GEK–24904B

DC-3033R

MACHINE TOOL DRIVE
(FEED)

180/240VDC OUTPUT

OPERATION AND MAINTENANCE
MANUAL

GENERAL ELECTRIC

SIMPLIFIED START-UP AND CHECKOUT PROCEDURE
(FOR FEED DRIVES WITH DIAGNOSTIC FUNCTION)

IF ANY DIFFICULTIES ARE ENCOUNTERED DURING START-UP AND CHECKOUT, REFER TO SECTION 4 OF INSTRUCTION BOOK FOR DETAILED START-UP AND CHECKOUT PROCEDURE.

WARNING

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS THROUGHOUT THE DRIVE.

1. VERIFY THAT THE 3-PHASE AC POWER INPUT TO THE DRIVE IS OF THE PROPER VALUE/FREQUENCY AS LISTED ON THE EQUIPMENT DATA NAMEPLATE (−5, +10%).

2. SET TEST REFERENCE POTENTIOMETER TO ZERO, SWITCH No. 1 TO CENTER, SWITCH No. 2 TO CENTER; THIS DISCONNECTS POWER FROM SCR MODULE AND DISCONNECTS ALL REFERENCE INPUTS.

3. APPLY MAIN AC POWER TO THE DRIVE SYSTEM. THE PHASE SEQUENCE INDICATOR ILLUMINATES (THE AC CIRCUIT BREAKER IN THE DRIVE SYSTEM MUST BE SWITCHED ON). THIS INDICATOR WHEN ILLUMINATED INDICATES THE FOLLOWING:

   A. THREE PHASE POWER IS APPLIED AND IS IN THE PROPER PHASE SEQUENCE.

NOTE

IF THE INDICATOR FAILS TO ILLUMINATE, INTERCHANGE ANY TWO INPUT PHASES ONCE: IF INDICATOR IS STILL OUT PROCEED TO THE TROUBLESHOOTING TABLE 6–1.

CAUTION

WHEN OPERATING DRIVE IN THE TEST OR MANUAL MODE, CONTINUALLY OBSERVE THE MACHINE TRAVEL TO AVOID HITTING THE ELECTRICAL AND/OR MECHANICAL LIMITS.

4. VERIFY TEST REFERENCE POTENTIOMETER IS SET TO 0, PLACE SWITCH No. 1 TO DOWN AND SWITCH No. 2 TO UP SWITCH POSITION. USE TEST REFERENCE POTENTIOMETER IN CW AND CCW DIRECTION TO VERIFY PROPER MOTOR OPERATION. VERIFY THAT THE TACHOMETER INPUT (TEST REFERENCE IS CW) IS NEGATIVE AT 1TB17.

5. SET TEST REFERENCE POTENTIOMETER TO 0, SWITCH No. 1 TO UP SWITCH POSITION, SWITCH No. 2 TO CENTER; THIS PROVIDES NORMAL SYSTEM OPERATION.

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SECTION I
GENERAL

1.1 SCOPE OF MANUAL

This instruction manual is structured around a basic system. It is a guide for the installation, check-out and operation of the equipment, furnished with general troubleshooting procedures for the basic system. Any special purpose equipment, as requested on the purchase order, will normally be covered in the schematic drawings included with this package. If special purpose equipment is added to the Troubleshooting or Description of Equipment section, it will be so noted by an asterisk. These instructions do not purport to cover all details or variations in the equipment nor to provide for every possible contingency in connection with the installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the General Electric Company.

1.2 SAFETY, PERSONNEL AND EQUIPMENT

The following paragraphs list some general safety reminders and safety recommendations to be followed when operating this equipment.

Only trained electrical and electronics personnel should install and maintain this equipment. It is dangerous to the untrained or unskilled.

Definition of terms and sign colors:

WARNING: Denotes operating procedures and practices that may result in personal injury or loss of life if not correctly followed.

Color: Black or white lettering on red field.

CAUTION: Denotes operating procedures and practices that, if not strictly observed, will result in damage to, or destruction of, the equipment.

Color: Black lettering on amber field.

NOTE: Denotes an operating procedure or condition that should be highlighted.

Color: Black lettering on white field.

WARNING: HIGH VOLTAGE

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS WITHIN THE SCR DRIVE. EXTREME CARE MUST BE EXERCISED IN THE SELECTION AND USE OF TEST INSTRUMENTS. OPERATOR SHOULD NOT STAND ON GROUNDED SURFACES OR BE IN CONTACT WITH GROUND WHEN APPLYING TEST INSTRUMENTS TO TEST POINTS. CONVENTIONAL TEST INSTRUMENTS SHOULD NOT HAVE CHASSIS GROUNDED WHILE TESTS ARE BEING MADE THUS THE CHASSIS CAN BE AT A HIGH VOLTAGE WITH RESPECT TO GROUND DURING TESTING. EXTREME CARE SHOULD BE TAKEN WHILE ATTEMPTING TO ADJUST, TROUBLESHOOT OR MAINTAIN ANY DRIVE SYSTEM DESCRIBED HEREIN.

When working on or near the equipment with power/voltage applied, it is recommended that all metal objects such as rings, watches and tie clasps be removed.

It is highly recommended that all personnel working on this equipment wear rubber soled shoes (insulated).

WARNING

WHEN WORKING AROUND ROTATING EQUIPMENT, DO NOT WEAR ANY LOOSE CLOTHING THAT COULD BECOME CAUGHT IN THE EQUIPMENT.

CAUTION

DO NOT INSERT OR REMOVE PRINTED CIRCUIT CARDS FROM THE EQUIPMENT WHILE POWER IS APPLIED OR OPERATING; THIS CAN DAMAGE THE EQUIPMENT.

NOTE

ALWAYS READ THE COMPLETE SUBSECTION (EXAMPLE 3-2) PRIOR TO ANY TURN-ON OR TROUBLESHOOTING OF THE EQUIPMENT, FOLLOW THE PROCEDURE STEP BY STEP.

READ AND HEED ALL WARNING, CAUTION AND NOTE SIGNS POSTED ON THE EQUIPMENT.

1.3 WARRANTY AND SHIPPING

1.3.1 Warranty Statement

The Company warrants to the Purchaser that the equipment to be delivered hereunder will be free from defects in material or workmanship and will be of the kind and quality designated or specified in the contract.

This warranty shall apply only to defects appearing within one year from the date of shipment by the Company. (For full "Conditions of Sale" and a complete statement of warranty, refer to your contract papers.)

1.3.2 Receipt of Shipment

All equipment is factory inspected before shipment and is shipped in good condition. Any damages or shortages evident when the equipment is received must be immediately reported to the commercial carrier who transported the equipment. If required, assistance may be received from the General Electric Company, Speed Variator Products Department, but when seeking assistance, please use the purchase order number and model number to help us in assisting you.

1.4 RECEIVING, HANDLING AND STORAGE

1.4.1 Receiving

The equipment should be placed under adequate cover immediately upon receipt as packing cases are not suitable for out-of-doors or unprotected storage.

1.4.2 Handling

Smaller power units, wall mounted, can be transported by lift trucks with forks completely under the base. The larger floor mounted power unit bases have two lifting holes on each side, so that a pipe may be slipped through each pair and crane hooks be used to pick up the unit by means of the pipes. The lifting holes on the top of the power unit may also be used for receiving crane hooks. Spreader bars should be used to spread the cables above the cabinet and bumpers should be used wherever hooks or cables may come into contact with the cabinet, to prevent damage to the cabinet metal and painted surfaces. "Lifting Information" tag should be followed on units that can receive crane hooks.

1.4.3 Storage

If the equipment is not to be installed immediately, it should be stored in a clean, dry location that is not subject to extreme temperatures. Precautions should be taken to prevent moisture from accumulating in the equipment. The entrance of moisture, dust or dirt during storage or installation is detrimental to the equipment insulation.

In addition, when a control that has been in operation and will be shut down for either a short or extended period of time, it is recommended the environmental conditions be maintained the same as when in operation. Space heaters or equivalent devices should be used to maintain the equipment in its normal operating state (temperature).

SECTION II
SYSTEMS EQUIPMENT DESCRIPTION

2.1 EQUIPMENT PURPOSE

The Speed Variator drive is a closed loop, adjustable speed, bidirectional, constant torque range system designed for coordinated lines, machine tool control and test stand systems. The system consists of three basic blocks:

1. DC Motor
2. Power and Control Unit
3. Transformer

2.2 EQUIPMENT FURNISHED - GENERAL

For the exact description of equipment received, refer to your order data and elementary diagrams.

2.2.1 DC Motor - 5-75 horsepower, permanent magnet or shunt wound separately excited field, 180 or 240 VDC armature, maximum ambient 40°C, thermostat protection, and with d-c tachometer normally supplied.

2.2.2 Power and Control Unit - 360 or 460 VAC, three phase, 60 HZ power input normally supplied; transformer neutral, SCR three phase, half wave conversion with full regeneration, with output voltage from zero to ±180 or ±240VDC; open panel, wall or floor mounted enclosures.

2.2.3 Standard Transformer: three phase "isolation" type with three phase input of 230 or 460 VAC, 60 HZ power and four wire (three phase and neutral) output of 360 or 460 VAC line to line and 208 or 267 VAC line to neutral.

2.2.4 Special Purpose Equipment - see System Elementary Diagrams.

2.2.5 Control and Indicator Functions

Table 2-1 will give a listing of the controls and indicators and their functions.

TABLE 2-1 FUNCTION OF CONTROLS/INDICATORS

EQUIPMENT/ITEM	CONTROL/INDICATOR	FUNCTION
FRONT DOOR	"READY-ON/FAULT-OFF" indicator light.	Illuminates when incoming 115VAC (if supplied externally) and 3 phase power is on (when circuit breaker is switched on) and in correct phase sequence and no other "faults" are in the system.
	"FAULT RESET" pushbutton	Resets the fault circuit if problem was of a transient nature or problem has been corrected.
	Maximum Speed Potentiometer	Provides a means of adjusting the speed reference from external source input to obtain top speed.
Adjustable Voltage Exciter (AVE) if supplied		Provides a means of weakening the motor field to increase motor speed range.
	"MIN FIELD" adjust potentiometer	(Protective circuit to inhibit excessive field weakening.) Adjusts the minimum weak field on motor.
	"CROSSOVER" adjust potentiometer	Sets armature voltage point at which field weakening begins.
"DIAGNOSTIC" Function (IDT)	"SWITCH #1" "SWITCH #2"	Two switches are used to select various test conditions or normal running.
	"TEST REFERENCE" (TRP) potentiometer	Provides a voltage or current source for the test functions.
	"FIELD LOSS BY-PASS" pushbutton	Button that shorts out field loss interlock. Use only for special tests or troubleshooting.
Regulator Test Function Card		Provides test function output for monitoring of regulator operations.
	Meter Range Selector (if supplied)	Selects meter scale multiplier for different voltage ranges. ±3 volts full scale, X1, X10, X100.
	"ON/OFF" Switch (if supplied)	Enables function desired to be displayed on meter.
	Meter Zero Adjustment	Mechanical zero adjust on back of meter.

TABLE 2-1 FUNCTION OF CONTROLS/INDICATORS

EQUIPMENT/ITEM	CONTROL/INDICATOR	FUNCTION
	Function monitor Select thumbwheel Switch	Selects positions 1 thru 19 for display on monitor.
	Banana Jacks	Output test function selected for external test equipment connection.
Auxiliary ±20V Power Supply Card When AVE Supplied	No adjustments	Supplies ±20VDC for the AVE and Tachometer Monitor Cards. Fused inputs FUA1 and 2.
Tachometer Monitor (TM) Card When AVE Supplied		Shuts drive down in the event of an overspeed or loss of tach signal.
	"TRIP SPEED" potentiometer	Used to set desired overspeed trip point.
	"ZERO ALIGN" potentiometer	Used to set trip point if tach signal is lost.
	"OVERSPEED/FAULT" indicator light	Illuminates when trip occurs.
Signal Level Detector (SL) Card - when supplied		Normally used when AVE is supplied for field programming but can be used for other auxiliary switching functions.
	"SLA GAIN" potentiometer	Used to set transfer point at which relay SLA actuates.
	"SLB GAIN" potentiometer	Used to set transfer point at which relay SLB actuates.
	"SLA or SLB" indicator lights	Light illuminates when relay energizes.
Circuit Breaker Back Panel Mounted	CB	Applies 3Ø Power, Provides fast interrupt (Trip) for circuit and motor protection for locked rotor and bolted fault conditions plus overloads.

TABLE 2-1 FUNCTION OF CONTROLS/INDICATORS

EQUIPMENT/ITEM	CONTROL/INDICATOR	FUNCTION
Motor Thermal Switch		Provides contact closure when motor heating is within safe operating range. Opens when motor temperature exceeds safe range.
Thermal Overloads (if supplied)	Switch	Opens on continuous overloads. Generally furnished external to drive.
Driver Regulator Tapered Current Limit Card	"CURR LIMIT" potentiometer	Provides a means of setting the high speed and low speed current limit levels for instantaneous current limits of the power unit.
(See 9.2.9 for detailed operation.)	"RANGE ADJ" potentiometer	Provides a means of setting the current limit speed shift point for the high/low current limit transfer function.

2.3 BASIC SYSTEM THEORY OF OPERATION

To understand the theory of operation, first the requirements of the drive system must be stated. The drive system must be able to perform the following:

Convert a-c power to d-c power
Start and stop motor
Control motor speed through range
Sense and correct motor needs (loads)
Protect system
Provide accurate and smooth operation of motor
Provide special acts or needs

The basic system block diagram is shown in Figure 2-1.

The system will be divided into five functional areas; Power, Command and Logic, Driver Regulator, Power Conversion Module and Motor.

2.3.1 Power

Three Phase (three wire) a-c power is brought into the transformer (IT) primary. The secondary of the transformer has a fourth leg, neutral (XO), for a return current path. The transformer supplies power to the power conversion unit through the circuit breaker and MA contacts for conversion to d-c power. It also supplies power, through the circuit breaker, to the synchronizing transformer assembly (STA). The STA provides synchronization voltage to the driver regulator. The STA also provides power to the d-c power supplies in the regulator. The d-c power supply provides card operating voltages and plus and minus d-c power to the command and logic circuitry where required. A phase sequence and power on circuit is provided and connected to the STA output. Also provided is a current isolator which provides an output signal proportional to and isolated from the armature current.

2.3.2 Command and Logic

The command logic circuitry (relays, switches and protective devices) is responsible for the starting, stopping, direction, protection and internal speed reference (REF) input to the system. Also, provided is an electronic inhibit circuit. This connection is provided on 2TB 25 and 26 and when not used must be jumpered together for the drive to operate.

2.3.3 Driver Regulator

The basic driver regulator is composed of six active printed circuit cards. When a AVE is supplied, there are nine active cards. Other cards may be supplied for special functions. Its task is to receive the reference input and coordinate and deliver firing signals to the power conversion module. The driver regulator, after reacting to the command, must then monitor the power conversion module and motor performance, by the way of feedback signals (FDBK) and maintain the input reference request. When the input reference changes, the driver regulator must provide the power conversion module with the new command signal. Refer to Figure 2-2.

2.3.4 Power Conversion Module

The power conversion module consists of three pulse transformer cards and six SCRs mounted on heatsink assemblies. The three phase a-c power from the transformer is converted to d-c power by the SCRs which adjusts the voltage applied to the motor. This is accomplished by the driver regulator firing signals acting on the SCR gates at the proper instant in time to allow the motor to meet the request. Also provided is snubber circuitry for protection of the SCRs.

2.3.5 DC Motor

The motor will react to the amount of voltage and current from the power conversion module providing power across its speed range. The motor field is determined by a static, non-adjustable, exciter or by an adjustable voltage exciter or by internal permanent magnets as applicable.

SEE ELEMENTARY DIAGRAM FOR EXACT CIRCUITRY SUPPLIED

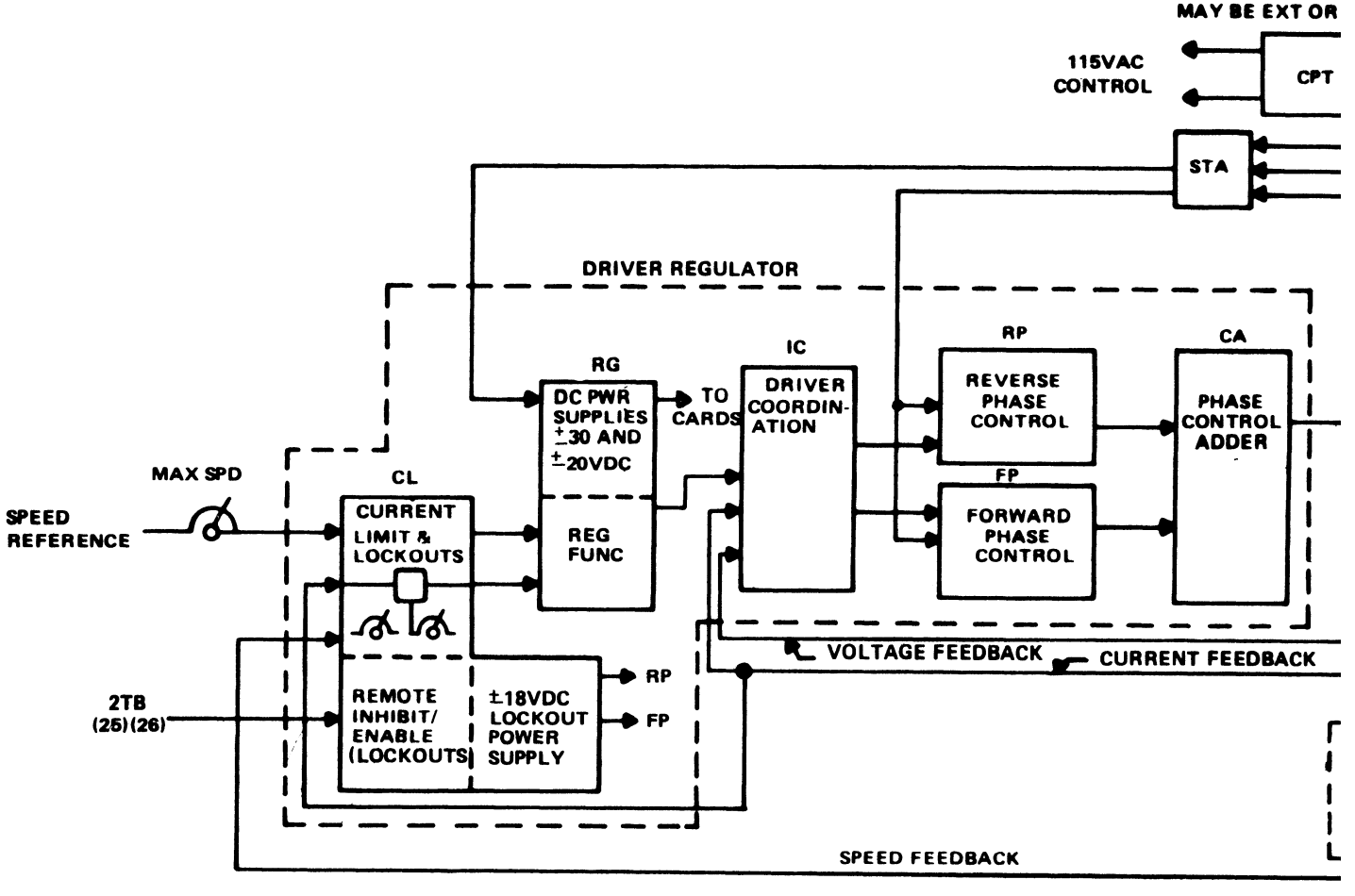


FIGURE 2–1 BASIC SYSTEM BLOCK DIAGRAM–FEED DRIVE
(WITH CURRENT LIMIT CARD)

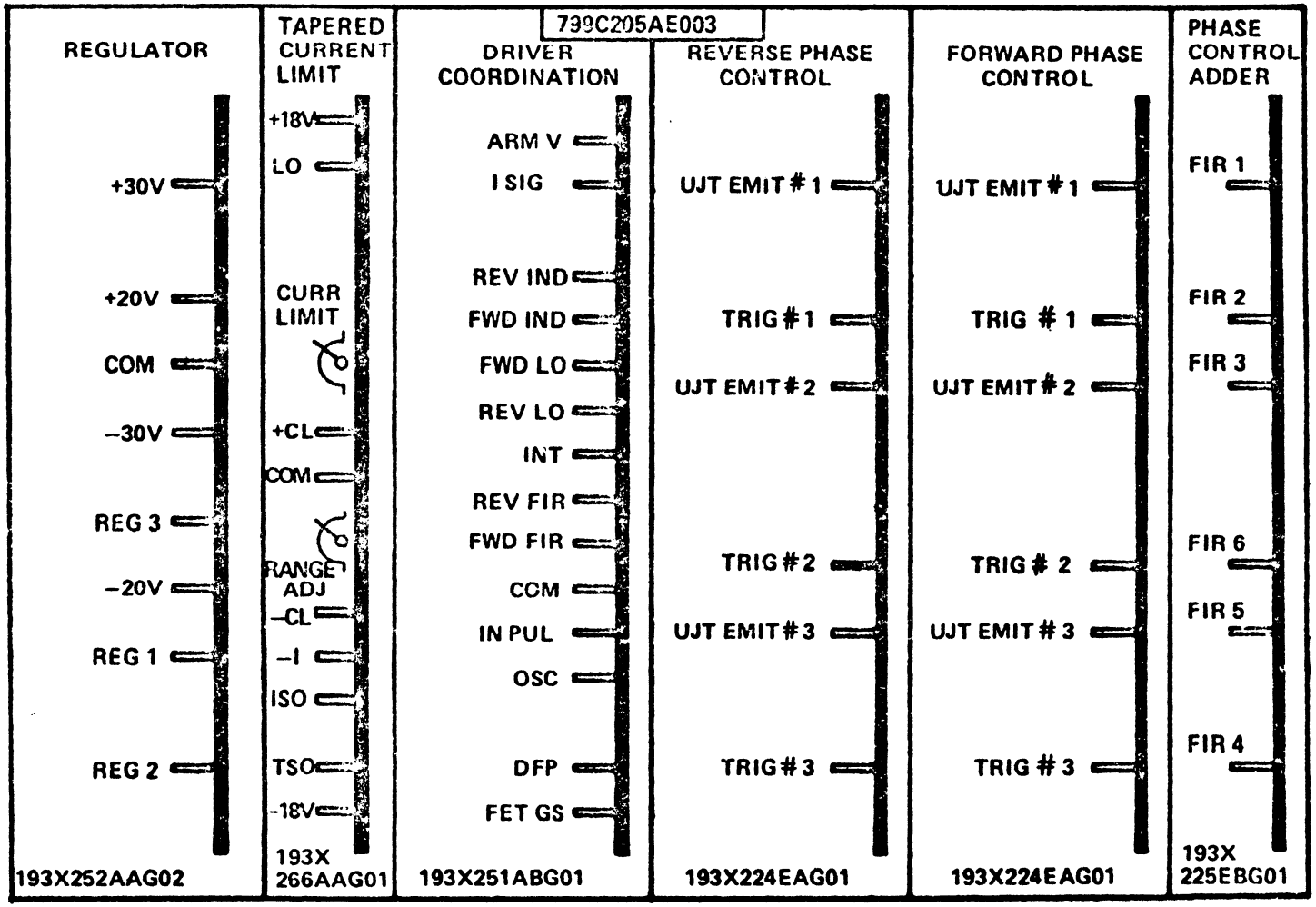


FIGURE 2-2 LOCATION AND FUNCTION OF DRIVER REGULATOR TEST RINGS

SECTION III
INSTALLATION

3.1 EQUIPMENT LOCATION

Speed Variator power units equipped with filters are suitable for most factory areas where other industrial equipment is installed. Locations subject to steam vapors or excess moisture, oil vapor or chemical fumes should be avoided. If your unit has a filter and blower system, the filters should be changed or cleaned before they become clogged. Power units should be installed in a well-ventilated area not subject to excessive heat. The Power and Control Circuit, plus transformer, are designed to operate in an ambient temperature range of 0°C to 55°C (+32°F to 131°F) maximum.

WARNING

EQUIPMENT SHOULD NEVER BE INSTALLED WHERE HAZARDOUS, INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT. SUFFICIENT CLEARANCE IN FRONT OF THE UNITS SHOULD BE ALLOWED FOR THE ACCESS OF MAINTENANCE OR REPAIR.

3.2 TOOLS REQUIRED

The normal electrical and mechanical tool boxes maintained in most factories are all that is required for the installation of this equipment.

3.3 MECHANICAL INSTALLATION

The mechanical installation will depend upon the type of mechanical enclosure supplied. If the equipment is supplied in an open panel for installation, this has been designed to be installed in a customer supplied enclosure. If the equipment supplied is mounted in a wall enclosure, install it as per outline drawings for wall enclosures. Floor mounted equipment enclosure should be mounted as per the outline for the floor mounted enclosure.

3.4 ELECTRICAL WIRING AND INTERCONNECTION

All external wiring shall be in accordance with the National Electrical Code and be consistent with all local codes. All internal electrical connections between components and the Speed Variator power units were made at the General Electric factory. When installing Speed Variators, all connections should be checked for tightness. Connections may become loose in shipping or storage. A diagram showing the connections between the power unit and the related components is furnished with each equipment. All terminals to which the external connections are to be made are numbered on the equipment as indicated on the connection diagram. It is recommended that level wiring be used to separate reference, motor tachometer and position feedback signals from all control, field and power circuits. It is also recommended as each connection or wire is connected to the equipment that it be checked off on the interconnection diagram and verified by continuity tests. When motor tachometer leads are connected it is recommended that tachometer feedback wiring be a twisted pair with at least ten turns per foot of length. Also the speed reference input leads should be twisted shielded with the shield grounded at only the remote control end (not the drive). The current limiting resistor(s) (CLR) is 0.5 ohms for the BY490 series motors or 1.2 ohms for the BY470 series motors.

WARNING

ALL MOTOR BASES AND EQUIPMENT ENCLOSURE HOUSING SHOULD BE CONNECTED TO THE FACTORY OR FACILITY EARTH GROUNDING SYSTEM.

NOTE

ON SOME SYSTEMS THE TRANSFORMER AND/OR CLR RESISTOR IS SHIPPED FOR SEPARATE MOUNTING AND MUST BE MOUNTED AND CONNECTED TO THE SYSTEM. THE BASIC DRIVE MAY REQUIRE EXTERNAL 115 VAC CONTROL POWER INPUT.

CAUTION

DO NOT USE POWER FACTOR CORRECTION CAPACITORS WITH THIS EQUIPMENT SINCE DAMAGE CAN RESULT FROM HIGH VOLTAGES GENERATED WHEN CAPACITORS ARE SWITCHED.

3.5 50 HZ OPERATION

To convert a 60 HZ base input frequency power unit to operate on a 50 HZ base input frequency, the following must be done:

a. A 50 HZ isolation transformer must be supplied. (If a dual 50/60 HZ, dual connection has been supplied, check transformer connection information for proper connection requirements).

b. Move the three wire jumpers to the 50 HZ stab-on posts on both Phase Control cards in the driver regulator.

c. Remove the metal jumper (if supplied) between CTB4 to CTB5 and add a 100K resistor, 1%, from CTB4 to BTB5. This is to provide adjustment for dither bias.

d. Readjust the "MIN FLD" potentiometer on the AVE back to the recorded value on the Test Data Sheet (for drives that have an Adjustable Voltage Exciter - AVE supplied).

SECTION IV
CHECKOUT

4.1 GENERAL

This section is written in a step-by-step approach to start-up the drive system and must be followed in sequence with all steps being completed as applicable. If during the course of start-up and checkout, a step/indication cannot be performed, refer to Section VI, TROUBLESHOOTING, Table 6-1 or 6-2. These Troubleshooting tables are written to follow each startup step in sequence. Startup and checkout steps are cross-referenced to paragraph/step numbers and indications in the Troubleshooting tables. This section does not include instructions on special regulators or axuiliary functions which may be included in individual systems. These instructions would be detailed elsewhere in the instruction book or system drawings. When two different voltage measurements are listed for a measurement in a step, the first listed without brackets is for a 240V armature motor and the second in brackets is for a 180V armature motor.

Using the diagnostic circuit (IDT), all checks may be made from in front of the regulator using the test reference potentiometer (TRP). External reference signals are not necessary until final system tests are made, but all motor connections must be connected. Systems with remote auxiliary protective devices may need to be jumpered when they have normally closed contacts (during system operation and when these contacts open they shut the drive down or stop the drive from being turned on). Any special input voltage that actuates relays is also required. (Refer to your System Elementary Diagram.) The following abbreviations will be used in this section for the diagnostic circuitry.

Switch #1	SW1
Switch #2	SW2
Switch Positions	
Up	Up
Center	Ctr
Down	Dn
Test Reference Potentiometer	TRP
TRP Direction	
Clockwise	CW
Counter-clockwise	CCW
DC Voltages Plus or Minus Signs	+ or -
Voltage Tolerance	± or +_% or -_%

AC Voltage	No ± sign except for tolerance
Volt Ohm Meter	VOM
Test Function Card Selective Test Points	TP(#)
Fault Reset Switch	FR
Ready-on/Fault-off indicator (Fault indicator)	FI
Field Loss Bypass Switch	FLS

WARNING

THE INTERNAL DRIVE CIRCUIT BREAKER DOES NOT DISCONNECT ALL POWER TO THIS DRIVE. PLACE EXTERNAL CIRCUIT BREAKER(S)/DISCONNECT DEVICE(S) TO OFF TO REMOVE ALL POWER TO THE DRIVE AND VERIFY POWER IS DISCONNECTED TO THE DRIVE BY MEASURING WITH A VOM AT THE THREE PHASE INPUT TO THE DRIVE AND 115VAC INPUT.

4.2 TEST EQUIPMENT REQUIRED

This equipment has been designed so that only a volt ohm meter (VOM), oscilloscope, and tachometer are all that are required for the normal startup and checkout. Test equipment that may be required for auxiliary functions and devices for detailed troubleshooting are also listed below:

Volt-ohm Meter (VOM) 3 ranges minimum (0 to 5 scale minimum) X1, X10, X100; 20,000 ohm per volt d-c sensitivity
Oscilloscope (scope)
RPM Measuring Device (0 to 3,000 RPM) Tach
DC type Ammeter - 0 to 500 amps, adjustable ranges

NOTE

DURING CHECKOUT, RECORD MEASUREMENTS AND SETTINGS ON THE TEST DATA SHEET SUPPLIED, UNDER THE USER DATA COLUMN. TDS BESIDE A STEP INDICATES AN ENTRY ON THE TEST DATA SHEET.

4.3 POWER-OFF CONTINUITY TEST

WARNING

VERIFY THAT THE MAIN THREE-PHASE AC POWER INPUT TO THE SYSTEM EQUIPMENT IS DISCONNECTED OR SWITCHED OFF.

Perform a point-to-point continuity test for all newly installed wiring and interconnection. Continuity is defined as 1/2 ohm or less.

NOTE

DUE TO THE VARIATIONS OF EQUIPMENT SUPPLIED THE TEST DATA SHEET ENTRIES UNDER THE FACTORY COLUMN SHOULD BE USED FOR COMPARISON MEASUREMENTS, WHENEVER ANY DIFFERENCE BETWEEN INSTRUCTION BOOK MEASUREMENTS AND EQUIPMENT MEASUREMENTS OCCUR.

4.4 NO LOAD - POWER-ON TEST

WARNING

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS THROUGHOUT THE DRIVE.

No load testing is defined as the motor shaft disconnected from the end devices or no working load on the end devices.

4.4.1 TURN ON - INITIAL CHECKOUT

CAUTION

ALWAYS RETURN SPEED REFERENCE INPUT TO ZERO AND LET MOTOR COME TO A REST PRIOR TO CHANGING ANY DIAGNOSTIC SWITCH POSITIONS.

TDS a. Verify that a 3-phase a-c power input to the drive is of the proper value as listed on the equipment data nameplate (-5, +10%).

b. Set TRP to zero, SW1 to Ctr, SW2 to Ctr; this disconnects power from SCR module (MA contacts open) and disconnects all reference and command inputs.

c. Apply main a-c power to the drive system (the a-c circuit breaker in the drive system must be switched on). The phase sequence indicator illuminates. This indicator being illuminated verifies:

1. That three phase power is applied and is in the proper phase sequence (unit internal circuit breaker switched on).

2. Motor field supply is energized (if supplied).

3. Regulator power and 115VAC supply.

4. Tachometer Monitor plugged in (if supplied).

NOTE

IF THE INDICATOR FAILS TO ILLUMINATE, INTERCHANGE ANY TWO TRANSFORMER INPUT PHASES ONCE: IF INDICATOR IS STILL OUT, PROCEED TO THE TROUBLE-SHOOTING TABLE 6-1.

d. Check for motor field voltage (as per motor data nameplate) and that the field loss relay is energized (when CVE or AVE is supplied for shunt motors only).

4.4.2 STATIC TEST REGULATOR CARD

This part of the test checks the following functions of the Regulator Card with the SCR module disconnect (MA open) and using the Test Reference potentiometer for reference input.

Test reference input/output
Regulator card power supplies

a. Verify TRP is set to 0 and SW1 is at Ctr. Place SW2 to Dn.

TDS b. With the VOM verify that +27V to +36V is measured between +30V test ring and common (COM).

TDS c. With the VOM verify that +20V ±2 is measured on TP1 and COM.

TDS d. With the VOM verify that -27V to -36V is measured between the -30V test ring and COM.

TDS e. With the VOM verify that -20V ±2 is measured between TP2 and COM.

TDS f. With the VOM monitoring TP3, turn the TRP fully CW and verify a voltage of +5 minimum as observed, still monitoring TP3 turn the TRP fully CCW and verify that an equal but opposite voltage is measured.

TDS g. With the VOM monitoring TP4, turn the TRP fully CCW and verify an increase in voltage (Check Test Data Sheet for exact value), still monitoring TP4 turn the TRP fully CW and verify that an equal but opposite polarity voltage increase is measured.

NOTE

IF NO VOLTAGE IS MEASURED IN THE ABOVE STEP, CHECK FOR EITHER A JUMPER FROM 2TB25 TO 2TB26 OR THAT THE NUMERICAL CONTROL INHIBIT/ENABLE SIGNAL IS WIRED IN. INHIBIT IS AN OPEN CIRCUIT.

TDS h. With the VOM monitoring TP5, verify that the voltages measured are approximately ±8V and equal but opposite in polarity to TP4 (CW is +, CCW is -).

TDS i. Adjustable Voltage Exciter (AVE) Adjustment (if supplied). With the TRP at zero and the VOM monitoring 6TB1 & 2 (-300V scale DC) verify that the voltage measured is the same as called for on the test data sheet for motor full field voltage ±10%. Turn the TRP fully CW and verify that the weak field voltage is as listed on the test data sheet (Normally set to 27V±3).

NOTE

FOR A FIXED FIELD "CVE" (IF SUPPLIED) VERIFY THE VOLTAGE IS AS PER TEST DATA SHEET VOLTAGE BY MEASURING, WITH VOM, ON 6TB1(-) TO 6TB2 (+) ON -300 SCALE.

If required, to set the Minimum Field Voltage, first perform the following calculation:

NP WEAK FLD CURR X NP FLD RES X .9 =
MIN FLD VOLT. SETTING: Example 2a X 20Ω X .9 =
36V
(NP = Motor Nameplate)

With the VOM still monitoring 6TB1&2 adjust the "MIN FLD" potentiometer to the above calculated value.

4.4.3 STATIC TEST-DRIVER PORTION

This part of the test checks the following functions of the Driver Portion of the Driver Regulator with the SCR module disconnected (MA open), Regulator unity gain and with no current or voltage feedback signals.

Driver Coordination Card Signals
Reverse Phase Control Card Signals
Forward Phase Control Card Signals
Phase Control Adder Card Signals

a. Verify TRP is set to 0 and SW1 is at Ctr and SW2 is at Dn.

b. With the VOM monitoring TP8, slowly turn the TRP CW until its fully CW and the output will change from .5V to +10V minimum (+8V produces full speed). Return TRP to 0.

c. With the VOM monitoring TP9 slowly turn the TRP CCW until its fully CCW and the output will change from .5V up to +10V minimum (+8V produces full speed).

TDS d. With the VOM monitoring TP10, turn the TRP slightly CCW. The VOM should indicate +4V minimum (+10V minimum on FWD LO test ring). Return the TRP to 0, VOM should indicate approximately 0.

TDS e. With the VOM monitoring TP11, turn the TRP slightly CW. The VOM should indicate +4V minimum (+10V minimum on REV LO test ring). Return the TRP to 0, VOM should indicate approximately 0.

TDS f. With the VOM monitoring OSC test ring, verify that a minimum of +2V is measured.

g. With the VOM, check each UJT EMIT test ring by turning the TRP fully CW and CCW; the voltage will rise from approximately +4.5V (at TRP-0) to +7V, in one direction only. Turning TRP CW provides the +7V on the Forward Phase Control UJT EMIT's, CCW for the Reverse Card.

h. With the VOM, check each FIR test ring by turning the TRP fully CW and CCW; the voltage will rise from approximately +.6V to +1.5V. Full CW on TRP FIRE 1, 2,3 approximately +.6V; FIRE 4,5 & 6 approximately +1.5V; Full CCW on TRP FIRE 1,2 & 3 approximately +1.5V; FIRE 4,5 & 6 approximately +.6V.

4.4.4 STATIC TEST - CURRENT LIMIT

This part of the test checks the static current limit setting and range adjust shift point between high and low current limit. The SCR module is disconnected (MA open) and simulated feedback signals are from the TRP control.

a. Verify TRP is set to 0 and SW1 is at Ctr. and place SW2 to Up.

TDS b. With the VOM monitoring TP13 (-I) turn the TRP CW or CCW until the reading is approximately the same as listed on the test data sheet. Leave TRP at this setting. With the VOM verify that +CL test ring is approximately the same as listed on the test data sheet.

TDS c. With the VOM monitoring TP12 (ISO) verify the reading is approximately the same as listed on the test data sheet. If required, adjust the CURR LIMIT potentiometer to approximately the same as listed on the test data sheet. ISO should be approximately -1V.

TDS d. With the VOM monitoring TP15 (TACH) turn the TRP fully CW or CCW until the reading is approximately the same as listed on the test data sheet. Leave TRP at this setting. This is the shift point between high and low current limit range which is set by the RANGE ADJ potentiometer. On permanent magnet motors the shift point is normally set between 500 and 550 RPM. Check your test data sheet for factory setting.

TDS e. At the setting in 4.4.4d at TP15 monitor TP14 (TSO) and verify the voltage is as listed on the test data sheet. If required, re-adjust Range Adjust potentiometer for TP14 to the listed value. If 0 volts is the listed value on TDS for TP14 do not adjust. Section 4.4.6 will test as a speed regulator.

4.4.5 SYSTEM VOLTAGE REGULATOR TEST

This part of the test checks the following functions using the TRP for the reference and operating the drive as a voltage regulator, not a speed regulator.

This test is normally used as a troubleshooting tool if the drive is not running properly. It also can be used to verify:

Proper armature voltage feedback
Proper current feedback
Proper armature voltage
Motor direction and speed
Proper tachometer polarity

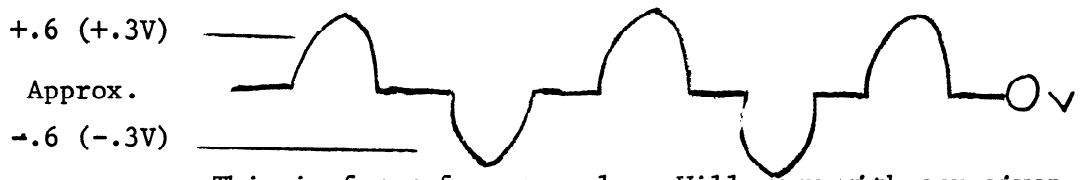
CAUTION

WHEN OPERATING DRIVE IN THE TEST OR MANUAL MODE, CONTINUALLY OBSERVE THE MACHINE TRAVEL TO AVOID HITTING THE ELECTRICAL AND/OR MECHANICAL LIMITS.

a. Verify the TRP is set to 0, place SW2 to Up and SW1 to Dn.

b. Verify that TP5 is at 0V; if not, adjust TRP to 0V.

c. Using the scope (set to 2 millisec./CM and .5V/CM) verify that the signal on TP6 is as indicated below:



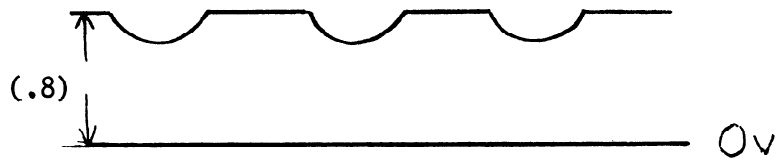
This is for reference only. Will vary with any given arrangement of motor or volts.

Note: Pulse on time vs. off time should be approximately equal for above.

d. Using the scope (set to 2 millisec./CM and 2V/CM) verify that the signal on TP7 is as indicated below:

TDS e. With the scope monitoring "ARM V" test ring, turn the TRP fully CCW and verify that the scope display is as indicated below: Scope set at 5V/CM, 2 millisec./CM. With the VOM verify that "ARM V" and the armature voltage (DC1 to DC2) are approximately the same as listed on the test data sheet.

f. With the scope verify that the display on "INT" test ring (TRP still fully CCW) is as indicated below: Scope set at 1V/CM, 2 millisec./CM.



TDS g. Turn the TRP fully CW and with the scope verify that "ARM V" test ring as displayed is approximately equal but of opposite polarity as pictured in step e and the test data sheet entries are approximately the same as measured with the VOM.

h. With the scope verify that the display on "INT" test ring is approximately equal but of opposite polarity as pictured in step f.

TDS i. With TRP fully CW check the tachometer input signal (TP18) polarity and verify that the negative is connected to 2TB29 and the other lead to 2TB30. Tachometer voltage is 18 volts per thousand RPM ±10% for permanent magnet motors (of the BY series), 50/100 volts per thousand RPM ±10% for shunt wound motors and other types of PM motors. See test data sheet for exact data.

TDS

j. With a tachometer verify that the motor top speed, in both directions, is as listed on the motor data nameplate. If some lesser operating speed is required the "MAX SPEED" pot will be set for the desired application in paragraph 4.4.7c.

4.4.6 SYSTEM SPEED REGULATION TEST (LOCAL CONTROL)

This part of the test checks the following functions using the TRP for the reference and operates the drive as a speed regulator.

Proper tachometer feedback level
Correct tachometer polarity
Proper drive operation as a speed regulator
Proper current limit

a. Verify the TRP is set to 0, SW1 is Dn and place SW2 to Ctr.

CAUTION

WHEN OPERATING DRIVE IN THE TEST OR MANUAL MODE, CONTINUALLY OBSERVE THE MACHINE TRAVEL TO AVOID HITTING THE ELECTRICAL AND/OR MECHANICAL LIMITS.

b. Slowly turn the TRP CW and verify smooth motor response up to top speed in the "forward" direction (armature voltage is positive). With the VOM verify that TP14 is the same as listed on the test data sheet at the stated tach volts/RPM.

c. Quickly turn the TRP CCW and verify fast smooth motor response up to top speed in the opposite direction. Return TRP to 0 and verify motor stops.

CAUTION

THE "RANGE ADJ" AND "CURR LIMIT" POTENTIOMETERS HAVE BEEN FACTORY SET AND THEIR SETTINGS ARE LISTED ON THE TEST DATA SHEET. TO VERIFY PROPER ADJUSTMENT (LIGHT BRUSH SPARKING) REMOVE THE MOTOR BRUSH ACCESS PLATE AND OPERATE THE MACHINE UNDER ITS NORMAL LOAD CONDITIONS, ACCELERATING AND DECELERATING THE DRIVE. IF OTHER THAN LIGHT SPARKING OCCURS, TURN THE "CURR LIMIT" POT CCW. EXCESSIVE SPARKING (OR ARMATURE FLASHOVER) WILL SHORTEN MOTOR BRUSH LIFE AND MAY DEMAGNETIZE THE MOTOR (PERMANENT MAGNET) OR CAUSE COMMUTATION BAR DAMAGE.

4.4.6.1 SIGNAL LEVEL DETECTOR CARD FUNCTIONS ADJUSTMENT (IF SUPPLIED)

a. The method of adjustment is dependent upon the normal circuit function, either normally picked up (indicator illuminated) or dropped out (indicator extinguished). Consult the System Elementary Diagrams for each circuit function and its normal operating state.

b. Normally Picked Up Adjustment

1. Energize the system and while monitoring the function under test (RPM, voltage or current) slowly increase the function until the card indicator illuminates, noting the value at which it illuminated.

2. While still monitoring the function under test slowly decrease the function until the card indicator extinguishes noting the value at which it extinguished. This is the drop-out point that the function should be set to operate. If required, readjust the associated "GAIN" potentiometer to the specified drop-out point for that function.

c. Normally Dropped Out Adjustment

1. Energize the system, and while monitoring the function under test (RPM, voltage or current), slowly increase the function until the card indicator extinguishes, noting the value at which the indicator extinguished.

2. While still monitoring the function under test, slowly decrease the function until the card indicator illuminates, noting the value at which it illuminates. This is the pick-up point that the function should be set at to operate. If required, readjust the associated "GAIN" potentiometer to the specified pick-up point for that function. For detailed information, see Instruction Book GEK-22950.

4.4.6.2 TACHOMETER MONITOR CARD ADJUSTMENT (IF SUPPLIED)

NOTE

THIS CARD IS ELECTRICALLY
INTERLOCKED TO THE FAULT RELAY.
THE CARD MUST BE IN THE DRIVE
TO OPERATE THE DRIVE.

a. Apply power to the drive system and slowly increase the "SPEED CONTROL" until motor reaches rated top speed. If drive trips prior to reaching motor rated top speed, turn the "TRIP SPEED ADJ" potentiometer CW five turns, reset the system and increase "SPEED CONTROL" until rated top speed.

b. With the TRP at 0 to check for an overspeed trip, counting the number of turns adjust the "TRIP SPEED" potentiometer CCW for five turns.

c. Quickly turn the TRP fully CW or CCW and the drive should trip. (If drive does not trip return TRP to 0 and turn "TRIP SPEED" potentiometer five more turns CCW and repeat start of this step.)

d. With the TRP at 0 readjust the "TRIP SPEED" potentiometer in a CW direction to the total number of turns decreased in steps b and c.

e. Sharply accelerate drive up to motor rated top speed and no trip should occur. For detailed information, see GEK 22942.

4.4.7 NORMAL SYSTEM OPERATION (REMOTE CONTROL)

This part of the test checks the following functions with the system operating from its remote control equipment.

For systems that are controlled by tape input but have a local manual control as part of their system, they should be used first prior to operating in the automatic mode.

CAUTION

IF ANY JUMPERS WERE USED ON REMOTE AUXILIARY PROTECTIVE DEVICES BE SURE TO REMOVE THEM AT THIS POINT.

Due to the many command/control input requirements used, the following "Turn-on and Checkout" subsection is written to functional test requirements, such as "Select Forward Direction", "Input Low Speed Reference Signal", "Close MA", or "Start/Stop Drive".

a. Connect the VOM (300V) leads between DC1 and DC2 on the PTB terminal board. Attach mechanical tach to motor shaft to measure motor speed (RPM).

b. Verify the TRP set to 0, place SW1 to Up - "REMOTE (NORMAL)" and SW2 to CTR "NORMAL". Verify that the MA contactor actuated (when external circuit is also activated).

TDS c. Select the Reverse direction and slowly apply full Speed Reference. Check/Adjust the "MAX SPEED" potentiometer for the desired motor top speed. Verify the rated armature voltage (180 or 240VDC minimum) has been reached or top speed obtained.

TDS d. If rated armature voltage is reached on field weakened drives, prior to top speed, slowly adjust the crossover pot located on the AVE assembly in such a direction that the armature voltage begins to decrease. At this point, again increase the speed reference input pot to rated armature voltage. Continue to adjust both the crossover pot and speed reference until top speed is reached at rated armature voltage with the speed reference input pot at maximum.

e. If top speed is reached on field weakened drives before rated armature voltage is obtained, adjust the crossover pot (on the AVE) in such a direction to increase the armature voltage. Continue the adjustments until the results of step d are obtained. Return the speed reference to 0 and disconnect VOM.

f. Quickly reverse motor direction command and verify fast, smooth response of motor up to top speed.

NOTE

IF ERRATIC MOTOR OPERATION IS OBSERVED ANYWHERE THROUGH THE SPEED RANGE, WITH A SCOPE, CHECK INPUT SPEED REFERENCE SIGNAL OR MOTOR TACHOMETER FEEDBACK SIGNAL FOR NOISE PICKUP.

g. Operate Drive System in its remote automatic mode.

NOTE

IF ANY SYSTEM ABNORMALITIES OCCUR IN THIS PORTION OF THE TEST, THE PROBABLE CAUSE IS IN THE REMOTE CONTROL EQUIPMENT, DUE TO THE FACT THAT THE DRIVE SYSTEM HAS OPERATED PROPERLY AS A VOLTAGE REGULATOR/SPEED REGULATOR.

TEST CONDITIONS	SWITCH #1	SWITCH #2	TEST CHECKS (INSTR. BOOK PARA # REFERENCE)
SCR POWER OFF - NO REFERENCE	CENTER	CENTER	READY-ON/FAULT-OFF LIGHT CIRCUITS. (4.4.1.c)
TEST REFERENCE POT. SCR POWER OFF, UNITY GAIN PREAMP	CENTER	DOWN	STATIC TEST CHECK, REGULATOR (4.4.2.h), LOCKOUTS (4.4.3.d & e), FIRING PULSES (4.4.3.h), SET MINIMUM MOTOR FIELD (4.4.2.i).
SCR POWER OFF	CENTER	UP	CHECK STATIC CURRENT LIMIT & RANGE ADJUST (4.4.4)
SCR POWER ON, MOTOR FIELD FIXED, TEST REFERENCE POT, PREAMP AT UNITY GAIN	DOWN	UP	RUN AS VOLTAGE REGULATOR. CHECK ARMATURE VOLTAGE (4.4.5.e), TACHOMETER INPUT (4.4.5.i)
SCR POWER ON, TEST REFERENCE POT, NORMAL REGULATOR - ABOVE BASE SPEED, SLIGHTLY WEAKENED FIXED MOTOR FIELD	DOWN	CENTER	RUN FROM TEST POT AS SPEED REGULATOR (4.4.6)
NORMAL	UP	CENTER	RUN NORMALLY (4.4.7)

TABLE 4-1 DIAGNOSTIC PROCEDURE FOR DC-3033R

SECTION V
MAINTENANCE

WARNING

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. IF POWER OFF MAINTENANCE IS BEING PERFORMED, VERIFY ALL POWER TO THE DRIVE SYSTEM IS SWITCHED OFF OR DISCONNECTED. RECOMMEND POWER SWITCHES BE RED TAGGED DURING POWER OFF MAINTENANCE.

5.1 MECHANICAL

The mechanical maintenance required for the drive system is divided into two basic units; power unit and motor. The power units only mechanical maintenance is checking and changing the air filter (if supplied) as required.

Motor maintenance is covered by the motor instruction book supplied with the motor and should be followed in all cases. Check motor brushes every six months and replace when brush length is less than 0.5 inches. Use a "Brush Seater Stone" and clean the commutator.

5.2 ELECTRICAL

The electrical maintenance for the drive system is divided into a "Power OFF" and "Power ON" inspection procedure.

5.2.1 Power Off (every six months)

a. Check all electrical connections for tightness.
b. Look for signs of poor connections or overheating (arcing, discoloration).
c. Manually check cooling fans for easy rotation (if supplied).

5.2.2 Power On

WARNING

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE.

a. Power on (Every month)
With drive system operating at top speed (full input reference), measure and record the voltage feedback signal on ARM V and Regulator "Common". The recorded measurement should be within 0.2 volts of the initial measurement recorded during installation and test of the equipment. If the measurement difference is greater than 0.2 volts DC, refer to Section VI.

b. Power On (every six months)
With the drive system operating, measure/record and compare the following functions with previous test data. If any significant differences are noted, re-adjustment or replacement may be in order. Refer to the appropriate step in Section IV for test/adjustment.

1. +20VDC
2. -20VDC
3. REG2 Reference Input, Forward/ Reverse Maximum
4. Firing Pulses, 1 thru 6
5. UJT, EMIT, 1, 2 and 3
6. Current Feedback
7. Top Speed (RPM) Forward-Reverse

5.2.3 Spare Cards

It is recommended that on hand spare cards be put in place of original cards every six months.

SECTION VI
TROUBLESHOOTING

6.1 GENERAL

These troubleshooting procedures assume that the system has been installed and checked out and has been operating properly prior to a malfunction. Fast efficient troubleshooting of the drive system is based on a thorough knowledge of the theory of operation plus well kept maintenance records that will provide trend data indicating the possible area of the problem. All measurements should be compared with checkout values. If temporary malfunctions/problems occur, then seem to disappear or self-correct themselves, then the incoming three phase a-c power should be checked for proper amplitude and phase at times of peak loading in the facility/building. Should repeated circuit breaker trip and/or SCR failures occur, the three phase a-c input power should be checked for high level spikes or extreme short duration power variations. During troubleshooting when a card or subassembly is found or suspected of being bad, it is recommended that prior to replacing the card/subassembly the inputs be checked for proper values. This will exclude the chance of further damage to the replacement item due to causes beyond the suspected item. If line fuses or SCR's have failed, it is recommended that the power conversion module be disconnected by placing SW1 to Ctr, and the system test, Section IV, be used to check for proper operation prior to connecting up the power conversion module after failed components are replaced and power is reapplied.

6.1.1 ELECTRICAL

The electrical troubleshooting procedures are divided into two parts; Drive System operating but not properly and Drive System not operating. The following checklist will help locate the malfunction with a minimum of effort when a logical approach/analysis of the problem is considered. If in troubleshooting, the inputs are found to be good but the outputs are bad, then the malfunction is assumed to be located. To use the checklist correctly, first select the proper checklist depending on the type malfunction indicated - Operating or Non Operating. Using this checklist, locate the type of malfunction indicated under the left-hand column, "Indication". The right-hand column "Check/Adjust/Replace" lists, in logical order, the

steps to be taken. When a step or action is completed and the malfunction still occurs, proceed to the next step. If the step located the problem area, troubleshoot, isolate and correct the malfunction. Retune/Adjust as required using Section IV.

NOTICE

DRIVER REGULATOR TERMINAL BOARDS HAVE CUSTOM SELECTED COMPONENTS FOR THIS SPECIFIC DRIVE. SEE YOUR TEST DATA SHEET FOR COMPONENT VALUES.

CONSULT THE FACTORY BEFORE ATTEMPTING TO CHANGE ANY OF THE ABOVE COMPONENT VALUES.

TABLE 6-1 DRIVE SYSTEM NOT OPERATING

INDICATION	CHECK/ADJUST/REPLACE
READY-ON/FAULT-OFF indicator not illuminated (4.4.1c)	1. External Power Applied 2. Internal Circuit Breaker Switched On. 3. Improper phase Sequence. 4. Damaged Light. 5. Regulator Power Supply. 6. 115VAC Control Power. 7. Motor Field Supply (if supplied). 8. Tach. Monitor Card (if supplied). 9. Field Loss Relay. 10. Faulty Wiring.
READY-ON/FAULT-OFF indicator illuminates momentarily (4.4.1c)	1. Check Field Supply fuses (if supplied). 2. Check for proper Field Supply output. 3. Press and hold Field Loss Bypass Pushbutton and press Fault Reset Pushbutton. If indicator illuminates, Field Loss Relay is inoperative replace. 4. If indicator fails to illuminate replace AVE or CVE (if supplied).
No voltage or improper level (4.4.2c)	1. Remove power and measure resistance at 2TB13 to Common. Should be in excess of 200 ohms. 2. Replace Card.
No voltage or improper level (4.4.2d)	1. Check input voltage to drive. 2. STA transformer secondary to COM,21 to 27VAC (STA Terminals A7, A8, B7, B8, C7 and C8 to COM). 3. Check continuity card pins to STA (See elementary or connection diagram). 4. Replace Card.
No voltage or improper level (4.4.2e)	1. Remove power and measure resistance at 2TB13 to Common. Should be in excess of 200 ohms. 2. Replace Card.
No voltage or low voltage at REG1 (4.4.2f&g)	1. Check diagnostic card switch settings. 2. TRP not fully CW or CCW. 3. Electronic inhibit input not connected or not jumpered (8TB25-26). 4. +20 volts at IDT(S) to com., and -20 volts at IDT(C) to com. check wiring if no voltage. 5. Approximately 8.5 volts at IDT(K) to com. Replace IDT Card if no voltage. 6. Check wiring/inputs to regulator card. If wiring/input OK, replace regulator card.

TABLE 6-1 DRIVE SYSTEM NOT OPERATING

INDICATION	CHECK/ADJUST/REPLACE
No voltage or low voltage at REG2 (4.4.2h)	1. Check wiring/inputs. 2. Replace Card.
Improper field voltage (4.4.2i)	1. Verify that SW1 & SW2 are in proper position. 2. Verify that TRP is set at 0. 3. Check 3TB1-3 for proper AC input voltage (268VAC for 120VDC field). 4. Insure proper connection of A-B jumper on AVE. 5. Remove wire from 3TB11. Voltage value on 6TB1&2 should remain the same. 6. Remove jumper A-B on AVE card. Adjust Min Fld pot. Voltage should vary smoothly from 0 to about 60% of desired voltage. If not, check phasing (wire to 3TB9-13, 3TB1-3 and 3TB-14 should be per the wiring diagram). 7. Reset Min Fld to original value. Replace A-B jumper and 3TB-11 wire. 8. Observe 6TB1&2 on scope. Almost a full half wave (at least 150°) should appear. 9. Replace AVE card.
Improper MIN FLD (4.4.2i)	1. Readjust MIN FLD pot. 2. Verify proper phasing (per 6 above). 3. Replace AVE card. 4. Check ±20V and common-connections at 3TB.
Crossover pot ineffective. (4.4.7d) (Motor field won't weaken)	1. Verify that SW1 & SW2 are in proper position. 2. Check 3TB-11 on AVE to insure presence of proper voltage (normal crossover point is about 6 volts at 3TB-11). 3. Check A-B jumper on AVE card for good connection. 4. Replace AVE card.
Improper Crossover balance between forward & reverse.	1. If armature voltage at top speed forward is more than ±12 volts different than armature voltage at top speed reverse, it is recommended that AVE card be replaced.
No voltage or low voltage (4.4.3b)	1. Check wiring/inputs. 2. Replace card.
No voltage or low voltage (4.4.3c)	1. Replace card.

TABLE 6-1 DRIVE SYSTEM NOT OPERATING

INDICATION	CHECK/ADJUST/REPLACE
No voltage or low voltage (4.4.3d)	1. Replace Card.
No voltage or low voltage (4.4.3e)	1. Replace Card.
No voltage or low voltage (4.4.3f)	1. Check wiring/inputs. 2. Replace Card.
No voltage or low voltage (4.4.3g)	1. Check wiring/inputs. 2. Replace Card.
No voltage or low voltage (4.4.3h)	1. Check wiring/inputs. 2. Replace Card.
Improper or missing signal on I SIG (4.4.5c)	1. Check REG2 for 0 volts output. 2. Check wiring/inputs to the card. 3. Replace Card.
Improper or missing signal on ARM V (4.4.5d)	1. Check REG2 for 0 volts output. 2. Check wiring/inputs to the card. 3. Replace Card.
No armature voltage or low armature voltage (4.4.5e)	1. Improper IDT switch position. 2. MA contactor not energized. 3. TRP not fully CW or CCW. 4. Replace Driver Coordination Card. 5. Replace the Forward or Reverse Phase Control Card depending on direction of failure.
Improper scope display (4.4.5f)	1. Replace Driver Coordination Card. 2. Replace the Forward or Reverse Phase Control Card depending on direction of failure.

TABLE 6-2 DRIVE SYSTEM OPERATING

INDICATION	CHECK/ADJUST/REPLACE
Circuit Breaker Trips	1. Check motor/machine for binding overload. Check for motor not connected or poor connection. 2. Reset circuit breaker and run motor/machine at low speed. 3. Check current feedback signal (I SIG). 4. Increase motor speed momentarily. 5. Reverse motor direction while observing I SIG for 3 equal amplitude pulses. 6. Check for severe line notching/ringing or marginal SCR and faulty suppression card. 7. Low line voltage (210VAC or less line to line) during regeneration. 8. Perform Driver Regulator signal check.
Cannot reach top speed	1. Check line voltage. 2. Check armature voltage with full reference applied. a. Voltage normal or low: 1. Check speed reference input. 2. Readjust Maximum Speed pot. 3. Check tachometer input voltage. 4. Check GTB7 to HTB7 for shorted C1. 5. Check Driver Regulator Signals. 3. Replace Pre-amplifier card.
Overspeed	1. Check ARM V and Armature Voltage. 2. Check for demagnetization if PM motor. 3. Check Maximum Speed setting. 4. Check input and output of Regulator card. 5. Check field circuit (when supplied).
Motor Runaway	1. Check Motor Field leads for continuity (if supplied). 2. Check tach feedback voltage by setting IDT to operate as a voltage regulator. 3. Check field loss relay circuit (if used).
System does not respond to command	
A. Drive will not respond to a change in direction command	1. Check for proper reference input. 2. Check direction circuit selected. 3. Check for outputs at: a. Regulator references. b. Driver Coordination output. c. FWD LO and REV LO.

TABLE 6-2 DRIVE SYSTEM OPERATING

INDICATION	CHECK/ADJUST/REPLACE
Motor/Machine unstable/erratic	1. Check three phase AC input power. 2. Check outputs for 60hz noise. 3. Run drive with IDT set to operate system as a voltage regulator. If drive is still erratic, replace regulator driver coordination or phase control card. 4. Check speed reference input for noise pickup (with speed). 5. Check tach feedback signal for noise. 6. Check current feedback signal for noise. NOTE THE FOLLOWING LEADS SHOULD BE TWISTED PAIRS: REFERENCE INPUT, TACH AND CURRENT FEEDBACKS. 7. Check components and connections on Driver Regulator G&HTB's. 8. Using the scope, check for noise on the following test rings: a. REG2 (exclude tach noise). b. Driver Coordination outputs. c. Common. d. Lockouts 1 and 2. e. ±20VDC. 9. Using the scope, check the following signals for proper width and time relationship to each other. For waveshapes refer to Table 6-3. a. UJT EMIT's b. TRIG's c. FIR #1, 2 and 3 or 4, 5 and 6. 10. Uncouple motor from load/machine and recheck for instability/erratic operation of motor. a. Check Circuit Breaker b. Check power supplies and I SIG. c. Check overload relay (OLD). (If supplied) d. Check any external/auxiliary protective devices. e. Check X0 lead on isolation transformer for continuity. f. Check for proper input reference. g. Check motor blower motor for correct rotation/operation.

TABLE 6-2 DRIVE SYSTEM OPERATING

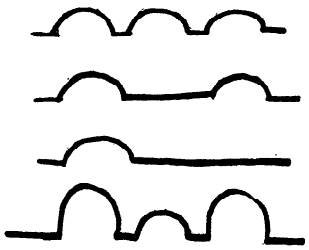
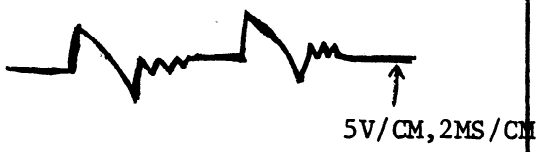
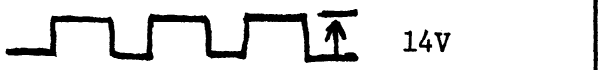
INDICATION	CHECK/ADJUST/REPLACE
Motor/Machine Hunting at standstill	1. Insert a 1/2W, 4.7 meg resistor from Driver Regulator terminal board HTB2 to HTB3. If excessive hunting still exists, lower the resistor value (in steps) but do <u>not</u> go lower than 330K ohms. 2. Consult factory.
SCR not firing/ conducting.	Check for the following signals using a scope: 1. Verify that all three current feedback pulses (per direction) are present and of equal amplitude on I SIG as indicated below:  proper SCR firing. one SCR not firing. two SCR's not firing. unbalanced firing. 2. With Test Switch #1 in <u>Center</u> position and Test Switch #2 in <u>Up</u> position, verify that Firing Signals are present on the output of each Pulse Transformer card on the SCR module (white wire gate - red scope probe common).

TABLE 6-3 DRIVER REGULATOR

Test Ring Voltage/Waveshapes

INDICATION	VOM	CHECK SCOPE
Test Point or Regulator Card Test Rings --		TRP FULLY CW, SW1 Dn, SW2 Ctr.
TP1 +30VDC	+25 to +36	None
+20VDC	+20 ±2V	None
COM		
-30VDC	-25 to -36	None
REG3	0V	None
TP2 -20VDC	-20 ±2V	None
TP3 REF Input	±8V	
TP4 REG1	-.4V Min	None
TP5 REG2	+8V Min	None
Driver Coordination Card Test Rings		
TP7 ARM V (times 36/30)	180/240 ±20V PTBDC2-DC1 (XO-P1)	
TP6 I SIG	+.16 Min	
REV IND	0V Approx.	
FWD IND	+3V (+.6)Min	
TP10 FWD LO	0V	
TP11 REV LO	+10V or 5V on TP11	
INT	-.65V Min	
TP9 REV FIR	-.4V Min	
TP8 FWD FIR	+3.1V Min	
COM		

Test Ring Voltage/Waveshapes

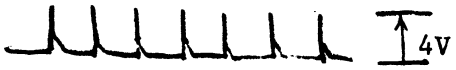
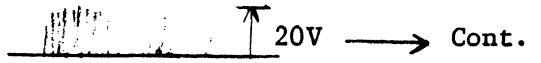
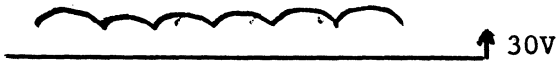
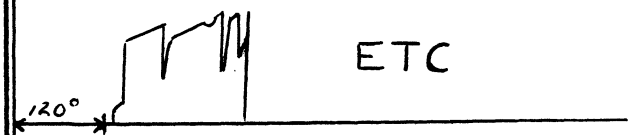
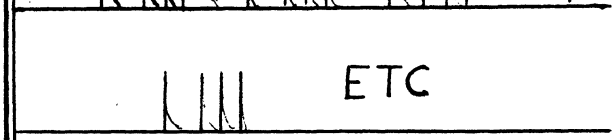
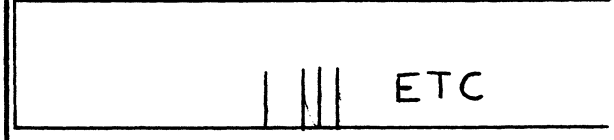
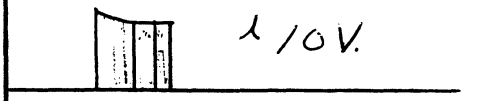
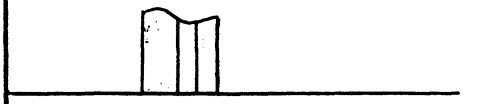
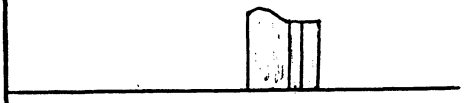
INDICATION	VOM	CHECK SCOPE
IN PUL	+.03V Min	
OSC	2V Min	
DFP	+26V Min	
		NOTE: TRP fully CCW, IN PUL. OSC. DFP, FETGS are the same, all others inverted.
FET GS	0V	
Forward Phase Control UJT EMIT #1	+7V Min. (Off +4.5V)	
UJT EMIT #2		
UJT EMIT #3		
TRIG #1		
TRIG #2		
TRIG #3		
Phase Control Adder FIR #1	Off +.6V approx.	
FIR #2		
FIR #3		

TABLE 6-3 DRIVER REGULATOR

Test Ring Voltage/Waveshapes

INDICATION	VOM	CHECK SCOPE
FIR #6	On +1.4V Min.	
FIR #5		
FIR #4		
Tapered Current Limit		Reference 6.3 for description
+18VDC	+17.2 min	none
LO	App. same as above when electronic inhibit signal is sent.	none
+CL	+2½V min (CL adjust fully CCW) and +12V min (CL adjust fully CW)	none
COM		
-CL	-2½V min (CL adjust fully CCW) and -12V min (CL adjust fully CW)	none
-I	App. equal I SIG and inverted	none

Test Ring Voltage/Waveshapes

INDICATION	VOM	CHECK	SCOPE
TP12 ISO TP13 Simulated-Input	0.2 when in curr. limit		
TP14 TSO	0 to +10.3V set by "RANGE ADJ"	none	
TP15 "RANGE ADJ" input	±15	Effective adjustment range to achieve TSO output is ±5 to ±15 using TRP for TP15 input.	
-18V	-17.2 min	none	
TP 16 Aux +20 Power Supply (when supplied)	+20V ±2V		
TP17 Aux -20 Power Supply (when supplied)	-20V ±2V		
TP18 Motor Tach Input	Tach V/1000 RPM		
TP19 Tach Monitor "TRIP ADJ" (if supplied)			

6.1.1.1 Checking SCR's

WARNING

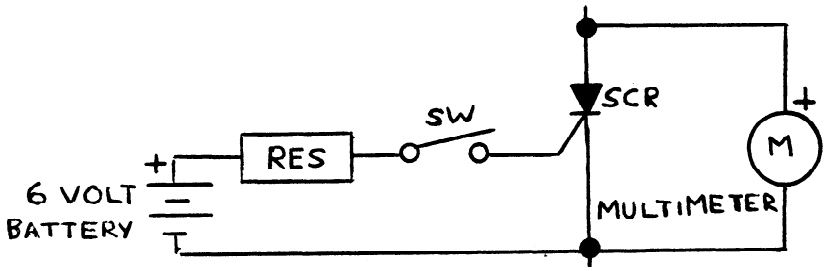
ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS THROUGHOUT THE SYSTEM.

a. Disconnect the AC power and make sure the DC armature loop contactor (MD) is open.

b. Using a multi-meter selected to read ohms on the times-1K scale, check the forward and reverse resistance of each individual SCR cell. This is done by reading across power terminals T1 and P1, T2 and P1, T3 and P1. (See conversion module elementary diagram.) Good or faulty SCR's will give the following typical readings:

SCR Description	Forward Reading	Reverse Reading
Good SCR	100K to Infinity	100K to Infinity
Shorted SCR	Zero	Zero
Inoperative SCR	1 to 2K	100K to Infinity
Open SCR	100K to Infinity	100K to Infinity

c. Since an open SCR will give about the same resistance reading as a good SCR, another method must be used to find this type of fault. It should be pointed out, however, that practically all cells fail by shorting and very few by opening. If an open SCR is suspected, or if it is desired to check the switching operation of an SCR, the following circuit should be used:



The multi-meter is selected to read ohms on the 1K scale, and is connected to read the forward resistance of the SCR. When switch SW is closed, the forward resistance of a good SCR will change from a high value (100K to infinity) to a low value (1 to 10K). When the switch

is opened, a good SCR will revert to its high forward resistance or blocking state, if the holding current (Multimeter battery) source is momentarily removed. A faulty SCR will not switch, remaining in either an open or a conducting state.

d. If any SCR's are suspected of being faulty from the above resistance checks, the SCR conversion module should be removed from the case. After the SCR pig-tail (cathode) and gate leads have been disconnected, recheck the forward and reverse resistances before replacing the SCR heat sink assembly. This should be done before any SCR is definitely classified as damaged or faulty, since a fault in another SCR or another part of the circuitry can produce a faulty reading from a good SCR before it is disconnected from the circuit.

6.1.2 Mechanical

Mechanical troubleshooting of the system is very limited. The following areas, mechanical in nature, would result in symptoms that would tend to lead you in the direction of an electrical problem but are solely mechanical:

a. Mechanical binding.
b. Improper equipment ventilation causing overheating conditions leading to electrical component failure.
c. Foreign matter intrusion into equipment causing arcing, shorts, poor connections or overheating.
d. Loose screws or bolts due to vibration causing bad connections, binding, arcing or improper connection.
e. Lack of regularly scheduled maintenance inspection.

6.2 SCR REPLACEMENT PROCEDURE (PRESS PAK CELLS)

In the event of an SCR cell failure the following steps are required for replacement of the press pak cell on the heatsink assembly.

If minimized down time is a critical factor, it is recommended that a complete Power Conversion Submodule (one phase consisting of two SCRs with heatsinks, pulse transformer card and suppression components) be an "on the shelf" spare.

6.2.1 Power Conversion Assembly

a. Remove the ac input cable (T1, T2 or T3) to the failed phase submodule and disconnect the associated wires (4 white, blue, brown & black) from their spade lugs on the pulse amplifier card plus the two wires on the terminal board.

b. Remove the nut and washer from each extreme top and bottom stud that hold the failed phase submodule to main assembly frame (see figure 1 parts 15 & 5), and slide the phase submodule out.

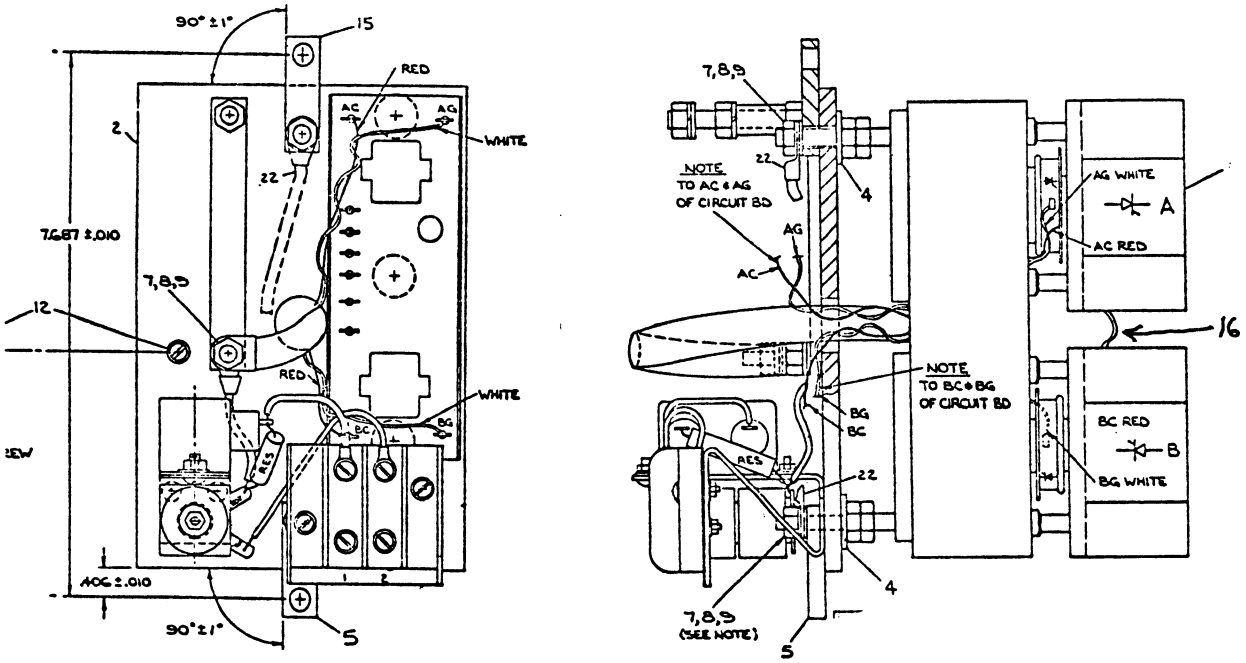


FIGURE 1 ONE PHASE SUBMODULE

c. SCR Cell Replacement

1. Reference Figure 2 for parts identification.

2. Remove the associated SCR gate (white) and cathode (red) twisted leads with spade connectors from the stab-ons on the pulse transformer card.

3. Remove the two nuts and the connector (part 16) that connect the two smaller heatsinks together.

4. On the failed SCR small heatsink remove the two nuts and washers (parts 15 & 20) and remove the failed cell.

5. Clean the heatsinks surface with a clean soft cloth and inspect the surfaces to make sure they are smooth.

6. Take the new replacement cell, twist the cell leads together, crimp on the female spade terminals, insert gate leads thru hole and apply a small amount of "Burndy Penetrox A" (or equivalent joint compound) to the small hole on each side of the cell (with a dab on top) so that under pressure the compound will cover only the raised center circular surface on each side.

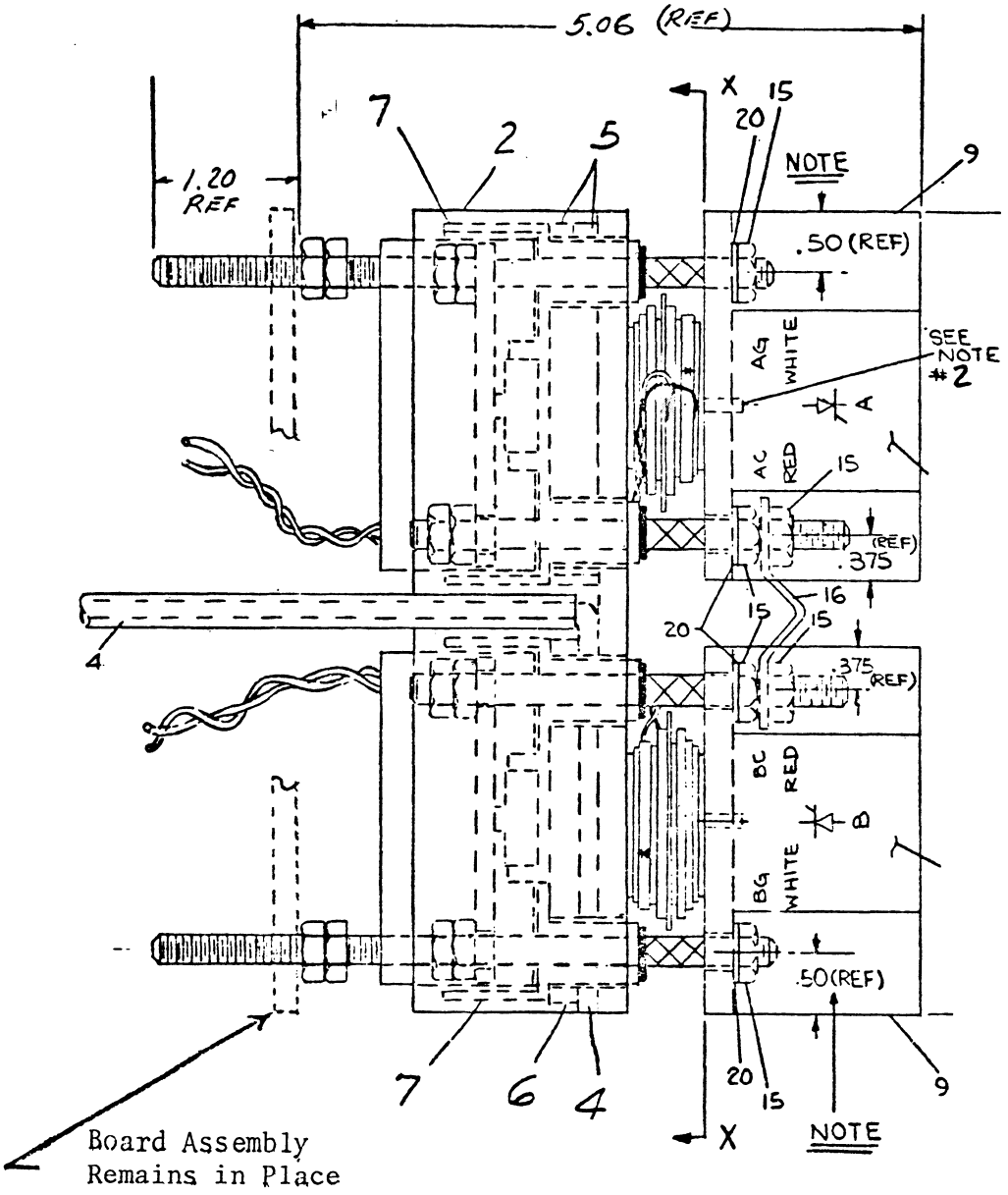
7. Place new cell in the same orientation as the failed cell and place on the roll pin of the heatsink so the roll pin is in the center hole of the cell.

8. Place the two washers and nuts (parts 20 & 15) back on the studs and tighten each nut finger tight so the heatsinks are parallel.

9. Check that the cell hole is still over the roll pin.

10. With the nuts finger tight, use a wrench and tighten each nut 1/6th of a turn (alternate between nuts) until the nuts have completed 5/6 turns each, making sure the stud does not turn when tightening nuts. Inspect the assembly to make sure that the heat-sinks are aligned equally and parallel with each other.

11. Reassemble all hardware and re-install submodule.



NOTES

1. APPLY PENETROX TYPE A TO FOLLOWING - CONN P4 ON SINK SIDE, BOTH CONTACT SURFACES OF RECTIFIERS, BOTH CONTACT SURFACES OF CONN. P16 AND TO THREADS & CONTACT SURFACES OF ALL P15 NUTS OF 2 SMALL SINKS.

2. ASSEMBLE PIN (P8) IN EACH SMALL SINK (P3) PER ASSEMBLY VIEW (P9).

FIGURE 2 PRESS PAK CELL(S) & HEATSINK ASSEMBLY

6.2.9 TAPERED CURRENT LIMIT CARD

The "Tapered Current Limit" card (when supplied) provides an adjustable, instantaneous current limit using feedback from the "Current Isolator". The current limit provides maximum safe utilization of the motor's torque capabilities. This is a dual level function incorporating a high and a low current limit which varies as a function of motor speed. The card also provides an electronic enable/inhibit circuit.

The tapered current limit circuit and its adjustments will be briefly explained with the following figures.

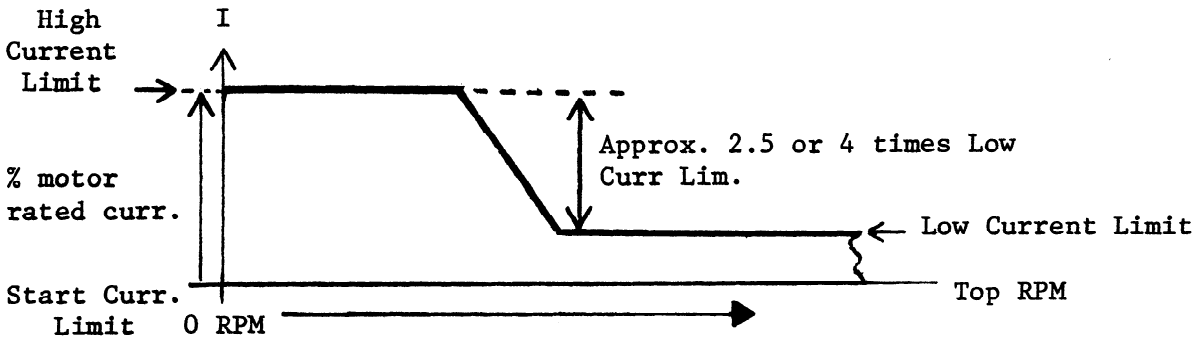


FIG. 1 Dual Range Current Limit - One Quadrant Pictured

Figure 1 shows the current limit versus speed. The normal ratio between high and low current limit is 2.5 or 4 to 1 (4 to 1 is normal setting). If the high current limit is set at 600% then the low would limit at 150% current.

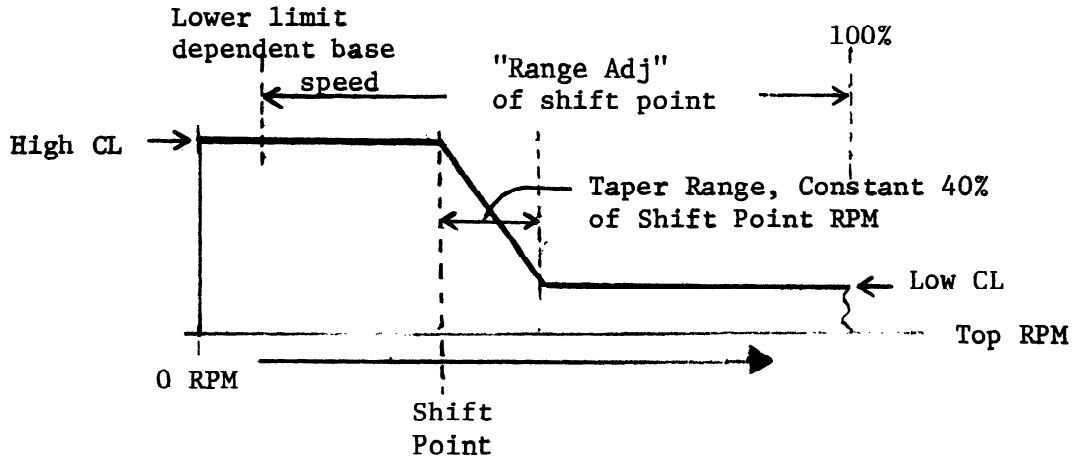


FIG. 2 Shift Point Set with Range Adj Potentiometer

Figure 2 shows the "Range Adj" potentiometer range which sets the point where the shift between high and low current limit occurs. The taper range is 40% of the set shift point (in rpm): if the shift point is set at 500rpm (9vdc tachometer input) then the tapered range would be 200rpm wide. The tachometer signal (±18vdc per thousand rpm on permanent magnet motors) in conjunction with the "Range Adj" potentiometer sets the point where the Tach Spillover amplifier output (TSO) increases which causes the shift from high to low level current limiting.

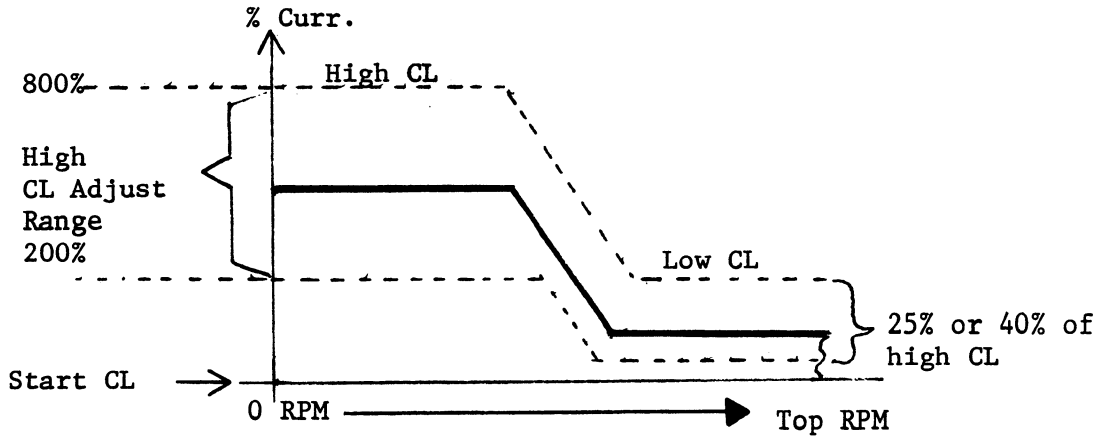


FIG. 3 Current Limit Range with "Cur Lim" Potentiometer

Figure 3 shows the range and ratio of the "Cur Lim" potentiometer for high and low current limit. The "Cur Lim" adjustment raises or lowers both the high and low range proportionally. There are two ratio selections from the output of the tach spillover amplifier; a 4 to 1 (high to low) and a 2.5 to 1. The proper ratio is selected based on the type of motor, rpm and application. Note: Custom Selected Components Values should not be changed.

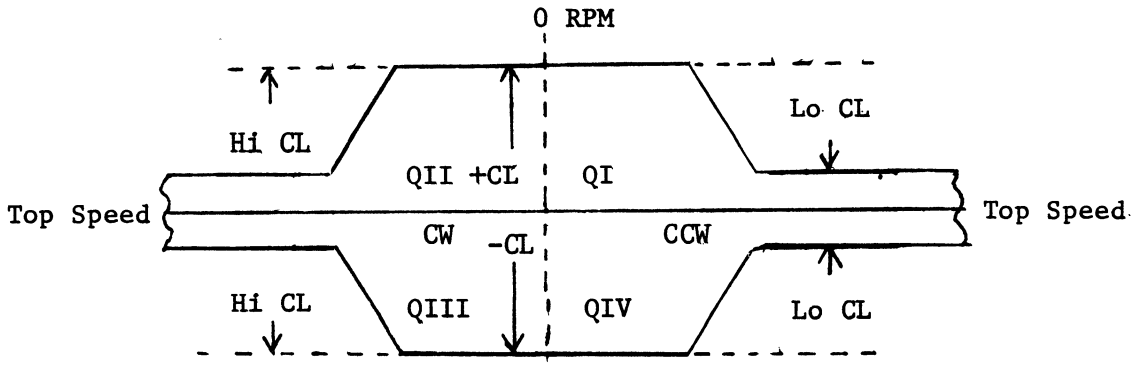


FIG. 4 Tapered Current Limit through all four quadrants.

6.4 CONVERSION OF ARMATURE AMPS IN CURRENT LIMIT BY VOLTAGE AT +CL OR -I TEST RINGS

HP @ 180V	HP @ 240V	CURRENT ISOLATOR EFFECTIVE TURNS*	CI GAIN AMPS PER VOLTS OF +CL OR -I
3	5	10	6
5,7½	7½,10	5	12
10,15	15,20,25	3	20
20,25,30	30,40,50	2	30
40,50	60 & 75	1	60

*Special care should be maintained in counting turns because parallel wires may be used. This can be determined by viewing the first cable termination on either end of the wire(s) passing through the current isolator window. To determine effective turns, divide actual turns by number of terminations at one end.

SECTION VII
SPARE PARTS RECOMMENDATION

7.1 GENERAL

A realistic "on hand" spares stock coupled with the Speed Variator low cost card exchange plan will lead to faster resolution of down time of the equipment in case of malfunction. By having on hand spare parts, there is no extended down time after the problem has been located awaiting parts that must be ordered and shipped from the factory. The concept of easily removable (plug in) printed circuit boards is a fallacy if it only takes a few minutes to discover the defective assembly but hours to order and procure a replacement. Therefore, from the standpoint of keeping the equipment/machine operating with a minimum of down time, readily available on hand spares are a must. The advantages coupled with the "Card Exchange Plan" are three fold:

1. Minimum down time, waiting time for part arrival is eliminated.
2. The lower cost of the "Card Exchange Plan".
3. No cost for time and special test equipment to troubleshoot, repair and test defective cards. The repair and testing of printed circuit cards takes special handling techniques and test equipment that most facilities do not have.

The proper evaluation of profits lost per hour of down time of the machine/system versus the cost of on-hand spare parts and the time saved is a readily available figure. A high volume machine output would therefore require a larger spare parts stock to insure minimum down time. For further information on the Speed Variator Products Department Card Exchange Plan, contact your local General Electric Company Installation and Service Engineering Component or your District Sales Representative or Speed Variator Products Department, Erie, Pennsylvania.

7.2 RECOMMENDED SPARE ASSEMBLIES, SUB-ASSEMBLIES AND PRINTED CIRCUIT CARD/BOARDS.

NOTE

WHEN ORDERING SPARE PARTS BE SURE TO GIVE COMPLETE PART NUMBER, AND ASSEMBLY NAME TO INSURE FAST AND EFFICIENT SERVICE.

The following is a list of recommended spare parts.

Assembly/Sub-assembly	Quantity
Regulator Card	1
Driver Coordination Card	1
Power Conversion Module	1
Phase Control	1
Control Adder	1
AVE or CVE Card	1

7.3 RECOMMENDED SPARE COMPONENTS

Component	Quantity
Command/Control Relays (small plug-in)	1 of each type

NOTE

ALL MOTOR SPARE PARTS AS PER RECOMMENDATION OF THE DC MOTORS INSTRUCTION BOOK INCLUDED IN THE DOCUMENTATION SUPPLIED SHOULD BE ON HAND.

SECTION VIII
DOCUMENTATION/DRAWINGS FURNISHED

8.1 GENERAL

The following types of documentation/drawings are normally supplied with your variable speed drive to aid in the installation and operation of your system. For the exact list of documentation/drawings supplied, see the "List of Equipment" sheets in the data package.

8.1.1 Documentation

a. Instruction Manual
b. Direct Current Motors and Generators Instruction
c. Control Devices Instructions/Bulletin (if applicable)
d. Printed Circuit Card Interchangeability List

8.1.2 Drawings/Prints

8.1.2.1 DC Motors
   a. Connection Diagram
   b. Outline

8.1.3 Power Unit

a. System Elementary Diagram
b. System Connection Diagram
c. Interconnection Diagram (if appliable)
d. Elementary Diagram, Driver Regulator
e. Connection Diagram, Driver Regulator

8.1.4 Auxiliary/Special Devices Diagram

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS OPERATION
ERIE, PENNSYLVANIA 16531

GENERAL ELECTRIC

GEK-24904B (7/82) 650 (P)