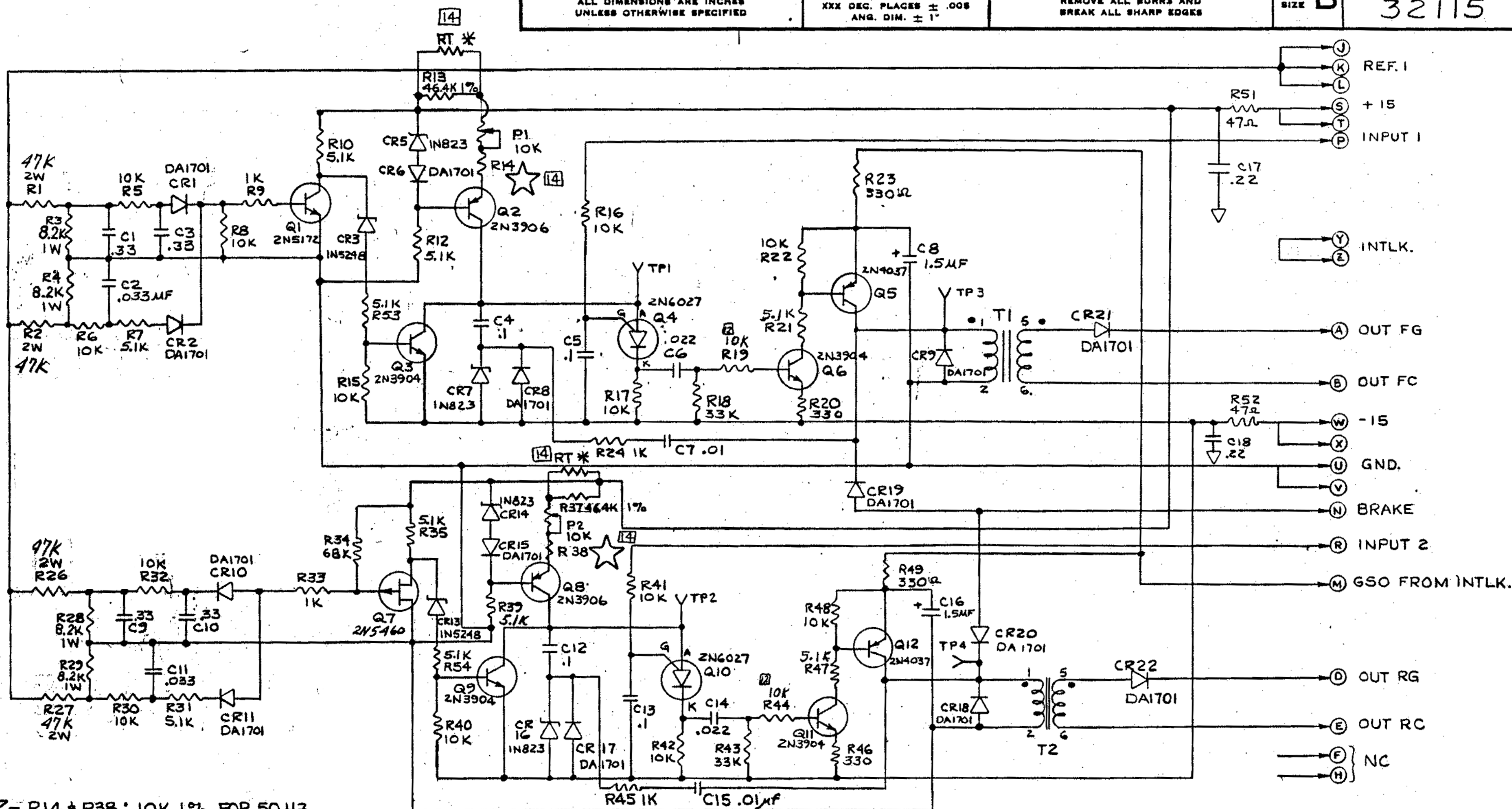
INTERLOCK & BRAKE
EM-3

SCALE: PART LIST NO. 2804

DWG. SIZE B DWG. NO. 32114 ISSUE 13

K COPY CODE

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 B	DWG. NO. 32115	ISSUE 14



14 ☆ - R14 & R38: 10K 1% FOR 50 HZ
JUMPER FOR 60 HZ

✳ - "TRIM RESISTOR" - VALUE VARIES DEPENDING ON SYSTEM

NOTE

P1, P2 ARE FACTORY SET
DO NOT ADJUST

			K	COPY CODE

MATERIAL:				HEAT TREAT:				FINISH:					
NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	NO.	ECN NO.	DATE	APP'D.	DW'N BY DET	DATE 9-15-71
12	78203 Z Cox	2/13/78	KLM	7	ECN 40046 J DEAN	12-3-73		2	34040 DET	12-15-71		CH'K BY	
13	78398 Z Cox	9/26/78	ZC	8	40345 J DEAN	2-4-74		3	ECN 35459	3/1/72		APP'D BY	1/21/72
14	78835 REYNOLDS	3/14/80	RFD	9	70340 JW	7-28-75		4	38097	2-2-73		JOB NO. RD-3062	
				10	ECN-79587	3/3/76	RLM	5	ECN 39493 J DEAN	6-9-73			
				11	70897 Joseph	4-22-76		6	ECN 39577	11-16-73		D.O. NO.	

INLAND MOTOR DIVISION
KOLLMORGEN CORPORATION
RADFORD VIRGINIA

SCHEMATIC - PULSE GEN.
EM-4

SCALE: NONE | PART LIST NO. 2805

DWG. SIZE B | DWG. NO. 32115 | ISSUE 14