INSTRUCTIONS

GEK-24908C

ValuTrol* INDUSTRIAL DRIVE SYSTEM

HALF WAVE REGENERATIVE

INSTALLATION – OPERATION – MAINTENANCE

(Photo MG-5236-4)

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to General Electric Company.

GENERAL ELECTRIC

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INTRODUCTION

This Instruction Book contains helpful suggestions for placing the Valutrol drive equipment in service. It contains general information about drive operation and maintenance.

The operator and maintenance man should have access to a copy of this instruction book.

Additional instructions are included in the supplementary instruction publications and diagrams included in the instruction folder with the equipment.

RECEIVING, HANDLING AND STORAGE

RECEIVING

The equipment should be placed under adequate cover immediately upon receipt as packing cases are not suitable for out-door or unprotected storage. Each shipment should be carefully examined upon arrival and checked with the packing list. Any shortage or damage should be reported promptly to the carrier. If required, assistance may be requested from the General Electric Company, Speed Variator Products Operation, Erie, Pa. When seeking assistance please use requisition number and model number to identify the equipment. ***Telephone 814-455-3219.***

HANDLING

Wall mounted power units can be transported by lift trucks with the forks completely under the base using care that the unit does not tip.

STORAGE

If the equipment is not to be installed immediately, it should be stored in a clean, dry location at ambient temperatures from -20 (-4°F)to +55°C (131 F). The surrounding air must be free of chemical and electrically conductive or corrosive contaminants.

Precautions should be taken to prevent condensation from forming within the equipment enclosure. If the storage environment exceeds at 15°C (27°F) drop in temperature at 50% humidity over a 4 hour period, a space heater should be installed inside each enclosure to prevent condensation. (A 100 watt lamp can sometimes serve as a substitute source of heat). Higher humidities with smaller temperature changes will also cause condensation.

Condensation occurs when air containing some moisture is cooled below its dew point. The dew point represents saturation of the air, and is the temperature at which the moisture starts to condense into water. It is not a fixed temperature but rather is related to the initial temperature. The amount of moisture that can be held in the air is related to the air temperature. The following examples illustrate some of these relationships.

TABLE I

Relationship Between Air Temperature, Relative Humidity and Dew Point

AIR TEMP °F	°C	RELATIVE HUMIDITY %	WGT. OF MOISTURE IN 1 LB OF DRY AIR. GRAINS	DEW POINT °F	°C
104	40	100	345	104	40
104	40	80	270	97	36
104	40	40	130	75	24
104	40	10	32	37	3
50	10	100	54	50	10
50	10	80	42	43	6
50	10	40	21	25	4

In industrial drives, condensation is a possibility in applications where air temperature changes are large and rapid and/or the air is moist. For example, an outdoor crane operating in sunshine on a winter day, which then is shut down and parked in the shade will experience a rapid drop in temperature. This can result in condensation.

If storage temperatures below -20°C (-4°F) are likely to be present then auxiliary heat should be added in each enclosure to maintain temperature at or above -20°C. For assistance in heater size selection contact the General Electric Company.

When a drive that has been in operation is shut down for either a short or exteanded period of time, it is recommended the environmental conditions be maintained the same as when in operation. Power, ventilation or heating and airconditioning (if used) shold be left on during th downtime to prevent large changes in temperature and possible moisture condensation.

SAFETY FOR PERSONNEL AND EQUIPMENT

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

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 MAY RESULT IN DAMAGE TO, OR DESTRUCTION OF, THE EQUIPMENT.

COLOR — BLACK LETTER AMBER FIELD.

NOTE

DENOTES AN OPERATING PROCEDURE OR CONDITION WHICH SHOULD BE HIGHLIGHTED.

COLOR — BLACK LETTERING ON A WHITE FIELD.

WARNING

IMPROPER LIFTING PRACTICES CAN CAUSE SERIOUS OR FATAL INJURY.

LIFT ONLY WITH ADEQUATE EQUIPMENT AND TRAINED PERSONNEL.

WARNING: HIGH VOLTAGE

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE, WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGE TO GROUND WILL BE PRESENT AT MANY POINTS. WHEN INSTRUMENTS SUCH AS OSCILLOSCOPES ARE USED TO WORK ON LIVE EQUIPMENT, GREAT CAUTION MUST BE USED. THE INSTRUMENT COMMON LEAD SHOULD NOT BE CONNECTED TO AN UNGROUNDED PART OF THE SYSTEM UNLESS THE INSTRUMENT IS ISOLATED FROM GROUND AND ITS METAL PARTS TREATED AS LIVE EQUIPMENT. USE OF AN INSTRUMENT HAVING BOTH LEADS ISOLATED FROM THE CASE PERMITS GROUNDING OF THE CASE EVEN WHEN MEASUREMENTS MUST BE MADE BETWEEN TWO LIVE PARTS.

CAUTION

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

NOTE

ALWAYS READ THE COMPLETE INSTRUCTIONS PRIOR TO APPLYING POWER OR TROUBLESHOOTING THE EQUIPMENT. FOLLOW THE START-UP PROCEDURE STEP BY STEP.

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

CAUTION

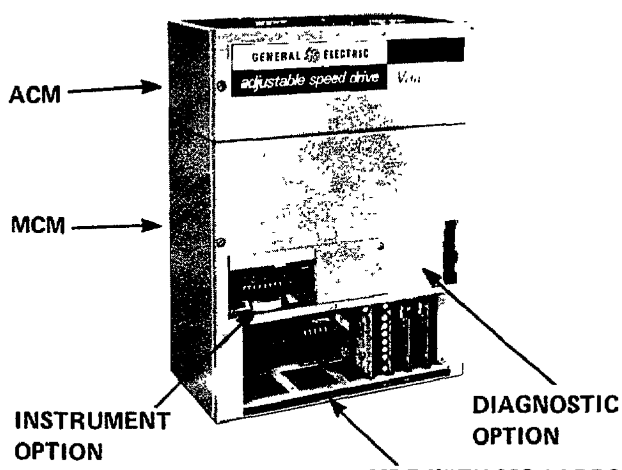
DO NOT REMOVE INPUT POWER FROM THE DRIVE UNTIL IT HAS FULLY EXECUTED A STOP SEQUENCE, AS THIS CAN DAMAGE THE DRIVE SYSTEM.

INSTALLATION

LOCATION

DC-SCR drive power units are suitable for most factory areas where other industrial equipment is installed. They should be installed in well ventilated areas with ambient temperatures ranging form 0°C (32°F) to 40°C (104°F) and relative humidites up to 90 percent. It should be recognized; however, that since the life expectancy of any electronic component decreases with increased ambient temperature, reduction of the ambient temperature will bring about extended component life. For example, longer component life should be expected if the ambient temperature is held between 20°C (68°F) and 30°C (87°F).

Proper performance and normal operational life can be expected by maintaining a proper environment for the drive system.



(Photo MG-5236-5)

Figure 1. Valutrol Power Unit

Environments which include excessive amounts of one or more of the following characteristics should be considered hostile to drive performance and life.

1. Dirt, dust and foreign matter.
2. Vibration and shock.
3. Moisture and vapors.
4. Temperature excursions.
5. Caustic fumes.
6. Power line fluctuations.
7. Electromagnetic interference (noise).

Totally enclosed power units should be positioned to permit heat radiation from all surfaces except the bottom; otherwise, the enclosure can be positioned as follows:

A wall mounted power unit enclosure (or floor mounted enclosure) may be placed side by side with another enclosure. Clearance at least equal to the width of the enclosure should be availabe in front so that the door may be fully opened for easy access.

WARNING

SOME POWER UNITS ARE FURNISHED WITH PARTIAL ENCLOSURES OPEN AT TOP AND BOTTOM. THESE ARE INTENDED ONLY FOR MOUNTING IN ANOTHER ENCLOSURE OR IN A CONTROL ROOM HAVING ACCESS BY QUALIFIED PERSONNEL ONLY. EXPLOSIONS OR FIRES MIGHT RESULT FROM MOUNTING DRIVE POWER UNITS IN HAZARDOUS AREAS SUCH AS LOCATIONS WHERE INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT. DRIVE POWER UNITS SHOULD BE INSTALLED AWAY FROM HAZARDOUS AREAS, EVEN IF USED WITH DC MOTORS SUITABLE FOR USE IN SUCH LOCATIONS.

MOUNTING

Wall mounted enclosures may be mounted on any firm, reasonably flat, vertical surface.

NOTE

FOUR HOLES (ONE IN EACH REAR CORNER) ARE PROVIDED FOR MOUNTING THE POWER UNIT. THE BOTTOM LEFT HAND MOUNTING HOLE IS COVERED BY A WIRE BUNDLE. TO GAIN ACCESS TO THIS HOLE, PULL ON THE TAIL ATTACHED TO THE HARNESS AND IT WILL POP DOWN OUT OF THE WAY. AFTER THE POWER UNIT HAS BEEN INSTALLED, POP THE HARNESS BACK INTO PLACE.

An optional mounting arrangement is also available which consists of two external brackets (one at top rear and one at the bottom rear of the power unit enclosure). Each bracket is fitted with two mounting holes for external mounting of the wall mounted enclosure.

CONNECTIONS

All internal electrical connections between components in DC-SCR drive power units are made at the factory of General Electric Company.

Be sure to protect the interior panel mounted components and sub-assemblies from metal particles when cutting or drilling entrances for interconnecting wiring and cables.

If additional relays, contactors, or electrical solenoids are added in the proximity of the SCR equipment enclosure RC suppression networks should be added across the coils. A series combination of a 220 ohm resistor and a 0.5 mfd capacitor in parallel with the relay coils is recommended.

NOTE

SOME SYSTEM TRANSFORMERS AND OTHER APPARATUS ARE SHIPPED SEPARATELY AND MUST BE MOUNTED AND CONNECTED TO THE SYSTEM.

WARNING

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

WARNING

IT IS RECOMMENDED THAT THE DRIVE SYSTEM COMMON CIRCUIT BE GROUNDED AT ONLY ONE POINT. THIS MEANS THAT IF THE DRIVE REFERENCE IS SUPPLIED BY A NUMERICAL CONTROL OR PROCESS INSTRUMENT WITH GROUNDED COMMON, THE DRIVE COMMON SHOULD **NOT BE GROUNDED.**

IF THE SECONDARY OF THE TRANSFORMER MUST BE GROUNDED, IT IS RECOMMENDED THAT HIGH RESISTANCE GROUNDING BE USED FOR GROUNDING THE TRANSFORMER NEUTRAL.

CAUTION

INSTALLATION WIRING MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND BE CONSISTENT WITH ALL LOCAL CODES. SECONDARIES OF 115 VOLT CONTROL TRANSFORMERS TYPICALLY HAVE ONE SIDE FUSED AND THE OTHER GROUNDED OR AVAILABLE FOR GROUNDING BY THE USER.

CAUTION

MEGGERING CAN DAMAGE ELECTRONIC COMPONENTS. DO NOT MEGGER OR HI-POT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS OPERATION, GENERAL ELECTRIC CO.

CAUTION

DO NOT CONNECT ANY EXTERNAL CIRCUITS OTHER THAN SHOWN ON THE ELEMENTARY DIAGRAM, SUCH AS AMMETERS ON THE SHUNT OR VOLTMETERS ON THE TACHOMETER BECAUSE THE PERFORMANCE OF THE DRIVE SYSTEM WILL BE DEGRADED.

CAUTION

DO NOT USE POWER FACTOR CORRECTION CAPACITORS WITH THIS EQUIPMENT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS OPERATION, GENERAL ELECTRIC CO. DAMAGE MAY RESULT FROM HIGH VOLTAGES GENERATED WHEN CAPACITORS ARE SWITCHED.

Before power is applied to the drive system, checks should be made to see that all internal connections are tight, that plug-in printed circuit cards in the optional regulator rack are fully seated and that all open relays and contactors operate freely by hand. Check that the equipment is clean and that no metal chips are present.

MAINTENANCE

Periodically inspect and maintain the equipment protective devices (particulary air filters when supplied) per instructions in this section. Check all electrical connections for tightness; look for signs of poor connections and over-heating (arcing or discoloration).

FANS AND FILTERS

On force ventilated drives, the power unit contains a fan and perhaps an air filter in the intake of the enclosure and/or on equipment inside the enclosure.

Inspect the fan at regular intervals to see that it is operating properly. Check for excessive noise and vibration, loose fan blades and for overheating of the motors. Keep the fan blades clean.

If the fan does not operate, replace the fan and integral motor with a unit with the same catalog number.

Clean and/or replace air filter as appropriate depending on the accumulation of dirt for the type supplied.

To clean metal filters, flush only with warm water, dry and recoat lightly with RP® Super Filter Coat or equivalent (light oil) or replace filter.

DC MOTORS

Maintenance instructions covering brushes, commutator and lubrication are found elsewhere in the equipment instruction book.

PRINTED CIRCUIT CARDS

Printed circuit cards normally do not require maintenance except to keep them clean and tightly secured to their respective terminal boards or tightly plugged in the optional modification rack receptacles. Clean as follow:

1. Dry Dust — Vacuum clean, then blow with dry filtered compress air (low pressure supply).

2. Oily Dirt — Certain components (electrolytic capacitors, switches, meters, potentiometers and transformers can be damaged by solvent, so its use is not recommended. If absolutely necessary, use solvent sparingly on a small brush and avoid above components. Clean contact terminals with dry non-linting cloth after solvent has been used. Recommended solvent: Freon* RE or TF.

3. If the card is badly contaminated or corroded, replace.

SILICON CONTROLLED RECTIFIERS

Keep SCRs and heatsink free from dirt, oil or grease, since any accumulation of dirt may cause overheating. Clean as follows:

1. Dry Dust — Vacuum clean, then blow with dry, filtered compressed air (low pressure).

CAUTION

SOLVENT CAN HARM NON-METAL COMPONENTS.

2. Oil Dirt — Use dry or barely moist (with solvent) non-linting cloth. Repeat until cloth remains clean. All contact tips must be cleaned with dry non-linting cloth after solvent has been used. Recommended solvents: Freon RE or TF.

CONTROL DEVICES

Inspect all relays and contactors at regular intervals and keep them free from dirt, oil or grease. Check for freedom of moving parts, corrosion, loose connections, worn or broken parts, charred insulation or odor, proper contract pressure and remaining wear allowance on contacts. Do not lubricate the contacts as lubrication shortens their life.

Both copper and silver contacts will become darkened and somewhat roughened in normal operation. This does not interfere with their performance, and does not indicate that the contacts should be filed. In general, contacts will not need attention during their normal life, but if prominent beads form on the surfaces due to severe arcing, the contact faces may be dressed with a fine file. **Do not** use sand paper or emery cloth.

Any contact that is worn to the point where contact wipe or pressure is lost should be replaced. Contactor shunts which are badly frayed or broken should also be replaced.

Cleaning procedure is the same as previously given for SCR and heatsink.

*Trademark of E.I. DuPont Co.

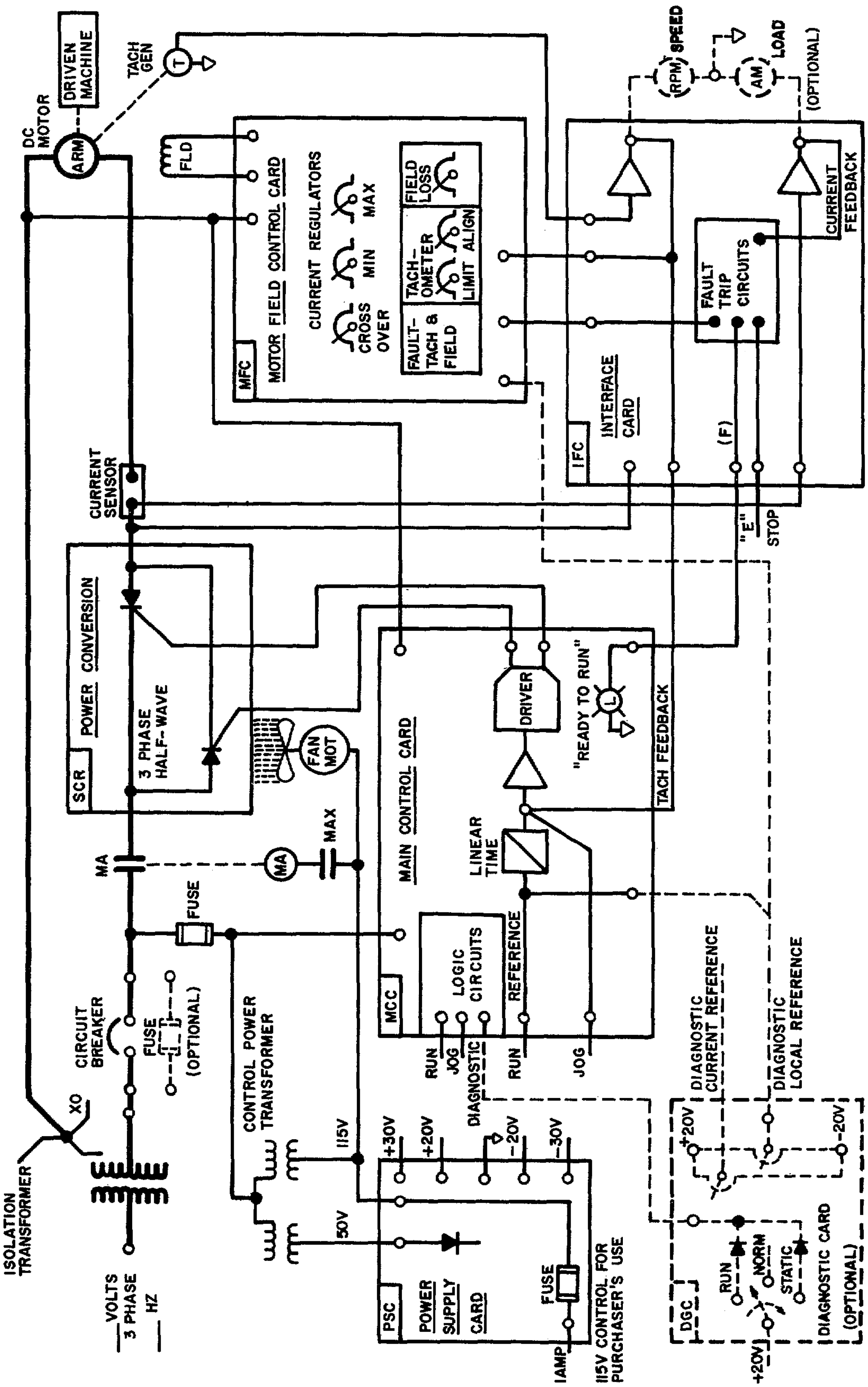


Figure 2. Valutrol Drive Block Diagram

INSTRUCTION INFORMATION

The instruction folder furnished with the equipment includes detailed instructions and diagrams applicable for each specific drive system.

In addition to this general instruction the folder includes instruction for the motor and other components furnished. Start-up and troubleshooting guides are included. All instructions and the accompanying diagrams should be consulted before applying power to the system.

TYPES OF DIAGRAMS

Different types of control diagrams are provided for specific purposes. The type of control diagram is noted in the title block of each diagram sheet.

The three major types of diagrams are Elementary, (sometimes called schematic), Layout or Connection and Interconnection.

The Elementary diagrams represents (in symbolic form) the fundamental operation and relationship of the electrical parts of a system. These diagrams are drawn in such a manner that the operation of the control system is easily understood. Mechanical relationships of control devices are subordinated to simple presentation of the electrical circuits. Connections made between control devices and power devices within the enclosure are also shown in this type of diagram. The Elementary diagram also identifies adjustments, signals, and test points.

The Layout or Connection diagram, when supplied is one which shows the relative physical position of the devices as well as other electrical components located within the same enclosure.

Adjustments are CAPITALIZED and UNDERLINED. Example: FMAX (Maximum motor field adjustments). – in this instruction book.

Signals and test points are CAPITALIZED only, Example: CFB (Current Feed back)

In many cases the Elementary diagram will be combined with the Interconnection diagram. On more complicated systems a separate Interconnection diagram will be furnished, which will show the type and number of connections to be made between major components of the system such as the power unit, motor, operator's station, the plant power source, auxiliary devices and other electrical machines. In some cases the Interconnection information may be presented in tabular form.

GENERAL DESCRIPTION

The basic elements of the half wave, regenerative, Valutrol, dc SCR drive are shown in the simplified block diagram. Fig. 2.

Three phase ac power enters through the primary winding of a separately mounted isolation transformer. Since this drive employs three phase, half wave rectification of ac power, the transformer must have a secondary neutral connection. (XO)

Power is fed through the circuit breaker, (or optional fuses) the MA contactor and enters the power conversion module (SCR) where it is converted to DC adjustable voltage. DC current is fed through a shunt to the DC motor armature. The return side of the DC motor is connected to the isolation transformer neutral connection (XO).

The speed of the motor is proportional to the dc voltage applied to its armature. Speed is measured by a tachometer generator directly connected to the dc motor.

The remainder of the control is manufactured on five (5) removable printed circuit boards. These are the power supply card (PSC) the main control card (MCC) the interface card (IFC) the motor field card (MFC) or motor field exciter (MFE) and the diagnostic card (DGC) (optional).

Signal level power for the control is taken from the three phase input through control fuses to the control power transformer (CPT). This transformer is fitted with two isolated secondary windings: (1) 115 V ac to operate the coil of the MA contactor, the conversion module cooling fans (if required) and the requirements (if any) for the modification rack (MDR); (2) the second winding is a 50 volt tapped secondary which provides the ac input to the power supply card.

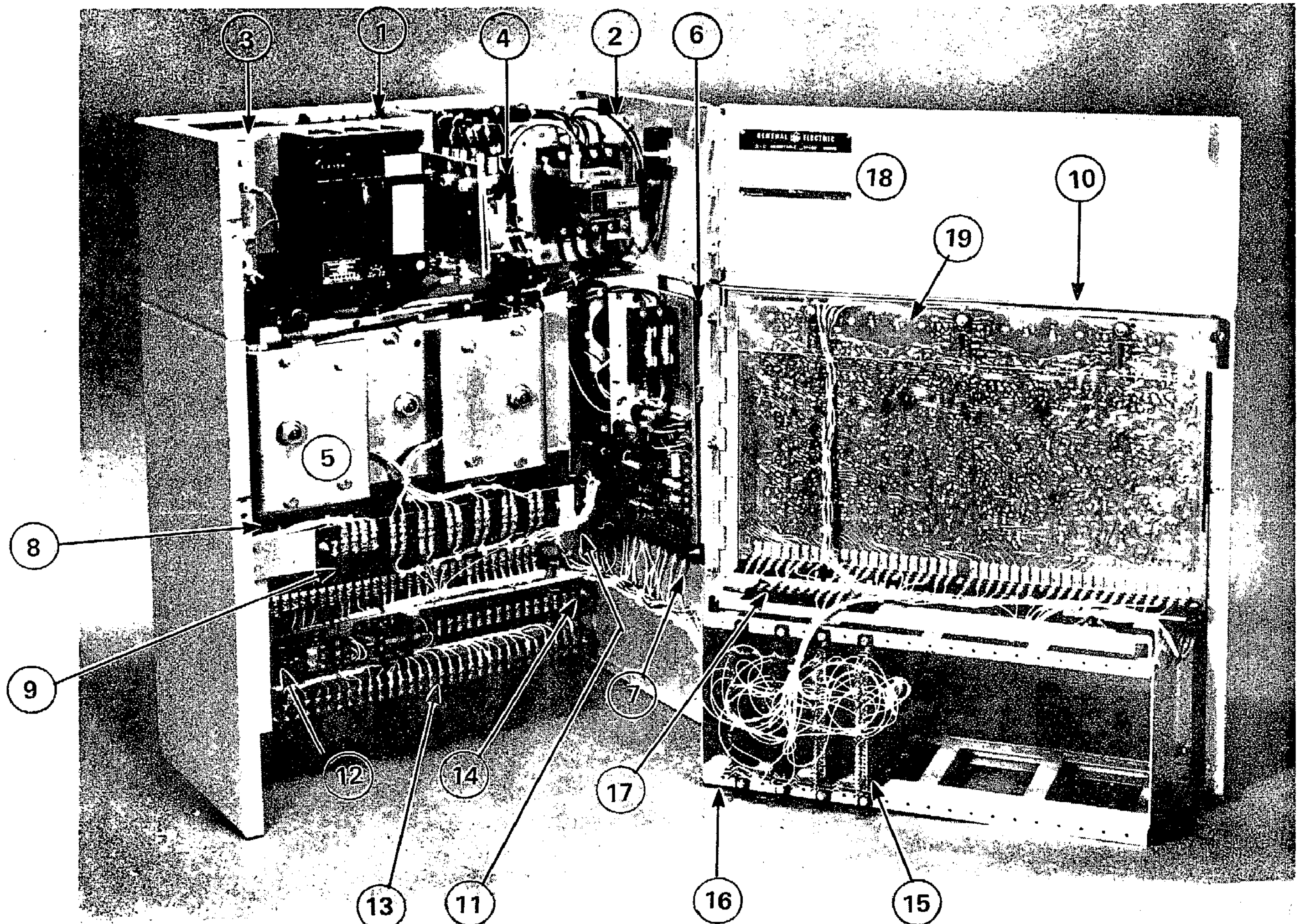
POWER SUPPLY CARD (PSC)

The power supply card rectifies the ac input and provides regulated plus and minus 20 volts for the printed circuit cards. Unregulated plus and minus 30 volts dc is also provided to drive the static logic switches and the "control on" function. All of the dc outputs are fused to protect the power supply card against overloads. The regulated plus and minus 20V dc outputs are protected against over voltage conditions caused by a power supply card failure.

MAIN CONTROL CARD (MCC)

The primary purpose of the main control card is to drive the conversion module (SCR) as commanded by the speed reference and feedback signals.

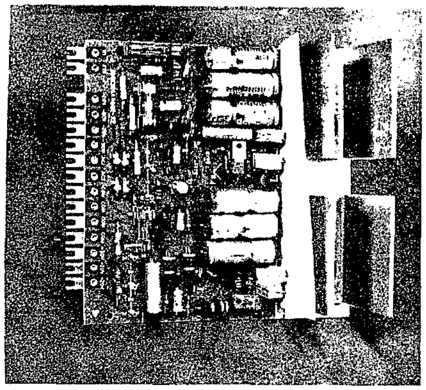
This card also performs several additional functions such as linear timing of the reference; current limit; "Ready to Run" indicator; and various scaling and trimming adjustments.



(Photo MG-5236-11)

1. FUSE OR BREAKER
2. LINE CONTACTOR
3. SHUNT
4. MOV SUPPRESSION
5. HEATSINK MODULE
6. MOTOR FIELD CONTROL OR EXCITER (MFC OR MFE)
7. MFTB
8. FANS
9. MTB
10. MAIN CONTROL CARD (MCC)
11. INTERFACE CARD (IFC)
12. POWER SUPPLY (PSC)
13. 2TB
14. 3TB
15. S-22 CARDS
16. MODIFICATION RACK (MDR)
17. RTB
18. NAMEPLATE
19. HI VOLTAGE SHIELD

Figure 3. Valutrol Power Unit (Door Open)



(Photo MG-5236-20)

Figure 4. Power Supply Card

A total of eleven (11) potentiometers are provided on this card, ten(10) of which are accessible from the front of the controller. The eleventh potentiometer is the card zero adjustment, ZERO ADJ, which is preset at the factory and should **not** be disturbed. All adjustments have been pre-aligned prior to shipment. These ten potentiometers are:

DAMP	MAX SPEED	MIN SPEED
CUR LIMIT	GAIN	REF SCALE
CEMF LIMIT	RESPONSE	LIN TIME
COMP		

When the drive is first placed into operation the actual top speed may be different from what might be expected due to minor variators between tachometers. By adjusting the MAX SPEED potentiometer, any variations between tachometers can be eliminated without disturbing any other adjustments in the drive.

TEST INSTRUMENT AND PROBE (OPTIONAL)

Located below the main control card (to the left) is a test instrument and probe that can be used to "readout" signals from any of the drive test points. The probe is fitted with two connections, one for the 4 volt instrument scale and the other for the 20 volt scale. Always apply the 20 volt connection first. If th reading is below 4 volts, switch to the 4 volt connection for improved accuracy of the readout.

INTERFACE CARD (IFC)

The primary purposes of the interface card are:

1. To provide low level isolated signals corresponding to the three phase ac, dc armature voltage, armature current and tachometer feedback.

2. To control the start, stop and synchronizing of the drive while monitoring the system for abnormal operation conditions.

3. To provide a milliampere signal for external speed and current indicators.

Other outputs provide:

1. A NO/NC contact indicating MA closure (MAX)
2. A NO contact indicating a fault condition (FLT)

For those drives employing an AC tachometer an output whose frequency is proportional to RPM is generated which may be used to drive a digital counter. AC tachometer furnished by the factory will generate 18 pulses for each revolution.

1. The IZERO is a bias adjustment for the current feedback output and is factory set. This control should not be disturbed.

2. R STOP is the drop out level of the regenerative stop sequencing circuit and is also factory set.

3. IMET is the calibration adjustment for the current indicator.

4. SMET is the calibration adjustment for the speed indicator.

5. ICAL is the calibration adjustment for the speed indicator.

Adjustment 3 and 4 will be factory set if the indicators are ordered with the drive and mounted in the power unit enclosure.

MOTOR FIELD CONTROL CARD (MFC) OPTIONAL

This card provides a current regulated field supply for the dc motor. Constant excitation is supplied in the constant torque range, as armature voltage is increased from zero to rated voltage. A cross—over, CROSS adjustment is provided at which time the motor field current is automatically decreased thereby increasing the speed of the motor above base speed. In this range the drive characteristic changes from constant torque to constant horsepower.

Other functions performed by this card include a tachometer monitor circuit to detect the loss of tachometer voltage and to detect reversed polarity when a dc tachometer is employed. Loss of motor field is also detected by this card. All of these conditions will shutdown the drive. A field economy circuit is also included on this card when called for, by circuits on the main control card.

MOTOR FIELD EXCITER CARD (MFE)

The motor field exciter card provides a fixed value of field excitation for use with constant torque drives. However, this value of voltage is directly related to ac line voltage variations. A filed loss circuit similar to the circuit on the motor field control card (MFC) is also provided.

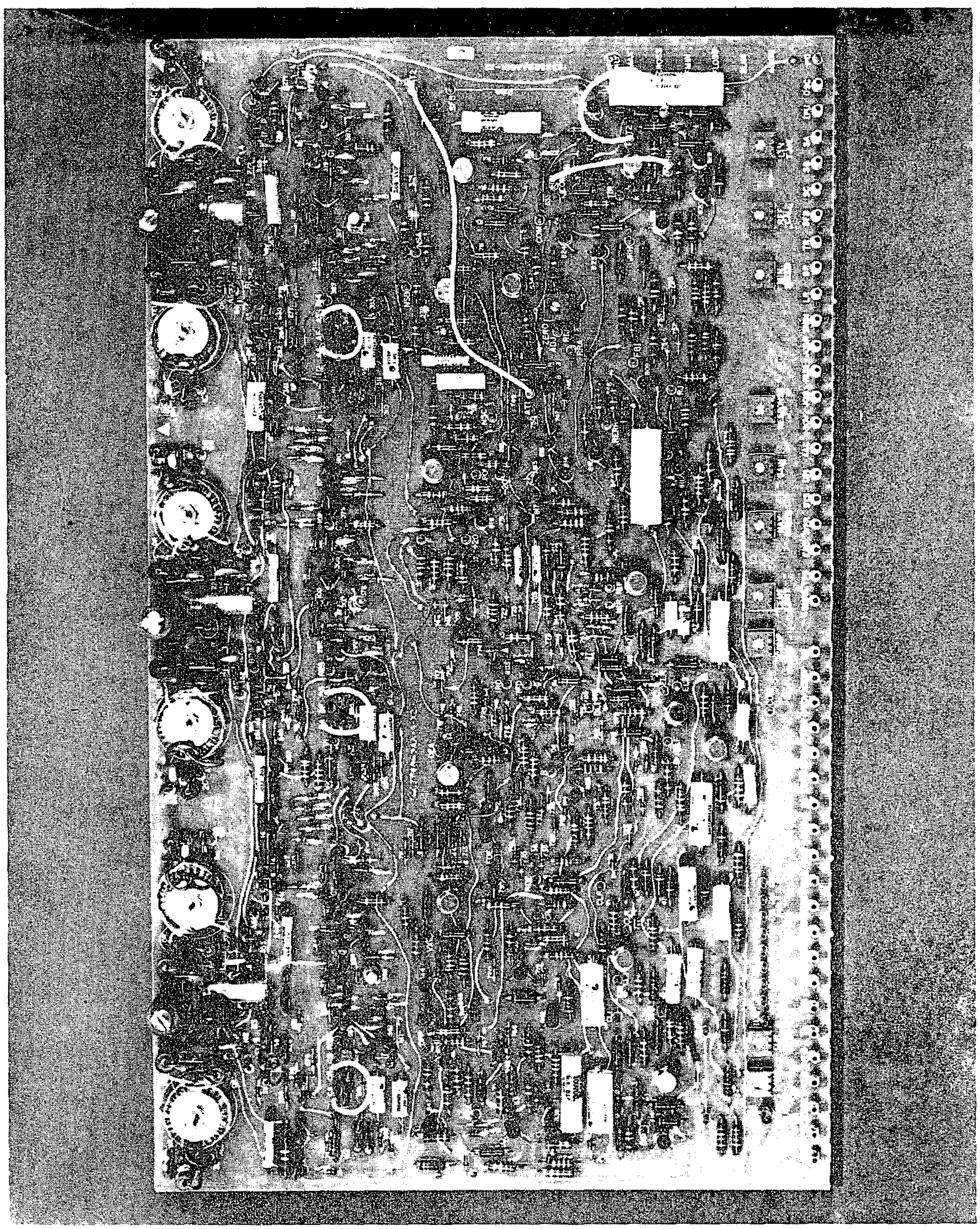


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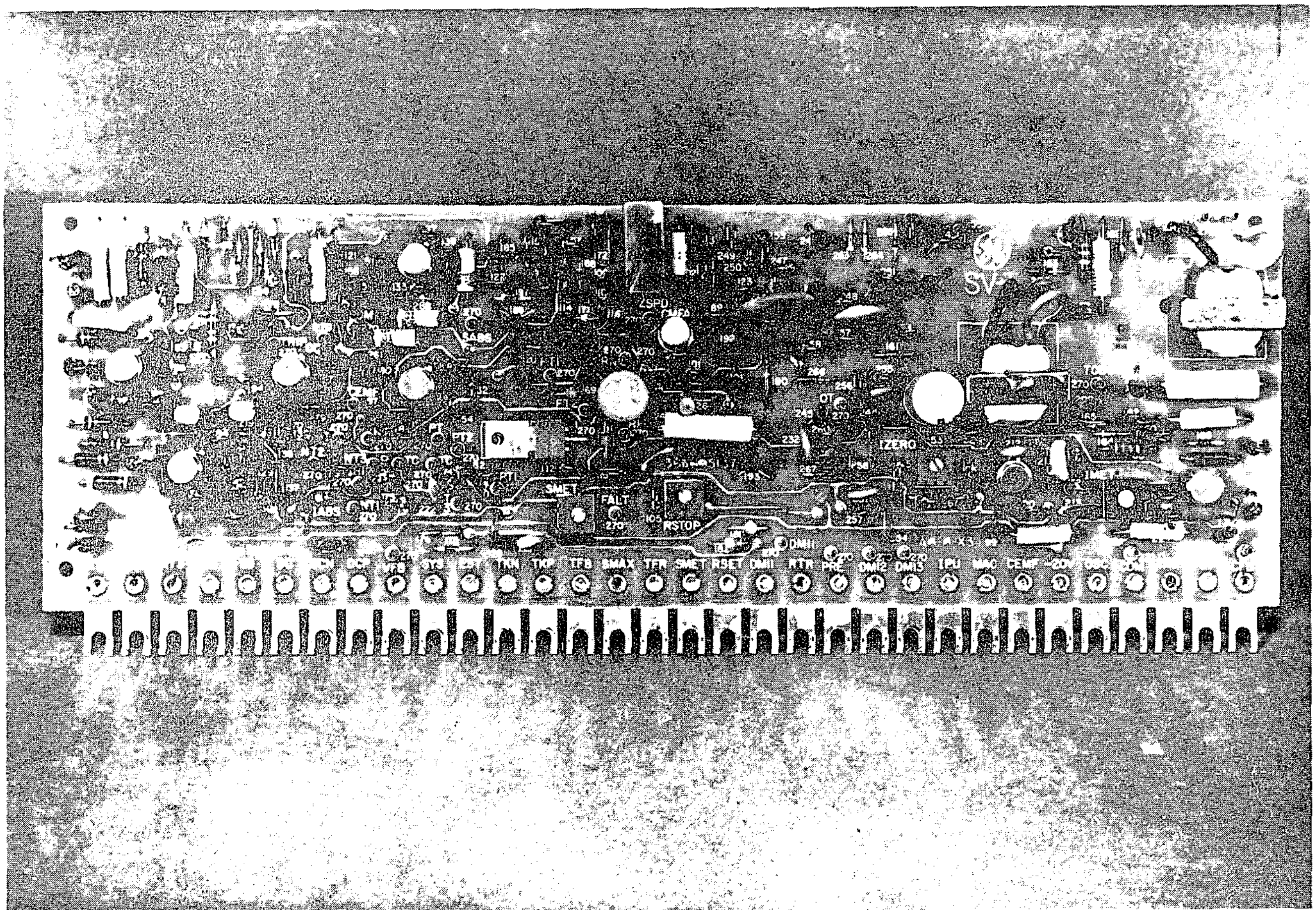
Figure 5. Main Control Card



(Photo MG-5236-13)

Figure 6. Interface Card

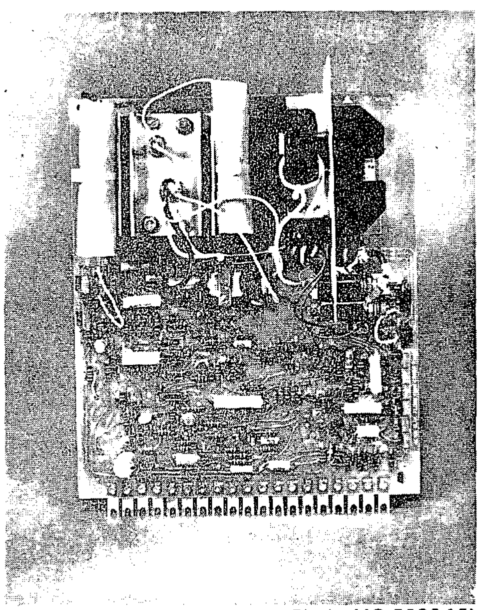


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Figure 7. Motor Field Control Card

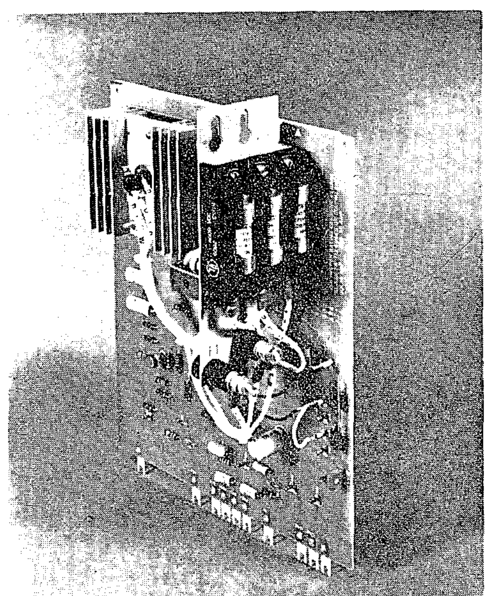

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Figure 7A. Motor Field Exciter Card

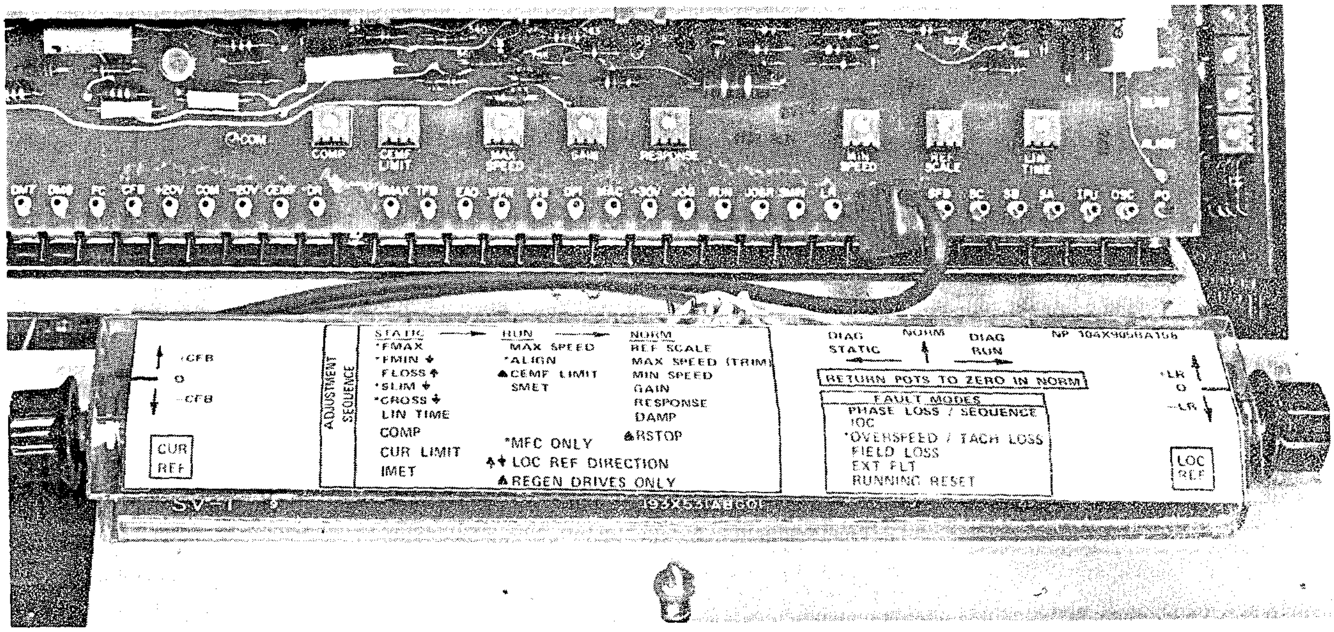


Fig. 8 Diagnostic Card Photo MG--5393

DIAGNOSTIC CARD (DGC) (OPTIONAL)

The diagnostic card performs no function under normal operating conditions but will program the drive into a diagnostic run mode and diagnostic static mode for ease in initial start up and troubleshooting.

MODIFICATION RACK (MDR) (OPTIONAL)

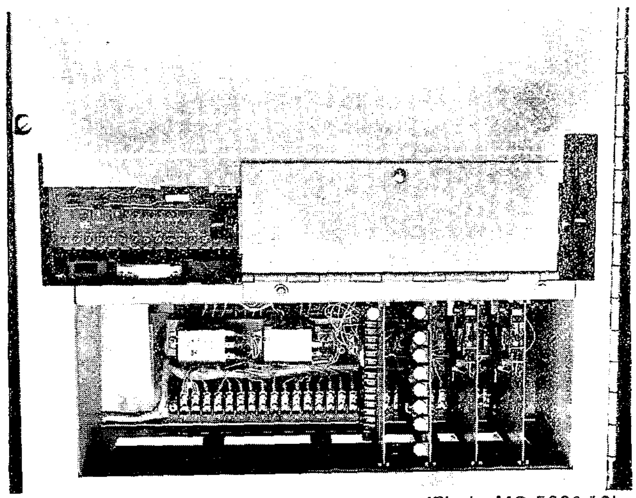
Any special features or functions which are related to the operation of the drive such as:

Special reference
Position orient
Up to speed
Independent timed acceleration and deceleration adjustments
Etc.

are located in the modification rack located below the main control card.

CONTROL FUSES, MOV S

The signal power for the control is taken from the three phase input through control fuses to the control voltage transformer (not shown on the block diagram). The control fuses are used to protect the control transformer and the metal oxide varistors (MOV) are used to protect the power unit from excessive transient over voltage conditions. Three (3) high resistance wires which provide line synchronization are connected to the load side of these fuses. The drive will not operate if any one of these fuses are open.



(Photo MG-5236-19)

Figure 9. Modification Rack

POWER CONNECTIONS

The power connections are the three phase input at L1A, L2A, and L3A on the circuit breaker (or optional fuses). The transformer neutral at XO on the ATB terminal board; motor field at F1 and F2 on the ATB terminal board and the dc power output DA1.

SIGNAL CONNECTIONS

All signal connections are made on the 2TB, 3TB and 4TB terminal boards. Terminal boards 3TB and 4TB will

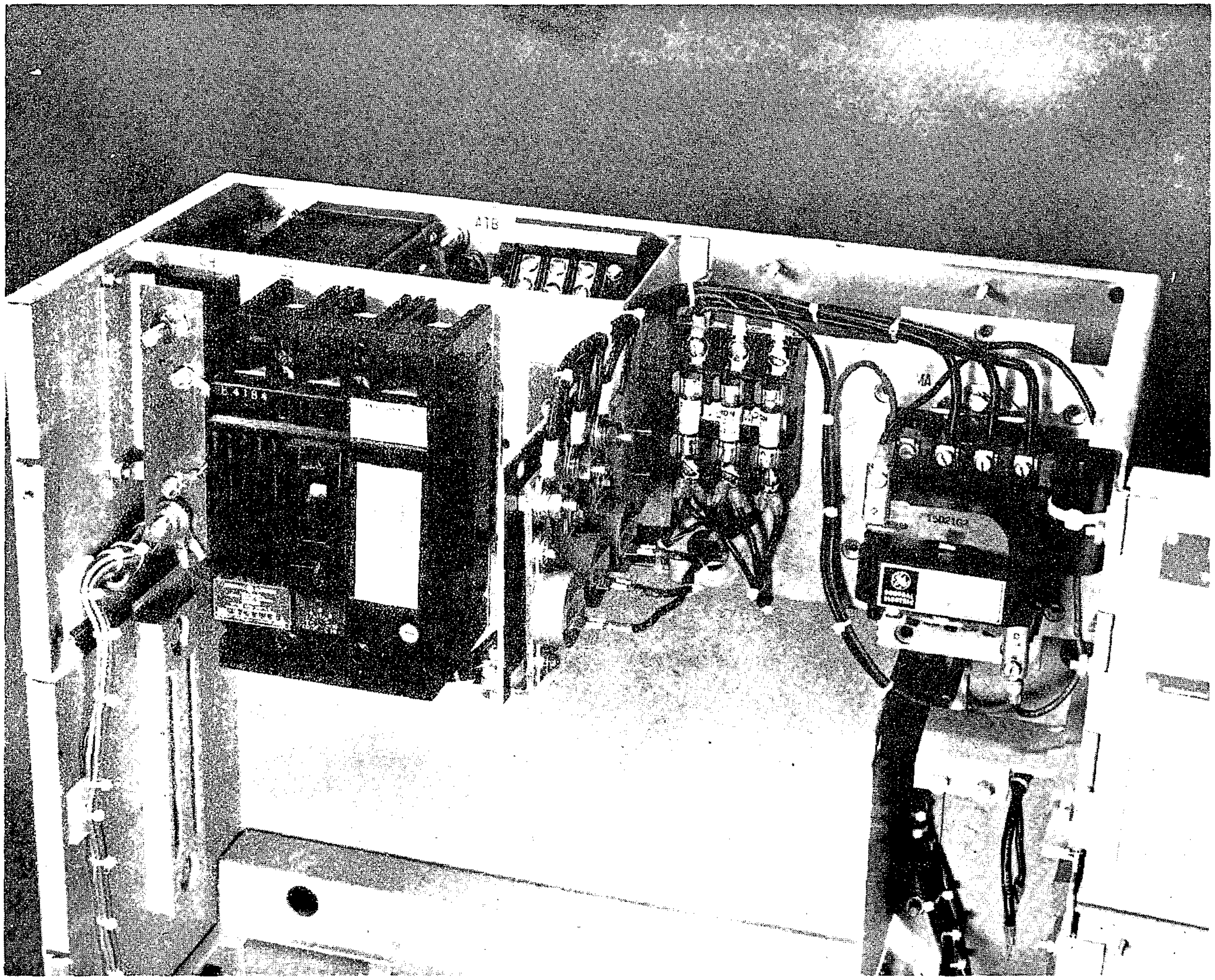


Figure 10. Control Fuses — MOV's (Photo MG-5236-2)

be furnished only if required. Refer to system elementary diagram for complete description. The signals appearing on 2TB and their functions are described in Table III. Refer to the system elementary diagram for details.

START-UP

Every Valutrol dc SCR drive can be started up and made to run satisfactorily if the following step by step procedures are followed:

1. Verify that the terminal board screws are tight.
2. Verify that incoming power is the proper voltage and that the incoming wiring is complete and correct. Verify that the incoming reference voltages are correct.
3. With the diagnostic switch in its NORMAL position, close the circuit breaker and then apply power to the drive. If the green "ready-to-run" light located on the lower left hand corner of the main control card is not illuminated, the most probably cause is incorrect incoming phase rotation. Remove power, reverse any two incoming leads and repeat.
4. Turn the local speed reference (<u>LOC REF</u>) potentiometer on the diagnostic card to the center of its rotation and switch into the diagnostic run (<u>DIAG RUN</u>) position. As the local speed reference (<u>LOC REF</u>) potentiometer is rotated away from the control, the motor will begin to rotate in the forward direction. Check the tachometer polarity. With a dc tachometer, TKP is positive for forward rotation. Switch back to the normal position. If motor rotation was incorrect, remove power and interchange the fields F1 and F2 at 2TB.

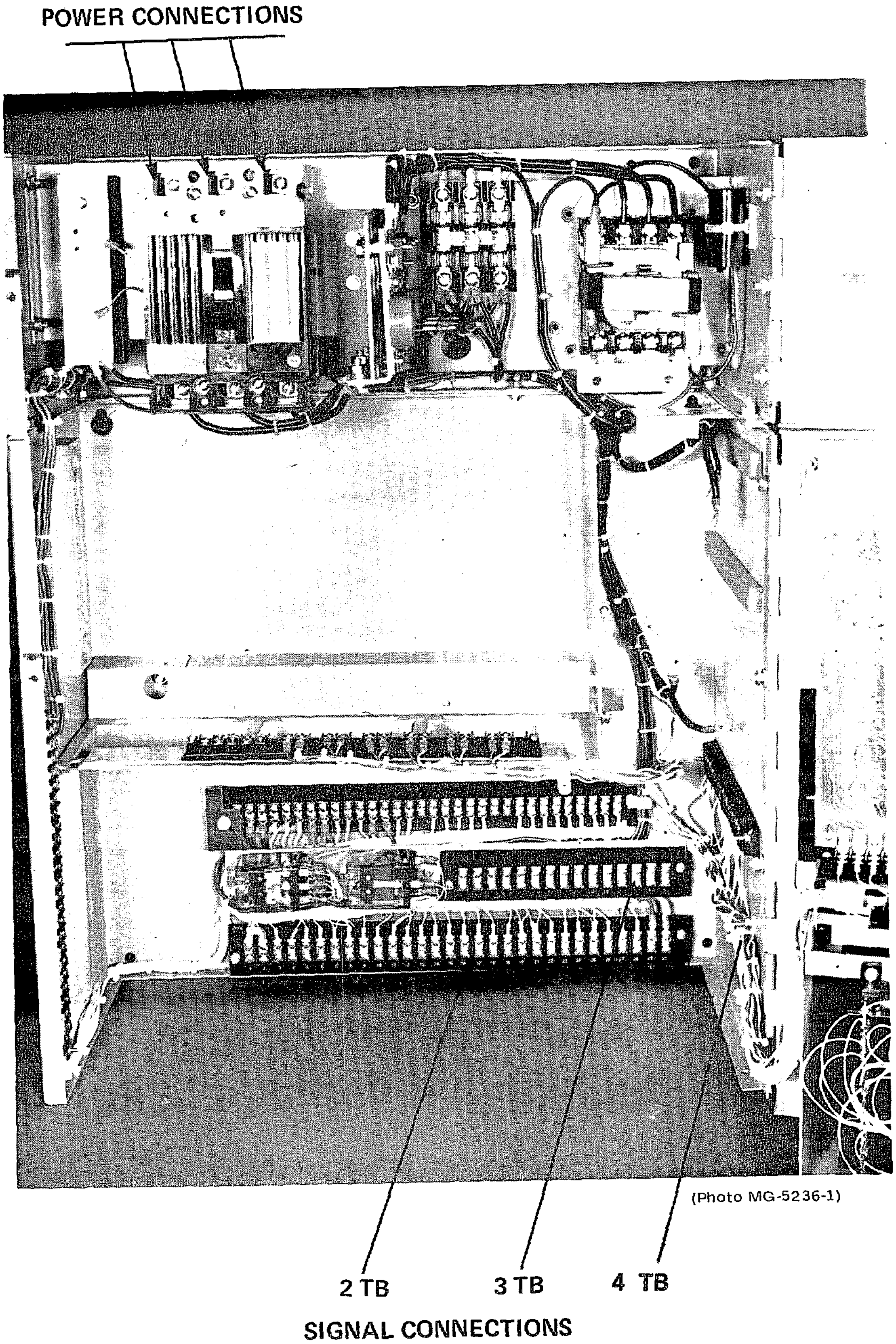


Figure 11. Signal and Power Connections

TABLE III SIGNAL CONNECTIONS

2TB NO.	NOMENCLATURE	DESCRIPTION
1	–30 V	Unregulated negative dc voltage used as the return line for the CONTROL ON function and the static switches RUN AND JOG., and possible modifications.
2	CONTROL ON	If CONTROL ON is not connected to –30V the drive will not start. If CONTROL ON is opened with the drive operating, the MA contactor will open and the drive will coast.
3, 4	FLT	A normally open, held closed relay contact. Under normal conditions this contact is closed. If a fault condition is detected, this contact opens.
5, 6, 7	MAX	A NO/NC relay contact which actuates when the MA contactor actuates.
8, 27	COM	Signal common. All signals are measured with respect to common, unless otherwise noted.
9	EST	**External** Stop input. If EST is momentarily disconnected from common, the MA contactor will open and the motor will coast. The drive may not be restarted until the reset line is momentarily connected to COMMON (2TB-12).
10, 11	FX1, X2	The internal 115V AC
12	RSET	Reset input. All fault shut downs inhibit the drive from starting until the fault has been cleared and the drive is reset. After the motor has come to a stop, the drive may be reset by momentarily connecting RSET to common. The drive will not restart until RSET is released from common. Momentarily connecting RSET to common or pushing the RESET BUTTON will initiate a coast stop shutdown.
13, 15 16, 17 18, 19 24, 25	SP1, SP2, ETC.	These are special purpose wires which are used to bring additional signals out of 2TB. Refer to the system elementary for details. Additional SP wires may be connected to 3TB and 4TB as required.
14	RUN	The drive will not start unless either RUN or JOG are connected to –30V, either at 2TB or by special purpose logic in the MDR. When RUN and JOG are released from –30V, the drive will decelerate to a stop and open the MA contactor.

TABLE III SIGNAL CONNECTIONS (Continued)

2TB NO.	NOMENCLATURE	DESCRIPTION
20, 21	±20V	Regulated power supply outputs.
22	IMET	Output to an optional 1ma load instrument. The instrument is calibrated with the IMET potentiometer on the Interface Card.
23	SMET	Output to a 1ma speed instrument. The instrument is calibrated with the SMET potentiometer on the Interface Card.
26	SMIN	Output from the MIN SPEED potentiometer on the main control card.
28	SR	Speed Reference input.
29, 30	TKP TKN	Input connections for motor mounted tachometer or machine mounted tachometer. NOTE: WITH A DC TACHOMETER, TKP IS POSITIVE FOR FORWARD DIRECTION.

5. Switch the diagnostic switch to the normal position. Run the drive from the normal reference up to top speed. Adjust MAX SPEED, if required.
6. Close and secure the front door of the panel unit.

SEQUENCE OF OPERATION

POWER APPLIED

The control transformer (CPT) is energized through its primary fuses. The fans (if supplied) will come on.

The power supply card is energized and the dc output (±20 volt) are applied through their fuses to the rest of the cards. All readings carry a tolerance of ±10%.

The motor field supply is energized. Refer to the motor field supply instructions for details. The motor field may be energized prior to closing the control circuit breaker, if the dynamic braking modification (optional) is provided. Refer to the system elementary.

If no faults have been detected by the monitor section of the interface card, the fault relay FLT will close, and the "ready-to-run" indicator on the main control card will illuminate. Table IV tabulates the fault conditions which are monitored.

The oscillator will start, and the synchronizing signals SA, SB, SC will measure 8.5 volts RMS, (±10%). See Fig. 18 and 20.

START (CONNECT RUN (OR JOG) TO –30 VOLTS

SWITCH LOGIC

RUN or JOG will be switched from +30V to –30 volts. (under external control).

The MA control line MAC from the main control card to the interface will be pulled down to –20 volts.

The interface card checks that no faults exist and that "control on" is connected to –30 volts before applying power to the coil of the MA pilot relay MAX.

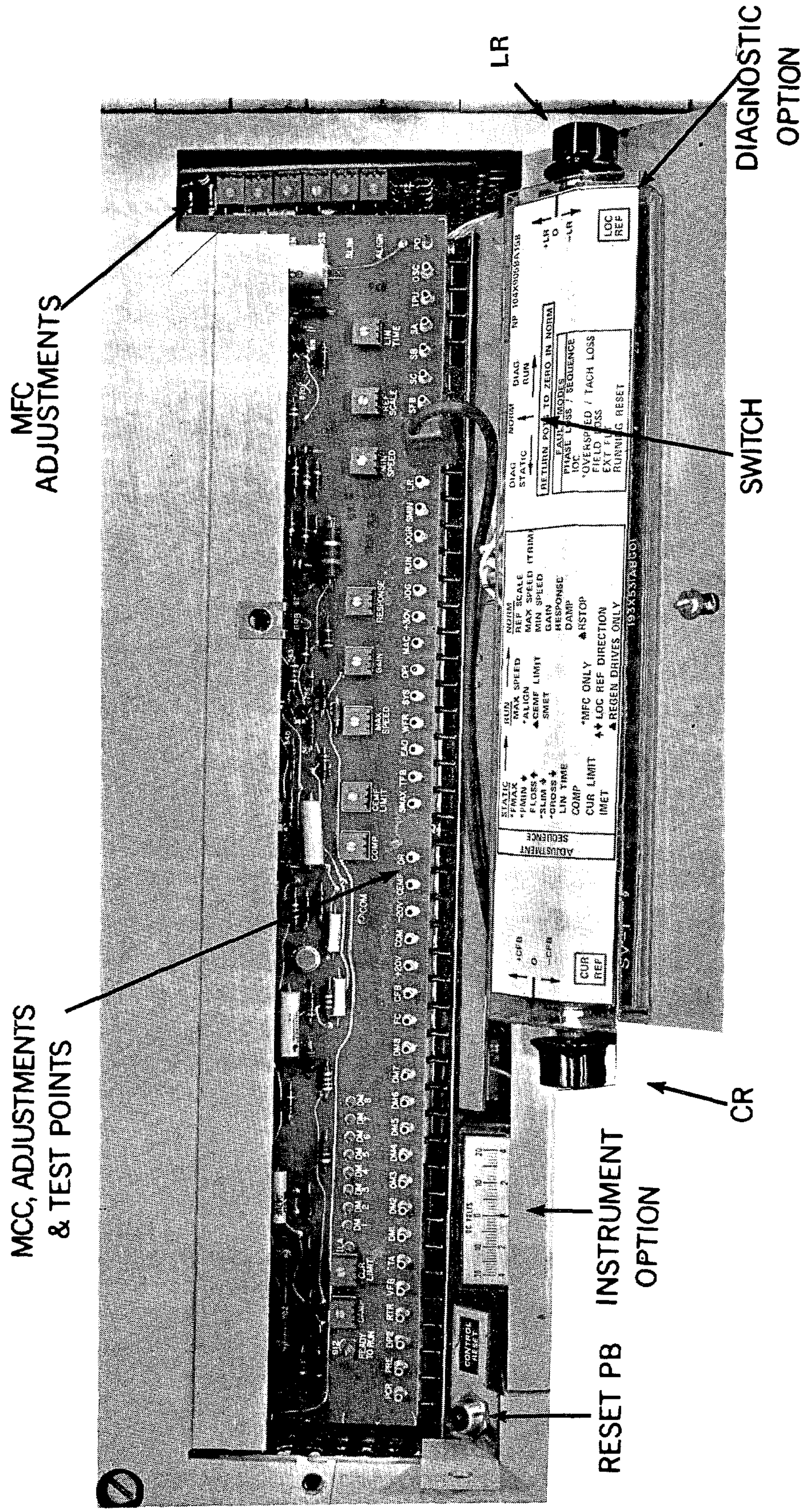
MAX picks up, releasing the preconditioning signal PRE from common and applies power to the coil of the MA contactor.

When PRE is released from common, it switches to –4 volts which will release the main control card preconditioning after approximately 80 milliseconds.

Releasing preconditioning allows the drive to send firing pulses to the gates of the SCRs in the conversion module, and allows the normal signal flow to occur.

SIGNAL FLOW

If RUN is switched, the reference at SR is applied to the linear time section. The timed reference output TR will ramp to a voltage proportional to SR. The REF SCALE adjustment is used to set TR to 10.0 volts when the input



(Photo MG-5393)

Figure 12. Diagnostic Card and Lower Portion of Main Control Card

TABLE IV FAULT CONDITIONS

A fault has occured if the fault relay contact (FLT) is open or if the READY TO RUN light is off. The conditions that can initiate a fault are as follows:

1. No three phase power to the circuit breaker (or optional fuses).
2. Circuit breaker is open, or ac power fuse blown.
3. Control fuse is open.
4. Power supply plus or minus dc fuse is open.
5. Loss of an incoming phase.
6. Incorrect phase rotation.

** 7. Instantaneous overcurrent (IOC) level exceeded.

8. Motor thermo–switch (OLD) (Usually wired in stop circuit)

* 9. Timed over current (TOC) - electronic.

** 10. Loss of motor field

11. External Fault Stop momentarily released from Common.

* 12. Other special functions to System Trip (SYS) or External Fault Stop inputs.

13. System Trip input (SYS) momentarily connected to + 10 volts.
14. RESET button depressed or RSET input momentarily connected to Common with motor rotating.
15. RESET button held depressed or RSET input held connected to Common.
16. Diagnostic mode selected with the motor rotating.
17. Oscillator failed "on".

* 18. Tachometer fault (loss of tachometer signal)

** 19. Overspeed

* May not be provided. Refer to instructions on Motor Field Supply and System elementary diagram.

** Can be caused by LOC REF and CUR REF settings in Static Diagnostic mode

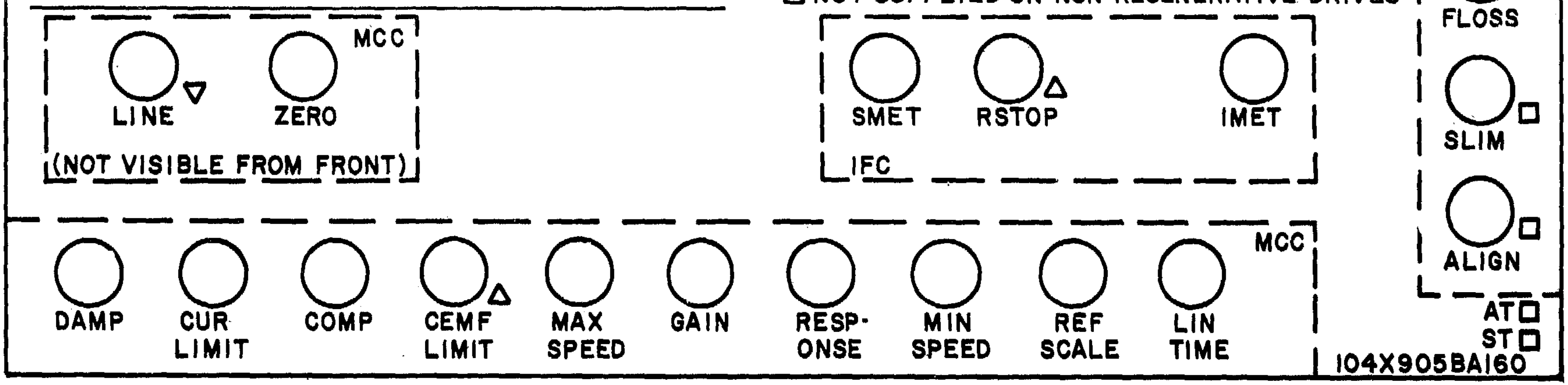
After the fault condition has been cleared and the motor has come to standstill, the drive can be RESET by any of the following three methods:

1. Momentarily remove and then reapply the three phase power.

2. Push the RESET button

3. Momentarily connect RSET to common.

If all fault conditions have been cleared but the drive fails to RESET, the RSTOP adjustment may be set too low.



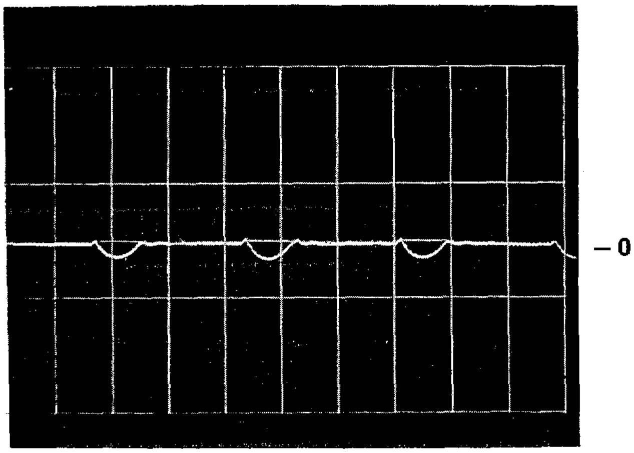
		TEST DATA (ALL DATA ±5%, EXCEPT WHERE NOTED)	ADJUSTMENT
VFB	:	−______ VOLTS AT +______ MOTOR VOLTS	NONE
CEMF	:	−______ VOLTS AT +______ NO LOAD MOTOR VOLTS	NONE
MAX FIELD	:	______ AMPS, FC = ______ VOLTS (DIAG STATIC)	FMAX
MIN FIELD	:	______ AMPS, FC = ______ VOLTS (DIAG STATIC)	FMIN
FIELD LOSS	:	______ AMPS, FC = ______ VOLTS (DIAG STATIC)	FLOSS
OVERSPEED	:	______ %, SFB = ______ VOLTS (DIAG STATIC)	SLIM
CROSSOVER	:	CEMF = −______ VOLTS (NORMAL) OR LR = −______ VOLTS (DIAG STATIC)	CROSS
IR COMP	:	CFB = 5 VOLTS AT CEMF = ______ VOLTS (DIAG STATIC)	COMP
CURRENT LIMIT	:	______ AMPS ± 10%, CFB = ______ VOLTS	CUR LIMIT
LINEAR TIME	:	______ SECONDS, ZERO TO 10 VOLTS AT TR (DIAG STATIC)	LIN TIME
CFB	:	−______ VOLTS AT ______ MOTOR AMPS ±10%	NONE
SFB (BASE)	:	+______ VOLTS AT 5 VOLTS CEMF (DIAG RUN)	MAX SPEED
CEMF AT LIMIT	:	−______ VOLTS AT +______ MOTOR VOLTS (NO LOAD) (±3%) (DIAG RUN)	CEMF LIMIT △
SFB (TOP)	:	+10 VOLTS AT ______ TOP SPEED RPM	MAX SPEED
TR	:	−10 VOLTS AT ______ VOLTS MAXIMUM REF. AT SR	REF SCALE
IOC TRIP	:	______ %, CFB = −______ VOLTS (DIAG STATIC) ±10%	SELECT

□ NOT SUPPLIED ON DRIVES WITH A MFE CARD
▽ ONLY ON FULL WAVE REGENERATIVE DRIVE
△ NOT SUPPLIED ON NON REGENERATIVE DRIVES

Figure 13. Test Data Sheet

WAVEFORMS

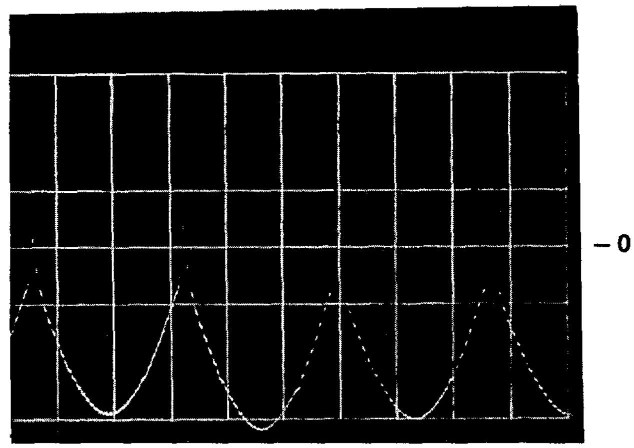
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



2 msec / div

At low current level 1 volt / division

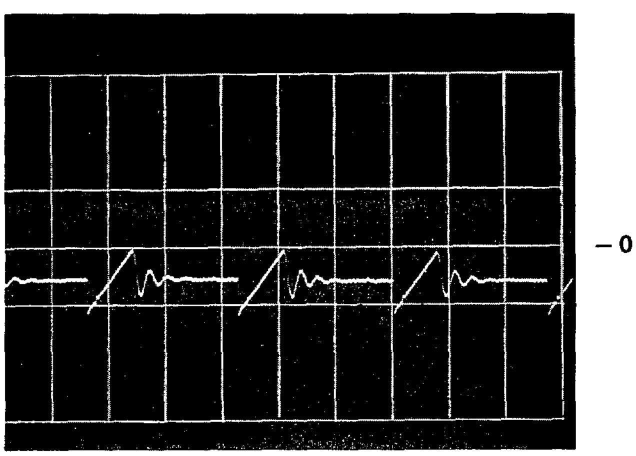
Figure 14. Current Feedback (CFB)



2 msec / div

At Continuous current 1 volt / division

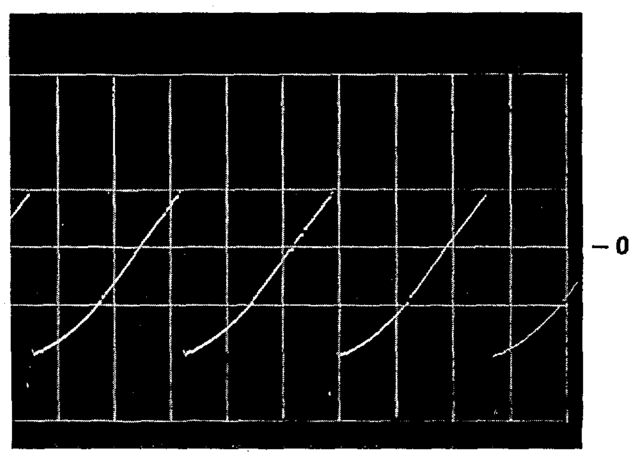
Figure 15. Current Feedback (CFB)



2 msec / div

At low current and 100 volts,5 volts / division

Figure 16. Voltage Feedback (VFB)



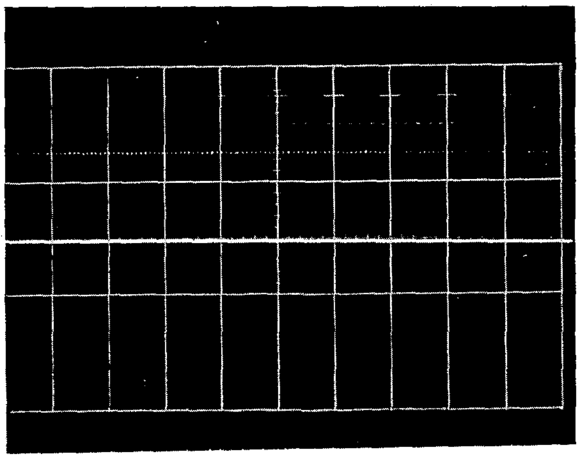
2 msec / div

At Continuous current and 100 volts,5 volts / division

Figure 17. Voltage Feedback (VFB)

WAVEFORMS

All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.

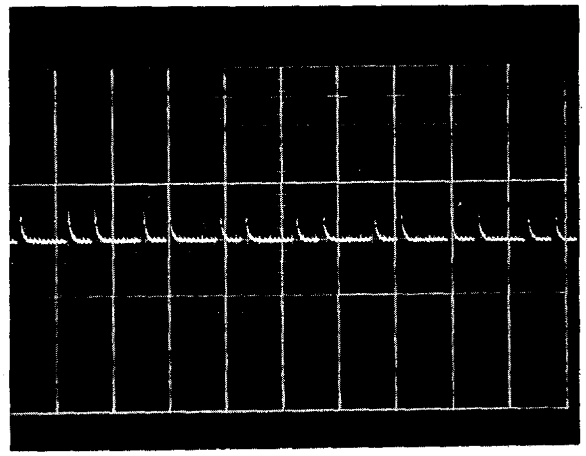


– 0

2 msec / div

10 volts / division

Figure 18. Oscillator (OSC)

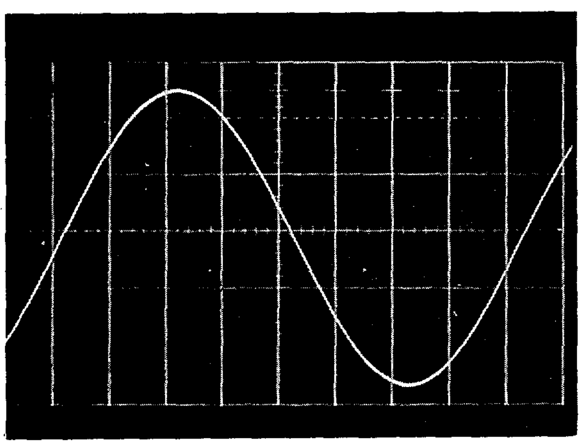


– 0

2 msec / div

2 volts / division

Figure 19. Initial Pulse (IPU)

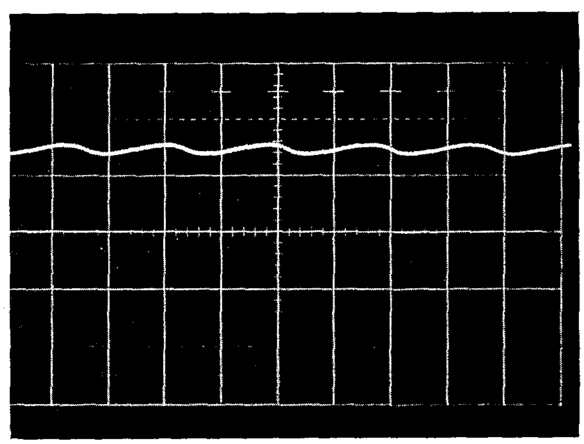


2 msec / div

Typical of SA, SB & SC
SB lags SA by 120^{o}
SC lags SB by 120^{o}

5 volts / division

Figure 20. Synchronizing Signal (SA)



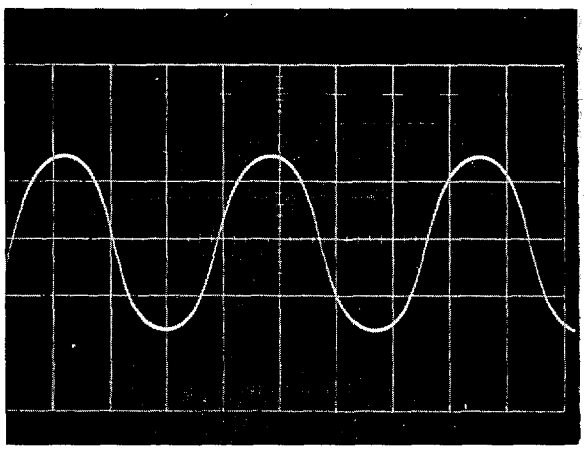
2 msec / div

With an AC tachometer at 450 RPM
1 volt / division

Figure 21. Speed Feedback (SFB)

WAVEFORMS

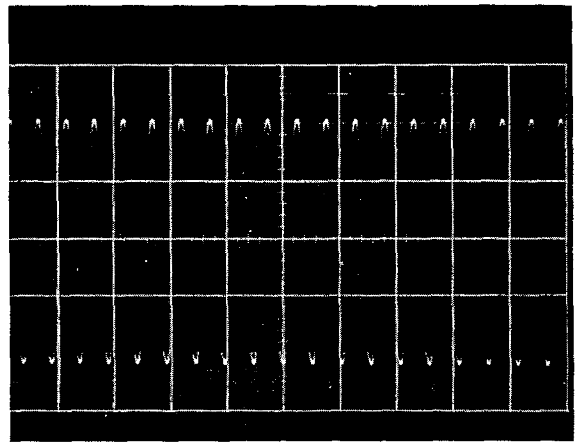
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



2 msec / div

With an AC Tachometer at 450 RPM
1 volt / division

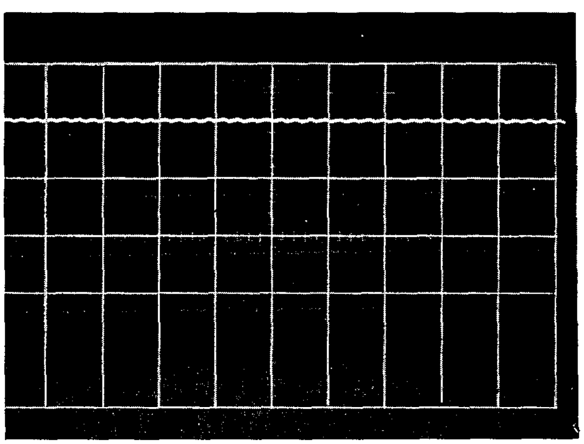
Figure 22. Tachometer Feedback (TFB)



2 msec / div

With an AC Tachometer at 3160 RPM
5 volts / division

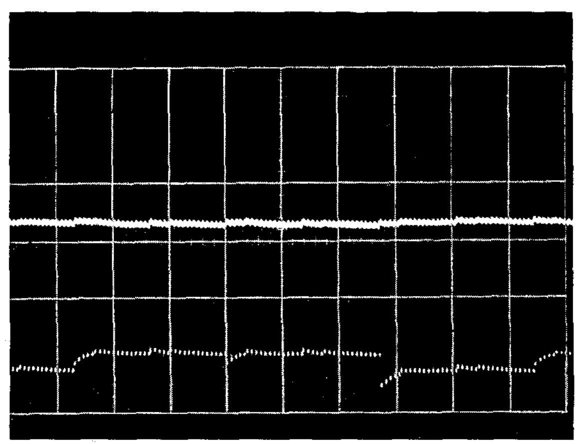
Figure 23. Tachometer Feedback (TFB)



2 msec / div

With an AC Tachometer at 3160 RPM
5 volts / division

Figure 24. Speed Feedback (SFB)



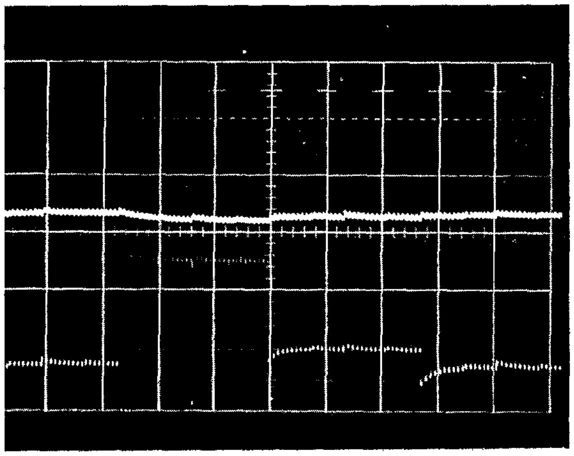
2 msec / div

Normal
1 volt / division

Figure 25. Pulse Output (PO)

WAVEFORMS

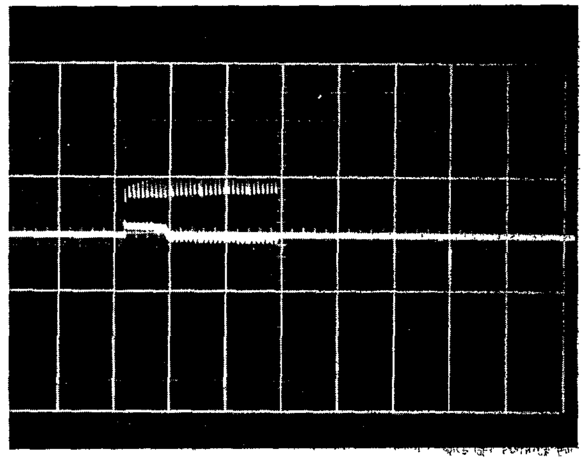
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



2 msec / div

With one SCR gate lead open
1 volt / division

Figure 26. Pulse Output (PO)



2 msec / div

Gate to Cathode Firing Signal 1G-1C
Typical of all six Signals
1 volt / division

Figure 27. Gate to Cathode Firing Signal

at SR is set for top speed. The time for TR to ramp from 0 to 10 volts is adjustable from .3 to 60 seconds with the LIN TIME adjustment. See jumper table on system elementary. (Ranges: .3 to 7 sec. or 2 to 60 sec).

The speed (or CEMF) feedback from the motor tachometer is scaled with a selectable resistor network on the interface card, and rectified (if required) on the main control card. The output of the speed feedback section is SFB, and will be 10 volts at top speed. MAX SPEED is adjusted to make the actual top speed correspond to desired top speed. See figures 21 and 24.

The timed reference TR, the JOG reference JOGR, and the speed feedback SFB are summed by the regulator error amplifier. The error amplifier output EAO will be a low voltage (nearly zero) when the drive is regulating speed. EAO will not be low when the drive is in current limit or CEMF limit. The gain of the error amplifier is set with the GAIN adjustment. The GAIN adjustment is used primarily to improve the response of the drive in the constant horsepower region when the motor field supply is a motor field control MFC.

To maintain good load regulation, the error amplifier is fed into the regulator integrator. The output of the integrator is the reference, DR, to the driver. The response of the control below base speed is set with the RESPONSE adjustment.

There is a limit however, to how responsive a drive may be set. Stability of the drive is decreased as its response is increased. If motor field supply is the motor field control (MFC), the RESPONSE adjustment is desensitized when the drive is operating in the constant horsepower region of the torque speed curve.

To protect the system, two limit sections are provided, counter-EMF or CEMF limit and current limit. The outputs of these limit sections also drive the regulator integrator and will override the error amplifier if required. The current limit is set with the CUR LIMIT adjustment and the counter EMF limit is set with the CEMF LIMIT adjustment. Typically current limit is set at 150% of the motor nameplate current or 3.75 volts (±10%) of current feedback, CFB; the counter EMF is normally limited to 250 armature volts at no load, or 5.75 volts (±10%) of CEMF.

The counter-EMF signal CEMF is developed on the main control card by subtracting a signal proportional to the IR drop of the motor from voltage feedback. This is set with the COMP adjustment.

The driver reference DR, the voltage feedback, VFB, and the damping adjustment DAMP are summed at the input to the driver. The driver converts this error to pulse trains which drive the SCR gates in such a manner as to maintain the motor voltage proportional to the driver reference. The damping adjustment DAMP controls the response of the driver. Generally speaking, DAMP is used only to quiet small oscillations which occur in the current under light load conditions. Too much damping will slow down the system response and tend to cause over shoot.

The driver provides a signal IPU to the oscillator on the interface card to generate an initial pulse at the exact point in time that an SCR is to be fired. See Fig. 19.

Two driver monitor points are available, PCR and PO. PCR is the phase control reference which causes the output pulse trains to phase shift in time with respect to the ac line. As PCR moves from zero to + 6 volts (±10%), the output pulses will shift from full off to full on. PO is used to monitor the pulse outputs to the SCR's. See Fig. 25 and 26.

STOP

There are two stop sequences, normal stop and fault stop. With a normal stop the drive regenerates to near zero speed before opening the MA contactor. A fault stop opens the contactor and drive coasts to a stop.

Normal stop (disconnect RUN from −30 volts).

RUN will switch from −30 volts to +30 volts. MAC will switch to zero volts and the system reference input to the linear time section will be shunted to common.

The timed reference TR will begin to time down to zero and the drive speed will come down accordingly.

The regenerative stop circuit on the interface card will hold the contactor closed until the CEMF signal is almost zero, corresponding to zero speed. At this time, the preconditioning signal PRE goes to common, removing power from the MAX coil. 100 milliseconds later, MAX drops out removing power from MA, which then drops out. The CEMF level corresponding to zero speed is set by the RSTOP adjustment. If RSTOP is set too far (CW) power is removed prematurely and the drive will coast into zero speed. If RSTOP is set too far (CCW) the contactor will not open at all.

In some cases the regenerative stop circuit, (described above) may be under the control of the speed feedback signal, SFB, rather than the CEMF signal.

FAULT STOP - Fault detected (See Table IV) or CONTROL ON is open.

The preconditioning signal PRE is immediately applied to the main control card, forcing the drive into zero current or coast conditions. As soon as the current goes to zero, preconditioning is established throughout the card.

The MA contactor unconditionally drops out 100 milliseconds after the fault condition occurs.

The drive can not be restarted until the motor has come to rest. If the STOP was initiated by a fault, this is taken care of automatically, but it is the purchaser's responsibility to not reclose "CONTROL ON" before the motor has come to rest. After the motor has stopped, push the RESET button.

DIAGNOSTIC STATIC (SWITCH TO LEFT)

LOGIC

The RUN and JOG inputs are inhibited. This prevents the references SR and JOGR from activating the drive and holds the MA contactor open.

The current reference potentiometer CUR REF controls the current feedback signal CFB.

The local reference LOC REF potentiometer is connected into the input of the linear time section and into the speed feedback section. The local reference is also connected to the field diagnostic reference FDR. Refer to motor field control instructions (GEK-24971) for details of operation.

To simplify signal tracing, the gain of the regulator and drive is reduced and the speed feedback signal to the regulator error amplifier is removed.

SIGNAL FLOW

The local reference LR is applied directly to the input of the linear time section, by-passing the REF SCALE adjustment. The timed output TR will ramp to a voltage equal to LR in magnitude and polarity in a time determined by the setting of LIN TIME.

The local reference LR is also applied to the input of the last stage of the speed feedback section. The output SFB will be equal to LR in magnitude, but opposite in polarity. The tachometer scaling circuit and its output TFB are unaffected by the local reference and will remain at zero. As the signal from SFB into the regulator error amplifier is inhibited the primary purpose of exercising SFB is to check those special function circuits in the modification rack which are programmed from SFB, and/or SFB functions of a MFC.

A dummy feedback signal to replace the normal SFB signal is connected from the output of the regulator integrator output DR to the input of the regulator error amplifier. Under these conditions DR is equal to the magnitude of TR but opposite in polarity as long as the current reference is below the current limit setting. As the current reference is raised, the current feedback signal CFB will exceed the current limit level set by CUR LIM and force the DR output into negative saturation for forward current limit and positive saturation for reverse current limit. See Fig. 14 and 15.

Current feedback will also program the CEMF output to a level proportional to the CFB level and the COMP adjustment.

The load instrument output IMET will also respond to the current reference.

The gain of the drive is reduced so that the phase control reference PCR is equal to the magnitude of the driver reference DR as long as the current reference is set to zero. The logic which determines SCR's are to be triggered will latch PCR slightly negative if a reverse current reference exists when the speed reference is turned to forward and when a forward current reference exists when the speed reference is turned to reverse.

With an osciloscope, the initial pulse output IPU, and the pulse output PO may be monitored to verify proper operation. See Fig. 19 and 25 and 26.

DIAGNOSTIC RUN (SWITCH RIGHT)

In diagnostic run, the local reference LR and the diagnostic switch are substituted for the reference(s) SR, JOGR and the RUN and JOG switch inputs just as in diagnostic static. The drive then runs normally with one important exception: system feedback is normal but the signal from system feedback to the regulator error amplifier is inhibited and the dummy feedback from DR is still in place.

The net effect is the drive operates as a base speed voltage regulator from the LOC REF potentiometer.

CALIBRATION PROCEDURE

The diagnostic card is used to generate the appropriate test signals and operating modes to calibrate the drive. If a diagnostic card has not been furnished, one may be ordered or the test circuit shown in Figure 28 may be used.

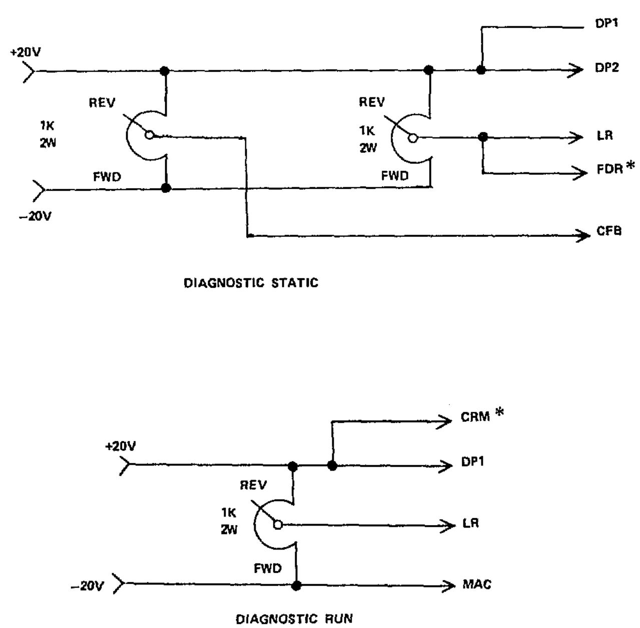


Figure 28. Diagnostic Test Circuits

Make all connections prior to applying input power. To exit from the DIAGNOSTIC RUN mode, push the RESET button to initiate a fault shutdown, then remove input power.

*All connections may be made to the test posts on the front of the main control card except for CRM and FDR which are located on the RTB terminal board.

To avoid confusion and possible interaction, the adjustments should be made in the following sequence. Two sequences are listed, one when a motor field exciter MFE is provided, and one when a motor field control MFC is provided. Refer to the system elementary to determine which has been furnished.

TABLE II

Recalibrating Adjustment Sequences

	WITH MOTOR FIELD CONTROL	WITH MOTOR FIELD EXCITER
DIAGNOSTIC STATIC MODE, ADJUST	FMAX FMIN FLOSS SLIM CROSS LIN TIME COMP CUR LIMIT IMET (IF USED)	FLOSS LIN TIME COMP CUR LIMIT IMET (IF USED)
DIAGNOSTIC RUN MODE, ADJUST	CEMF LIMIT MAX SPEED ALIGN SMET (IF USED)	MAX SPEED CEMF LIMIT SMET (IF USED)
NORMAL MODE, ADJUST	REF SCALE MAX SPEED (TRIM) MIN SPEED (IF USED) GAIN RESPONSE DAMP RSTOP	REF SCALE MAX SPEED (TRIM MIN SPEED (IF USED) GAIN RESPONSE DAMP RSTOP

All of the high voltage inputs to the controller have been scaled down with the scale factors shown on the test data sheet.

For example: Voltage feedback VFB will be 5 volts when the armature voltage is 216 volts. If VFB is 3.2 volts, then the armature voltage is 3.2 X 216/5 = 138 volts. If armature voltage is 67 volts, VFB will be 67 X 5/216 = 1.55 volts. All values have a tolerance of ±10%.

CALIBRATION WITH MOTOR FIELD CONTROL (MFC)

All readings can have a tolerance of ±10%.

Select Diagnostic static and set the CUR REF and LOC REF to the center positions.

FMAX (maximum field)

Set the LOC REF potentiometer for –1 volt at LR. Adjust FMAX until FC corresponds to the maximum field FC on the test data sheet.

FMIN (minimum field – limit)

Set LOC REF potentiometer for – 7volts at LR. Adjust FMIN until FC corresponds to minimum field FC on the test data sheet.

FLOSS (field loss – fault)

Set the LOC REF to center position and reset the drive. Adjust FLOSS full CCW.

Monitor FC and move the LOC REF potentiometer (+LR) until FC corresponds to the field loss value on the test data sheet. Slowly rotate FLOSS CW until the "Ready to Run" light turns off indicating a drive fault.. Reset the drive.

SLIM (Speed limit – overspeed fault)

Set the LOC REF to center position and reset the drive. Adjust SLIM full CW.

Monitor SFB and move the LOC REF potentiometer (–LR) until SFB corresponds to the overspeed limit on the test data sheet. Slowly adjust SLIM CCW until the "Ready to Run" light turns off indicating a drive fault.

CROSS (cross over – field)

Set CROSS full CCW. Turn the LOC REF potentio– meter (–LR) until LR corresponds to the cross over LR on the test data sheet.

Monitor FC and adjust CROSS CW until FC just starts to increase. CROSS may be checked when the drive is running in normal operation by verifying that CEMF reads the value on the test data sheet with the drive operating above based speed.

LIN TIME (linear time)

Monitor TR and set –10 volts with the LOC REF potentiometer. Flip the diagnostic switch to NORMAL, then back to STATIC and measure the time for TR to ramp from 0 to –10 volts. Adjust LIN TIME to correspond to test data sheet linear time.

COMP (compensation – IR)

Set the LOC REF potentiometer to center position. Adjust the CUR REF potentiometer (–) or (+) until CFB is at 5 volts (± 10%).

Monitor CEMF and adjust COMP until CEMF equals the value on the test data sheet.

CUR LIMIT (current limit)

Set CUR LIMIT full CW. Adjust the CUR REF potentiometer until CFB corresponds to the current limit level on the test data sheet. Monitor DR and turn CUR LIMIT CCW until DR just moves away from zero.

IMET (load instrument calibration)

Adjust the CUR REF until CFB corresponds to full load current. Verify that the optional load instrument reads full load. If not, remove power; adjust IMET and repeat.

Set the LOC REF to the center position; reset the drive and switch to Diagnostic Run.

CEMF LIMIT (counter emf limit)

Turn CEMF LIMIT full CCW and turn the LOC REF potentiometer full (–LR). Adjust CEMF LIMIT until CEMF corresponds to the CEMF LIMIT on the test data sheet.

MAX SPEED/ALIGN (max speed/tachometer loss align-fault).

Turn MAX SPEED full CW. Turn ALIGN full CW. Adjust the LOC REF potentiometer until CEMF reads 5 volts (±10%). Adjust MAX SPEED until SFB corresponds to the base speed feedback on the test data sheet.

Monitor TA and slowly adjust ALIGN CCW until TA is approximately zero volts.

SMET (Speed instrument calibration)

Turn the LOC REF potentiometer until SFB is 3 volts (±10%). The optional speed indicator should indicate 30% top speed. If it does not, push the RESET button to initiate a shut down. Remove power, adjust SMET and repeat.

Return the Diagnostic switch to Normal.

REF SCALE/MAX SPEED (reference scale/max speed)

Turn REF SCALE full CCW. Start the drive and apply top speed reference to SR. Adjust the REF SCALE potentiometer until SFB is 10 volts (±10%). This normalizes the timed reference TR and speed feedback, SFB for 10 volts (±10%) at top speed.

Now measure motor RPM and adjust MAX SPEED (if necessary) until the actual RPM corresponds to the desired top speed. If actual top RPM was off by more than 5% reset ALIGN as detailed above.

RSTOP (Regenerative stop)

With the motor operating at some RPM, call for a drive stop by initiating the proper magnetics which will release 2TB-14 from −30 volts. The motor will decelerate to a low speed and the MA contactor will open. If the MA contactor opens before the drive comes down to a stop, RSTOP is set too high. If the MA contactor fails to open, RSTOP is set too low. Push the RESET button to drop out MA prior to removing power. RSTOP should be readjusted with power removed. Turn RSTOP CW to drop out MA at a higher speed.

MIN SPEED (minimum speed)

Reduce the system reference to minimum and start the drive. Adjust MIN SPEED, as required, to meet system minimum speed requirements. Refer to system elementary for circuit details.

GAIN RESPONSE DAMP AND COMP (Stability adjustments)

1. **Set DAMP potentiometer at minimum 7 o'clock position.**
2. **Place the Diagnostic switch in the static mode. Adjust CUR REF for 2.5 volts at CFB. This is equivalent to rated armature current.**
3. **Set COMP potentiometer by reading at CEMF a value equal to 0.0312 (240V–motor counter EMF).**

   Typical values of motor counter EMF.

MOTOR HORSEPOWER	MOTOR COUNTER EMF
5 to 15	215
20 to 40	225
50 to 125	230

   The reading at CEMF is a voltage proportional to **240V**-counter EMF.

   Example: 20 to 40 HP

   CEMF = 0.0312 (240 - 225)
   = 0.468 volts

   The COMP potentiometer is now set for proper operation. Regardless of overload range, IOC setting or motor field range this setting is correct and should not be changed.

4. Set the GAIN adjustment by calculating the GAIN number and referring to the chart. (Fig. 28A)

   $$\text{Gain No} = \frac{\text{Maximum Operating Speed}}{\text{Motor Base Speed}}$$

   See motor nameplate under - Speed

   Motor Base Speed/Maximum Operating Speed

   Example: 1150/3600 RPM

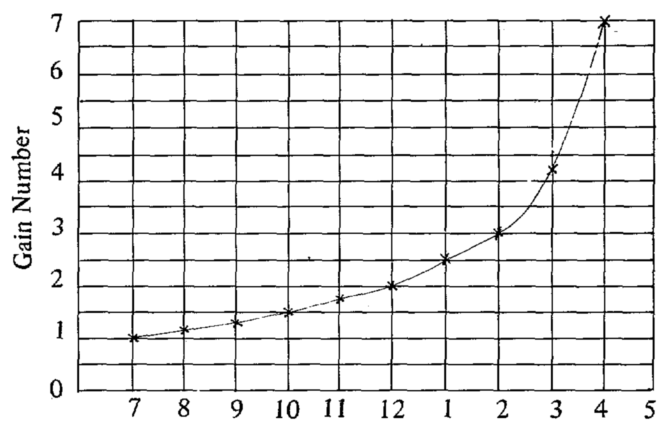
5. Set LIN TIME potentiometer at minimum (7 o'clock)
6. Set RESPONSE potentiometer at minimum (7 o'clock)

   When the drive is functioning properly in all other respects make small incremental step increases and decreases in speed below base speed. Observe armature current for bumping repeatedly before steady state speed is attained.

   Increase the RESPONSE setting (move CW) until bumpy setting current is observed. Then reduce the RESPONSE setting until no bumps (or only one) is observed. This is the maximum RESPONSE setting.

   In general, settings below 10 o'clock will show signs of increasing sluggishness. Settings greater than 2 o'clock may show signs of hard or even continuous bumping. Full RESPONSE setting (5 o'clock) will usually trip the IOC

7. RESET LIN TIME to required setting.



After this setting has been made, make no further adjustments to the Gain Pot.

Figure 28A. Gain Adjustment

CALIBRATION WITH MOTOR FIELD EXCITER (MFE)

Refer to motor field exciter instructions GEK-24972 for details of operation.

Select Diagnostic Static and set CUR REF and LOC REF to the center positions.

FLOSS (field loss - fault)

Adjust FLOSS full CCW and reset

Monitor FC and move the LOC REF (+LR) until FC corresponds to the field loss value on the test data sheet. Slowly adjust FLOSS CW until the "Ready to Run" light turns off indicating a drive fault. Reset the drive.

COMP (compensation - IR)

Adjust the LOC REF potentiometer to the center position. Adjust the CUR REF potentiometer (–) or (+) until CFB is at 5 volts (± 10%).

Monitor CEMF and adjust COMP until CEMF equals the value on the test data sheet.

CUR LIMIT (current limit)

Adjust CUR LIMIT full CW. Turn the CUR REF potentiometer until CFB corresponds to the current limit value on the test data sheet.

Monitor DR and turn CUR LIMIT CCW until DR just moves away from zero.

IMET (load instrument calibration)

Turn the CUR REF until CFB corresponds to full load current. Verify that the optional load instrument reads full load. If not, remove power, adjust IMET and repeat.

LIN TIME (linear time)

Monitor TR and set –10 volts with the LOC REF potentiometer. Flip the diagnostic switch to NORMAL, then back to STATIC and measure the time for TR to ramp from 0 to –10 volts. Adjust LIN TIME to correspond to test data sheet linear time.

Set the LOC REF to the center position and switch to Diagnostic Run.

MAX SPEED (maximum speed)

Adjust the LOC REF until the motor is running at actual top speed. Adjust MAX SPEED Until SFB is 10 volts (±10%).

CEMF LIMIT (counter emf limit)

Turn CEMF LIMIT full CCW and turn the LOC REF full Fwd. Adjust CEMF LIMIT until CEMF corresponds to the CEMF LIMIT on the test data sheet.

SMET (speed instrument calibration)

Turn the LOC REF potentiometer until SFB is 3 volts (±10%). The optional speed indicator should indicate 30% top speed. If it does not, push the RESET button to initiate a shut down. Remove power, adjust SMET and repeat.

Return the Diagnostic switch to Normal.

REF SCALE (reference scale)

Turn REF SCALE full CCW. Start the drive and apply top speed reference to SR. Adjust the REF SCALE potentiometer until SFB is 10 volts (±10%). This normalizes the timed reference TR and speed feedback, SFB for 10 volts (±10%) at top speed.

MIN SPEED (minimum speed)

Reduce the system reference to minimum and start the drive. Adjust MIN SPEED as required to meet system minimum speed requirements. Refer to system elementary diagram for circuit details.

RSTOP (regenerative stop)

With the motor operating at some RPM, call for a drive stop by initiating the proper magnetics which will release 2TB-14 from –30 volts. The motor will decelerate to zero speed and the MA contactor will open. If the MA opens before the drive comes down to a stop, RSTOP is set too high. If the MA fails to open, RSTOP is set too low. Push the RESET button to drop out MA prior to removing power. RSTOP should be adjusted with power removed.

GAIN, RESPONSE, DAMP and COMP (Stability adjustments)

1. **Set DAMP potentiometer at minimum 7 o'clock position.**
2. **Place the Diagnostic switch in the static mode. Adjust CUR REF for 2.5 volts at CFB. This is equivalent to rated armature current.**
3. **Set COMP potentiometer by reading at CEMF a value equal to 0.0312 (240V–motor counter EMF).**

Typical values of motor counter EMF.

MOTOR HORSEPOWER	MOTOR COUNTER EMF
5 to 15	215
20 to 40	225
50 to 125	230

The reading at CEMF test pin is a voltage porportional to 240V-counter EMF.

Example: 20 to 40 HP

CEMF = 0.0312 (240 - 225)
= 0.468 volts

The COMP potentiometer is now set for proper operation. Regardless of overload range or IOC setting this is correct and should not be changed.

4. Set the GAIN adjustment to minimum 7 o'clock position.
5. Set LIN TIME potentiometer at minimum 7 o'clock position.
6. Set RESPONSE potentiometer at minimum 7 o'clock position.

   When the drive is functioning properly in all other respects make small incremental step increases in speed. Observe armature current for bumping repeatedly before steady state speed is attained.

   Increase the RESPONSE setting (move CW) until bumpy current is observed. Then reduce the RESPONSE setting until no bumps (or only one) is observed. This is the maximum RESPONSE setting.

   In general, setting below 10 o'clock will show signs of increasing sluggishness. Settings greater than 2 o'clock may show signs of hard or even continuous bumping. Full RESPONSE setting (5 o'clock) will usually trip the IOC.
7. Reset LIN TIME to required setting.

TROUBLE SHOOTING

Although many of the problems which may arise can be effectively located with a multi-meter, an oscilloscope is a very powerful trouble shooting tool. The only requirements are that the selected scope have a dc input capability and a line synchronization mode. Caution should be exercised in measuring any point with a possible high potential with any instrument; however, particular care should be taken with an oscilloscope since the common clip is normally connected directly to the instrument case. If the grounded plug has not been defeated it will cause a short circuit between the high potential point under test and ground.

RECOMMENDED INSTRUMENTATION

Simpson Multi-meter (or equivalent). 10,000 ohms/volt (or higher)

Hewlett-Packard or Tektronix (or equivalent). Dual Trace oscilloscope rated for operation from dc to 10 MHZ at 0.01V/CM with deflection factors to provide 0.01 V/cm to 1300V peak to peak deflection when used with appropriate attentuator probes.

PROCEDURES

In trouble shooting this drive system the most appropriate place to start is to follow the SEQUENCE OF OPERATION (previously described) until a discrepancy or fault is noted. This step by step procedure will determine which part, sub assembly or printed circuit card is causing the problem

Included in this procedure is the use of the built-in Diagnostic Card (DGC) (or Test Circuit Fig. 28). This is another powerful tool for quickly locating drive system faults.

If the malfunction is a performance problem, then the quickest way to discover the problem is to follow the CALIBRATION PROCEDURE (previously described). There are two calibration procedures (1) With Motor Field Control (MFC) and (2) With Motor Field Exciter (MFE).

Detailed descriptions of these two cards are found in GEK–24971 for the MFC card and GEK–24972 in for the MFE card

HOW TO TEST AN SCR

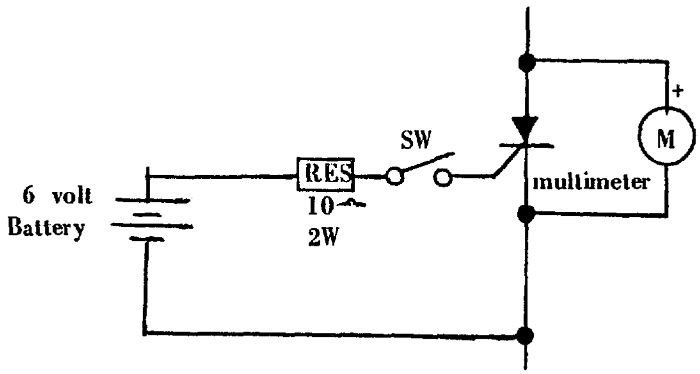
WARNING

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.

1. Disconnect the ac power and make sure the loop contactor (MA) is open.
2. Using a multi-meter selected to read ohms on the time 1K scale, check the forward and reverse resistance of each individual SCR cell. This is done by reading across power terminals T1 and DA1, T2 and DA1, T3 and DA1. See conversion unit 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

3. 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 it is desired to check the switching operation of an SCR, the following circuit should be used:



The multimeter 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 (multi-meter battery) source is momentarily removed. A faulty SCR will not switch remaining in either an open or a conducting state.

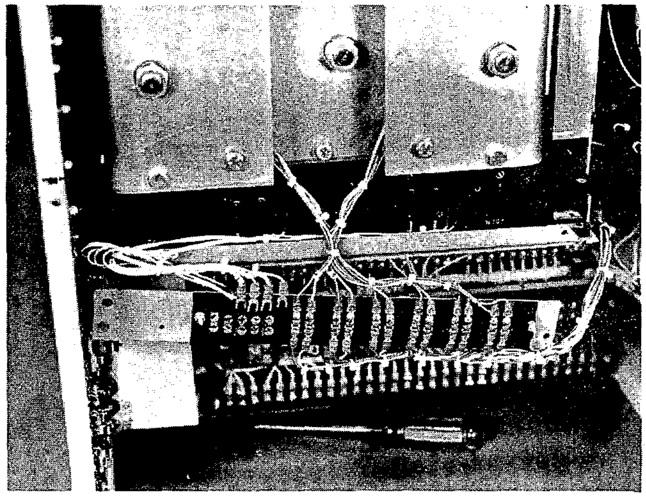
4. If any SCR's are suspected of being faulty from the above resistance checks, the SCR conversion module should be removed from the case. After the SCR cathode and gate leads have been disconnected, re-check the forward and reverse resistances before replacing the SCR heat sink assembly. This should 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.

REMOVAL/REPAIR

CONVERSION MODULE

The conversion module is best removed as follows:

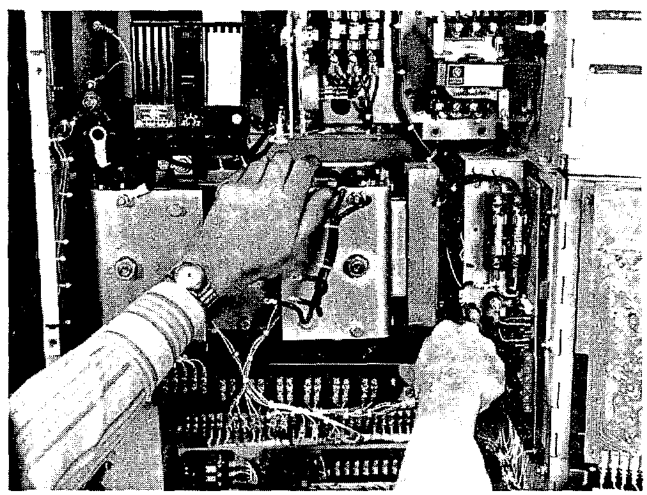
Disconnect the three ac input power and dc output leads as shown.



(Photo MG-5236-7)

Figure 29. Removal of Gate Leads

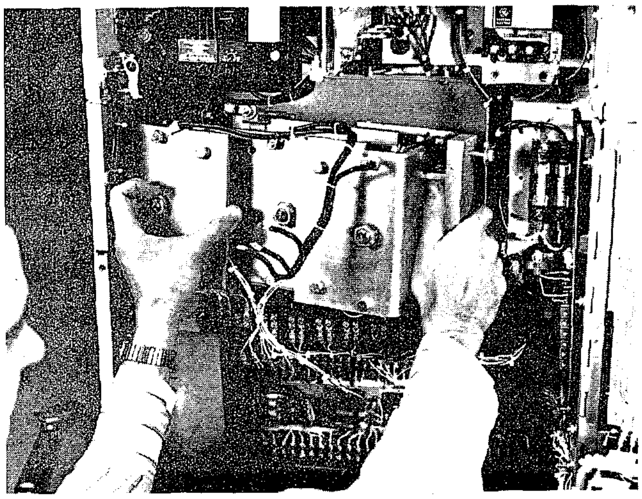
Disconnect the SCR gate leads from the terminal board MTB. If markings are not legible, remark prior to removal.



(Photo MG-5236-10)

Figure 30. Removal of Slotted Spacer

Loosen two nuts on the right hand side and remove the slotted spacer.



(Photo MG-5236-22)

Figure 31. Removal of Conversion Module

Slide module to the right and pull out.

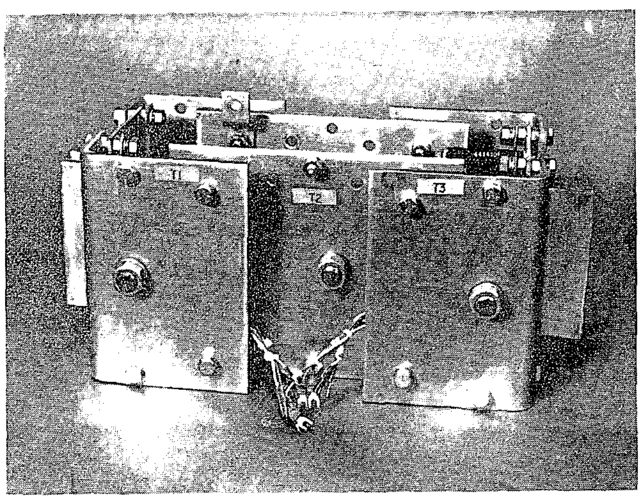
SCR REPLACEMENT

The joint between the SCR and the heat sink performs two functions: (1) it carries the current and (2) it conducts the heat out of the SCR. To perform these functions properly, special care must be taken when reassembling an SCR to the heat sink as follows:

STUD MOUNT SCR'S

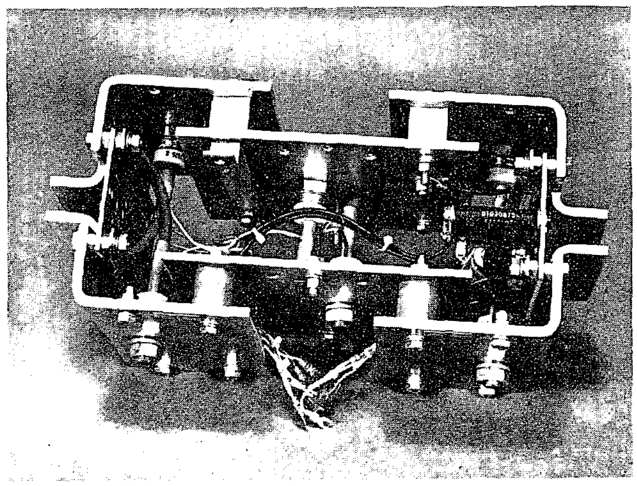
Clean all surfaces of old lubricant and stray dust. Apply a thin film of General Electric G322L VERSILUBE™ and tighten with a torque wrench to the following specifications:

STUD SIZE	TORQUE
1/4 - 28	30 inch lbs.
1/2 - 20	135 inch lbs.



(Photo MG-5236-26)

Figure 32. Stud Mount Heat Sink (Front View)



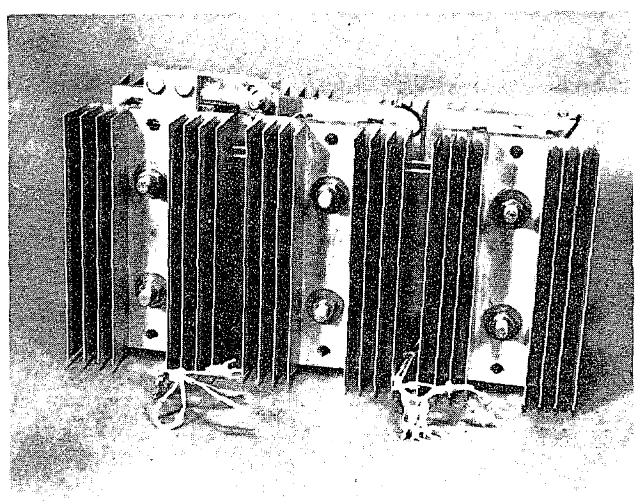
(Photo MG-5236-27)

Figure 33. Stud Mount Heat Sink (Top View)

PRESS PAK SCR'S

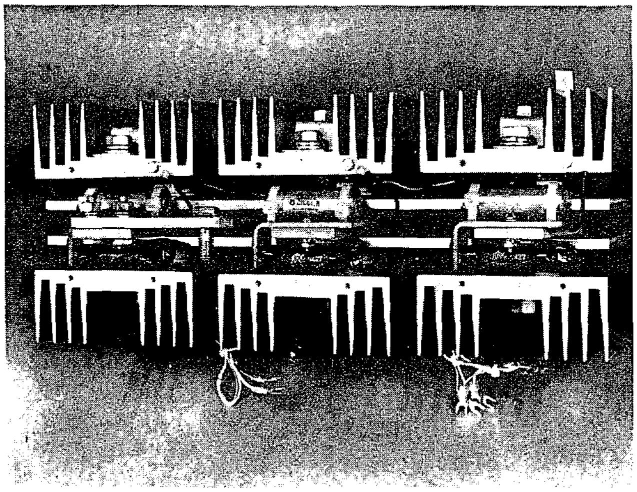
Clean both surfaces of old lubricant and dust. Apply a thin film of General Electric G322L VERSILUBE. Line up the assembly and evenly tighten the nuts finger tight. Tighten the nuts, one at a time, alternating between nuts according to the following specifications.

CELL THICKNESS	TORQUE
1/2", 5/8"	40 inch lbs.
1"	80 inch lbs.



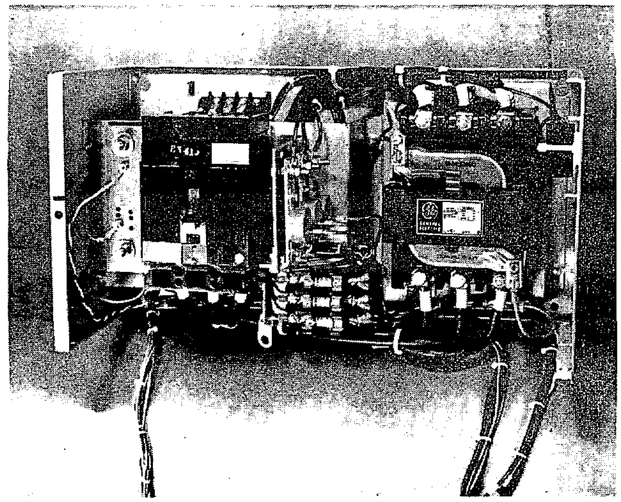
(Photo MG-5236-24)

Figure 34. Press Pak Heat Sink (Front View)



(Photo MG-5236-18)

Figure 35. Press Pak Heat Sink (Top View)

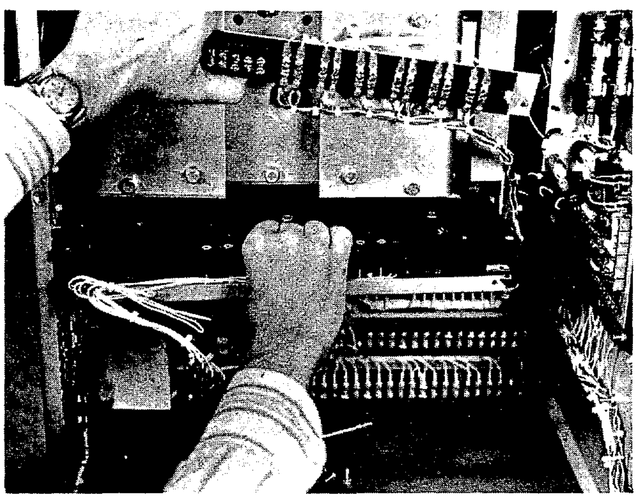


(Photo MG-5236-25)

Figure 37. MOV's

FANS (if supplied)

Remove the fan wires from the terminal board assembly and remove the two screws holding the terminal board assembly to the fan shelf. Loosen the two nuts on the bottom of the fan bracket and slide the fan bracket out.



(Photo MG-5236-23)

Figure 36. Removal of Fans

MOV'S (100 - 125 HP ONLY)

The 100 and 125 horsepower drives have the MOV assembly screwed to the bottom of the fuse bracket with two screws. Remove the screws and the assembly to gain access to the MOV's.

NOTE

THERE SHOULD BE NO NEED TO RETUNE THE DRIVE AFTER REMOVAL/REPAIR OF A CONVERSION MODULE, AN SCR OR ANY OTHER REMOVABLE SUB-ASSEMBLY UNLESS OF COURSE AN ADJUSTMENT WAS INADVERTENLY MOVED OR DISTURBED. IF A PRINTED CIRCUIT CARD IS REPLACED (OTHER THAN THE POWER SUPPLY CARD PSC):

1. ADD STAB-ON JUMPERS TO THE REPLACEMENT CARD JUST LIKE THE JUMPERS ON THE CARD THAT WAS REPLACED OR AS LISTED ON THE SYSTEM ELEMENTARY DIAGRAM "PROGRAMMING" TABLE.
2. ADD STAB-ON RESISTORS AND CAPACITORS TO THE REPLACEMENT CARD JUST LIKE THE COMPONENTS ON THE CARD THAT WAS REPLACED OR AS SHOWN WITH VALUES ON THE SYSTEM ELEMENTARY MAIN CONTROL CARD (MCC) AT STAB-ON TERMINALS. TL, RJ, SFB, NDE, CL1, CLJ AND **LT1** OR ON THE DM1, DM2, ETC. TERMINALS ON ANY OTHER PRINTED CIRCUIT CARD.
3. SET THE POTENTIOMETERS ON THE REPLACEMENT PRINTED CIRCUIT CARD TO THE POSITION AS WAS SET ON THE CARD THAT WAS REPLACED OR TO THE POSITION SHOWN ON THE TEST DATA SHEET. RECHECK THE RECALIBRATION PROCEDURES DESCRIBED.

GLOSSARY OF TERMS

* Test Points Located on Door Front (See MCC Illustration, Fig. 5 and Fig. 12)

GLOSSARY OF TERMS
(Continued)

Page

MA – Line Contactor 19, 26, 30, 31, 32
* MAC – MA Control Signal 13, 19, 26
MAX – Pilot Relay for MA 18, 19, 26
MAX SPEED – Adjustment 12, 19, 25, 27, 29, 31
MCC – Main Control Card 10
MDR – Modification Rack 10, 15
MFC – Motor Field Control Card . . . . . . (1), 10, 12, 14, 25, 26, 27, 29, 32
MFE – Motor Field Exciter Card . . . . . . (2), 10, 12, 14, 27, 30, 32
MIN SPEED – Adjustment 12, 19, 27, 30, 31
MOV – Metal Oxide Varistor 15, 35

* OSC – Oscillator 13, 23

P1 – Motor Thermal Switch Output 21
P2 – Motor Thermal Switch Output 21

* PCR – Phase Control Reference 13, 26, 27
PO – Pulse Outputs 24, 25, 26, 27
* PRE – Preconditioning 13, 19, 26
PSC – Power Supply Card 10

REF SCALE – Adjustment 12, 19, 26, 27, 29, 31
RESPONSE – Speed Loop Response Adjustment 12, 25, 27, 30, 31, 32
RESET – Pushbutton 18, 19, 21, 26, 27, 29, 30, 31
RSTOP – Regenerative Stop Adjustment 12, 19, 27, 30, 31
* RTR – "Ready to Run" Indicator 13, 20, 21
* RUN – Run Switch Input 13, 18, 19, 26, 27

SCR – Power Conversion Module 19, 26, 27, 32, 33, 34
* SA, SB, SC – Synchronizing Signals 13, 19, 23
* SFB – Speed Feedback 13, 23, 24, 25, 26, 29
SLIM – Speed Limit Adjustment . . . . . . (1), 27
* SMAX – Maximum Speed Adjustment and Output 13, 27
SMET – Speed Instrument Output and Adjustment 12, 19, 27, 29, 31
* SMIN – Minimum Speed Reference Adjustment and Input 13, 19, 29
* SR – Speed Reference Input 13, 19, 20, 26
* SYS – System Fault Trip 13, 21

* TA – Tachometer Align Output 13, 29
* TFB – Tachometer Feedback Signal 13, 24
TKN – Negative Tachometer Input 19
TKP – Positive Tachometer Input 19
* TR – Timed Reference 13, 19, 25, 26
TRIP – Fault Trip Amplifier Output 14

* Test Points Located on Door Front (See MCC Illustrations, Fig. 5 and Fig. 12)

(1) Also see Motor Field Control Instructions, GEK-24971
(2) Also see Motor Field Exciter Instructions, GEK-24972

Tabulation of recommended lugs and crimping tools is furnished for drive power stud wiring being made at the drive installation site.

CRIMPING TOOLS FOR POWER STUD WIRING TERMINALS

ITEM	CRIMPING TOOL AMP CAT. NO.	CRIMPING TOOL TYPE		FOR WIRE SIZE	TERMINAL TYPE
1	49592	Hand		14-12 AWG	Solistrand
2	49935	Hand		12-10 AWG	Solistrand
3	69062	Hand-hydraulic with self-contained dies		8-2 AWG	Solistrand
	ELECTRO-HYDRAULIC POWER UNIT 115VAC AMP CAT. NO.	HEAD CAT. NO.	DIE CAT. NO.		
4	69120-1	69065	46322-2	1-1/0 AWG	Solistrand
5	69120-1	69065	46323-2	2/0 AWG	Solistrand
6	69120-1	69065	46324-2	3/0 AWG	Solistrand
7	69120-1	69065	46325-2	4/0 AWG	Solistrand
8	69120-1	69060	46326-2	250 MCM	Ampower
9	69120-1	69060	46327-2	300 MCM	Ampower

RECOMMENDED POWER STUD WIRING AND TERMINALS

Drive HP	Stud. Dia. AC (c)	Stud. Dia. DC	Power Wire (a) Qty. (b)	Power Wire (a) AWG	Power Wire (a) MCM	TERMINAL (AMP SOLISTRAND OR AMPOWER) GE Cat. No. 104X161AA	AMP Inc. Cat. No.	Hole Dia.	Crimping Tool See previous page
1-3	#10		1	14		005	34123	#10	Item 1
		.25	1	12		009	33458	.25	Item 2
5	#10		1	14		005	34123	#10	Item 1
		.25	1	12		009	33458	.25	Item 2
7.5	#10		1	14		005	34123	#10	Item 1
		.25	1	10		009	33458	.25	Item 2
10	.25		1	10		009	33458	.25	Item 2
		.25	1	8		012	33461	.25	Item 3
15	.25		1	8		012	33461	.25	Item 3
		.25	1	4		017	33469	.25	Item 3
20	.25		1	6		015	33465	.25	Item 3
		.25	1	3		057	320383	.25	Item 3
25	.25		1	6		015	33465	.25	Item 3
		.25	1	1		021	36917	.38	Item 4
30	.25		1	4		017	33469	.25	Item 3
		.25	1	1/0		021	36917	.38	Item 4
40	.25		1	2		057	320383	.25	Item 3
		.25	1	3/0		025	36927	.38	Item 6
50	.25		1	1		021	36917	.38	Item 4
		.25	2	1/0		021	36917	.38	Item 4
60	.25		1	2/0		023	36923	.38	Item 5
		.25	2	1/0		021	36917	.38	Item 4
75	.25		1	3/0		025	36927	.38	Item 6
		.25	2	2/0		023	36923	.38	Item 5
100	.38		2	2/0		023	36923	.38	Item 5
		.38	2		250	—	325705	.50	Item 8
125	.38		2	2/0		023	36923	.38	Item 5
		.38	2		300	—	325805	.50	Item 9

NOTES:

(a) Wire size from NEC Table 310—16. Copper wire rated 90° C in 40° C ambient and 1.25 times drive rated amps. These are minimum wire sizes; consult and conform to local and national codes as required for long runs, aluminum cable, etc.

(b) Quantity of wires and terminals in parallel per stud.

(c) AC stud is not used for wiring on drives which have circuit breaker.

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS OPERATION
ERIE, PENNSYLVANIA 16531

GENERAL ELECTRIC